Thursday, July 20th, 2023

24th ANNUAL LIVESTOCK & FORAGE FIELD DAY PRESENTED BY:

NORTH FLORIDA
LIVESTOCK AGENTS GROUP

Hosted by:

Santa Fe River Ranch

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Institute of Food and Agricultural Sciences
Northeast Extension District
Northeast Florida Livestcok Agents Working Group

Dear Producer:

Welcome to our Annual Livestock & Forages Field Day, hosted by UF/IFAS Extension Agents representing 13 north Florida Counties! We hope you will enjoy the educational activities planned for you today and that you take away new knowledge, new ideas, and new plans to improve your livestock and forage production. Our goal is to help you be more informed and better able to remain sustainable and profitable in all your agricultural endeavors.

I want to take a moment and ask you to help us thank all our industry supporters. Please visit their displays and when the time comes for a new purchase, perhaps one of them may be able to help. I want to also thank you again for supporting our efforts, not just today but throughout the year. Whether you attend this event or any of our local programs, we appreciate your support and look forward to hearing from you about how we can better meet your educational needs.

Two of our biggest supporters that also need to be thanked are:

> **Alan Hitchcock & his family** for providing us with this beautiful ranch as a venue each year – Thank you Alan and crew.
>
> **Farm Credit of Florida** for always being there for this event to provide us a great meal.

Thank you all for your generosity and support.

Again, on behalf of all of us in the North Florida Livestock Agents Group (NFLAG), we appreciate you coming, please let us know if we can help in any way. There are plenty of us!

Sincerely,

Cassidy Dossin

Cassidy Dossin
NFLAG - Chair

UF/IFAS Extension

LIVESTOCK & FORAGE FIELD DAY

Thursday, July 20th, 2023

Agenda

8:00 **Vendor Setup**

8:30 **Registration and Trade Show Opens**

9:00 **Welcome & Introductions**

9:10 **Concurrent Sessions** (You may attend as many as time permits but please do not move from station to station during presentations.)

Session 1 9:10- 9:40
Session 2 9:40-10:10

11:00 **Equipment & Sponsorship Break**- 10:10-11:00 AM

Session 3 11:00-11:30
Session 4 11:30-12:00

12:00 **Lunch** (Provided by Farm Credit of Florida)

1:30 **Lunch Panel Discussion, Livestock Tagging Requirements in Florida**

2:00 **Adjourn** (Exhibit stations and sponsorship booths will be available until 2:30 PM for questions and discussion.)

Presented by North Florida Livestock Agents Group and Hosted by Santa Fe River Ranch.

Discussion Panelists:

Cracker Johnson

Robert Capote

Ken Griner

Concurrent Session Topics

- Livestock Fencing Demonstration
- Pregnancy Testing Methods for Beef Cattle
- Livestock Nutrition
- Pasture Weed ID and Herbicide Application

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2023 Livestock and Forage Field Day

1. Registration
2. Pasture Weed Identification and Management
3. Pregnancy Testing for Cattle
4. Livestock Nutrition
5. Livestock Fencing
6. Covered Barn (Sponsors and Vendors)
7. Equipment Dealer Displays
8. Inside Main Hall (Lunch and Keynote Speaker)

Field Day Rotation Fact Sheets

NORTH FLORIDA
LIVESTOCK AGENTS GROUP

Identification & Management of Spiderwort & Tropical Spiderwort

Kevin Korus, UF/IFAS Extension, Alachua County

Spiderwort (*Tradescantia ohiensis*)

Identification

Spiderwort is a native perennial that forms clumps throughout the pasture (figure 1).

Figure 1. Spiderwort forming clumps in a pasture.
Photo Credit: Doug Mayo. UF/IFAS Extension

Leaves & Stems: The stem is large and fleshy; leaves are narrow and grass-like. The leaves can be up to 1.5 feet long and arch downward from the stems (figure 2).

Flowers: Purple to pink flowers with three petals appear in dense clusters (figure 2).

Roots: The roots are fibrous and not spreading but can create offshoots (figure 2).

Biology

Spiderwort emerges in the spring an continues to flower and create a prolific number of seeds during the summer. It is a fleshy, clump-forming perennial. Although this plant can reproduce vegetatively through root offshoots, it spreads mostly by seed.

Figure 2. Leaves, stems and roots of spiderwort.
Photo Credit: Michael Durham, and Pratap Deckota, UF/IFAS Extension

Control

Hand removal of the entire plant (roots included) is the best form of control; therefore, pastures need to be scouted often to detect his weed before it reaches a population that makes hand removal impractical. Tillage may serve to spread the plant, rather than decrease its numbers. Herbicides (i.e. glyphosate, 2, 4-D, triclopyr) provide temporary control and need to be applied repeatedly until the weed is exhausted (See UF/IFAS EDIS Publication SS-AGR-404).

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Tropical Spiderwort aka Benghal Dayflower (*Commelina benghalensis*)

Identification

Tropical spiderwort is commonly misidentified as spreading dayflower (*Commelina diffusa*) and Asiatic dayflower (*C. communis*). Although control methods do not differ greatly between the species, there are morphological characteristics that separate tropical spiderwort from the other dayflowers:

Leaves & Stems: Stems are fleshy, succulent, covered in fine hairs and have a light green color. Young leaves are egg-shaped but become more pointed or lanceolate when they mature. Leaf margins are entire (smooth). Small white or red hairs may be present on the leaf sheath (figure 3). Tropical spiderwort leaves are wider and shorter than other dayflower species and may contain hairs on the young leaves and petioles. Other dayflower species have leaves that are waxy, thick and glabrous (no hairs).

Figure 3. Left: Leaf sheath with red hairs. Right: Mature leaves. Photo Credit: Annette Chandler, UF/IFAS

Flowers: Tropical spiderwort flowers have three petals, they are purple/lavender, while other dayflowers have blue flower petals (figure 4).

Roots: Roots are fibrous but contain shallow rhizomes. The most unique feature of tropical spiderwort is its ability to produce underground flowers. These flowers, which produce viable seed, appear as swollen nodes. No other dayflower species produce underground flowers (figure 5).

Figure 4. Tropical spiderwort flower. Photo Credit: Herb Pilcher, USDA Agricultural Research Service, Bugwood.org

Figure 5. Tropical spiderwort roots and subterranean flowers. Photo Credit: Dr. Ted Webster, University of Georgia

Figure 6. Tropical spiderwort forming a dense mat in a pasture. Photo Credit: Pratap Deckota, UF/IFAS

Biology

Tropical spiderwort typically germinates in June/July in Florida. It is a prostrate, spreading perennial with fleshy stems that root readily at the nodes. Some stems may be erect to about 12 inches. This plant can form a dense mat if not managed (figure 6).

Control

Mowing is not an effective means of control as broken stems can regenerate into new plants. Tillage may also serve to spread the plant because of the presence of the underground seeds. Herbicides (i.e. glyphosate, 2, 4-D, triclopyr) provide temporary control and need to be applied repeatedly until the weed is exhausted (See UF/IFAS EDIS Publication ENH1085).

BEEF CATTLE

NUTRITION 101

UF/IFAS Extension Factsheet

Livestock and Forage Field Day, July 20, 2023

Profitability of your cattle herd lies in meeting the nutritional requirements of your animals. Nutrition is key for reproduction, health, and growth. It is important to understand requirements change based on production cycle, age, sex, breed, activity level, pest load, and environment.

BASIC NUTRIENT REQUIREMENTS

WATER: *a vital nutrient*

Water is a key required component for cattle nutrition, it helps cattle during temperature regulation, reproduction, lactation, and many metabolic functions. Reduction in access to water will reduce feed intake and overall cattle performance. It is important to provide clean water to cattle, especially young growing cattle, dirty water can introduce diseases and decrease performance.

FORAGE: *the foundation of the diet*

Forage is the most natural and economical feed source for cattle. Forage can be high in protein and energy, but grazing management is a key component to maintaining nutritional value. As plants mature digestibility declines, grazing strategies such as rotational grazing and managing stocking rates can help to keep pastures in a vegetative state. In winter months when pasture grasses are in their dormant stage producers can incorporate winter annuals to offer an increase in nutritional value for cattle grazing.

ENERGY: *total digestible nutrients*

Energy is often refereed to as digestible energy, when energy is limited intake and performance suffer. Carbohydrates are a main source of energy in beef cattle diets. Providing adequate energy is important for animal health and productivity to achieve profitability. If energy requirements can not be met through forage energy supplements may be optimal such as feedstuffs, range cubes, protein blocks or liquid supplements.

PROTEIN: *crude protein*

Crude Protein implies the crude measurement of the protein in feedstuffs. The cattle's requirements of protein are met by two sources, the feedstuffs they consume and the microorganisms in the rumen. Similar to energy cattle protein requirements vary depending on the stage of production and age.

VITAMINS AND MINERALS: *crucial for performance*

Only trace amounts of vitamins and minerals are needed but are crucial for health and productivity. The macrominerals of primary importance are calcium, phosphorus, potassium, and magnesium. The key vitamins are vitamin A-D-E.

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Nutrition is the key to success.

REQUIREMENTS

Weaned Calves

The first 30-45 days after a calf is weaned is the most stressful period of it's life, the performance during this time period sets the stage for a profitable feedout or a long productive cow in your herd.

Body Weight lbs.	Avg. Daily Gain (ADG) lbs.	Dry Matter Intake (DMI) lbs./day	Crude Protein (CP) %	Energy (TDN) %
300-500	2.0	10-15	10-13%	60%

Pregnant Keeping Heifers

Nutrition is an important management tool for influencing heifers when they are reaching puberty. Heifers needs vary depending on age, stage of puberty, and stage of gestation. When breeding, a heifer should be 55-65% of it's mature target weight.

Month Since Conception	Mature weight (lbs.)	Dry Matter Intake (DMI) lbs./day	Crude Protein (CP) %	Energy (TDN) %
1-9	1000	16-21	7-10 %	50-61%

Mature Cows

Meeting basic requirements of beef cows is a key component to meeting cow herd production and profitability goals for your beef enterprise. Nutritional requirements will vary depending on the cow's age, gestation, lactation, or maintenance stage.

Months Since Calving	Mature weight (lbs.)	Dry Matter Intake (DMI) lbs./day	Crude Protein (CP) %	Energy (TDN) %
1-7	1200	24-26	6-8%	50-55%

Bulls

Meeting requirements of bulls are important to ensure they are ready to go to work for your herd. As a bull matures his nutritional requirements change. Mature bulls use nutrients for maintenance where younger bulls use their nutrients for growth and maintenance.

Mature Weight	Dry Matter Intake (DMI) lbs./day	Crude Protein (CP) %	Energy (TDN) %
1800	~33	5.7%	48%

Erin Jones
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Livestock Agent
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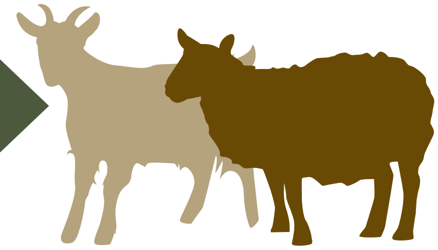
SMALL RUMINANT

NUTRITION 101

UF/IFAS Extension Fact Sheet



FORAGE: *the foundation*

Pasture (grass), forbs (weeds), and browse (woody plants and vines) typically make up the primary and most economical source of nutrients for small ruminants.

Forage can be high in protein and energy, but proper grazing management is needed to maintain nutritional quality. Mature plants rapidly degrade in digestibility, so keeping pasture plants in a vegetative state by implementing grazing strategies, such as rotation, is crucial.

Producers can also increase the nutrition offered by their pastures by incorporating new species. Winter annual forages provide nutrition when Florida pasture grasses are dormant; summer annuals offer a greater plane of nutrition, potentially when lactating ewes and does need it most.

Lush winter annual grass/legume mixture - triticale and vetch

HAY: *quality is key*

When grazing is sparse or unavailable, hay is the primary means of providing forage for small ruminants. The quality of hay is widely variable, the nutrition depending heavily on the maturity of the forage when harvested.

Legume hays such as alfalfa are typically higher in protein and energy, but a hay sample test should be conducted to provide a precise analysis for ration development. Reach out to your local UF/IFAS Extension office for resources for hay sampling and testing.

Target moisture for hay is between 13-15%.

Parts of the DIET

CONCENTRATES: *energy and protein*

Oftentimes, it is necessary for producers to rely on concentrates to supplement forage-based diets. Supplementation is especially important when nutritional requirements are the highest, which is typically the case for growing lambs and kids and lactating ewes and does.

protein supplements for small ruminants are typically >15% protein and include soybean, cottonseed, and fish meals. Ruminant digestive tracts contain microorganisms that create protein to be used by the animal, so the protein quantity provided is more important than the quality. Small ruminants cannot be fed ruminant-derived meat and bone meals.

fish meal

energy is directly related to the total digestible nutrients (TDN) available in a feedstuff. Energy feeds are typically higher in calories but lower in CP. Cereal grains such as corn, barley, oats, wheat, and rye are high energy supplements and can be fed whole and unprocessed to small ruminants.

barley

VITAMINS & MINERALS: *small but crucial*

Only trace amounts of most vitamins and minerals need to be added to small ruminant diets, but they are crucial to animal health and productivity.

The most important minerals are salt, calcium, and phosphorus. Small ruminants need trace amounts of vitamins A, D, and E, while the other vitamins are produced by microorganisms in the rumen. High levels of copper are toxic to sheep, while goats require a higher level of copper.

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Nutrition dictates animal performance.

REQUIREMENTS

LAMBS

Most lambs are weaned at 60-80 days of age, however a creep ration with 16-18% CP should be offered to lambs before weaning to supplement their nutrition and increase weight gain.

Body Weight lbs.	Avg. Daily Gain (ADG) lbs.	Dry Matter Intake (DMI) %BW	Crude Protein (CP) lbs.	Energy (TDN) lbs.
20-50	0.4-0.6	5%	0.3-0.4	1-2

EWES

Individual ewes can vary widely in their nutritional requirements depending on their breed, size, age, and many other characteristics. Maintenance requirements will be similar to early gestation. Producers should increase nutrition in the last weeks of gestation.

Maintenance Requirements

Body Weight lbs.	Dry Matter Intake (DMI) %BW	Crude Protein (CP) lbs.	Energy (TDN) lbs.
100-200	1.5-2%	0.2-0.3	1-2

It has been shown that flushing ewes, or increasing the plane of nutrition ahead of and into the breeding season, can increase pregnancy rates. Flushing is often started 2 weeks prebreeding and can go 3 weeks into the breeding season.

Flushing Diet

Body Weight lbs.	Dry Matter Intake (DMI) %BW	Crude Protein (CP) lbs.	Energy (TDN) lbs.
100-200	2-3%	0.3-0.4	2-2.5

The ewe's highest nutritional requirements will be during lactaction while she is nursing lambs. Keep in mind that these requirements can vary greatly depending on the ewe as well as if she is nursing a single or twins. It is recommended to decrease this plane of nutrition before weaning to decrease milk production.

Lactation Requirements

Body Weight lbs.	Dry Matter Intake (DMI) %BW	Crude Protein (CP) lbs.	Energy (TDN) lbs.
100-200	3-4%	0.6-1.0	3-4.5

The data provided are estimations of daily requirements from the National Research Council, 2007

KIDS

Typically it is not economical to creep feed kids, depending on the producer's goals. Once kids are weaned, they should be fed a high quality feed of 14% CP and 70% TDN.

DOES

There is a wide range of goat breeds and a large variety of uses for goats, from meat, milk, and fiber, to weed control and companion animals. Therefore, there is a huge amount of variation in goat nutritional requirements and rations. For any livestock diet, it may take trial and error to develop the proper ration for your herd. Producers should use nutritional status checks, such as body condition scoring, as part of their management system to adjust nutrition strategies.

Dry does in maintenance can perform well with a diet of 8% CP and 58% TDN (which can potentially be provided solely by forage). This target should increase to 12% CP and 66% TDN for does in late gestation.

Maintenance Requirements

Body Weight lbs.	Dry Matter Intake (DMI) %BW	Crude Protein (CP) lbs.	Energy (TDN) lbs.
20-200	1.6-2.8%	0.05-0.3	0.3-2

Lactation will increase nutritional requirements, and this is especially true for goats raised for milk production. During lactation, producers should strive to provide does with a diet of 9-12% CP and 60-65% TDN, depending on milk production.

RAMS & BUCKS

Rams and bucks typically have the lowest nutritional requirements on a small ruminant operation. However, they should be kept in good nutritional status year round. A ration consisting of 8% CP and 60% TDN is often sufficient. Approximately 30-45 days ahead of the breeding season, increase feed for rams and bucks to ensure they are in good physical condition and have additional energy required for breeding.

Cassidy Dossin, UF/IFAS Extension Clay County

Livestock Fence Construction

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Tyler Pittman, Ph.d., Agriculture & Natural Resources Agent, UF/IFAS Extension Gilchrist County
Emily Beach, Agriculture & Natural Resources Agent, UF/IFAS Extension Lafayette County

Fencing is essential to any livestock operation but adequate fencing to meet animal containment needs and make producers eligible for cost share programs through state and federal agencies requires additional attention to details and specification during the construction process.

Brace Construction

Brace Materials - Braces, more commonly known as H-braces, can either be constructed from wood or steel post. Wood brace posts should be a minimum of 5.5 inches top diameter with a minimum of 8 ft. length, while steel posts should be a minimum of 4 inches in diameter with a water-tight cap. Horizontal brace members should be a minimum of 3 inches in diameter for wood and 2 inches for steel with a minimum length of 6.5 feet.

All brace posts should be rot resistant. For wood post this means they should be pressure treated or made from a rot resistant wood like cedar, black locust or Osage orange while steel post should be class 3 galvanized or coated with a rust-resistant metal pain.

Brace Construction – Brace posts should be set a minimum of 42 inches in the ground leaving at least 2 inches of the topmost line on he fence. Horizonal braces should be anchored through the brace post with 3/8 inch spikes and located at least 36 inches about the ground and less than 6 inches from the top of the brace posts. If fences are taller than 48 inches the horizontal brace should be located in the top third of the of the brace post. For wood post notching is notching of brace posts for the horizontal brace is not required, especially when using the 3/8th inch spike. If constructing steel braces post must be placed in concrete.

Brace Locations and Tension – The tables below highlight the requirements for when and…

Cont - …where to place H-braces and sizes and types of materials to use to meet necessary requirements for cost-sharing agencies.

Fence Brace Spacings

Fence Type	Distance of Fence Run	Type of H Brace
Barbwire	0 to 1320 Feet Fence	Single
Barbwire	Greater than 1320 Feet	Double
Woven Wire or Smoothwire	0 to 660 Feet	Single
Woven Wire or Smoothwire	Greater than 660 Feet	Double

*Double H braces are required at turns greater than 15 degrees.

Brace Material Requirements

Brace Posts	5.5 in Diameter x 8 ft Length	4 in Diameter x 8 ft Length
Depth in Ground	42 in	42 in
Horizontal brace	3 in Diameter x 6.5 ft Length	3 in Diameter x 6.5 ft Length

Tension Wire Requirements

Wire Type	Number of loops	Minimum Gauge
Smoothwire	Two Loops	9-gauge
Double Standed Barb/Smoothwire	Two Loops	12.5 Gauge
Double Standed high tensile barb/smoothwire	Two Loops	15.5 Gauge

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Fencing Specifications

Based NRCS and other cost-share program requirements

Recommended Fence Wire Spacing for Cattle and Horses

Fence Type	Strands	Placement	Spacing (in)
Barbed (Class 3 galvanized 12.5 or 15.5 gauge high tensile steel)	5	Interior Fence	6, 16, 26, 36, 46
	4	Interior Fence	16, 26, 32, 44
	3	Interior Fence	16, 26, 38
	5	Boundary Fence	10, 20, 30, 40, 50
	4	Boundary Fence	12, 24, 36, 48
Electric (Class 3 galvanized 12.5 gauge, 200,000 PSI tensile strength)	5	Interior Fence	6, 16, 26, 24, 46
	4	Interior Fence	16, 26, 32, 44
	3	Interior Fence	12, 22, 38
	2	Interior Fence	24, 38
	1	Interior Fence	28 to 32
	5	Boundary Fence	6, 16, 26, 24, 46
	4	Boundary Fence	12, 24, 36, 46
Smooth Wire (Class 3 galvanized 12.5 or 15.5 gauge high tensile steel, 200,000 PSI)	5	Interior Fence	6, 16, 26, 24, 46
	4	Interior Fence	16, 26, 24, 46
	3	Interior Fence	12, 22, 38
	5	Boundary Fence	6, 16, 26, 24, 46
	4	Boundary Fence	12, 24, 36, 46
Woven	2 above	Both	32, 36, 46
	1 above	Both	39, 46

Recommended Fence Wire Spacing for Sheep and Goats

Fence Type	Strands	Placement	Spacing (in)
Barbed	5	Interior Fence	4, 14, 24, 34, 44
	5	Boundary Fence	4, 14, 24, 34, 46
Electric	5	Interior Fence	5, 10, 17, 27, 38
	4	Interior Fence	8, 16, 24, 36
	5	Boundary Fence	4, 14, 24, 34, 46
Smooth Wire	5	Interior Fence	5, 10, 17, 27, 38
	4	Interior Fence	10, 16, 24, 32
	5	Boundary Fence	6, 16, 26, 24, 46
Woven	1 above	Both	30, 32

For Boundary Fence, place bottom wire at 2 in height, for Interior fence place bottom wire at 4 in height.

Pregnancy Testing Methods on Beef Cattle

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Lizzie Whitehead, Livestock and Natural Resource Agent Bradford County Extension,
Dr. Angela Gonella, Assistant Professor, Beef Cattle Reproduction

Introduction

In the beef industry, it is a standard for females to be expected to produce one calf every year. By using a pregnancy diagnosis, producers can identify if their females if they are pregnant or open within 30 days of breeding, instead of waiting 283 days at the end of their gestation period when they are supposed to calve. According to recent statistics produced by the United States Department of Agriculture, it costs roughly $600-$700 per year to maintain the average beef cow in the United States. One of the most important and overlooked methods of a cattle operation from being more efficient is pregnancy testing their cattle. There are a few different methods available: rectal palpation, ultrasound, and blood test.

Rectal Palpation

This method is the oldest, simplest, and most commonly one used in cattle, but it requires a technician or a veterinarian with the proper training to ensure accuracy on this method. The technician will use their skills to find the uterus and horns of the cow through the rectum (Image 1).

1. Diagnosis can be made 35-40 days following breeding.
2. Accuracy depends on your palpator’s skills (usually 95%).
3. Have result in real-time.

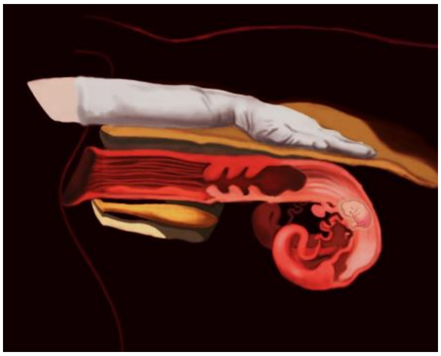

Image 1: Rectal palpation, one hand is used to palpate the uterus and the horns through the rectum (NFREC Repro Lab, 2022).

Ultrasound

The ultrasound method has become more widely used in the cattle industry and is a recommended technique for pregnancy diagnosis. This exam can be performed by the technician by introducing the ultrasound probe with their hand in the rectum of the cow and will monitor the ultrasound to find the uterus and horns, to try and find signs of pregnancy.

1. Diagnosis can be made 28 days following breeding.
2. Accuracy depends on your technician’s skills and has the highest degree of accuracy.
3. Have result in real-time (Image 2).
4. Provide more information of age of pregnancy, size of fetus, sex, twins, status of ovaries, and more.

Image 2: Image taken by Dr. Mario Binelli, UF Animal Science Professor.

Blood Test

There are particular proteins that are present in a cow’s blood when it becomes pregnant. Science has allowed for blood tests to be developed to use to identify these proteins in the blood. There are several types of commercial test that producers can purchase or send off to a lab to be tested. The small sample will need (2cc-5cc) of blood from the cow’s tail in their coccygeal vein. The sample can either be sent to a lab or can be processed chute-side.

1. Diagnosis can be made 26 days following breeding.
2. Accuracy is very high.
3. Have results within 20 minutes or if you send it to a lab within a couple of days.

Supplemental Materials

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Basic Nutrient Requirements of Beef Cows[1]

Matt Hersom[2]

Introduction

Meeting the basic nutrient requirements of beef cows is a key component of meeting cow herd production and profitability goals for the beef cattle enterprise. Adequate nutrition is vital for adequate cow reproduction, cow and calf health, and growth of all classes of cattle. Nutrient requirements of cattle change throughout the year based upon stage of the production cycle, age, sex, breed, level of activity, pest load, and environment. All of the previous factors mentioned have an additive effect on the nutrient requirements of cattle. In all cases, specific adjustments to the standard nutrient requirements may be warranted. Therefore, it is imperative that cattle producers have an adequate understanding of the basic nutrient requirements of the cow herd to make informed and effective nutrition-related decisions.

In most production situations, the basis for cow herd nutrient supply is grazed or harvested forage. With the utilization of forage comes the need for seasonal supplementation strategies to compensate for forage quality deficiencies. Without knowledge of the cow's basic nutrient requirements, effective and cost effective supplementation practices will be difficult to implement.

This publication will discuss the basic nutrients that are required for production and provide tables indicating diet concentration and daily intake requirements of key nutrients for beef cattle. The information contained in this publication is based upon the recommendations published in the Nutrient Requirements of Beef Cattle (2000).

Dry Matter Intake

Beef cattle have no requirement for feed intake; however, consumption of adequate levels of feedstuffs is imperative to deliver the required nutrients for adequate production. Dry matter intake (DMI) is affected by a number of factors including cow body weight, stage of production, forage quality, supplementation level and type, and environmental factors. Cattle of larger frame size and body weight have greater potential to consume forage and feed compared to smaller frame or lighter body weight cattle. Likewise, lactating cows have greater DMI potential compared to gestating cows. Additionally, thin cows are more likely to consume greater amounts of feedstuffs compared to well-conditioned cows. Forage intake is generally limited by forage quality. The greater the forage quality (energy and protein concentrations, digestibility) of the base forage, the greater the potential for increased DMI by cattle. The estimates of DMI listed in the tables were determined by prediction equations. These prediction equations assume diets that are adequate in all required nutrients. Likewise, examination of the tables will show that differences in DMI occur across mature body weight, cow milking ability, and stage of production cycle. Table 1 provides some general guidelines for prediction of forage DMI based upon forage quality and cow production stage.

Water

Water is an important, yet overlooked, nutrient required by cattle. Water is an important component in many body functions including temperature regulation, growth,

1. This document is AN190, one of a series of the Animal Sciences Department, UF/IFAS Extension. Original publication date October 2007. Reviewed March 2020. Visit the EDIS Website at https://edis.ifas.ufl.edu.

2. Matt Hersom, associate professor, Department of Animal Sciences; UF/IFAS Extension, Gainesville, FL 32611.

reproduction, lactation, and many metabolic functions. Water comes from two sources, feedstuffs and ad libitum consumption. The water requirement is influenced by several factors including pregnancy, lactation, activity, type of diet, level of intake, and environmental temperature. Restriction of water intake below requirement will reduce feed intake, which will lower cattle production. Cattle lose water from the body through a number of routes. Sources of water loss include urine, feces, sweat, and water vapor from the skin and lungs. Urine production depends upon activity level, air temperature, water consumption and other factors. The amount of water loss in the feces depends upon the diet. Clean water is especially important for young growing cattle, while dirty water can decrease cattle performance and be a potential source of disease. Basic total water intake requirements are indicated in Table 2.

Energy

Energy requirements are expressed in the tables in terms of total digestible nutrients (TDN) and net energy for maintenance (NEm). Total digestible nutrients are the sum of digestible starch, fiber, protein, and fat in the feedstuffs. Energy requirements, expressed as TDN, are shown in the tables as a percent of the diet dry matter or as pounds per day. The Net Energy system assigns energy values of feeds according to how the energy within a feedstuff can be assigned to either maintenance or growth/lactation/pregnancy. Likewise the amount of energy needed for maintenance or growth can be determined independent of the dietary composition. The NEm requirement is expressed as mega calories per pound or mega calories per day.

Cow energy requirements change throughout the year. The requirement for energy by the mature cow is a dynamic situation because the production cycle is not static. At no point in a yearly production cycle does a cow experience only maintenance energy requirements. We may say that "a cow is just maintaining herself," but if she is a productive member of the herd, more than maintenance is occurring on a daily basis. Maintenance is defined as the amount of feed energy intake that will result in no net loss or gain of energy from the tissues of the cow's body. In reality a cow must always be adding or subtracting energy from her body tissues. The additive functions to maintenance include; growth, gestation, and lactation. All ongoing energetic functions result in the total energy requirement of the cow.

Maintenance

Interestingly, not all maintenance is considered equal. There exist two distinct phases of NEm requirements; that during the lactation period and that during the dry period. About a 20% difference exists between these two periods. This increase in maintenance energy requirement associated with lactation is due to the increased metabolic demand upon body tissues, not the product (milk) result of lactation. Additionally, the initial energy requirement does not account for any energy expenditure for activity associated with grazing. The difference in maintenance energy requirements for grazing cattle could be from 10 to 50% depending upon the grazing conditions and forage availability.

Lactation

The energy requirement for lactation is a function of milk yield, milk fat %, and milk protein %. The previously mentioned variables change during the lactation cycle, and thus the energy requirement of lactation changes accordingly. Identified differences between and within breeds that affect milk yield and milk composition also affect the lactation energy requirement. Unlike other energy requirements, lactation has a rapid onset of demand for energy that is initiated by parturition. The development of mammary tissue occurs pre-partum, but the majority of the lactation energy requirement is associated with milk production.

Gestation

The energy requirement associated with pregnancy is an underlying energetic demand for 10 out of 12 months during the yearly production cycle. Whereas the energy required for gestation is initially very small, just 0.1% of the energy requirement during the third month postpartum. In contrast, the gestation energy requirement one month prior to parturition is approximately 56% of the total energy requirement. The post-weaning period is often referred to as a "maintenance period" for the grazing beef cow. Indeed, gestational requirements at weaning do not equate to the greater energetic demand of lactation; however, this is an important energetic supply and demand period. This period is utilized for growth of the products of conception.

Growth

Growth in the case of the mature cow herd can be construed as the recovery of body tissue energy (i.e. bodyweight and body condition) not associated with the products of conception. During a small time period after the cessation of lactation and prior to the accelerated fetal growth, additional energy supplied to the cow can be utilized for growth of body tissues. This growth is utilized to regain lost bodyweight and body condition score due to the mobilization of body tissues during lactation. These accreted body tissues will most likely be re-utilized at some point during the production cycle to support maintenance or lactation.

Protein

Protein requirements are expressed in the tables in terms of crude protein (CP). The protein requirement of cattle is shown in the tables as a percent of the diet dry matter or as pounds per day. Similar to energy, a cow's protein requirements change throughout the year. The requirement for protein is dependent upon the age of the cow, stage of production, and level of production. Protein requirements, like energy, are additive during any point in the cow's production cycle.

The CP system, as the name implies, is a crude measurement of the protein in any feedstuffs. The amount of CP in a feedstuff is a calculation determined by the following equation: CP = nitrogen concentration x 6.25. The CP system is the basic description of protein for cattle. However, protein requirements have been further characterized to indicate the amount of protein that is actually available for the cow to metabolize. Cattle protein requirements are met by two basic sources, the feedstuffs that they consume and the microorganism that populate the rumen. The protein component of feedstuffs can be divided into two fractions identified as degradable intake protein (DIP) and undegradable intake protein (UIP). The DIP fraction is comprised of the protein fraction of the diet that is digested in the rumen, utilized by rumen microorganisms, and ultimately results in bacterial (microbial) protein; or that passes through the rumen wall as ammonia and is ultimately metabolized in the liver. In the liver, excess nitrogen is metabolized to urea, which can be recycled back to the gastrointestinal tract or excreted through the kidney into urine. The UIP fraction is comprised of the protein fraction of the diet that is not digested in the rumen and that thereby "escapes or bypasses" the rumen. The UIP protein may then be digested and absorbed in the small intestine. Together, the bacterial protein and UIP fraction comprise the metabolizable protein available for the cow to meet her protein requirement.

Maintenance

The general rule of thumb is that forages with a CP concentration of 7% or greater are adequate to meet a mature cow's CP requirements. Research has shown that the bacterial protein fraction of the diet can provide anywhere from 50% to all 100% of the cow's metabolizable protein requirement depending upon the UIP content of the diet. This would imply that forage-based diets of sufficient CP concentration can maintain a mature cow during certain phases of the cow's productive cycle.

Lactation

Lactation is the most stressful time in the cow production cycle. Milk contains a large concentration of protein. The source of the protein in milk comes either from dietary sources or mobilization of body lean tissue. Mobilization of lean tissue decreases the overall body condition score of the cow. Research indicates that maintenance of body condition score from calving to rebreeding is imperative to ensure acceptable conception rates. Therefore adequate protein from the diet is an important nutritional consideration.

Gestation

The effect of gestation does not greatly affect the cow's protein requirement during the first seven months of gestation. The majority of the protein requirement is associated with placental development and growth. However, during the last two months of gestation, 2/3 of the fetal growth occurs. This fetal growth results in a large demand on maternal protein supply. Thus protein requirements leading up to parturition are largely associated with fetal growth and other products of conception. During this period, the cow will sacrifice body condition to support fetal growth. Additionally, adequate protein status leading up to parturition is essential for the production of adequate high quality colostrum to support newborn calf health.

Growth

Like energy, protein requirements for mature cattle are associated with the recovery of lean body tissue that was mobilized during the production cycle. Lean tissue mobilization supplies a good deal of protein when it is needed. However, because of differences in the efficiency of protein utilization, a greater amount of dietary crude protein above maintenance requirements is needed to replace the mobilized tissue.

Calcium and Phosphorus

Calcium is the most abundant mineral in the body and is an important component for bones, teeth, membrane permeability, muscle contraction, and many other metabolic functions. The calcium requirements listed in the tables are converted to dietary calcium requirements assuming a true absorption of 50%. Absorption of calcium is largely determined by the balance of requirement and intake. Skeletal reserves serve as a large repository of calcium that can be utilized to maintain blood concentrations.

Phosphorus is generally discussed with calcium because the two minerals function together in bone metabolism. Phosphorus is predominantly associated with bones and teeth, but also functions in cell growth, energy utilization, and membrane formation. Historically, the calcium:phosphorus ratio recommendation was 2:1; however, research has indicated that ratios between 1:1 and 7:1 result in similar performance assuming that the dietary phosphorus requirement was met.

Conclusions

The key concept to remember in feeding the beef cow herd is that cattle need to be fed to meet nutrient requirements. Cows do not have requirements for specific feeds; they have requirements for energy and specific nutrients. Energy and other nutrients will first be utilized to meet the cow's manintenance requirements, and then nutrients and energy will be allocated to productive uses (growth, reproduction, lactation). The data presented in these tables are to be utilized as guidelines and a starting point for nutrition decision making.

Table 1. Intake guidelines for beef cows.

Forage Type	Gestating Cow	Lactation Cow
Low quality (<52% TDN)	% of Body weight	
Un-supplemented	1.8	2.0
Protein supplemented	1.8	2.2
Energy supplemented[1]	1.5	2.0
Medium quality (52-59% TDN)		
Un-supplemented	2.0	2.3
Protein supplemented	2.2	2.5
Energy supplemented[1]	2.0	2.3
High quality (>59% TDN)		
Un-supplemented	2.5	2.7
Protein supplemented	2.5	2.7
Energy supplemented[2]	2.5	2.7

[1]Above 4 lb of supp, each lb of supp decreases forage consumption by 0.6 lb.
[2]Lb for lb substitution of supplement for forage.

Table 2. Approximate total daily water requirement of beef cows and bulls.

	Temperature in fahrenheit[2]					
	50	60	70	80	90	
Pregnant cows[3]			*gallons*			
900 lbs	6.7	7.2	8.3	9.7	11.4	13.7
1,100 lbs	6.0	6.5	7.4	8.7	10.4	12.5
Lactating cows						
All weights	11.4	12.6	14.5	16.9	17.9	16.2
Mature bulls						
1,400 lbs	8.0	8.6	9.9	11.7	13.4	19.0
1,600 lbs	8.7	9.4	110.8	12.6	14.5	20.6

[1]Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.
[2]Water intake of a given class of cattle in a specific management system is a function of DMI and temperature. Water intake is constant up to 40° F.
[3]DMI has a major influence on water intake. Heavier cows are assumed to be in better conditions and thus require less DMI and in turn less water intake.

Table 3. Nutrient requirements of 1,000 lb mature cow.

Mature weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
1,000	(10 lbs peak milk)												
	DMI, lb/d	21.6	22.1	23.0	22.5	22.1	21.0	21.1	21.0	20.9	20.8	21.0	21.4
	TDN, %	55.8	56.6	54.3	53.4	52.5	51.8	44.9	45.7	47.0	49.1	52.0	55.7
	NEm, mcal/lb	0.55	0.56	0.52	0.51	0.49	0.48	0.37	0.38	0.40	0.44	0.49	0.54
	CP, %	8.70	9.10	8.41	7.97	7.51	7.14	5.98	6.16	6.47	6.95	7.66	8.67
	Ca, %	0.24	0.25	0.23	0.22	0.20	0.19	0.15	0.15	0.15	0.24	0.24	0.24
	P, %	0.17	0.17	0.16	0.15	.014	0.14	0.11	0.11	0.11	0.15	0.15	0.15
	TDN, lb/d	12.05	12.51	12.49	12.02	11.60	10.88	9.47	9.60	9.82	10.21	10.92	11.92
	NEm, mcal/d	11.88	12.38	11.96	11.48	10.83	10.08	7.81	7.98	8.36	9.15	10.29	11.56
	CP, lb/d	1.88	2.01	1.93	1.79	1.66	1.50	1.26	1.29	1.35	1.45	1.61	1.86
	Ca, lb/d	0.05	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05
	P, lb/d	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03
1,000	(20 lbs peak milk)												
	DMI, lb/d	24.0	25.0	25.4	24.4	23.5	22.7	21.1	21.0	20.9	20.8	21.0	21.4
	TDN, %	59.6	60.9	58.6	57.0	55.4	54.0	44.9	45.7	47.0	49.1	52.0	55.7
	NEm, mcal/lb	0.60	0.62	0.59	0.56	0.54	0.52	0.37	0.38	0.40	0.44	0.49	0.54
	CP, %	10.54	11.18	10.38	9.65	8.86	8.17	5.98	6.16	6.47	6.95	7.66	8.67
	Ca, %	0.30	0.32	0.30	0.27	0.24	0.22	0.15	0.15	0.15	0.24	0.24	0.24
	P, %	0.20	0.21	0.19	0.18	0.17	0.15	0.11	0.11	0.11	0.15	0.15	0.15
	TDN, lb/d	14.30	15.23	14.88	13.91	13.02	12.26	9.47	9.60	9.82	10.21	10.92	11.92
	NEm, mcal/d	14.40	15.50	14.99	13.66	12.69	11.80	7.81	7.98	8.36	9.15	10.29	11.56
	CP, lb/d	2.53	2.80	2.64	2.35	2.08	1.85	1.26	1.29	1.35	1.45	1.61	1.86
	Ca, lb/d	0.07	0.08	0.08	0.07	0.06	0.05	0.03	0.03	0.03	0.05	0.05	0.05
	P, lb/d	0.05	0.05	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.03	0.03	0.03
1,000	(30 lbs peak milk)												
	DMI, lb/d	26.4	27.8	27.8	23.4	24.9	23.7	21.1	21.0	20.9	20.8	21.0	21.4
	TDN, %	62.8	64.5	62.1	60.1	57.9	55.9	44.9	45.7	47.0	49.1	52.0	55.7
	NEm, mcal/lb	0.65	0.68	0.64	0.61	0.58	0.55	0.37	0.38	0.40	0.44	0.49	0.54
	CP, %	12.06	12.86	12.00	11.07	10.04	9.09	5.98	6.16	6.47	6.95	7.66	8.67
	Ca, %	0.35	0.38	0.35	0.32	0.28	0.25	0.15	0.15	0.15	0.24	0.24	0.24
	P, %	0.22	0.24	0.22	0.21	0.19	0.17	0.11	0.11	0.11	0.15	0.15	0.15
	TDN, lb/d	16.58	17.93	17.26	15.87	14.42	13.25	9.47	9.60	9.82	10.21	10.92	11.92

Mature weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
	NEm, mcal/d	17.16	18.90	17.79	16.10	14.44	13.04	7.81	7.98	8.36	9.15	10.29	11.56
	CP, lb/d	3.18	3.58	3.34	2.92	2.50	2.15	1.26	1.29	1.35	1.45	1.61	1.86
	Ca, lb/d	0.09	0.11	0.10	0.08	0.07	0.06	0.03	0.03	0.03	0.05	0.05	0.05
	P, lb/d	0.06	0.07	0.06	0.06	0.05	0.04	0.02	0.02	0.02	0.03	0.03	0.03
Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.													

Table 4. Nutrient requirements of 1,200 lb mature cow.

Mature Weight	Nutrient	Months Since Calving											
		1	2	3	4	5	6	7	8	9	10	11	12
1,200	(10 lbs peak milk)												
	DMI, lb/d	24.4	24.9	26.0	25.6	25.1	24.8	24.2	24.1	24.0	23.9	21.4	24.6
	TDN, %	55.3	56.0	53.7	52.9	52.1	51.5	44.9	45.8	47.1	49.3	52.3	56.2
	NEm, mcal/lb	0.54	0.55	0.51	0.50	0.49	0.48	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	8.43	8.79	8.13	7.73	7.33	7.00	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.24	0.25	0.23	0.21	0.20	0.19	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.17	0.17	0.16	0.15	0.14	0.14	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	13.49	13.94	13.96	13.54	13.08	12.77	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	13.18	13.70	13.29	12.80	12.30	11.90	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	2.06	2.19	2.11	1.98	1.84	1.74	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.06	0.05	0.06
	P, lb/d	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04
1,200	(20 lbs peak milk)												
	DMI, lb/d	26.8	27.8	28.4	27.4	26.5	25.7	24.2	24.1	24.0	23.9	21.4	24.6
	TDN, %	58.7	59.9	57.6	56.2	54.7	53.4	44.9	45.8	47.1	49.3	52.3	56.2
	NEm, mcal/lb	0.59	0.61	0.57	0.55	0.53	0.51	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	10.10	10.69	9.92	9.25	8.54	7.92	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.29	0.31	0.29	0.26	0.24	0.22	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.19	0.21	0.19	0.18	0.17	0.15	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	15.73	16.65	16.36	15.40	14.50	13.72	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	15.81	16.96	16.19	15.07	14.05	13.11	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	2.71	2.97	2.82	2.53	2.26	2.04	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.08	0.09	0.08	0.07	0.06	0.06	0.04	0.04	0.04	0.05	0.06	0.06
	P, lb/d	0.05	0.06	0.05	0.05	0.05	0.04	0.03	0.03	0.03	0.04	0.03	0.04
1,200	(30 lbs peak milk)												
	DMI, lb/d	29.2	30.6	30.8	28.4	27.9	23.7	24.2	21.1	24.0	23.9	21.4	24.6
	TDN, %	61.6	63.2	60.8	59.0	57.0	55.2	44.9	45.8	47.1	49.3	52.3	56.2

Mature Weight	Nutrient	Months Since Calving											
		1	2	3	4	5	6	7	8	9	10	11	12
	NEm, mcal/lb	0.64	0.66	0.62	0.59	0.56	0.54	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	11.51	12.25	11.41	10.55	9.61	8.45	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.34	0.36	.34	0.31	0.27	0.25	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.22	0.23	0.22	0.20	0.18	0.17	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	17.99	19.34	18.73	17.35	15.90	14.74	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	18.69	20.20	19.10	17.35	15.62	14.42	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	3.36	3.76	3.51	3.10	2.68	2.34	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.10	0.11	0.10	0.09	0.08	0.07	0.04	0.04	0.04	0.06	0.05	0.06
	P, lb/d	0.06	0.07	0.07	0.06	0.05	0.05	0.03	0.03	0.03	0.04	0.03	0.04

Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.

Table 5. Nutrient requirements of 1,400 lb mature cow.

Mature weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
1,400	(10 lbs peak milk)												
	DMI, lb/d	27.1	27.6	28.9	28.5	28.0	27.7	27.2	27.0	26.9	26.8	27.0	27.6
	TDN, %	54.9	55.5	53.3	52.5	51.8	51.2	45.0	45.8	47.3	49.5	52.6	56.6
	NEm, mcal/lb	0.53	0.54	0.51	0.49	0.48	0.47	0.37	0.39	0.41	0.44	0.49	0.56
	CP, %	8.23	8.56	7.91	7.55	7.19	6.90	6.00	6.20	6.53	7.04	7.80	8.88
	Ca, %	0.23	0.25	0.23	0.21	0.20	0.19	0.16	0.16	0.16	0.27	0.26	0.26
	P, %	0.17	0.17	0.16	0.15	0.15	0.14	0.12	0.12	0.12	0.17	0.17	0.16
	TDN, lb/d	14.88	15.32	15.40	14.96	14.50	14.18	12.24	12.37	12.72	13.27	14.20	15.62
	NEm, mcal/d	14.36	14.90	14.74	13.97	13.44	13.02	10.06	10.53	11.03	11.79	13.23	15.46
	CP, lb/d	2.23	2.36	2.29	2.15	2.01	1.91	1.63	1.67	1.76	1.89	2.11	2.45
	Ca, lb/d	0.06	0.07	0.07	0.06	0.06	0.05	0.04	0.04	0.04	0.07	0.07	0.07
	P, lb/d	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.04
1,400	(20 lbs peak milk)												
	DMI, lb/d	29.5	30.5	31.3	30.3	29.4	28.6	27.2	27.0	26.9	26.8	27.0	27.6
	TDN, %	58.0	59.1	56.8	55.5	54.1	53.0	45.0	45.8	47.3	49.5	52.6	56.6
	NEm, mcal/lb	0.58	0.60	0.56	0.54	0.52	0.50	0.37	0.39	0.41	0.44	0.49	0.56
	CP, %	9.76	10.31	9.56	8.94	8.29	7.73	6.00	6.20	6.53	7.04	7.80	8.88
	Ca, %	0.28	0.30	0.28	0.26	0.24	0.22	0.16	0.16	0.16	0.27	0.26	0.26
	P, %	0.19	0.20	0.19	0.18	0.17	0.16	0.12	0.12	0.12	0.17	0.17	0.16
	TDN, lb/d	17.11	18.03	17.78	16.82	15.91	15.16	12.24	12.37	12.72	13.27	14.20	15.62
	NEm, mcal/d	17.11	18.30	17.53	16.36	15.29	14.30	10.06	10.53	11.03	11.79	13.23	15.46

Mature weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
	CP, lb/d	2.88	3.14	2.99	2.71	2.44	2.21	1.63	1.67	1.76	1.89	2.11	2.45
	Ca, lb/d	0.08	0.09	0.09	0.08	0.07	0.06	0.04	0.04	0.04	0.07	0.07	0.07
	P, lb/d	0.06	0.06	0.06	0.05	0.05	0.05	0.03	0.03	0.03	0.05	0.05	0.04
1,400	(30 lbs peak milk)												
	DMI, lb/d	31.9	33.3	33.7	32.3	30.8	29.6	27.2	27.0	26.9	26.8	27.0	27.6
	TDN, %	60.7	62.2	59.8	58.1	26.2	24.7	45.0	45.8	47.3	49.5	52.6	56.6
	NEm, mcal/lb	0.62	0.64	0.61	0.58	0.55	0.53	0.37	0.39	0.41	0.44	0.49	0.56
	CP, %	11.07	11.77	10.95	10.15	9.27	8.49	6.00	6.20	6.53	7.04	7.80	8.88
	Ca, %	0.33	0.35	0.32	0.30	0.27	0.24	0.16	0.16	0.16	0.27	0.26	0.26
	P, %	0.22	0.23	0.21	0.20	0.18	0.17	0.12	0.12	0.12	0.17	0.17	0.16
	TDN, lb/d	19.36	20.71	20.15	18.77	17.31	16.19	12.24	12.37	12.72	13.27	14.20	15.62
	NEm, mcal/d	19.78	21.31	20.56	18.73	16.94	15.69	10.06	10.53	11.03	11.79	13.23	15.46
	CP, lb/d	3.53	3.92	3.69	3.28	2.86	2.51	1.63	1.67	1.76	1.89	2.111	2.45
	Ca, lb/d	0.11	0.12	0.11	0.10	0.08	0.07	0.04	0.04	0.04	0.07	0.07	0.07
	P, lb/d	0.07	0.08	0.07	0.06	0.06	0.05	0.03	0.03	0.03	0.05	0.05	0.04

Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.

Table 6. Nutrient requirements of 1,600 lb mature cow.

Mature Weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
1,600	(10 lbs peak milk)												
	DMI, lb/d	29.8	30.3	31.8	31.4	31.1	30.6	30.2	30.0	26.9	29.7	29.9	30.6
	TDN, %	54.5	55.0	52.9	52.1	51.4	51.0	45.0	45.8	47.5	49.7	52.9	56.9
	NEm, mcal/lb	0.52	0.53	0.50	0.48	0.48	0.47	0.38	0.39	0.42	0.45	0.49	0.56
	CP, %	8.03	8.33	7.69	7.3	7.05	6.8	6.01	6.22	6.56	7.10	7.87	8.98
	Ca, %	0.23	0.25	0.23	0.21	0.20	0.19	0.16	0.16	0.16	0.27	0.26	0.26
	P, %	0.17	0.17	0.16	0.15	0.15	0.14	0.12	0.12	0.12	0.17	0.17	0.17
	TDN, lb/d	16.24	16.67	16.82	16.36	15.99	15.61	13.59	13.74	12.78	14.76	15.82	17.41
	NEm, mcal/d	15.50	16.06	15.90	15.07	14.93	14.38	11.48	11.70	11.30	13.37	14.65	17.14
	CP, lb/d	2.39	2.52	2.45	2.29	2.19	2.08	1.82	1.87	1.76	2.11	2.35	2.75
	Ca, lb/d	0.07	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.08	0.08	0.08
	P, lb/d	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.05	0.05	0.05
1,600	(20 lbs peak milk)												
	DMI, lb/d	32.1	33.1	34.0	33.0	32.2	31.4	30.1	29.9	29.8	29.7	29.9	30.5
	TDN, %	57.5	59.0	56.7	55.3	54.0	53.0	45.0	45.8	47.5	49.7	52.9	60.0

Mature Weight	Nutrient	Months since calving											
		1	2	3	4	5	6	7	8	9	10	11	12
	NEm, mcal/lb	0.57	0.59	0.56	0.53	0.51	0.50	0.37	0.39	0.41	0.44	0.49	0.56
	CP, %	9.5	10.10	9.30	8.70	8.05	7.50	6.05	6.25	6.55	7.10	7.90	8.95
	Ca, %	0.27	0.29	0.27	0.25	0.23	0.21	0.16	0.16	0.16	0.27	0.26	0.26
	P, %	0.17	0.18	0.17	0.16	0.15	0.14	0.10	0.10	0.10	0.15	0.15	0.16
	TDN, lb/d	18.46	19.53	19.28	18.25	17.39	16.64	13.55	13.69	14.16	14.76	15.82	18.30
	NEm, mcal/d	18.30	19.53	19.04	17.49	16.42	15.70	11.14	11.66	12.22	13.07	14.65	17.08
	CP, lb/d	3.05	3.34	3.16	2.87	2.59	2.36	1.82	1.87	1.95	2.11	2.36	2.73
	Ca, lb/d	0.09	0.10	0.09	0.08	0.07	0.07	0.05	0.05	0.05	0.08	0.08	0.08
	P, lb/d	0.05	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.04	0.04	0.05
1,600	(30 lbs peak milk)												
	DMI, lb/d	34.6	36.0	36.4	35.0	33.5	32.3	30.0	29.5	29.4	29.3	29.5	30.0
	TDN, %	59.9	61.3	59.0	57.3	55.4	50.0	45.0	45.8	47.3	50.0	53.1	57.0
	NEm, mcal/lb	0.62	0.65	0.62	0.59	0.56	0.54	0.37	0.39	0.41	0.44	0.49	0.57
	CP, %	10.74	11.50	10.70	9.90	9.15	8.40	6.00	6.22	6.60	8.05	8.80	9.95
	Ca, %	0.32	0.34	0.31	0.29	0.26	0.23	0.15	0.15	0.15	0.26	0.26	0.26
	P, %	0.22	0.23	0.21	0.20	0.18	0.17	0.12	0.12	0.12	0.17	0.17	0.17
	TDN, lb/d	20.73	22.07	21.48	20.06	18.56	16.15	13.50	13.51	13.91	14.65	15.66	17.10
	NEm, mcal/d	21.45	23.40	22.57	20.65	18.76	17.44	11.10	11.51	12.05	12.89	14.46	17.10
	CP, lb/d	3.72	4.14	3.89	3.47	3.07	2.71	1.80	1.83	1.94	2.36	2.60	2.99
	Ca, lb/d	0.11	0.12	0.11	0.10	0.09	0.07	0.05	0.04	0.04	0.08	0.08	0.08
	P, lb/d	0.08	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.04	0.05	0.05	0.05

Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.

Growing Calf and Show Steer Feed Management[1]

Matt Hersom and Todd Thrift[2]

Properly starting a calf on feed and maintaining the calf's feed intake is a key component to successful development of a quality show calf. Adequate nutrition of the growing calf is essential in order for the calf to grow frame, gain body weight, and achieve an acceptable final weight. A basic understanding of cattle nutrition, feedstuffs, and feed management is necessary to successfully reach your goals. The following discussion will detail feeds, feed management, and nutrient requirements for growing cattle.

Receiving and Starting Calves on Feed

Calves can come from a variety of sources with very different previous feed and nutritional management. Therefore, an appropriate receiving diet and adaptation period is important. Unless indicated by the person you purchased the calf from, cattle should be adapted gradually to growing rations rather than abruptly put on high-grain diets.

When the calf starts on feed, first provide high-quality grass hay for free choice consumption (3% of body weight; 15 lbs per day for a 500 lb calf). Also make sure the calf has access to plenty of clean, fresh, cool water. Water is the most important nutrient for all animals. Let the calf adapt to their new environment for approximately 3 days before introducing grain. After the initial 3 days, begin to slowly introduce grain to the calf. Hay should still be offered free choice during this time. Begin grain feeding by starting with 2 lbs of grain per day. Continue this level of grain in the diet for 2 to 3 days; monitor the calf to make sure it handles the addition of grain and does not become sick or stop eating. After 2 to 3 days, increase the grain fed to 3 lbs, and follow the same observation period before increasing the grain amount to 4 lbs. After 14 days, the calf should be consuming 6 to 8 pounds of grain, and its total diet should be 50:50 grain:roughage (hay). After this initial receiving period, the calf can be transitioned to formulated or commercial growing and finishing diets that contain greater amounts of grains and concentrates. Table 1 presents a general timeline for feed adaptation.

Growing and Finishing Feeding

Once the calf has adapted to eating from a bunk and its rumen microbes have adjusted to digesting grain, the diet can be transitioned to a growing ration. The growing ration's purpose is to increase the size and muscularity of the calf without adding excessive fat cover to the calf early on. The amount of time the calf remains on the growing ration will depend upon how much time is available before the show. A calf should be on the finishing diet for no less than 100 days, and likely closer to 120 days, to reach an adequate level of finish for the show. During the growing period, the amount of feed consumed by the calf will increase, hay will be replaced by grain, and the energy content (total digestible nutrients [TDN]) of the diet will increase to support greater daily body weight gain (ADG). Table 2 and

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3 (Nutrient Requirements of Growing Cattle; NRC 1996) can provide guidance for the amount of feed and amount of nutrients that calves will require.

Transitioning from the growing to finishing ration likely requires an increase in feed intake and an increase in the proportion of grain in the calf's diet. Increasing the amount of grain in the diet should be accomplished by a step-up procedure. The proportion of grain in the diet should be increased by no more than 10% every 5 to 7 days. Transitioning from a 50:50 grain:roughage (hay) growing ration to an 80:20 grain:roughage (hay) finishing ration will require 15 to 21 days. Feeding a step-up diet will require planning because it will require feeding a diet with 60% grain for one week and then 70% grain for the second week before feeding 80% grain in the third week. During the step-up period, the calf should be monitored closely to avoid digestive upsets, acidosis, and bloat. Feeding an ionophore like Rumensin® can help prevent digestive problems on high-grain diets. Once the calf reaches the final diet formulation, feed changes should be only for amounts of the daily feed offered. During this period, feed amounts should only be altered by 1 to 2 lbs on any given day. Consistent feed intake prevents digestive upsets and promotes calf growth.

Managing the Feed Bunk

Cattle perform better when they can consume frequent meals throughout the day. Cattle are also stimulated to eat when new feed shows up in their feed bunk. So it is recommended that the calf be fed at least 2 times a day. Ideally the 2 feedings would be at the same time from day to day, for example at 7 a.m. and 6 p.m. The total amount of the daily feed amount should be divided into equal portions and half offered in the morning and the other half in the evening. During particularly hot weather, cattle do not eat as much during the day. The daily feed amount can be adjusted to offer 60% of the ration in the evening and 40% in the morning.

Keep the feed bunk and water source clean. Feed intake is very closely associated with water consumption, especially during hot weather. Clean out old feed or manure from the bunk, and water prior to feeding. Feed that accumulates in the bunk should be removed after 1 to 2 days. This feed can mold and spoil, especially in warm, humid weather. This is also a sign that the calf is receiving too much feed or is not feeling well. If a large amount of feed is left over, remove it, and at the next feeding, decrease the amount of total feed by 2 to 5 lbs. After that, gradually increase the amount of feed offered to reach the previous amount. Never increase the amount of feed by more than 1 lb at a feeding (2 lbs per day). Keeping records of the daily feed offered to the calf will track feed offered, consumption, and refusal.

Choosing the Right Feed

There are many options when it comes to growing-finishing and show cattle feed. Generally the decision is first made to use either a commercial feed product that is available from local feed manufacturers or a custom-blended ration. There are multiple companies to choose from when purchasing a premade calf feed. One drawback of commercial feeds is that TDN values are not listed on the feed tag. Knowing the TDN value of the feed makes prediction of ADG and cattle performance possible. Fortunately, TDN can be estimated using the guaranteed analysis of fiber, protein, fat, and ash that is on the feed tag. Table 4 provides the guidelines to determine TDN from feed tag guaranteed analysis (Sprinkle 1999). Commercial feeds generally include a vitamin/mineral premix in the formulation so additional supplementation is not necessary. Certainly some products are better than others, and all products have potential and can be used, but there is no perfect feed. Likewise there is no "magical ingredient" that will make cattle grow hair or their hair coat shine. Calf quality and showman knowledge, management skill, and effort are the ingredients that differentiate cattle in the show ring.

The second option is for calf owners to mix their own feed. To formulate and mix a custom feed blend requires some knowledge and experience in ration formulation. Often the custom mix will contain a roughage source, corn, protein pellet, vitamin-mineral premix, and some coproducts. A formulated ration can offer added flexibility to change the ration but requires additional knowledge and skill.

Regardless of the feed choice, the feed should have a good texture. This means that the particle sizes are a good mix—not too large and as little fine material as possible. Dusty or moldy feed should absolutely be avoided. Many commercial feeds include fat or molasses to "condition" the feed to decrease dust and increase the palatability of the feed.

Feed Components

It is important to meet the calf's nutritional requirements that are outlined in Table 2 and 3. The nutrient requirements are met through the feeds that are provided to the calf. The following are helpful discussions about different feed components and the nutrients they supply.

Grains and Concentrates

Cattle that have a high growth rate need energy to fuel their accelerated growth. Cereal grains and concentrates provide the required energy (TDN) to meet the growth requirement. Calves that are gaining at a moderate rate (2 to 3 lbs/day) need about 1.5% of their body weight as grains (800 lb calf = 12 lbs of grain), whereas calves gaining at a greater rate (+ 3 lbs/day) need more grain in their diet and should consume up to 2.0 to 2.25% of their body weight as grain (800 lb calf = 16 to 20 lbs of grain). Feeding grain at greater than 2.25% of a calf's body weight dramatically increases the risk for digestive upset, acidosis, and laminitis. Corn, oats, milo, and barley are the main cereal grains utilized to provide energy, with corn being the most popular. All of the grains are normally processed in some manner to improve the availability of the energy. Corn is normally cracked or rolled; oats are often crimped or rolled. Avoid ground cereal grains, as the grinding process makes the particles' size too small, which increases the risk of fines and digestive upset when fed at high levels in the diet. Ensure that the calf is consuming enough energy (TDN) to achieve the desired ADG to reach the final body weight.

Proteins

Growing cattle have a greater requirement for protein than mature cattle, but protein is not nearly as important as energy to support body weight gain. Protein is mainly supplied by the inclusion of oilseed meals like soybean and cottonseed meals. Other protein sources include corn gluten feed, corn gluten meal, dried distillers grains, and other oilseed meals. Some commercially formulated feeds can include urea as a nonprotein nitrogen source to increase the formulated crude protein value. Urea can be an effective feed ingredient, but its use requires a greater level of feed management. Producers with little previous experience feeding grain diets to growing cattle would be suggested to feed natural sources of protein rather than nonprotein nitrogen because they provide protein, amino acids, and some energy.

Minerals

Growing calves need minerals to support accelerated growth. The macrominerals of primary importance are calcium, phosphorus, potassium, and magnesium. Often feeds in the diet can supply adequate levels of phosphorus, potassium, and magnesium, but calcium needs to be supplemented. An appropriate calcium to phosphorus ratio of 2:1 or 3:1 should be maintained to support growth. Feed-grade limestone is an acceptable source for additional calcium; other sources are acceptable but may increase the cost of the feed. Most commercial cattle feeds have some amount of added calcium and other additional minerals. Additionally, many cattle feeds are fortified with numerous other trace minerals that are important to support growth and immune function for the growing calf. Custom-made feeds should balance calcium and phosphorus and include a trace mineral supplement to meet the needs of the calf.

Vitamins

Vitamins are important components to many of the functions in a growing calf. Most often, commercial show feeds are fortified with a vitamin A-D-E supplement. Vitamin A is of primary importance because growing-finishing and most show cattle are consuming conserved forages and high-grain diets that are low in vitamin A. Dietary levels should be in the range of 20,000 to 30,000 international units. Vitamin D is not an issue because most calves have some exposure to sunlight and will make their own vitamin D. Vitamin E is included in feeds because of its antioxidant properties and anecdotal benefit on hair coat quality.

Calculating Desired Average Daily Gain (ADG)

To calculate the ADG needed to grow your steer to an adequate final and/or show body weight, several pieces of information are needed. First, obtain an accurate and current body weight of the calf; second, determine the frame score (Table 5; medium or large) of the calf (Kunkle et al. 1996). Next, determine the desired final or show weight of the calf and the number of days until finish point or the show. Below is an example to demonstrate the ADG calculation.

Example.

Information	What this tells us
6-month-old calf (Oct 1st)	
43 inch hip height	Medium frame calf (see Table 2 for nutrient requirements)
Starting body weight of 650 lbs	
Desired final body weight 1,100 lbs	(1,100 final wt—650 initial wt) = 450 lbs to gain
Show date March 1st	450 lbs / 150 days = **3.0 lbs/day ADG required**

Referring to Table 2 indicates that this calf should consume 13.8 lbs of dry feed; the total diet should contain 83% TDN and 15.7% crude protein for the calf to gain adequately.

Conclusion

Feeding a growing-finishing or show calf correctly is an important aspect to successfully reach the desired final product. Correctly feeding the calf requires planning, knowledge, and dedication. However, feeding the calf can provide a great learning environment for cattle nutrition, management, finance, and cattle handling. Be sure to consult with a person knowledgeable about feeding show calves when you have questions.

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Table 1. Feeding system adaptation timeline

Timeline	Roughage-Hay	Grain-Concentrate, lbs	Predicted Total Intake, lbs
Arrival at home Day 0 to 3	All calf will consume	0	15
Adaptation			
Day 3	All calf will consume	2	15
Day 5 to 6	All calf will consume	3	15
Day 7 to 8	All calf will consume	4	15
Day 9 to 10	All calf will consume	5	15
Day 11 to 12	All calf will consume	6	15
Day 13 to 14	All calf will consume	7	15
Growing-Finishing Step-up	**Roughage-Hay, lbs (% of diet)**	**Grain-Concentrate, lbs (% of diet)**	**Predicted Total Intake, lbs**
1 – 5 days	7 (50%)	7 (50%)	14
2 – 5 days	6 (40%)	9 (60%)	15
3 – 5 days	5 (30%)	11 (70%)	16
4 – 5 days	4 (20%)	13 (80%)	17
5 – remaining days	20%	80%	Increase daily feed amount

Table 2. Nutrient requirements of growing and finishing medium-frame beef calves[1]

Body weight (lbs)	Average daily gain (lbs/day)	Dry matter intake (lbs)	TDN (%)	Protein (%)	TDN (lbs)	Protein (lbs)	Calcium (%)	Phosphorus (%)
300	0.5	7.9	54	9.2	4.3	0.73	0.31	0.20
	1.0	8.4	59	11.4	5.0	0.95	0.45	0.24
	1.5	8.6	64	13.6	5.5	1.17	0.58	0.28
	2.0	8.6	69	16.2	5.9	1.39	0.72	0.32
	2.5	8.5	75	18.9	6.4	1.61	0.87	0.37
	3.0	8.2	83	22.2	6.8	1.83	1.13	0.47
400	0.5	9.8	54	8.7	5.3	0.85	0.27	0.18
	1.0	10.4	59	10.4	6.1	1.08	0.38	0.21
	1.5	10.7	61	12.1	6.8	1.30	0.47	0.25
	2.0	10.7	69	14.1	7.4	1.51	0.56	0.26
	2.5	10.6	75	16.3	8.0	1.72	0.68	0.30
	3.0	10.2	83	19.0	8.5	1.94	0.86	0.37
500	0.5	11.6	54	8.4	6.3	0.97	0.25	0.17
	1.0	12.2	59	9.8	7.2	1.19	0.32	0.20
	1.5	12.6	61	11.2	8.1	1.41	0.40	0.22
	2.0	12.7	69	12.8	8.8	1.63	0.47	0.24
	2.5	12.5	75	14.7	9.4	1.84	0.56	0.27
	3.0	12.1	83	16.9	10.0	2.05	0.69	0.32
600	0.5	13.2	54	8.2	7.1	1.08	0.23	0.18
	1.0	14.0	59	9.4	8.3	1.31	0.28	0.19
	1.5	14.4	61	10.6	9.2	1.53	0.35	0.21
	2.0	14.6	69	11.9	10.1	1.74	0.40	0.22
	2.5	14.4	75	13.6	10.8	1.95	0.46	0.24
	3.0	13.8	83	15.7	11.5	2.17	0.57	0.29
700	0.5	14.9	54	8.0	8.0	1.19	0.22	0.18
	1.0	15.8	59	9.0	9.3	1.42	0.27	0.18
	1.5	16.2	61	10.1	10.4	1.64	0.31	0.20
	2.0	16.3	69	11.4	11.2	1.85	0.34	0.21
	2.5	16.1	75	12.8	12.1	2.06	0.40	0.22
	3.0	15.5	83	14.6	12.9	2.27	0.49	0.26
800	0.5	16.4	54	7.7	8.9	1.27	0.22	0.17
	1.0	17.5	59	8.3	10.3	1.44	0.24	0.19
	1.5	18.2	61	8.8	11.1	1.58	0.28	0.19
	2.0	18.6	69	9.2	12.8	1.72	0.31	0.20
	2.5	18.5	75	9.8	13.9	1.81	0.35	0.21
	3.0	16.8	83	10.8	13.9	1.81	0.42	0.25
900	0.5	17.9	54	7.6	9.7	1.36	0.21	0.18
	1.0	19.1	59	8.0	11.3	1.52	0.23	0.18
	1.5	19.9	61	8.4	12.1	1.66	0.25	0.19
	2.0	20.3	69	8.8	14.0	1.79	0.28	0.20
	2.5	20.2	75	9.3	15.2	1.84	0.31	0.20
	3.0	18.3	83	10.1	15.2	1.85	0.37	0.23

Body weight (lbs)	Average daily gain (lbs/day)	Dry matter intake (lbs)	TDN (%)	Protein (%)	TDN (lbs)	Protein (lbs)	Calcium (%)	Phosphorus (%)
1,000	0.5	19.3	54	7.5	10.4	1.45	0.21	0.18
	1.0	20.7	59	7.8	12.2	1.60	0.21	0.18
	1.5	21.5	61	8.1	13.1	1.74	0.24	0.18
	2.0	22.0	69	8.4	15.2	1.85	0.25	0.19
	2.5	21.9	75	8.8	16.4	1.92	0.27	0.19
	3.0	19.8	83	9.5	16.4	1.88	0.32	0.22

[1] Adapted from the 1996 Nutrient Requirements of Beef Cattle.

Table 3. Nutrient requirements of growing and finishing large-frame beef calves[1]

Body weight (lbs)	Average daily gain (lbs/day)	Dry matter intake (lbs)	TDN (%)	Protein (%)	TDN (lbs)	Protein (lbs)	Calcium (%)	Phosphorus (%)
300	0.5	8.2	52.5	9.5	4.3	0.77	0.30	0.19
	1.0	8.7	56.0	11.3	4.9	0.99	0.46	0.23
	1.5	9.1	59.5	12.9	5.4	1.19	0.58	0.27
	2.0	9.4	63.5	14.6	6.0	1.37	0.70	0.30
	2.5	9.6	67.5	16.3	6.5	1.55	0.85	0.34
	3.0	9.6	72.0	18.0	6.9	1.73	0.99	0.39
	3.5	9.3	78.5	20.3	7.3	1.88	1.16	0.45
400	0.5	10.1	52.5	8.9	5.3	0.89	0.26	0.17
	1.0	10.8	56.0	10.2	6.0	1.10	0.37	0.20
	1.5	11.3	59.5	11.4	6.7	1.30	0.47	0.23
	2.0	11.7	63.5	12.7	7.4	1.47	0.57	0.26
	2.5	11.9	67.5	13.9	8.0	1.64	0.65	0.30
	3.0	11.9	72.0	15.2	8.6	1.81	0.76	0.33
	3.5	11.5	78.5	16.9	9.0	1.94	0.90	0.36
500	0.5	12.0	52.5	8.5	6.3	1.0	0.24	0.17
	1.0	12.8	56.0	9.5	7.2	1.21	0.33	0.19
	1.5	13.4	59.5	10.4	8.0	1.40	0.39	0.21
	2.0	13.8	63.5	11.4	8.8	1.57	0.46	0.24
	2.5	14.0	67.5	12.4	9.5	1.73	0.55	0.25
	3.0	14.0	72.0	13.4	10.1	1.88	0.63	0.28
	3.5	13.6	78.5	14.7	10.7	2.00	0.73	0.32
600	0.5	13.8	52.5	8.2	7.2	1.11	0.22	0.18
	1.0	14.6	56.0	9.0	8.2	1.31	0.29	0.18
	1.5	15.3	59.5	9.7	9.1	1.5	0.35	0.20
	2.0	15.8	63.5	10.5	10.0	1.66	0.40	0.22
	2.5	16.1	67.5	11.3	10.9	1.81	0.47	0.23
	3.0	16.1	72.0	12.1	11.6	1.95	0.52	0.26
	3.5	15.6	78.5	13.2	12.2	2.05	0.61	0.28
700	0.5	15.4	52.5	7.9	8.1	1.21	0.21	0.17
	1.0	16.4	56.0	8.6	9.2	1.41	0.27	0.19
	1.5	17.2	59.5	9.2	10.2	1.59	0.31	0.19
	2.0	17.8	63.5	9.8	11.3	1.74	0.36	0.21
	2.5	18.0	67.5	10.5	12.2	1.88	0.40	0.22
	3.0	18.0	72.0	11.1	13.0	2.01	0.45	0.23
	3.5	17.5	78.5	12.0	13.7	2.10	0.52	0.26

Body weight (lbs)	Average daily gain (lbs/day)	Dry matter intake (lbs)	TDN (%)	Protein (%)	TDN (lbs)	Protein (lbs)	Calcium (%)	Phosphorus (%)
800	0.5	17.1	52.5	7.7	9.0	1.31	0.21	0.18
	1.0	18.2	56.0	8.3	10.2	1.51	0.24	0.18
	1.5	19.0	59.5	8.8	11.3	1.68	0.28	0.19
	2.0	19.6	63.5	9.3	12.4	1.82	0.32	0.20
	2.5	19.9	67.5	9.8	13.4	1.96	0.35	0.21
	3.0	19.9	72.0	10.4	14.3	2.07	0.40	0.22
	3.5	19.3	78.5	11.1	15.2	2.15	0.45	0.24
900	0.5	18.6	52.5	7.6	9.8	1.40	0.20	0.18
	1.0	19.8	56.0	8.0	11.1	1.60	0.23	0.18
	1.5	20.8	59.5	8.5	12.4	1.77	0.27	0.18
	2.0	21.4	63.5	8.9	13.6	1.91	0.29	0.20
	2.5	21.8	67.5	9.3	14.7	2.03	0.31	0.20
	3.0	21.7	72.0	9.8	15.6	2.13	0.36	0.21
	3.5	21.1	78.5	10.4	16.6	2.19	0.40	0.23
1,000	0.5	20.2	52.5	7.5	10.6	1.49	0.20	0.17
	1.0	21.5	56.0	7.8	12.0	1.69	0.23	0.17
	1.5	22.5	59.5	8.2	13.4	1.85	0.25	0.18
	2.0	23.2	63.5	8.6	14.7	1.98	0.27	0.18
	2.5	23.6	67.5	8.9	15.9	2.09	0.29	0.19
	3.0	23.6	72.0	9.3	17.0	2.19	0.32	0.20
	3.5	22.8	78.5	9.8	17.9	2.24	0.35	0.21

[1] Adapted from the 1996 Nutrient Requirements of Beef Cattle.

Table 4. Estimating TDN of commercial feed (base: 13% crude protein, 2% crude fat) using fiber and ash content[1]

	% Ash on the feed tag					
% Crude Fiber on feed tag	**2**	**4**	**6**	**8**	**10**	**12**
2	86.9	85.1	82.3	81.5	79.7	77.9
3	86.1	84.3	82.5	80.7	78.9	77.1
4	85.3	83.5	81.7	79.9	78.1	76.3
5	84.5	82.7	80.9	79.1	77.3	75.5
6	83.7	81.9	80.1	78.3	76.5	74.7
7	82.9	81.1	79.3	77.5	75.7	73.9
8	82.1	80.3	78.5	76.7	74.9	73.1
9	81.3	79.5	77.7	75.9	74.1	72.3
10	80.5	78.7	76.9	75.1	73.3	71.5

[1]For 16% protein feed, deduct 0.5% TDN from the estimate in the table.
For 10% protein feed, add 0.5% TDN to the estimate in the table.
For each 1% fat over 2%, add 2.25% TDN to the estimate in the table.
Adapted from J. Sprinkle, 1999, Univ. of Arizona Coop. Extension bulletin AZ1054.

Table 5. Estimating calf frame size from hip height measurement

Age of Calf	Inches measured at hook bones	
	Medium Frame Calf	Large Frame Calf
5 months	Less than 43	Greater than 45
6 months	Less than 44	Greater than 46
7 months	Less than 45	Greater than 47
8 months	Less than 46	Greater than 48
9 months	Less than 48	Greater than 50
12 months	Less than 50	Greater than 52

Adapted from Kunkle et al., 1996, Univ. of Florida Coop. Extension bulletin AS42.
Adapted from J. Sprinkle, 1999, Univ. of Arizona Coop. Extension bulletin AZ1054.

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Precalving Nutrition of Beef Females in Florida[1]

Philipe Moriel and Joao Vendramini[2]

Introduction

The primary goal of precalving supplementation of protein and energy is to increase body condition score (BCS) of beef cows before calving, which is positively correlated with reproductive success of cows during the subsequent breeding season. Body condition score is an assessment of the fat cover (energy reserves) that the cow is carrying. For more details on how to measure BCS and its impacts on cow reproduction, see Ask IFAS publications AN319 ("Implications of Cow Body Condition Score on Productivity") and AN347 ("How to Measure Body Condition Score in Florida Beef Cattle"). This publication was developed for beef cattle producers to modify the supplementation strategy during the precalving period to improve calf performance after birth.

Benefits beyond Cow Reproduction

Beef cattle production in Florida is constantly exposed to environmental (e.g., heat and humidity) and seasonal conditions (e.g., cyclic forage maturity and nutritive value) that can lead to nutrient deficiency in beef females during gestation, particularly for late pregnancy in fall-calving herds. Maternal nutrition during gestation regulates fetal development by affecting fetal organ and tissue development and tissue-specific epigenetics (i.e., alterations to gene expression that result in increased or decreased gene expression). These modifications to fetal development will determine the long-term growth and health of beef calves following birth (fetal programming theory). For example, late gestation is one of the most critical periods for the formation of muscle and adipose tissues (Du et al. 2010). In terms of health, nutrient restriction during late gestation has been shown to reduce vaccine response, increase the number of antibiotic treatments needed to combat bovine respiratory disease, and increase morbidity and mortality of beef calves (Moriel et al. 2021). Therefore, precalving nutrition of beef cows can be explored by beef producers to optimize future performance of the offspring.

Precalving Supplementation of Beef Females in Florida

Since 2016, the UF/IFAS Range Cattle Research and Education Center in Ona, FL has conducted multiple studies identifying the benefits of improved maternal nutrition during pregnancy on future offspring performance (Table 1). These studies demonstrated that precalving supplementation of protein and energy (on average, 2.2 lb/cow daily of a protein and energy supplement for the last 70 days before calving) could be implemented to increase cow BCS at calving by 0.50 to 0.75 units (scale of 1 to 9). In terms of cow reproduction, we observed that precalving supplementation of protein and energy did not increase pregnancy rates during the subsequent breeding season compared to no precalving supplementation when all cows calved in acceptable BCS (BCS ≥ 5). However, it increased pregnancy rates compared to no precalving supplementation when cows calved with a below-optimal BCS (BCS < 5). In certain studies, precalving supplementation of protein and energy also altered calving distribution and increased

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the percentage of cows calving during the first 21 days of the calving season, leading to older and heavier calves at weaning (Palmer et al. 2020; Palmer et al. 2022a).

In terms of offspring preweaning growth, these studies observed that precalving supplementation of protein and energy increased calf body weight at weaning by, on average, 25 lb, regardless of cow BCS at the time of calving (Table 1). We did not include an economic analysis in this fact sheet because economic calculations need to be performed frequently due to the dynamic changes in feed cost and calf prices. Nonetheless, the income from the additional weaning weight was often sufficient to offset the cost of precalving supplementation in all studies. The following sections will discuss additional changes to precalving nutrition and their implications for calf performance.

Timing of Supplementation

Energy and protein requirements of beef cows reach their lowest values immediately after weaning (beginning of the third trimester of gestation) but dramatically increase as the third trimester of gestation progresses, mainly because of the exponential fetal growth (NASEM 2016). Differentiation and maturation of each fetal organ and tissue occur at different moments during gestation (Lemley 2020). Therefore, timing of protein and energy supplementation during late gestation can have different impacts on offspring performance. In 2020, Brangus cows were provided: 0 lb/day of dried distillers' grains during the third trimester of gestation; 2.2 lb/day of dried distillers' grain during the last 84 days of the third trimester of gestation (185 lb of supplement per cow); or 4.4 lb/day of dried distillers' grains during the first 42 days of third trimester gestation (also 185 lb of supplement per cow). Calf weaning weight was greater for calves born from cows that received protein and energy supplementation during the first half of the last trimester of gestation compared to calves born from cows that did not receive precalving supplementation (575 lb vs. 562 lb, respectively). However, calves born from cows that were supplemented with protein and energy during the entire last trimester of gestation achieved the best results on calf preweaning growth (593 lb) (Palmer et al. 2022). Therefore, we recommend implementing a longer period of precalving supplementation of protein and energy if maximizing calf weaning weight is your primary goal. In this study, we also observed that vaccine response against bovine respiratory disease and percentage of carcasses grading Choice were greater for calves born from cows supplemented during the first 42 days of third trimester gestation compared to calves born from cows that did not receive precalving supplementation. Calves born from cows that were supplemented during the entire third trimester of gestation were intermediate (Palmer et al. 2022). Therefore, we recommend that producers implement precalving supplementation of protein and energy during the first 42 days of the third trimester of gestation if maximizing calf post-weaning vaccine response and carcass quality are the primary goals.

Frequency of Supplementation

Several conditions can create a negative nutrient availability for fetal development, including altered cow metabolic status caused by infrequent concentrate supplementation. Decreasing the frequency of concentrate supplementation reduces labor and feeding costs of beef cattle while modulating blood concentrations of hormones and metabolites (Moriel et al. 2016; Moriel et al. 2020a). In a study conducted in North Carolina with Angus cows, reducing the frequency of wet brewers' grains supplementation from daily to 3 times weekly during the last 60 days of gestation did not impact BCS change and reproduction of cows. However, it led to fluctuations in precalving plasma glucose concentrations of cows (glucose is essential for fetal growth) and calf plasma concentrations of haptoglobin and cortisol (indicators of inflammatory response). These data suggest a greater physiological stress in offspring born frominfrequently supplemented cows (Moriel et al. 2016). In 2021, we completed a study at the UF/IFAS Range Cattle Research and Education Center to evaluate the impacts of reduced frequency of dried distillers' grains supplementation during late gestation on cow and calf performance (see Table 2) (Izquierdo et al. 2022). Cows were assigned to receive 0 lb/day of dried distillers' grains (NOSUP) or precalving supplementation of dried distillers' grains at: 2.2 lb/cow daily (7X); 5.1 lb/cow every Monday, Wednesday, and Friday (3X); or 15.4 lb/cow every Monday (1X) during the last 77 days of late gestation. All cows assigned to receive precalving supplementation consumed the same total amount of dried distillers' grains (15.4 lb/cow) during late gestation. The main question was, what is the lowest frequency of supplementation that can be provided during late gestation without negatively impacting cow and calf performance? In the study, decreasing the frequency of maternal protein and energy supplementation from daily to either once or 3 times weekly during late gestation did not impact cow body condition score, but it reduced offspring preweaning growth (Table 2). Therefore, frequent supplementation of protein and energy is required during late gestation to maximize calf body weight at weaning.

Feed Additives

Precalving supplementation of protein and energy provides an opportunity to include feed additives known for improving cattle performance. For example, methionine is an essential amino acid that has a crucial role in early embryonic development (Palmer et al. 2021). Methionine supplementation to lactating beef cows from calving until the end of the breeding season altered post-weaning performance of the offspring (Silva et al. 2021). Cows offered supplemental methionine rather than a control supplement without methionine tended to produce more milk without increasing calf adjusted weaning body weight. However, calves born from dams supplemented with methionine had greater total intestinal tract digestibility, average daily gain, and gain:feed compared with control calves during a 42-day post-weaning metabolism evaluation (Silva et al. 2021). In contrast, maternal supplementation of methionine during the third trimester of gestation altered calf muscle gene expression (Palmer et al. 2021) but did not impact offspring preweaning and post-weaning growth (Moriel et al. 2020b; Palmer et al. 2020) or immune function after vaccination (Moriel et al. 2020b) compared with supplementation without methionine. It is possible that a methionine deficiency did not occur in the last studies described above (Palmer et al. 2020; Moriel et al. 2020b). Oversupplying methionine during the third trimester may have not been sufficient to modulate calf growth and immune responses following birth. Cattle subspecies, final protein intake (combined outcome of forage quality and forage and supplement intake) and lack of methionine deficiency in some grazing scenarios, source, amount, timing, and duration of methionine supplementation (and potentially an interaction among all these factors) are potential explanations for the inconsistent results. Therefore, we currently do not have evidence that methionine supplementation during late gestation of beef cows in Florida is beneficial to calf performance.

Another feed additive that our group evaluated was monensin, which is an ionophore widely used in cattle diets to alter the ruminal microbial population and fermentation routes. Monensin supplementation may also support rumen propionate production, and subsequently the circulating concentrations of glucose and insulin growth factor-1 (Vendramini et al. 2018; Moriel et al. 2019), which play an important role in fetal development. In our study, cows were assigned to receive no precalving supplementation of protein and energy (NOSUP), precalving supplementation of protein and energy during the last 77 days of gestation (SUP), or precalving supplementation of protein and energy with 200 mg/day of monensin (SUPMO) during the last 77 days of gestation (Table 3). After calving, all cows and their calves were managed similarly and were not given monensin. Overall, cows that received precalving supplementation (with or without monensin) had greater pregnancy rates and BCS at calving, and weaned heavier calves compared to cows that did not receive precalving supplementation (Table 3). Adding monensin to maternal supplements did not improve maternal performance compared to maternal supplementation without monensin, but significantly increased preweaning growth of their offspring (Table 3). Therefore, we recommend adding monensin to precalving supplementation of beef cows to optimize calf weaning weight. However, extreme caution must be used when adding monensin. Accidental consumption of monensin by monogastric animals (e.g., dogs, horses, and humans) could lead to death.

Conclusion

Beef producers could explore precalving supplementation with protein and energy in beef females in Florida to enhance offspring growth, immune function, and carcass quality. Offspring outcomes to previous maternal precalving nutrition are variable and dependent on the timing and frequency of supplementation as well as the feed additive included. Maternal supplementation with protein and energy during gestation enhanced offspring growth more consistently during preweaning compared to post-weaning phases. Additionally, optimal calf body weight at weaning was achieved when cows were supplemented for longer periods (i.e., entire third trimester of gestation vs. first half of third trimester of gestation), more frequently (i.e., daily vs. infrequent supplementation), and when monensin (but not methionine) was included into cow supplementation during late gestation. Further studies to evaluate additional supplementation strategies are necessary. Findings will be shared with producers in future Ask IFAS publications.

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Table 1. Summary of five studies[1] evaluating the cow-calf performance after cows received (Supp.) or did not receive (No Supp.) supplementation of protein and energy during the precalving period.

	Study 1		Study 2		Study 3		Study 4		Study 5	
Item	No Supp.	Supp.	No Supp.	Supp.	No Supp.	Supp.	No Supp.	Supp.	No Supp.	Supp.
Initial BCS (September)	5.7	5.7	5.5	5.5	5.3	5.4	5.0	5.0	5.5	5.5
Calving BCS (November)	5.8[a]	6.1[b]	5.0[a]	5.4[b]	5.2[a]	5.8[b]	4.7[a]	5.6[b]	5.0[a]	5.5[b]
Pregnancy rate, % of total	91.7	94.4	78.5	75.8	96.2	96.3	82.0[a]	95.0[b]	93.3	86.8
Calf weaning weight, lb	275[a]	295[b]	579[a]	597[b]	561[a]	591[b]	535[a]	563[b]	557[a]	581[b]
Response to vaccination, %	56.1[a]	81.5[b]	-	-	21[a]	54[b]	-	-	-	-

[a,b] Means without a common superscript differed (*P* < 0.05).

[1] **Study 1:** Cows provided 0 lb/day or 2.2 lb/day of molasses and urea supplement (20% crude protein) for 57 days before calving (Moriel et al. 2020b).

Study 2: Cows provided 0 lb/day or 2.2 lb/day of molasses and urea supplement (20% crude protein) for 47 days before calving (Palmer et al. 2020).

Study 3: Cows provided 0 lb/day or 2.2 lb/day of dried distillers' grains for 90 days before calving (Palmer et al. 2022).

Study 4: Cows provided 0 lb/day or 2.2 lb/day dried distillers' grains for 70 days before calving (Izquierdo et al. 2022).

Study 5: Cows provided 0 lb/day or 2.2 lb/day dried distillers' grains for 77 days before calving (Vedovatto et al. 2022).

In all studies, cows and their calves were managed similarly from calving until calf weaning. Calves were weaned early at 2 to 3 months of age in Study 1 and normally weaned at 8 to 9 months of age in Studies 2, 3, 4, and 5.

Table 2. Performance of cows (and their calves) assigned to receive 0 lb/day of dried distillers' grains (NOSUP) or precalving supplementation of dried distillers' grains at 2.2 lb/cow daily (7X), 5.1 lb/cow every Monday, Wednesday, and Friday (3X), or 15.4 lb/cow every Monday (1X) during the last 77 days of late gestation. Adapted from Izquierdo et al. (2022).

	Supplementation Frequency				
Item	NOSUP	1X	3X	7X	SEM
Cow BCS at calving	4.75[a]	5.34[b]	5.36[b]	5.45[b]	0.092
Pregnancy rate[1], % of total cows	93.3	81.5	85.7	93.3	5.91
Calf birth body weight[2], lb	73.1[a]	78.0[ab]	81.7[b]	79.5[b]	2.55
Calf weaning body weight, lb	557[a]	575[b]	575[b]	593[c]	7.48

[a,b] Means without a common superscript differed (*P* < 0.05).

[1] Pregnancy rates did not differ among treatments (*P* = 0.39).

[2] No signs of calving difficulty or differences in percentage of calves born alive were observed in this study.

Table 3. Performance of cows (and their calves) assigned to receive no precalving supplementation of dried distillers' grains (NOSUP) or dried distillers' grains supplementation at 2.2 lb/cow daily (dry matter basis) with 0 mg (SUP) or 200 mg/day of monensin (SUPMO) for the last 77 days of late gestation. Adapted from Vedovatto et al. (2022).

	Maternal Precalving Supplementation			
Item	NOSUP	SUP	SUPMO	SEM
Cow BCS at calving	4.68[a]	5.57[b]	5.74[b]	0.091
Pregnancy rate, % of total cows	82.1[a]	94.9[b]	92.3[b]	5.15
Calf birth body weight[1], lb	75.1[a]	81.5[b]	80.6[b]	2.31
Calf weaning body weight, lb	535[a]	564[b]	588[c]	9.5

[a,b] Means without a common superscript differed (*P* < 0.05).

[1] No signs of calving difficulty or differences in percentage of calves born alive were observed in this study.

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Practical Uses for Ultrasound in Managing Beef Cattle Reproduction[1]

Mario Binelli, Thiago Martins, John Arthington, Kalyn Waters, Vitor Mercadante, Philipe Moriel, and Angela Gonella-Diaza[2]

Ultrasound has been used as a tool in beef and dairy research since the early 1980s (Perry and Cushman 2016). Since the early 2000s, it has become available to commercial livestock agriculture. An ultrasound is an electronic instrument that sends out ultrasonic sound waves from an attached device called a transducer. The waves pass freely through fluid and are reflected back to the probe once they contact a soft tissue like muscle or a dense structure like bone, resulting in an image that can be identified as the placenta, fetus, or other organs. Ultrasound may be used to determine subcutaneous fat content on finishing cattle (Hicks 2014); it is also an important diagnostic tool for veterinary medicine. More recently, Doppler ultrasonography has been used as a novel tool in cattle reproduction, because it estimates the blood flow to reproductive organs as a measure of their functionality. This publication aims to discuss the use of ultrasound to assist with beef cattle reproduction, which includes evaluation of the pre-service status of heifers and cows, diagnosis of pregnancy, determination of fetal age and sex, and evaluation of reproductive fitness of embryo recipients. This report is intended to be used by county Extension faculty in educating producers on reproductive management on cow-calf operations, and by producers who are interested in learning about the uses of a powerful technology to increase reproductive efficiency in their operations.

Reproductive Evaluation of Yearling Heifers prior to the Breeding Season

Yearling replacement heifers are critical to cow-calf operations. Reproductive success of replacement heifers depends on how close the heifers are to reaching puberty (Holm et al. 2009). Mature heifers become pregnant early in their first breeding season and remain longer in the maternal herd (Cushman et al. 2013). The reproductive maturity of heifers can be estimated by a method called "reproductive tract score" or RTS (Table 1) (Anderson et al. 1991), which varies from 1 to 5. Heifers with an RTS of 1 to 3 are called immature or prepubertal, meaning that they have not shown estrus yet and are not ready to be naturally or artificially serviced. On the other hand, heifers with an RTS of 4 or 5 are called mature or pubertal; they have shown estrus and are ready to be serviced. The methodology to evaluate RTS consists of making the following technical determinations: uterine size and tonus by rectal palpation, presence of a corpus luteum (CL), and size of the largest

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ovarian follicle by transrectal ultrasonography. According to these parameters (Table 1), heifers receive an RTS of 1 to 5.

The RTS is associated positively with pregnancy rates attained during the breeding season (Holm et al. 2009). Indeed, RTS 5 heifers become pregnant earlier during the breeding season and present the greatest reproductive performance as first-calf heifers (Holm et al. 2009). Moreover, data collected in Florida confirmed that RTS 5 heifers presented the greatest pregnancy rates to artificial insemination (AI), measured at 30 days (Figure 1A), and at the end of the breeding season (Figure 1B). Thus, the evaluation of RTS before the beginning of the breeding season provides a management tool to make strategic decisions. For example, producers may opt to cull RTS 1 heifers, which will likely present the lowest pregnancy rates (e.g., <60%) and may not be cost effective to develop, depending on the production system. Culling a large proportion of heifers because they are RTS 1–3 may be burdensome. Another option is to induce puberty by using estrus synchronization programs (https://beefrepro.org/wp-content/uploads/2022/01/2022-Cow-and-Heifer-Protocols-for-Sire-Directories.pdf) based on intravaginal progesterone-releasing devices (such as CIDR) or oral progestins (such as MGA). In addition to benefiting the reproductive performance of mature heifers, the treatment of immature heifers with progesterone hastens puberty onset (Lucy et al. 2001). The long-term estrus synchronization programs seem to be the most favorable to improve reproductive performance of immature heifers.

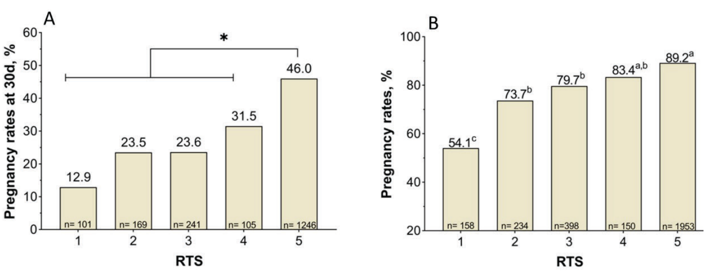

Figure 1. The effect of RTS on pregnancy rates at 30 days (A) or at the end of the breeding season (B). Prior to the beginning of the breeding season, heifers were scored as immature (RTS 1–3) or mature (RTS 4–5). The RTS 5 heifers presented the greatest pregnancy rates. This dataset is a compilation of data collected between 2019 and 2021 in Florida (https://animal.ifas.ufl.edu/extension/beef/KYH/).
Credits: Binelli Lab, UF/IFAS

Pregnancy Diagnosis and Resynchronization

Pregnancy diagnosis in cattle using ultrasound is an accurate, rapid, and safe method (Fricke and Lamb 2002; Baxter and Ward 1997). This is a non-invasive tool that can be used to diagnose pregnancy in cattle without harmful effects to either the fetus or the dam. At 30 to 40 days of pregnancy, Baxter and Ward (1997) did not report an increase in fetal losses when assessing pregnancy by ultrasound. Although ultrasound can be used for pregnancy diagnosis, after 45 days of pregnancy, there is not an increase in diagnostic accuracy when compared to rectal palpation performed by an experienced technician (Fricke and Lamb 2002). However, ultrasonography may improve diagnostic accuracy of technicians who are less experienced in rectal palpation (Fricke and Lamb 2002). The main advantage of using ultrasonography for pregnancy diagnosis is that it allows the detection of early gestations. Using the conventional brightness mode or B-mode makes it possible to detect the presence of a viable embryo as early as 28 days after mating (Ribadu et al. 1999). An ultrasound at 30 days can serve as a diagnostic tool after artificially inseminating the animals. For example, at this early diagnostic exam, a lower-than-expected proportion of females diagnosed as pregnant may indicate that semen quality, AI technique, and synchronization protocol should be investigated to decrease further financial burden. Additionally, pregnancy diagnosis 30 days after artificial insemination can allow producers to identify the pregnancies derived from artificial insemination and manage females differently than those pregnant by natural service.

Ultrasonography has also been fundamental to the development and implementation of programs of estrus resynchronization. The adoption of estrus synchronization programs improves reproductive performance of a cow-calf enterprise (Rodgers et al. 2012). Among other advantages, it increases overall pregnancy rates and proportion of females becoming pregnant during the beginning of the breeding season (Rodgers et al. 2012). These two factors are important because they are associated with an increase in pounds of calf produced at weaning. The resynchronization further increases the likelihood of these beneficial effects (Bó et al. 2016; Baruselli et al. 2018; Ojeda-Rojas et al. 2021), favoring productivity. Currently, the conventional resynchronization programs consist of inserting CIDRs in all inseminated animals before knowing their pregnancy status. On day 28, CIDRs are removed and pregnancy diagnosis based on B-mode ultrasonography is performed in all cows. Pregnant cows are not handled further, while open females receive additional synchronization treatments and are subsequently re-inseminated. The super-early resynchronization is nowadays the state of the art on the topic of resynchronization (Baruselli et al. 2018; Ojeda-Rojas et al. 2021). Such programs allow repeated inseminations of females, every 24 days, which is very close to the physiological 21-day estrous cycle interval. The development of such a program was only possible because of the use of Doppler ultrasonography for pregnancy diagnosis (Pugliesi et al. 2014). By using this technology, the technician evaluates the blood flow to the corpus luteum as early as 20 days after AI. Through this ultrasonography exam, the pregnancy diagnosis shifts from the visualization of a fetus to the determination of a functional corpus luteum as a proxy of the pregnancy. A well-vascularized corpus luteum indicates an ongoing pregnancy with a 90% accuracy (Figure 2A), while a poorly-vascularized corpus luteum (Figure 2B) indicates that the female is not pregnant, with a 99.9% accuracy.

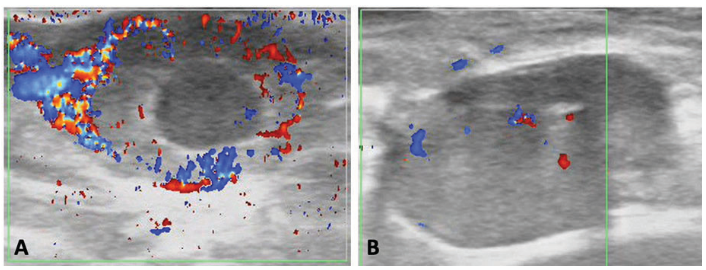

Figure 2. Color Doppler ultrasonographic images representing pregnant cows (A) and nonpregnant cows (B) based on vascularization of corpus luteum 20 days after AI.
Credits: Gonella-Diaza Lab, UF/IFAS

Estimation of Age and Sex of a Fetus

A trained technician can determine the pregnancy age based on the size of the embryo (30 to 45 days) or fetus (Figure 3). After 90 days of pregnancy, estimating pregnancy age might be difficult due to the position of the uterus in the abdominal cavity, the high liquid volume, and the large size. To determine the pregnancy age, the technician uses specific embryo or fetal measurements such as crown-rump length (Table 2) (Hughes and Davies 1989). Estimated pregnancy age at the final pregnancy diagnosis can help producers to divide the herd into groups of females that became pregnant early or late during the breeding season. For example, late-pregnant cows may be maintained on pastures that will optimize calf growth to alleviate differences in calf weaning weights. Producers may wish to use creep feeding for calves born to cows in the late-pregnant group, or supplement these cows in a way that might lessen the following postpartum interval. Finally, producers may wish to wean these groups on different dates, optimizing calf uniformity and market price.

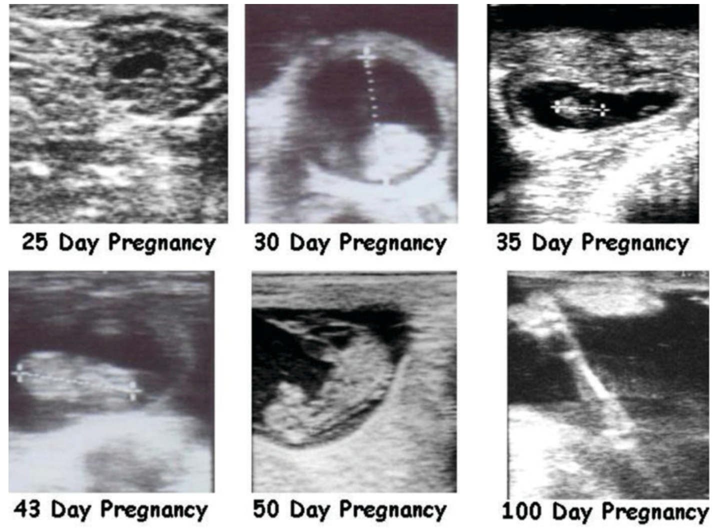

Figure 3. Ultrasound images of the bovine pregnancy at various stages of development.
Credits: Adapted from Lamb (2001)

Another important function of an ultrasonography exam is to determine the fetal sex. Between 60 and 85 days of pregnancy, a trained technician can determine fetal sex, according to the localization of the genital tubercle with over 95% accuracy. For a female, it is located under the tail (Figure 4), while it is located slightly caudal to the umbilicus in a male (Figure 5). For more information about fetal sexing technique and images, refer to chapter 7 of *Practical Atlas of Ruminant and Camelid Reproductive Ultrasonography* (https://onlinelibrary.wiley.com/doi/book/10.1002/9781119265818). After 85 days of pregnancy, it may be difficult to obtain an adequate image for fetal sexing due to the increased size of the fetus and the enlarged and downward position of the uterus in the body cavity (Fricke and Lamb 2002). The determination of fetal sex can also help producers to manage pregnant cows in groups aiming to optimize determined progenies. An example of this management strategy is found in purebred operations that aim to separate cows giving birth to bull calves from those giving birth to heifers. Producers would then be able to divide their herds and manage each of the categories in a way that best fits their production system for heifer and bull calves. Fetal sexing using ultrasonography will become less important as sex-sorted semen becomes available and the sex of the offspring is selected with high accuracy prior to service (Holden and Butler 2018).

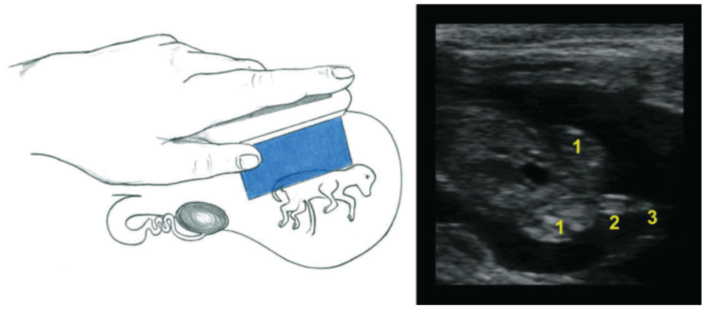

Figure 4. Female fetus at 60 days of gestation in longitudinal plane. The left side of the figure shows the position of the probe in relation to the fetus inside the uterus. The right side of the figure shows what will be seen on the screen at the same moment. 1: Hindlimbs; 2: Genital tubercle; 3: Tail.
Credits: Adapted from Practical Atlas of Ruminant and Camelid Reproductive Ultrasonography (https://onlinelibrary.wiley.com/doi/book/10.1002/9781119265818)

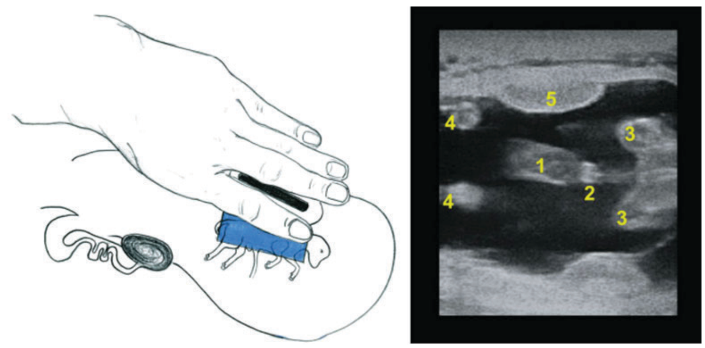

Figure 5. Male fetus at 65 days of gestation in longitudinal plane. The left side of the figure shows the position of the probe in relation to the fetus inside the uterus. The right side of the figure shows what will be seen on the screen at the same moment. Note that the free part of the probe appears on the left side of the ultrasound image. 1: Umbilicus; 2: Genital tubercle; 3: Hindlimbs; 4: Forelimbs; 5: Placentome.
Credits: Adapted from Practical Atlas of Ruminant and Camelid Reproductive Ultrasonography (https://onlinelibrary.wiley.com/doi/book/10.1002/9781119265818)

Evaluation of the Reproductive Fitness of an Embryo Recipient

Embryo transfer is an advanced reproductive technology meant to rapidly increase the genetic merit of a herd by transferring genetically superior embryos to fertile recipients. Another novel use of Doppler-mode ultrasonography is to evaluate the fitness of embryo recipients before embryo transfer (i.e., 7 days after estrus) (Pugliesi et al. 2019). Size and vascularization of the corpus luteum in embryo recipients are associated positively with pregnancy success for embryo transfer.

Additional Common Uses of Reproductive Ultrasound Technology in Florida

Ultrasound for yearling heifers 30 days after the end of the breeding season can be used to accurately (95% to 100%) determine pregnancy status compared to rectal palpation (which achieves the same accuracy only between 50 and 60 days after service). Producers are able to make immediate culling decisions on heifers, which reduces the feed cost significantly.

For large groups of yearling heifers, ultrasonography may assist in culling heifers based on fetal size. Only the heifers that become pregnant in the first 60 days of a 90-day breeding season would be retained. The remaining late-pregnant heifers would be sold and not kept in the cow herd. This allows producers to sell pregnant heifers that are worth more than open heifers.

For commercial producers who use AI programs, ultrasound may be used at 50 to 60 days after AI to identify which cows are pregnant from AI compared to natural service. In production systems that use timed AI programs, ultrasound can be performed as early as 30 days after AI, allowing producers to make management and strategic reproductive decisions during the breeding season. Identifying cows pregnant to AI (by notching ear tags or inserting an additional ear tag) allows producers to sort cows into calving groups the following spring based on whether they were pregnant to AI or not. Ultrasound allows producers to identify the cows that were not pregnant at the end of the breeding season and can therefore be culled earlier, which reduces feeding cost and increases profitability.

First-calf heifers are more prone to dystocia (calving problems). By identifying service dates, approximate calving dates can be determined. This directs increased observation of animals during the calving of first-calf heifers to help reduce the incidence of calf loss from calving difficulties.

There are other potential uses for ultrasound in cow-calf production systems. In Florida, the expansive nature of beef production systems generally does not afford cattlemen access to the cows when ultrasound may be most effective. Nonetheless, transrectal ultrasonography has and will continue to have a role in the successful reproductive management of cattle herds (Perry and Cushman 2016). There are many advantages to incorporating ultrasound into reproductive management practices for beef cattle. Contact your local UF/IFAS Extension agriculture agent to find a trained ultrasound technician in your area. If you need more information, contact your beef state specialist.

Acknowledgments

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Table 1. Reproductive tract score (RTS) system. Adapted from Anderson et al. (1991).

RTS	Uterine Horn	Ovarian Structures
1	Immature <20-mm diameter, no tone	No palpable structures
2	20- to 25-mm diameter, no tone	8-mm follicles
3	25- to 30-mm diameter, slight tone	8- to 10-mm follicles
4	30-mm diameter, good tone	>10-mm follicles, corpus luteum possible
5	>30-mm diameter, good tone, erect	>10-mm follicles, corpus luteum present

Table 2. Identification of fetal age by crown-rump length. Adapted from Curran et al. (1986), and Perry and Cushman (2016).

Pregnancy Age (weeks)	Crown-Rump Length (inches)	Range of Length (inches)
4	0.35	0.24 to 0.43
5	0.50	0.31 to 0.75
6	0.80	0.63 to 1.02
7	1.09	0.91 to 1.42
8	1.79	1.42 to 2.05
9	2.46	1.54 to 2.80
10	3.44	2.40 to 3.98
11	4.19	3.74 to 4.65
12	4.80	4.21 to 5.39

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