Welcome to the Mississippi Master Cattle Producer Program Self-Study Program Forage Systems training module. This program is administered by the Mississippi State University Extension Service. For answers to questions about this training program, contact Dr. Jane Parish, MSU-ES Extension Beef Cattle Specialist.

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Mississippi Master Cattle Producer Program

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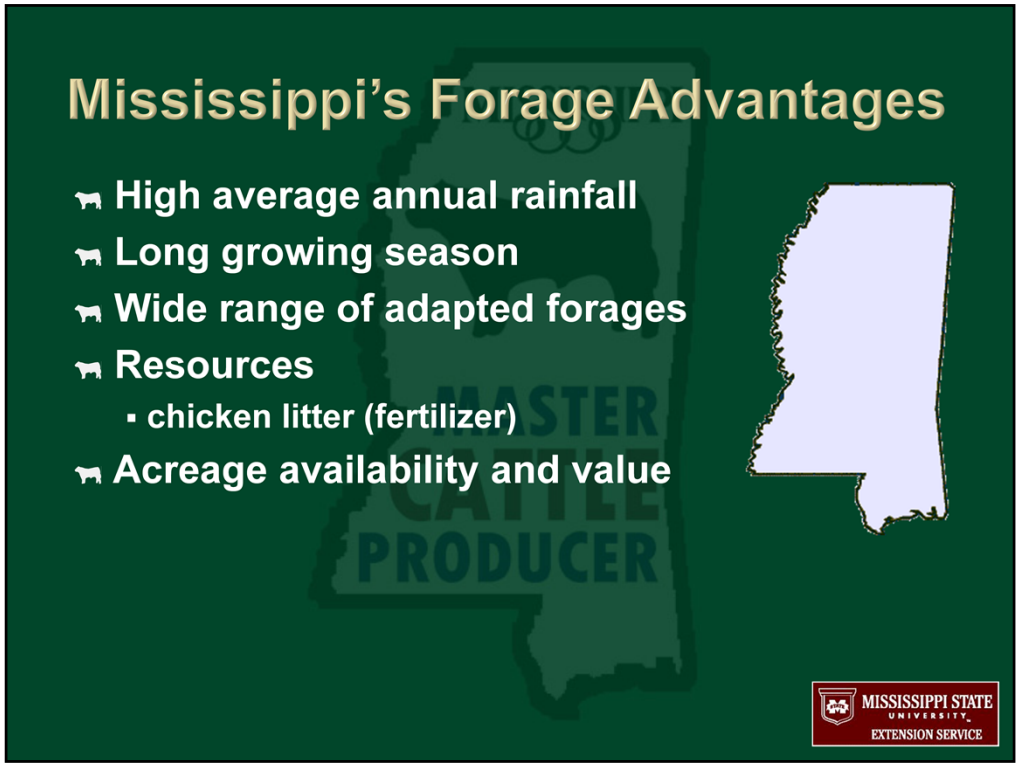
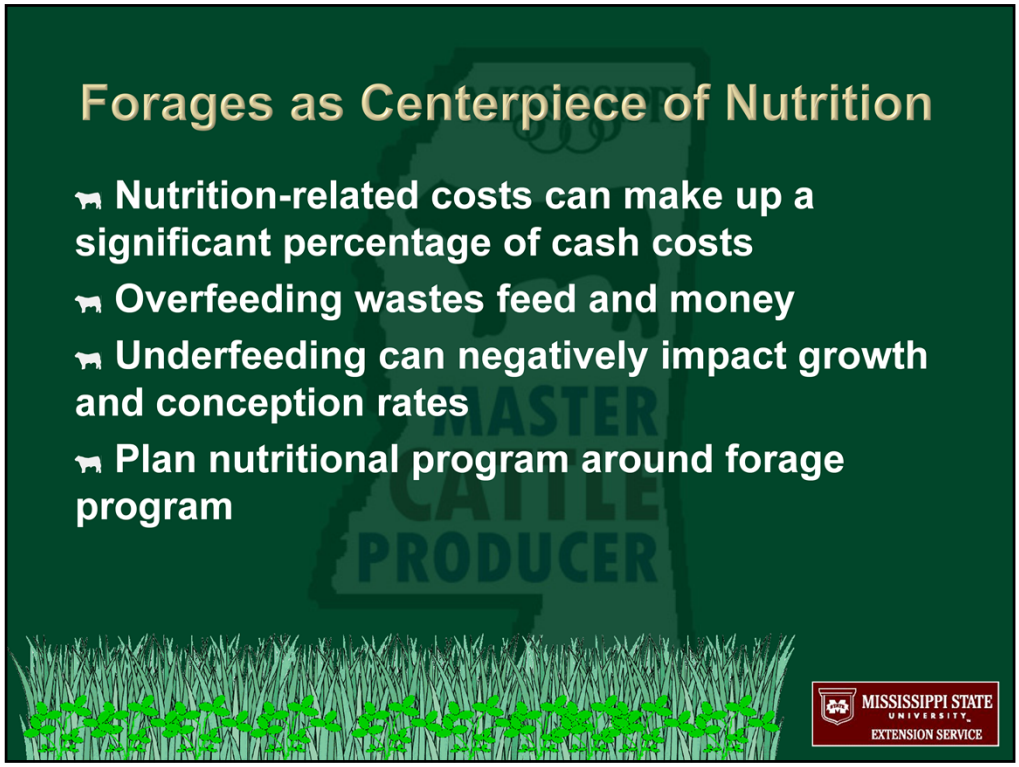


Beef cattle production in Mississippi is primarily forage based. Cow-calf, stocker cattle, and even forage-based finishing can be accomplished using Mississippi forage systems. Mississippi is an excellent environment for forage and beef cattle production for several reasons. High average annual rainfall, long growing seasons, a wide range of forages adapted to areas of the state, local resources such as chicken litter for fertilizer, and the relative availability and value of acreage for forage production compared to other states are some of Mississippi's forage production advantages. Many forage species and cultivars have been researched and field tested within the state, giving producers local information about forage production. The forage variety testing program also provides producers with forage yield data for specific locations within the state each year.

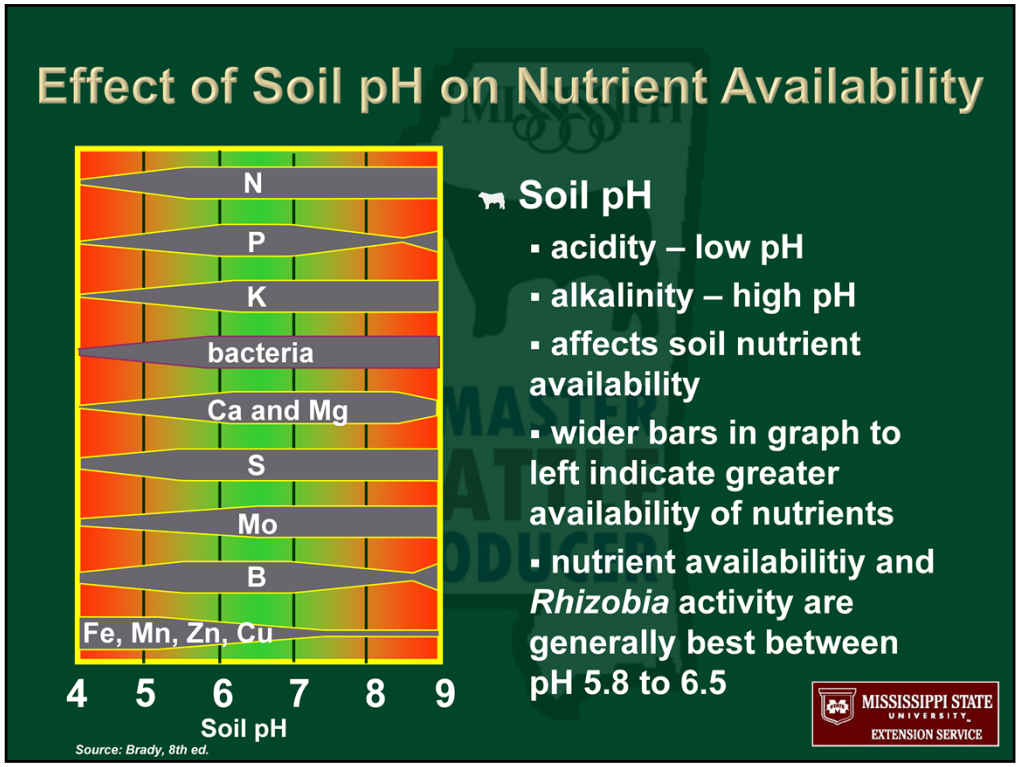


Beef cattle producers are forage producers who utilize forage resources as inputs in their cattle operations. In most U.S. beef cattle operations, nutrition-related costs make up a significant and sometimes a majority of cash costs. Overfeeding wastes both feed and money. Underfeeding, on the other hand, can hurt cattle reproductive and growth rates. Forages are often the most cost-effective means to supply cattle with needed nutrients. By planning the nutritional program around the forage program, efficient and effective feeding systems can be accomplished. Start by implementing a controlled breeding and calving season for cow-calf herds to better match animal nutrient needs to changing forage quality and yield throughout the year.

Proper, timely soil testing followed by liming and fertilization according to soil test recommendations is vital for good forage stand productivity and longevity. Test soils for pH and nutrient levels, and make sure that soil samples are representative of the pasture or hay field. Soil test perennial pastures at least once every 2 to 3 years. Soil test hay fields and pastures where annual forages are planted at least once a year.

Major nutrients required by forages are nitrogen (N), phosphorus (P), and potassium (K). Nitrogen is important for plant growth response. Phosphorus is important for plant food manufacturing, seed formation, root growth, and seedling survival and growth. Potassium is needed for cold hardiness, legume longevity, and bermudagrass rhizome production. Secondary nutrients required by forages include calcium (Ca), magnesium (Mg), and sulfur (S). Liming soils according to soil tests usually provides adequate calcium for forages. Dolomitic lime is also a source of magnesium. Micronutrients needed for forage production include manganese (Mn), iron (Fe), boron (B), copper (Cu), molybdenum (Mo), chloride (Cl), zinc (Zn), and nickel (Ni). Most micronutrients do not need to be added to the soil, but fertilization with boron is often needed by clovers and alfalfa.

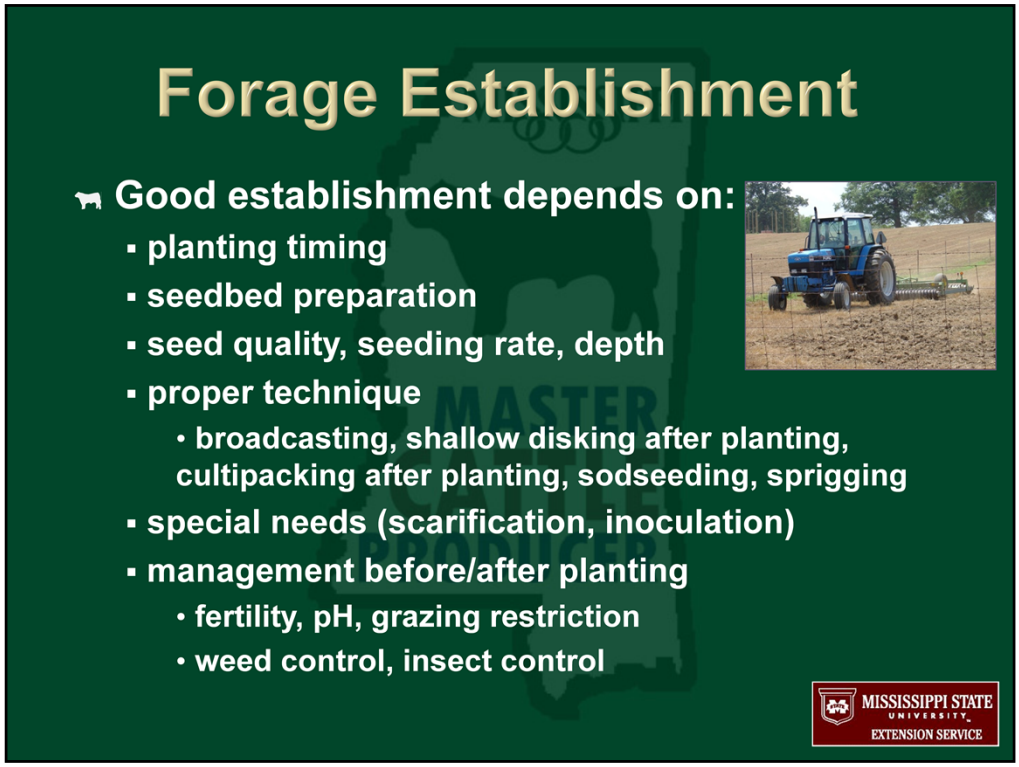
Recognize that hay harvests remove nutrients from fields. Grazing animals remove and redistribute nutrients from pastures as well. It is common to see more lush forage growth in manure and urine spots, particularly in areas where cattle congregate or camp.



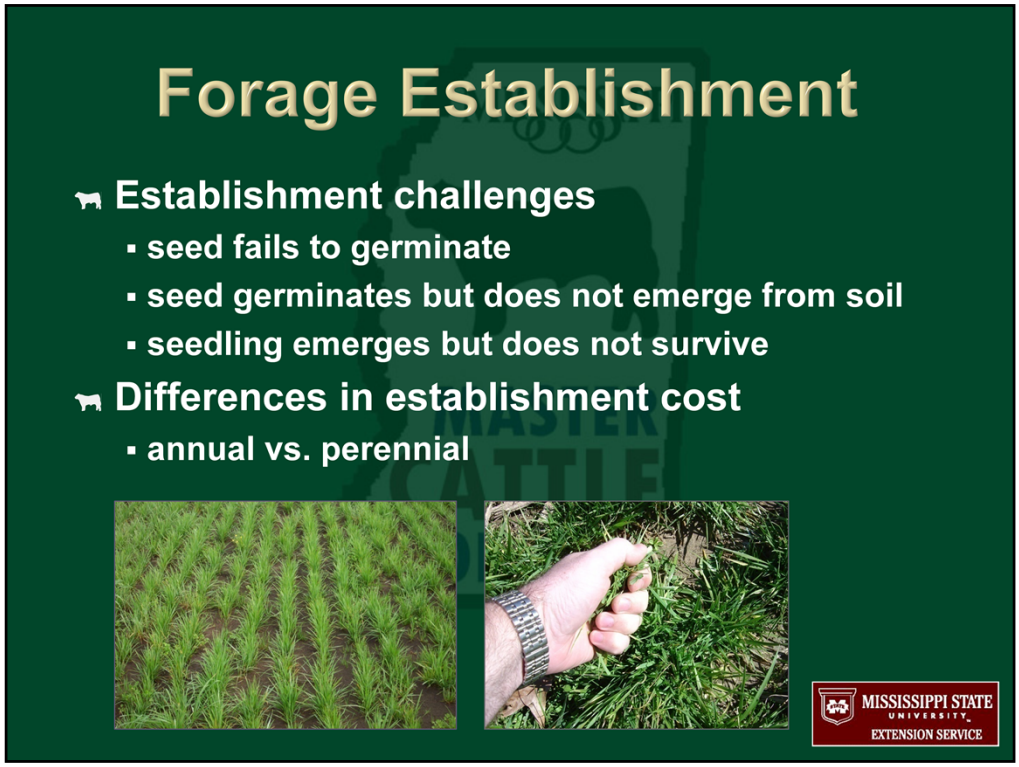
Soil pH refers to soil acidity (low pH, below 7.0) or alkalinity (high pH, above 7.0). A pH of 7.0 is neutral. Lime applications are often recommended on very acidic soils to raise pH. Lime takes time to react with soil, sometimes 6 months or more to appreciably raise soil pH to desired levels. It is best to till lime applications into the plow layer in cultivated fields to move lime into the soil profile. Apply lime well in advance of establishing a forage crop needing an upward soil pH adjustment.

The graph above illustrates the relationships between soil pH and the relative availability of plant nutrients from soil. The wider the bar, the greater the availability. Also included in the graph is a bar for activity of *Rhizobia* bacteria important for legume root nodulation and nitrogen fixation. Because soil pH affects soil nutrient availability, lime applications can help improve the effectiveness of later fertilizer applications. Most forage crops perform best between pH 5.8 to 6.5, but there are exceptions.

For detailed information on forage quality, refer to Mississippi State University Extension Service Publication 2496, “Establishing a Forage Fertility Program”, and Publication 2497, “Strategies for Better Management of Pasture Fertilization”.



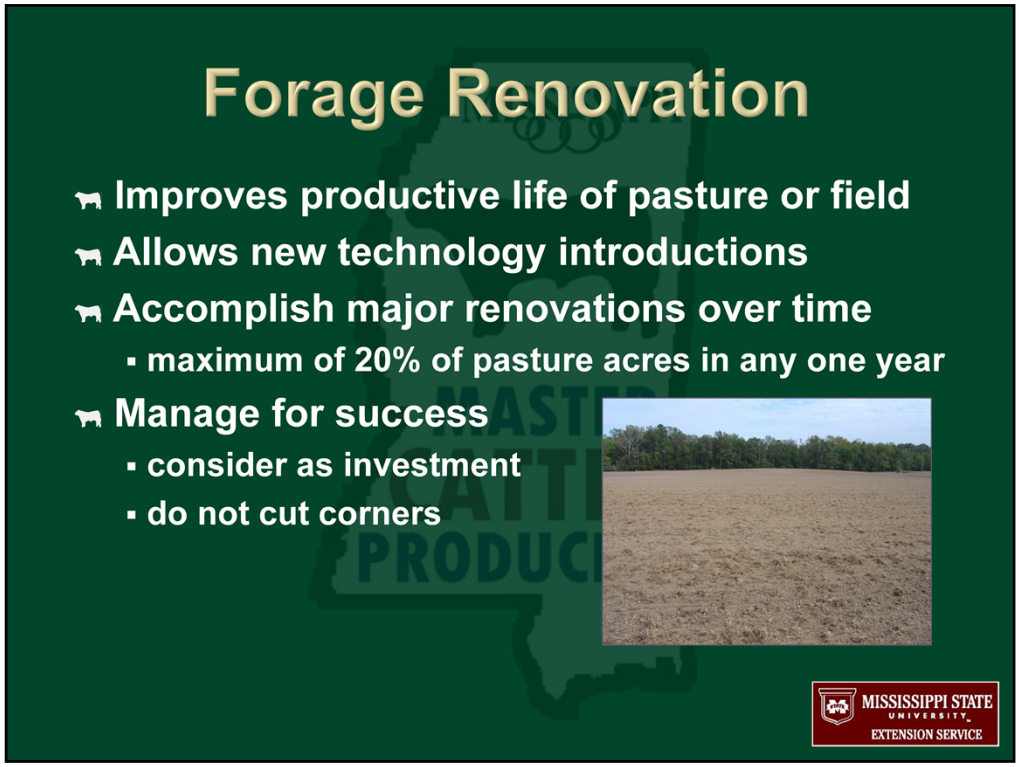
Proper forage establishment is an investment in the future productivity of the forage stand. Successful forage establishment requires attention to many details. Planting timing must be appropriate for the location and forage crop being planted. Late plantings may be subject to competition from weeds or other forages or weather extremes. Seedbed preparation requires removal of forage canopy with close grazing or clipping for sodseeding or tilling for a well prepared seedbed. Some fields also need smoothing or firming. Appropriate seeding rate (amount of seed used per acre) and seeding depth are critical for successful forage establishment. Always use good quality seed. Mixing seeds of different forage species for planting together must consider differences in recommended seeding depths. Forage establishment requires proper planting technique for productive stand development. Some forages establish best with a well-prepared seedbed, and others can be sodseeded (no-till drilled or broadcast) into existing forage stands. Some forages are best established from seed, whereas others need vegetative propagation. Vegetative establishment is used for hybrid bermudagrass where forage stands are established through sprigging vegetative plant parts. Some forage seeds such as arrowleaf clover require scarification (seed coat scratching) due to a hard seed coat. Legumes typically require proper inoculation with *Rhizobium* bacteria for good root nodulation to occur. Mixing fertilizer with inoculated seed often kills the *Rhizobium* bacteria and is not recommended. Proper management before and after planting is critical. This includes maintaining adequate soil fertility and pH and restricting animal access until plants are ready for grazing. Pre- and post-emergence weed control may be needed along with pest control. Weeds competition can hamper forage establishment, and insect damage can also hurt growing plants.



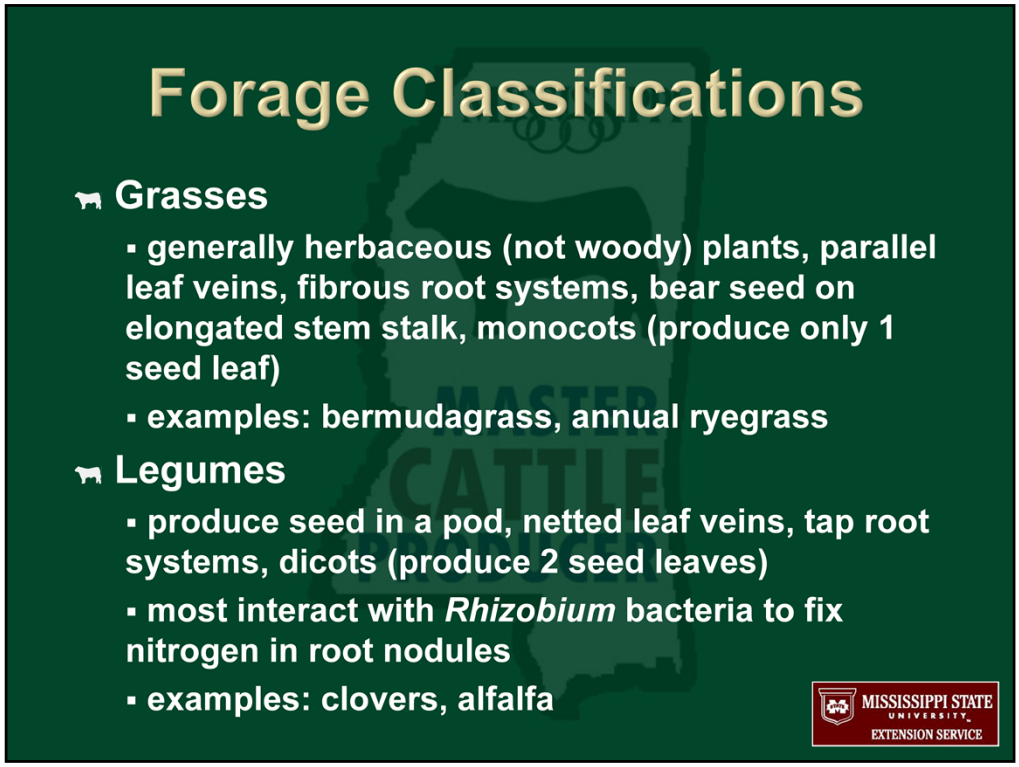
Potential causes of seed failing to germinate include dry seedbed, non-viable seed, hard (unscarfied) seed, dormant seed, unfavorable temperature, herbicide residue, and waterlogged soil. Seed may germinate but not break the soil surface due to being planted deep, soil surface crusting, poor seedling vigor, insects, diseases, or extreme temperature. Some emerged seedlings do not survive because of soil acidity, low fertility, insects, diseases, drought, weed competition, lack of legume nodulation (often due to poor or no seed inoculation), winterkill, grazing too early (plants pulled up out of the ground), heaving from soil freezing and thawing, or sandblasting of seedlings from high winds.

Forage establishment costs are incurred each year with annual crops. The cost of establishment is spread out over the life of the stand with perennial forage crops. A seemingly “expensive” perennial forage may actually be “cheaper” on an annual basis over the stand life than an annual forage than costs less up front to establish.

For detailed information on forage establishment, refer to Mississippi State University Extension Service Publication 2541, “Guidelines for Pasture Establishment”.



Forage renovation is used to improve the productive life of a pasture or hay field. It is a means to introduce new forage technologies, such as improved cultivars, to the operation. Only renovate small portions of the ranch at a time to keep large portions of the ranch from being unproductive. This safeguards against low forage supplies throughout the ranch if forage renovation is unsuccessful. Consider forage renovation an investment, similar to developing replacement heifers. Manage forage renovation to be successful by providing the necessary input and management practices at the appropriate times. Cutting corners in forage renovation can risk the success of the renovation. With perennial forages, a single establishment should be done such that it results in a productive forage crop for many years.

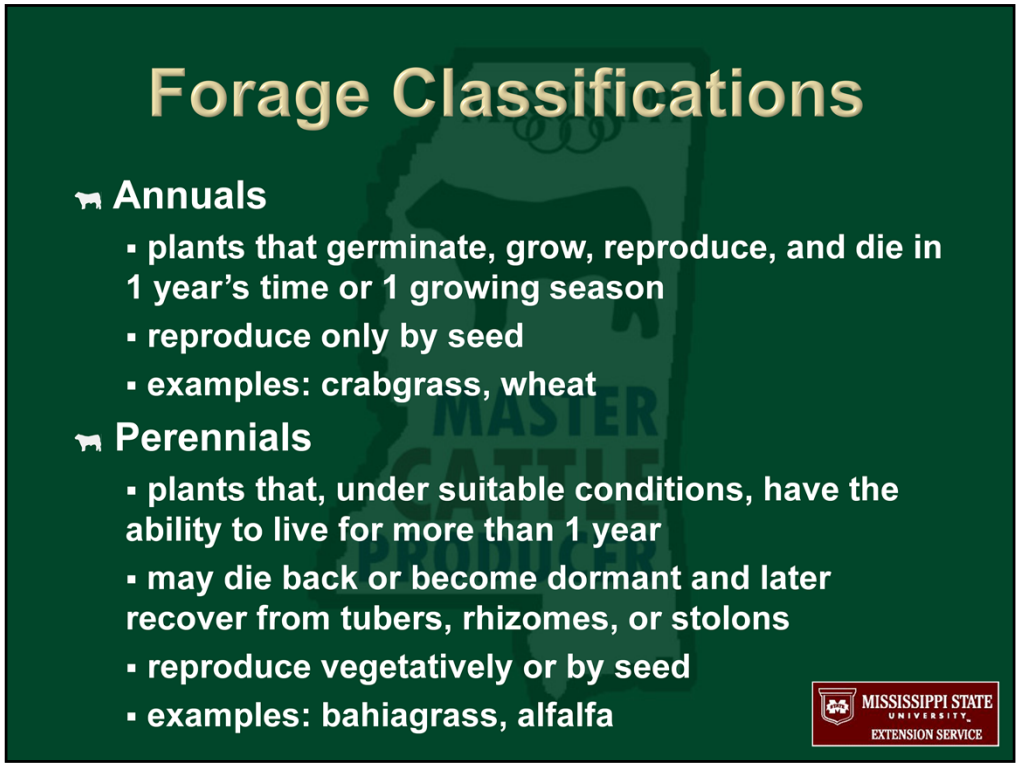


Categorizing forages makes it easier to understand how to use them. Forages can be classified in several ways.

Grasses are generally herbaceous (not woody) plants with parallel leaf veins and fibrous root systems. Grasses bear seed on elongated stem stalk and are monocots (produce only 1 seed leaf). Examples of grasses include bermudagrass and annual ryegrass.

Legumes produce seed in a pod and have netted leaf veins and tap root systems. They are dicots (produce 2 seed leaves). Legumes are unique in that most interact with *Rhizobium* bacteria to fix nitrogen in root nodules. This reduces the need for nitrogen fertilization. Legumes are generally high-quality forage for cattle. Clovers and alfalfa are examples of forage legumes.

Forbs are another class of forages to be discussed later.



Another way to classify forages is as perennials or annuals based on expected lifespan. This designation is critical for planning forage systems and understanding stand establishment needs.

Annuals are plants that germinate, grow, reproduce, and die in 1 year's time or 1 growing season. They reproduce only by seed. Examples of annual forages are crabgrass and wheat.

Perennials are plants that, under suitable conditions, have the ability to live for more than 1 year. They may die back or become dormant and later recover from tubers, rhizomes, or stolons. Perennials reproduce vegetatively or by seed. Bahiagrass and alfalfa are examples of perennial forages.

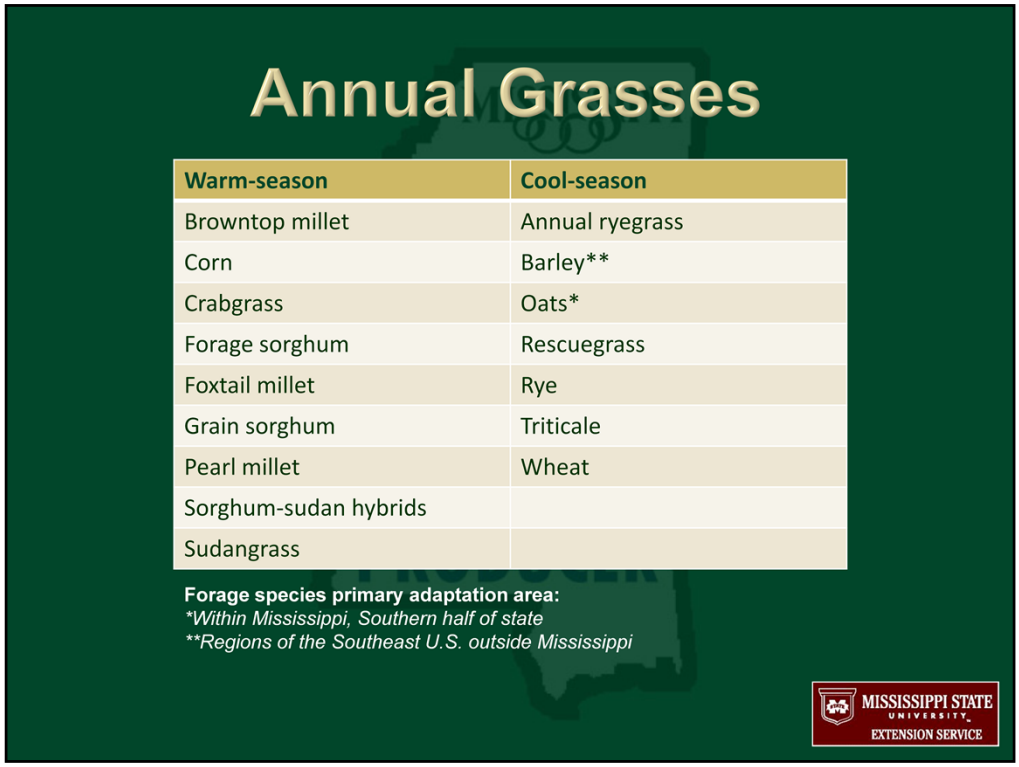
Some forages are biennials that live for 2 years or short-lived perennials. They live longer than annuals but much less time than most other perennial forages. Red clover falls into this category under some growing conditions.

Forages can be classified as either warm-season or cool-season plants based on their growing seasons or seasonal distribution of growth. This categorization is important for planning for forage supplies throughout the year.

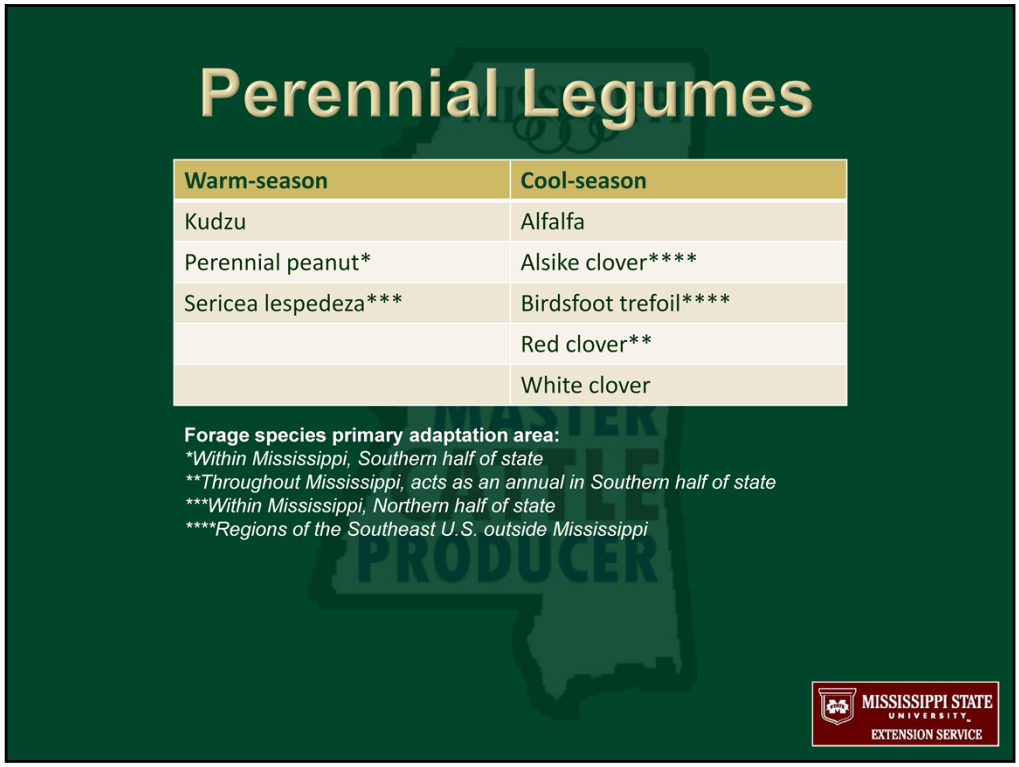
Warm-season forages begin growth and/or are planted in the spring or early summer and make most of their growth during the warmest months of the year. Dallisgrass and pearl millet are examples of warm-season forages.

Cool-season forages begin growth and/or are planted in the autumn or sometimes early spring and make most of their growth during the coolest months of the year, except for the coldest periods of the winter. Examples of cool-season forages include tall fescue and white clover.

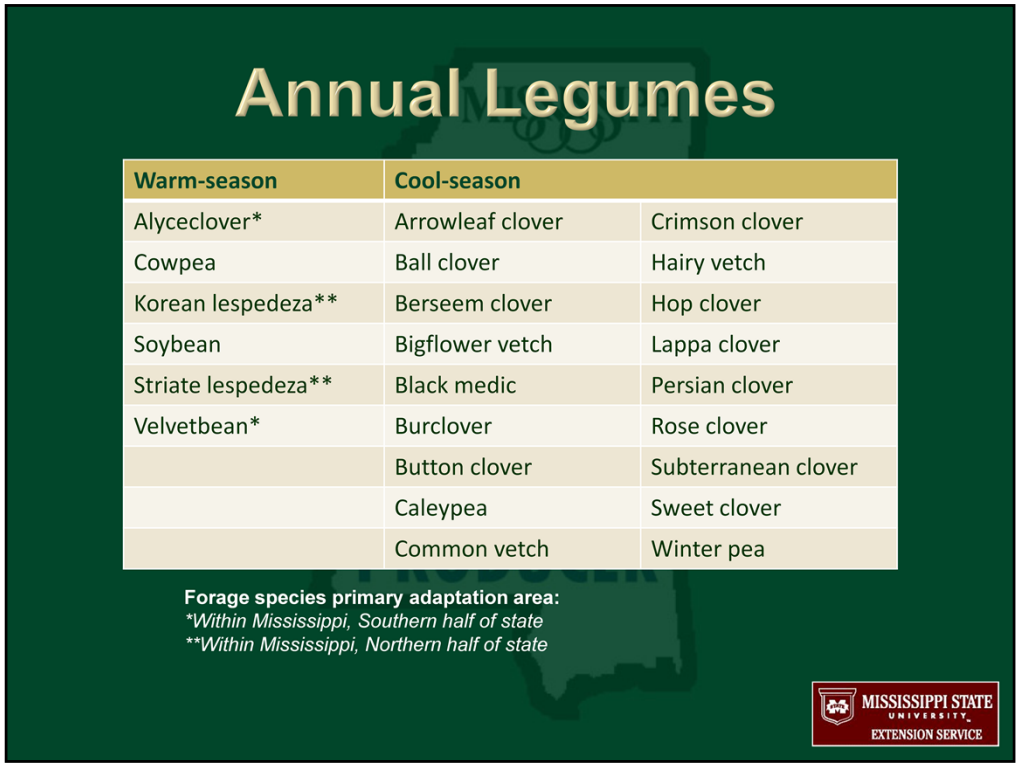
Perennial grasses are listed by growing season classification. Asterisks indicate forage adaptation. Many of these forages can be grown in Mississippi. Others may not be adapted to or widely used in the state but could be utilized in cattle feeding programs in the form of hay imported from other areas. Bermudagrass and bahiagrass are currently the most widely utilized warm-season forages in Mississippi of the forages listed above. Tall fescue is the most widely grown cool-season perennial forage in North Mississippi.



Annual grasses are listed by growing season classification. Asterisks indicate forage adaptation. Many of these forages can be grown in Mississippi. Others may not be adapted to or widely used in the state but could be utilized in cattle feeding programs in the form of hay imported from other areas. Annual ryegrass is currently the most widely utilized forage in Mississippi of the forages listed above.



Perennial legumes are listed by growing season classification. Asterisks indicate forage adaptation. Many of these forages can be grown in Mississippi. Others may not be adapted to or widely used in the state but could be utilized in cattle feeding programs in the form of hay imported from other areas. White clover is the most widely grown perennial legume in Mississippi, but there is potential to utilize other legumes on this list, including alfalfa, in the state.



Annual legumes are listed by growing season classification. Asterisks indicate forage adaptation. Many of these forages can be grown in Mississippi. Others may not be adapted to or widely used in the state but could be utilized in cattle feeding programs in the form of hay imported from other areas. Arrowleaf and crimson clovers are 2 of the more widely utilized forages in Mississippi of the forages listed above.

Chicory is neither a grass nor a legume. It is classified as a forage herb or forb. Chicory originates from southern Europe, and is a short-lived (3 to 5 years) perennial. While chicory is a cool-season plant, it is summer-active and continues to be quite productive during Mississippi summers. At first glance, chicory looks more like a pasture weed, such as curly dock, or mescaline lettuce found in the grocery store, rather than a forage crop.

Chicory has a deep tap root (which makes it very drought tolerant) like alfalfa, broad "lettuce-like" leaves that grow from a crown, and produces 4- to 5-feet tall stems with pink, purple, and blue flowers. Chicory does not like heavy wet soils, particularly if they are wet in the hot summer months. Like many taproot species, chicory suffers from diseases in wet ground. Chicory grows best in moderately- to free-draining soils with no impediment to root penetration. Chicory can tolerate soil pH down to 5 but tends to do better when lime, P and K are applied according to soil test recommendations for the cool-season grasses. Chicory also needs regular nitrogen applications. Do not use broadleaf herbicides on chicory crops (2,4-D products kill chicory very effectively).

Chicory is best managed as a specialty crop when used as a perennial. Chicory needs to be strip or rotationally grazed to prolong stand life. Manage for a pregrazing forage height of about 6 to 14 inches and a postgrazing forage height of no shorter than 3 to 4 inches. Cattle growth performance on chicory rivals annual ryegrass for average daily gains. Chicory has very high nutritive value (crude protein 15% to 30% and digestibility 75% to 90%), is high in many important minerals, and palatable to a wide range of livestock, including cattle. Chicory makes up a significant portion of the U.S. wildlife seed market. Three chicory varieties (Oasis, Puna, and Choice) vary in levels of a compound called lactucin (Oasis = high, Puna = intermediate, and Choice = low). The low lactucin line is more suitable for the dairy cattle market where desirable milk flavor is critical.

Bahiagrass (*Paspalum notatum*)

Plant Characteristics: Bahiagrass is a perennial warm-season grass distinguished by J-shaped, purplish rhizomes. Seed heads have 2 or 3 spikes attached at a common point. Bahiagrass forms a very dense sod and grows 12 to 20 inches tall.

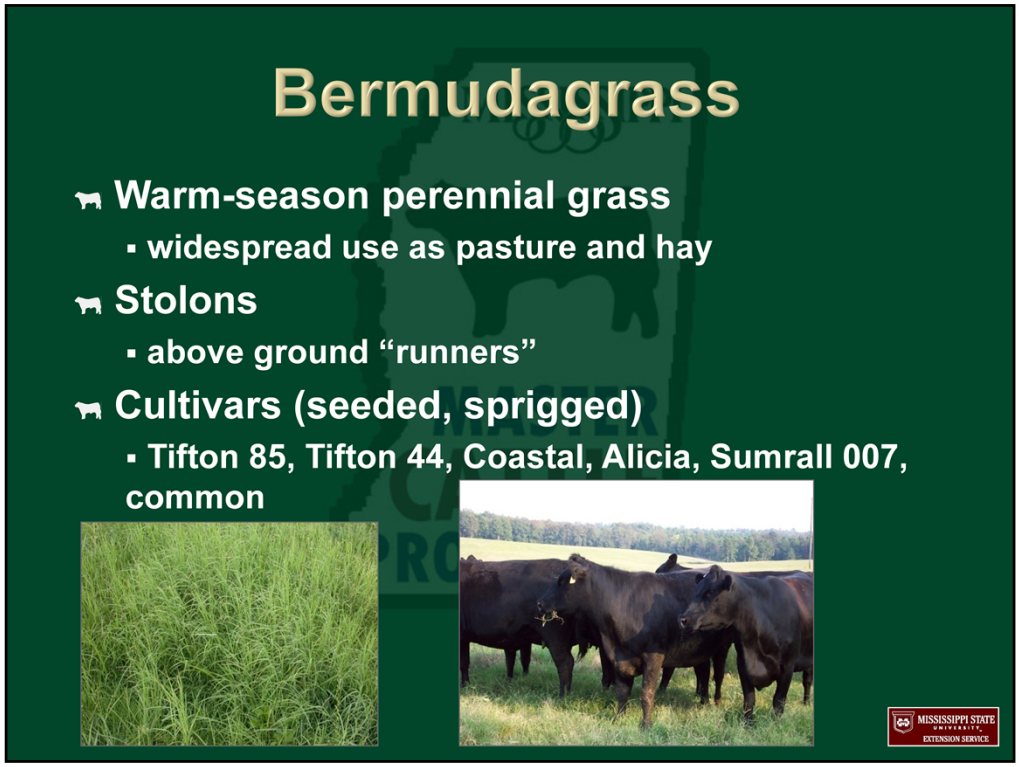
Establishment: Bahiagrass is well adapted to the central and southern part of Mississippi but is also grown in the northern part of the state. It has excellent tolerance to drought and good tolerance to poor drainage conditions. Seedling vigor is poor. Bahiagrass can be established from March to April at seeding rate of 15 to 20 lb/acre. Plant bahiagrass ¼ to ½ inch deep.

Fertilization: Bahiagrass is adapted to sandy and sandy loam soils. It is tolerant to low fertility and soil acidity. It is also extremely competitive, making it difficult to grow in mixtures with legumes. Bahiagrass has a good response to nitrogen and potassium. Inadequate potassium results in low hay yields, especially if hay is harvested from the same pasture for several years.

Grazing/Hay Management: Bahiagrass can be used for pasture or hay. It is also useful for erosion control. Most forage production occurs from April to October with hay yields ranging from 2 to 5 tons/acre. It can tolerate close grazing. Start grazing at 6 to 10 inches forage height, and end grazing at 1 to 2 inches forage height. Allow 10 to 20 days rest between grazing. Bahiagrass can be overseeded with small grains or annual ryegrass.

Forage Quality: Forage quality is typically lower than bermudagrass. Hay is generally 9 to 11% CP and 50 to 56% TDN. Bahiagrass quality tends to decline sharply late in the growing season.

Varieties/Cultivars: Common, Pensacola, Tifton 9, Argentine, Paraguay



Bermudagrass (*Cynodon dactylon*)

Plant Characteristics: Bermudagrass is a warm-season perennial grass that is spread by stolons, rhizomes, or seed. It has hairy ligules. Seed heads have 3 to 5 slender spikes connected at a common point. Hybrids are deep rooted. Bermudagrass grows 15 to 24 inches tall.

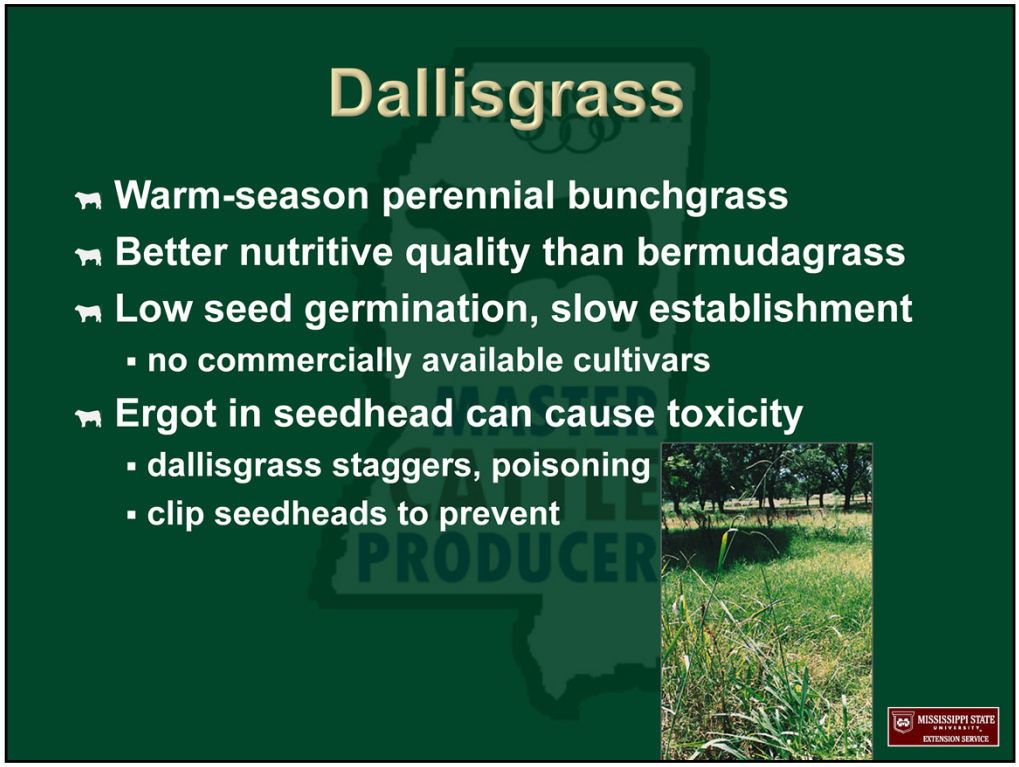
Establishment: Bermudagrass is extremely drought tolerant and can be planted throughout the state. Adaptation varies by cultivar. Plant hulled bermudagrass seed in spring at a seeding rate of 5 to 10 lb/acre. Seeding depth is 0 to ½ inches. Hybrid bermudagrass propagated by sprigs should be planted at a rate of 10 bu/acre in rows or broadcast and covered at rates of 25 to 40 bu/acre. Potassium deficiency increases leafspot disease. Armyworms and spittlebug can reduce yields. It is extremely tolerant of drought but has low tolerance to poor drainage.

Fertilization: Bermudagrass is best adapted to sandy soils. It tolerates soil acidity very well and is highly responsive to N fertilization. Total requirements for N and K are similar. Inadequate K fertilization is the most common cause of stand declines. Leafspot is more likely when soil K levels are low.

Grazing/Hay Management: Bermudagrass is widely utilized throughout Mississippi for pasture and hay. Most forage production occurs late May to October with hay yields ranging from 2 to 6 tons/acre for common bermudagrass and 5 to 8 tons/acre for hybrid bermudagrass. Hay should be harvested at 4 to 6 weeks intervals. Close grazing helps maintain forage quality. Start grazing at 4 to 8 inches forage height, and end grazing at 1 to 2 inches forage height. Allow 1 to 2 week rest between grazing. Annual clovers and winter annual grasses can be overseeded in autumn for winter-spring forage.

Forage Quality: Forage quality varies by maturity and cultivar: Coastal bermudagrass harvested at 4-weeks (CP 10 to 14%, TDN 52 to 58%); Coastal bermudagrass harvested at 8-weeks (CP 6 to 8%, TDN 45 to 50%); common bermudagrass (CP 9 to 11%, TDN 50 to 56%); Tifton 85 is generally the highest quality cultivar.

Varieties/Cultivars: Seeded: Common, Giant, Majestic, Cheyenne, Mohawk; Blends: Pasto Rico (common, giant), Texas Tough Plus (common, giant, Majestic), Pasture Supreme (common, giant), Tierra Verde (common. giant), Ranchero Frio (Cheyenne, Mohawk, giant), Sungrazer Plus (KF 194, CD90160, giant), Vaquero (CD 90160, Mirage); Propagated: Coastal, Tifton 85, Tifton 44, Midland, Midland 99, Sumrall 007.



Dallisgrass (*Paspalum dilatatum*)

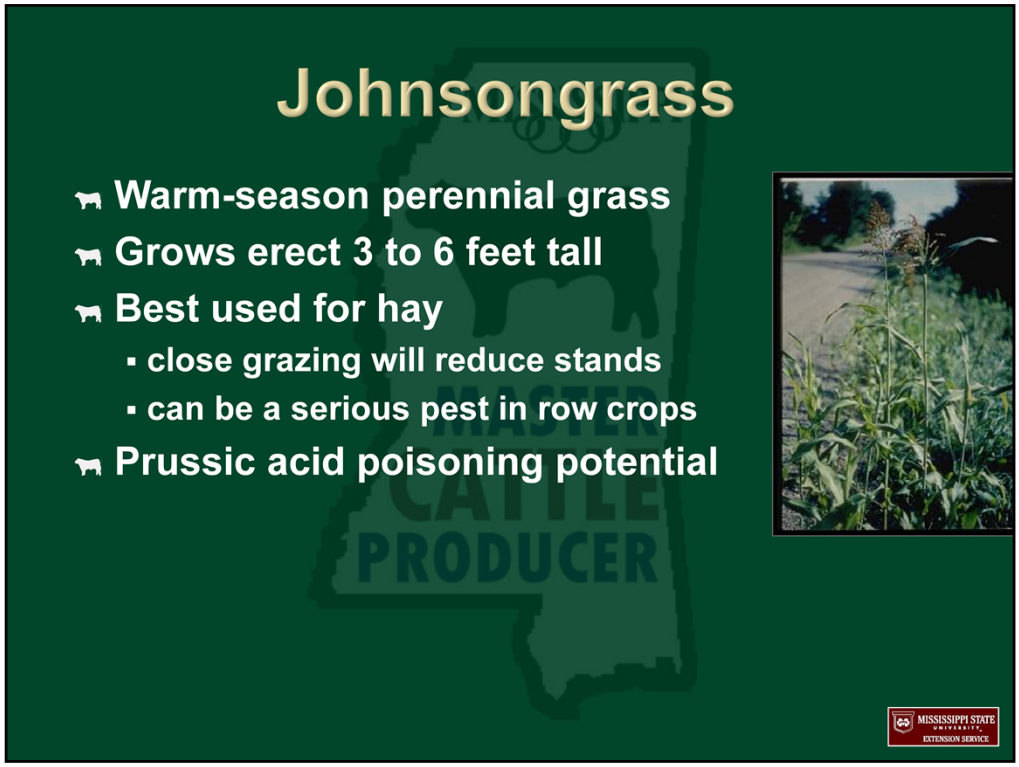
Plant Characteristics: Dallisgrass is a perennial warm-season bunchgrass distinguished by short rhizomes and seed heads with 3 to 6 spikes that often droop. It grows 10 to 20 inches tall and is very leafy, with rough leaf edges and sparse hairs near leaf bases.

Establishment: Dallisgrass is well adapted throughout Mississippi. It is best adapted on clay and loam soils in areas of good summer moisture. Dallisgrass has good tolerance to drought, excellent tolerance to poor drainage. It can be established from pure live seed in March and April at a broadcast seeding rate of 10 to 15 lb/acre. Seeding depth is ¼ to ½ inch. Seed germination is very low, and establishment is generally slow. It may be difficult to find seed for sale for planting.

Fertilization: Dallisgrass has a fair tolerance to soil acidity. It is moderately responsive to nitrogen.

Grazing/Hay Management: Dallisgrass can be used for pasture or hay. It is very compatible with white or red clover. Most forage production occurs from April to October. Dallisgrass has good tolerance to grazing. Start grazing at 6 to 8 inches forage height, and end grazing at 3 to 4 inches forage height. Allow 1 to 2 weeks rest between grazing. Hay yield is often 2 to 4 tons/acre.

Forage Quality: Dallisgrass quality is typically higher than bermudagrass. Hay is generally 9 to 12% CP and 50-56% TDN.



Johnsongrass (*Sorghum halepense*)

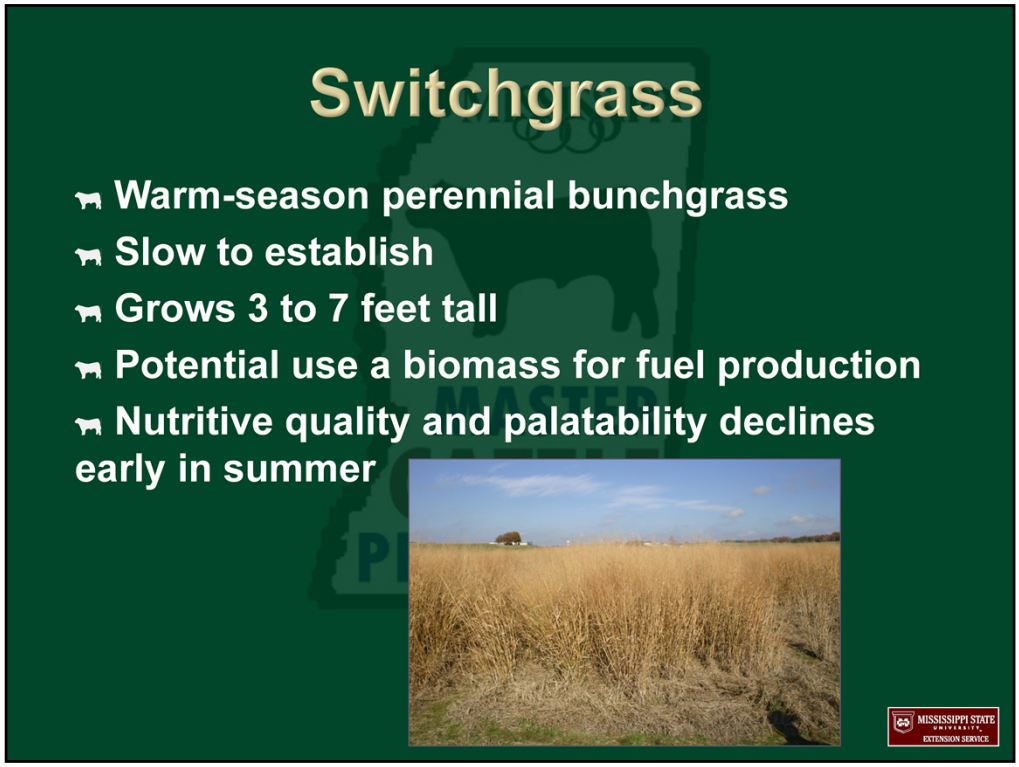
Plant Characteristics: Johnsongrass is a perennial warm-season grass. It grows erect 3 to 6 feet tall. Leaves have a white midrib and a very tall ligule. The seed head is an open brown panicle. Johnsongrass has rhizomes.

Establishment: Johnsongrass is well adapted throughout Mississippi. It is best adapted on clay soils. Johnsongrass has good tolerance to drought and excellent tolerance to poor drainage. It spreads by rhizomes and seed. Johnsongrass can be established from seed in April at a broadcast seeding rate of 20 to 30 lb/acre or 10 to 15 lb/acre drilled. Seeding depth is ½ to 1 inch. Johnsongrass is considered a serious pest in row crops.

Fertilization: Johnsongrass has fair tolerance to soil acidity. It responds well to nitrogen.

Grazing/Hay Management: Johnsongrass is best used for hay. Harvest hay at heading. Most forage production occurs from May to September. It is not very tolerant of close grazing. Rotational stocking is required to maintain stands. Start grazing at 16 to 20 inches forage height, and end grazing at 8 to 12 inches forage height. Allow 30 to 40 days rest between grazing. Hay yield is often 2 to 5 tons/acre.

Forage Quality: Johnsongrass hay is generally 10 to 14% CP and 50 to 60% TDN. It has prussic acid potential and should be managed to prevent poisoning.



Switchgrass (*Panicum virgatum*)

Plant Characteristics: Switchgrass is a perennial warm-season bunchgrass. It grows erect 3 to 7 feet tall and is deep rooted. Leaves are hairy near their bases. The seed head is an open panicle. Switchgrass has rhizomes.

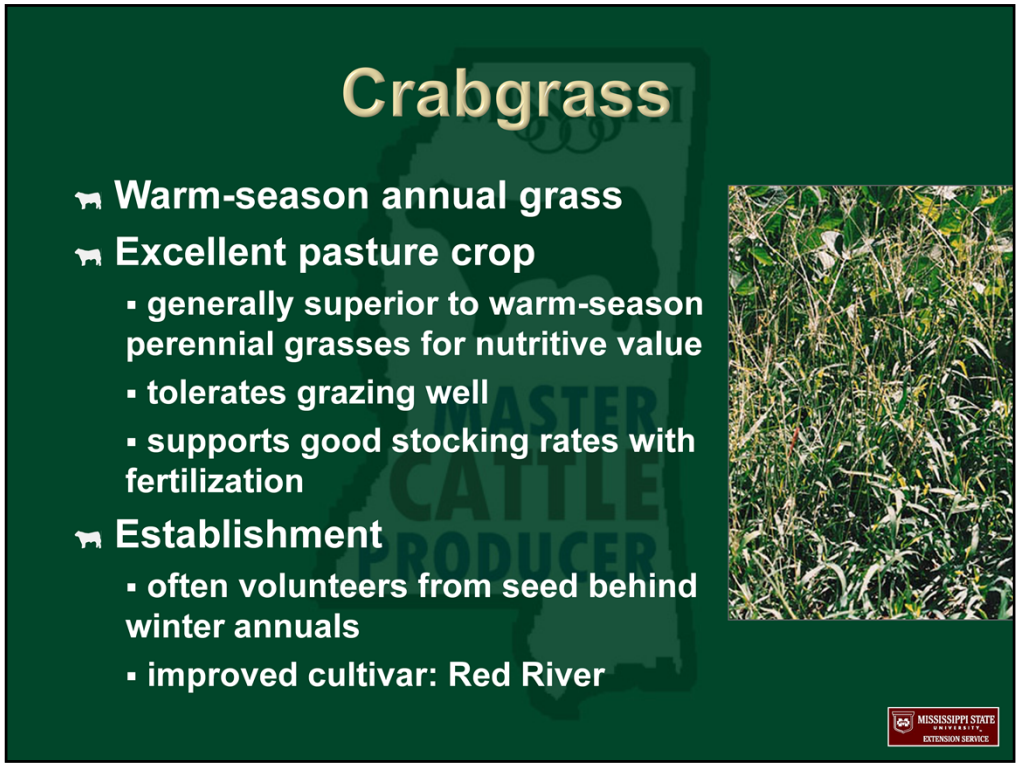
Establishment: Switchgrass is well adapted throughout Mississippi. It has excellent tolerance to drought and fair tolerance to poor drainage. Switchgrass spreads by rhizomes and seed. Seedling vigor is poor, and seedling establishment is slow. It can be established from pure live seed in April and May at a seeding rate of 5 to 6 lb/acre. Seeding depth is ¼ to ½ inch.

Fertilization: Switchgrass has fair tolerance to soil acidity. It responds well to nitrogen.

Grazing/Hay Management: Switchgrass is used for pasture and hay. Most forage production occurs from late May to July. It is not very tolerant of close grazing. Switchgrass should be stocked heavy in a rotational grazing system. Start grazing at 18 to 22 inches forage height, and end grazing at 8 to 12 inches forage height. Allow 4 to 6 weeks rest between grazings to maintain quality and stands.

Forage Quality: Switchgrass is generally 10 to 14% CP and 58 to 62% TDN at the vegetative to boot stages. At heading, it is generally 6 to 10% CP and 50 to 58% TDN. Switchgrass develops stems several weeks earlier than other warm-season grasses. It may become stemmy and unpalatable early in summer. Improved cultivars have higher nutritive quality and yields.

Varieties/Cultivars: Alamo, Pathfinder, Cave-in-Rock, Blackwell, Shelter, Summer, Trailblazer, Forestburg, Dacotah, Caddo, Kanlow, Nebraska 28



Crabgrass (*Digitaria sanguinalis*)

Plant Characteristics: Crabgrass is an annual warm-season grass. It grows 2 to 4 feet tall in a creeping manner with long stolons. Crabgrass is very leafy with sparse hairs, long hairs at collars, and tall ligules. The seed head has 3 or more spikes.

Establishment: Crabgrass is well adapted throughout Mississippi. Much of the crabgrass used is from volunteer stands, often behind winter annuals. It reseeds well, and has good seedling vigor. Crabgrass can be established from seed in March to May at a seeding rate of 4 to 6 lb/acre. It has fair tolerance to drought and low tolerance to poor drainage.

Fertilization: Crabgrass has good tolerance to soil acidity. It responds very well to nitrogen.

Grazing/Hay Management: Crabgrass is used for pasture and hay, although it can be difficult to cure for hay. It is considered a weed in many farming situations. Most forage production occurs from May to September. Crabgrass has excellent grazing tolerance. With adequate fertilization, crabgrass will support good stocking rates.

Forage Quality: The nutritive quality of crabgrass is generally superior to warm-season perennial grasses.

Varieties/Cultivars: Red River

Pearl Millet (*Pennisetum glaucum*)

Plant Characteristics: Pearl millet is a warm-season annual grass. It grows erect 3 to 8 feet tall. Pearl millet is very leafy with wide leaves serrated at margins and hairy ligules. The seed head is a large cylindrical spike (cattail).

Establishment: Pearl millet is well adapted throughout Mississippi. It is best adapted on sandy soils and does not do well on calcareous soils (will turn yellow from iron deficiency). Pearl millet has excellent tolerance to drought but very low tolerance to poor drainage. It has excellent seedling vigor. Pearl millet can be established from seed in April to June at a seeding rate of 12 to 15 lb/acre drilled or 25 to 30 lb/acre broadcast. Seeding depth is ½ to 1½ inch.

Fertilization: Pearl millet has excellent tolerance to soil acidity, much more so than sorghum. It responds very well to nitrogen.

Grazing/Hay Management: Pearl millet is used for pasture and silage. Silage harvest should take place when plants are 30 to 40 inches tall. Hay making is difficult due to thick stems. Most forage production occurs from June to September, and it is very productive over this short season. It has fair grazing tolerance. Pearl millet requires a high stocking rate and does best with rotational stocking. Start grazing at 20 to 24 inches forage height, and end grazing at 8 to 12 inches forage height. Allow 10 to 20 days rest before grazing again. Stems may need to be mowed after grazing. Armyworms and cinch bugs are pests of pearl millet.

Forage Quality: Pearl millet is generally 8 to 12% CP and 50 to 58% TDN. The nutritive quality of pearl millet is high if harvested at the immature stage. Nitrate accumulation can cause toxicity problems under certain conditions.

Varieties/Cultivars: Several hybrid millets are commercially available including Tifleaf-3. Some hybrids are tall-growing and produce high yields. Other hybrids are dwarf, low-growing millets that are excellent for grazing. Dwarf millets produce leafy forage and support higher average daily gains than taller hybrids. Newer dwarf millet varieties are resistant to *Pyricularia* leafspot, which can reduce millet yields in late summer.

Sorghum-Sudan Hybrids and Sudangrass (*Sorghum bicolor*)

Plant Characteristics: Sorghum sudangrass is a warm-season annual grass. It grows erect 4 to 8 feet tall and is very leafy. The seed head is an open panicle.

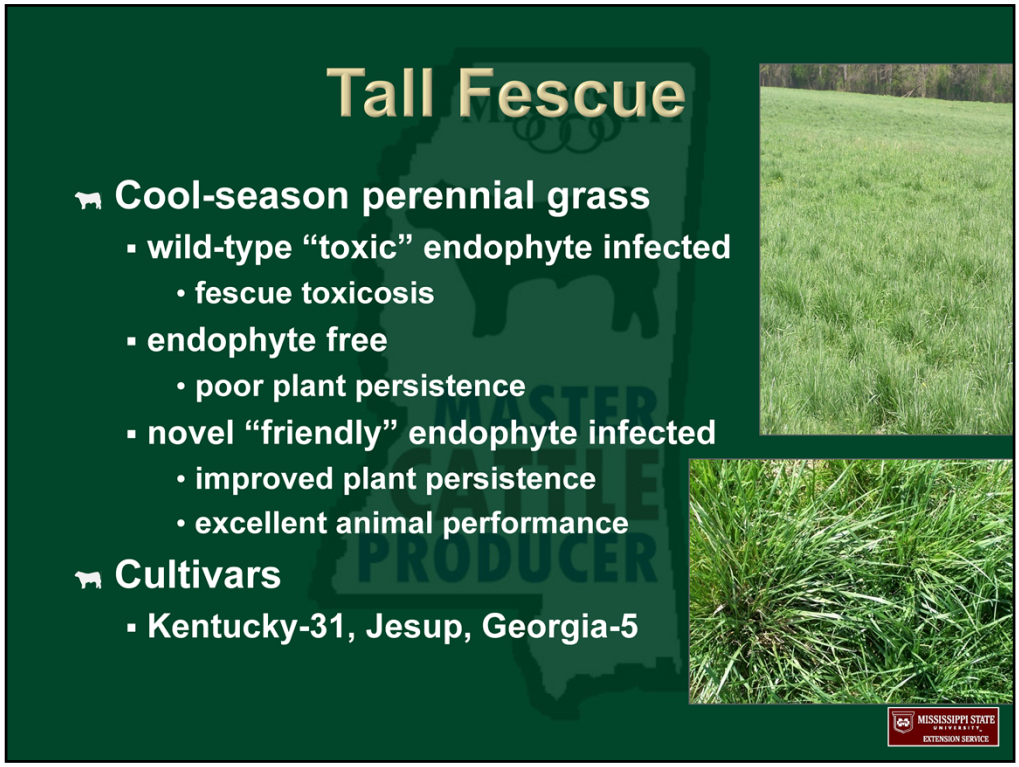
Establishment: Sorghum sudangrass is well adapted throughout Mississippi. It has good tolerance to drought and fair tolerance to poor drainage. Sorghum sudangrass has excellent seedling vigor. It can be established from seed in May to June at a seeding rate of 20 to 25 lb/acre drilled or 30 to 40 lb/acre broadcast. Seeding depth is ½ to 1 inch.

Fertilization: Sorghum sudangrass is not tolerant of highly acid soils and needs lime on these soils. It responds very well to nitrogen.

Grazing/Hay Management: Sorghum sudangrass is used for pasture, hay, and silage. Hay and silage harvest should take place when plants are 30 to 40 inches tall. Hay making is difficult due to thick stems. Most forage production occurs from June to September, and it is very productive over this short season. It has fair grazing tolerance. Sorghum sudangrass requires a high stocking rate and does best with rotational stocking. Start grazing at 20 to 24 inches forage height, and end grazing at 8 to 12 inches forage height. Allow 10 to 20 days rest before grazing again. Thin-stemmed varieties recover sooner after harvest than thick-stemmed varieties. Stems may need to be mowed after grazing. Armyworms are pests of sorghum sudangrass.

Forage Quality: Sorghum sudangrass is generally 8 to 12% CP and 50 to 58% TDN. The nutritive quality of sorghum sudangrass is high if harvested at the immature stage. Nitrate accumulation or prussic acid can cause toxicity problems under certain conditions.

Varieties/Cultivars: Varieties include Piper, Greenleaf, and Imperial hybrid sudangrass. Cultivars are available with the brown mid-rib (BMR) trait that results in higher digestibility and nutritive value.



Tall Fescue (*Lolium arundinacea*)

Plant Characteristics: Tall fescue is a cool-season perennial bunchgrass with short rhizomes. It grows 2 to 4 feet tall and is deep rooted. Leaves are dark green and slightly shiny with prominent veins and rough edges. The seed head is a compressed panicle. Tall fescue can be infected with an endophyte (fungus) that provides benefits to the plant such as insect and drought resistance. Wild-type endophyte infection produces alkaloids that are toxic to livestock and drastically reduce animal performance, fescue toxicosis. Endophytes that improve tall fescue plant persistence and allow for good animal performance are available. These novel tall fescue-endophyte combinations are often referred to as "friendly" or "non-toxic" tall fescues.

Establishment: Tall fescue is adapted to North Mississippi but is grown to a limited degree in areas of South Mississippi. It has good seedling vigor if endophyte infected, fair otherwise. Tall fescue can be established from seed in September to November at a seeding rate of 15 to 20 lb/acre drilled or 20 to 25 lb/acre broadcast. Seeding depth is ¼ to ½ inch. It grows well in mixtures with white clover, red clover, or alfalfa. Tall fescue has good tolerance to drought if endophyte infected and only fair tolerance without endophyte infection. Tolerance to poor drainage is good.

Fertilization: Tall fescue has good tolerance to soil acidity. It responds very well to nitrogen.

Grazing/Hay Management: Tall fescue is used for pasture, hay, and erosion control. Most forage production occurs from September to December and March to June. Grazing tolerance is excellent when infected with the wild-type, toxic endophyte. Livestock increase intake and performance on endophyte-free and friendly, novel endophyte-infected stands. Do not graze these stands less than 3 inches, particularly during summer. Start grazing at 4 to 8 inches forage height, and end grazing at 2 to 3 inches forage height. Allow 2 to 4 weeks rest before grazing again. Endophyte-free stands can only be maintained long term with careful grazing management. Tall fescue works well stockpiled in autumn for deferred grazing. Nematodes are a serious problem for tall fescue on sandy soil.

Forage Quality: Tall fescue is generally 12 to 16% CP and 61 to 66% TDN at the vegetative to boot stages. At heading, it is generally 8 to 12% CP and 56 to 61% TDN. Harvest hay in the late boot stage for high quality and then afterwards at 4- to 6-week intervals. Alkaloids produced by wild-type endophyte infection of tall fescue plants produce tall fescue toxicosis in livestock.

Varieties/Cultivars: The predominant "native" variety is Kentucky-31, most of which is infected with the toxic, wild-type endophyte. Endophyte-free varieties include AU Triumph, Forager, and others. Jesup and Georgia-5 cultivars are marketed with the "friendly" endophyte technology as MaxQ tall fescue. 'Texoma' is another cultivar with "friendly" endophyte technology that is commercially available.

Annual Ryegrass (*Lolium multiflorum*)

Plant Characteristics: Annual ryegrass is a cool-season annual bunchgrass. It grows 2 to 3 feet tall. Leaves are dark and shiny with smooth edges. Auricles are soft and clasping. The seed head is a spike with awned seeds.

Establishment: Annual ryegrass is well adapted and widely used throughout Mississippi. It is less winter hardy than tall fescue or orchardgrass. Annual ryegrass has a high moisture requirement and excellent tolerance to poor drainage. It has good seedling vigor, and natural reseeding is common. Annual ryegrass can be established from seed in September to October at a seeding rate of 10 to 30 lb/acre in mixtures or 20 to 30 lb/acre alone. November overseeding of warm-season grasses can be done in Mississippi. Seeding depth is 0 to ½ inch.

Fertilization: Annual ryegrass has good tolerance to soil acidity. It responds well to nitrogen.

Grazing/Hay Management: Annual ryegrass is used for mainly for pasture but also for hay and silage. Most forage production occurs from November to May, with most production concentrated from late February through May. Under favorable conditions, high forage production and excellent animal gains are possible. It has excellent grazing tolerance. Annual ryegrass is often limit grazed for a few hours at a time. It can also be used for creep grazing. For rotational stocking, start grazing at 6 to 12 inches forage height, and end grazing at 3 to 4 inches forage height. Allow 1 to 2 weeks rest before grazing again. Rust and blast (fungal infection) can be a problem, particularly in South Mississippi after periods of warm, humid conditions.

Forage Quality: Annual ryegrass has high nutritive quality. It is generally 12 to 16% CP and 63 to 68% TDN at the vegetative to boot stages. At heading, annual ryegrass is generally 8 to 12% CP and 59 to 63% TDN.

Varieties/Cultivars: Varieties include Marshall, TAM 90, Passarel Plus, Bulldog Grazer, Brigadier, Big Boss, Jackson, Stampede, and Ribeye. Cultivars differ in yields, crown rust resistance, and cold tolerance.

Small Grains: Rye (*Secale cereale*), Oats (*Avena sativa*), Wheat (*Triticum aestivum*), Barley (*Hordeum vulgare*), Triticale (*Triticum secale*)

Plant Characteristics: The small grains are cool-season annual bunchgrasses. They grow 2 to 4 feet tall. The seed heads are spikes on all except for oats, which has a panicle.

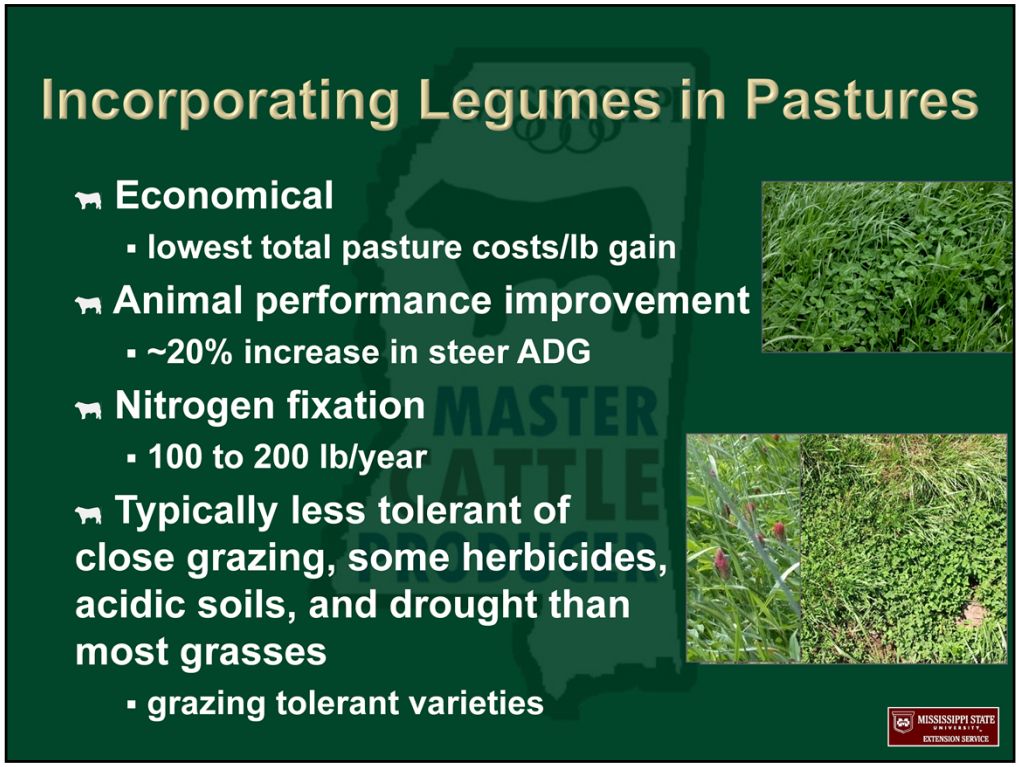
Establishment: Rye and wheat are adapted throughout Mississippi. Oats are adapted to South Mississippi. In the northern part of the state, winter kill can be a problem with oats, although varieties differ in this sensitivity. Wheat is more tolerant of heavy, wet soils than rye or oats. The small grains have high moisture requirements. They also all have excellent seedling vigor. Small grains can be established from seed in September to October at a seeding rate of 60 to 90 lb/acre in mixtures or 90 to 120 lb/acre alone. November overseeding of warm-season grasses is also possible. Seeding depth is 1 to 2 inches.

Fertilization: Rye is more tolerant of soil acidity than wheat or oats. All the small grains are highly responsive to nitrogen. They require adequate amounts of phosphorus and potassium as well.

Grazing/Hay Management: Rye is used for mainly for pasture. Wheat, oats, and barley are used for pasture, hay, and silage. Triticale is used for hay and silage production. Most forage production occurs from November to April in South Mississippi and from November to December and February to April in North Mississippi. The small grains have good grazing tolerance. For rotational stocking, start grazing at 8 to 12 inches forage height, and end grazing at 3 to 4 inches forage height. Allow 1 to 2 weeks rest before grazing again. Harvest hay in the boot to early head stage. Rusts, powdery mildew, viruses, Hessian fly, and especially armyworms can be a problem for the small grains.

Forage Quality: Rye is generally 8 to 10% CP and 50 to 55% TDN. Oats are typically 8 to 12% CP and 55 to 60% TDN. Wheat usually runs 8 to 10% CP and 54 to 60% TDN.

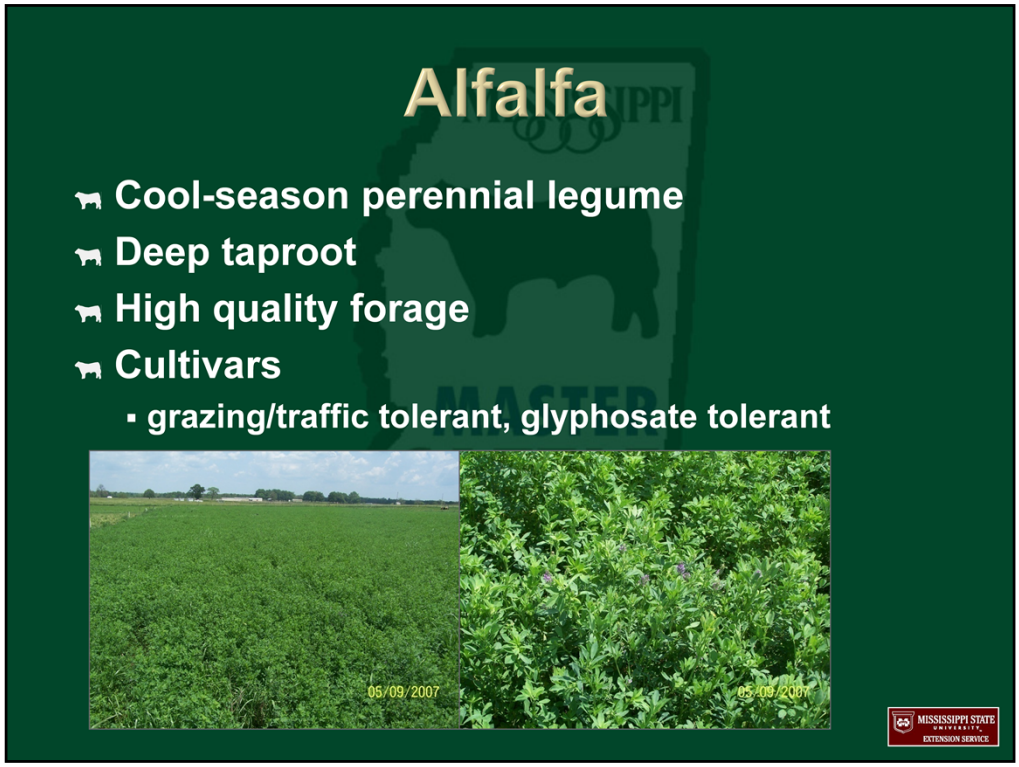
Varieties/Cultivars: Oat cultivars include Dallas (best cold tolerance), TAM 606, Harrison, and Horizon 314. Elbon Rye is a commonly used rye cultivar. Wheat cultivars include Longhorn and Lockett. A triticale cultivar is TAMCALE 5019.



There are good reasons to consider adding legumes to pastures. More often than not, the pasture systems with the lowest total pasture costs per pound of animal gain involve legumes. Legumes are generally higher quality than grasses in terms of crude protein content. However, they often do not produce the dry matter yields that grasses do. Inclusion of at least ¼ of the pasture cover as legumes can increase grazing animal performance. Stocker cattle average daily gains can improve by ¼ pound per day or more by adding legumes to pastures.

The unique ability of legumes to obtain nitrogen from the air also makes them especially valuable in forage programs. The specific amounts of nitrogen fixed per year vary by legume species, but legume nitrogen fixation levels generally range from 100 to 200 pounds of nitrogen per acre per year. This nitrogen does not become available for other forages to utilize until the root nodules and other plant parts containing this nitrogen break down in the soil.

A potential drawback to legumes is that they are typically less tolerant of close grazing than grasses. However, cultivars selected specifically for improved grazing tolerance are available. White clover is an example of a legume with stolons that enhance grazing tolerance. A major reason that keeps some producers from adding legumes to pastures is the susceptibility of legumes to some commonly used pasture herbicides. Instead of viewing this as a tradeoff between weed control and legume use, consider strategic weed control practices that use herbicide selection and application timing practices that provide for both weed control and legume stand maintenance. On very acidic soils, legume establishment and maintenance is difficult. Soil testing and liming well in advance of legume planting is needed for successful legume establishment. Make sure that proper legume seed inoculation is practiced prior to planting as well. Drought tolerance is sometimes noted as a problem with managing legumes, but this can be addressed through legume species and cultivar selection, use on soils with acceptable water holding capacity, and irrigation practices when warranted.



Alfalfa (*Medicago sativa*)

Plant Characteristics: Alfalfa is a cool-season perennial legume with up to 36 inches of growth and a deep taproot. Most tillers arise from the crown. Leaves are trifoliate with long, narrow leaflets serrated at the tips. Flowers are normally shades of purple.

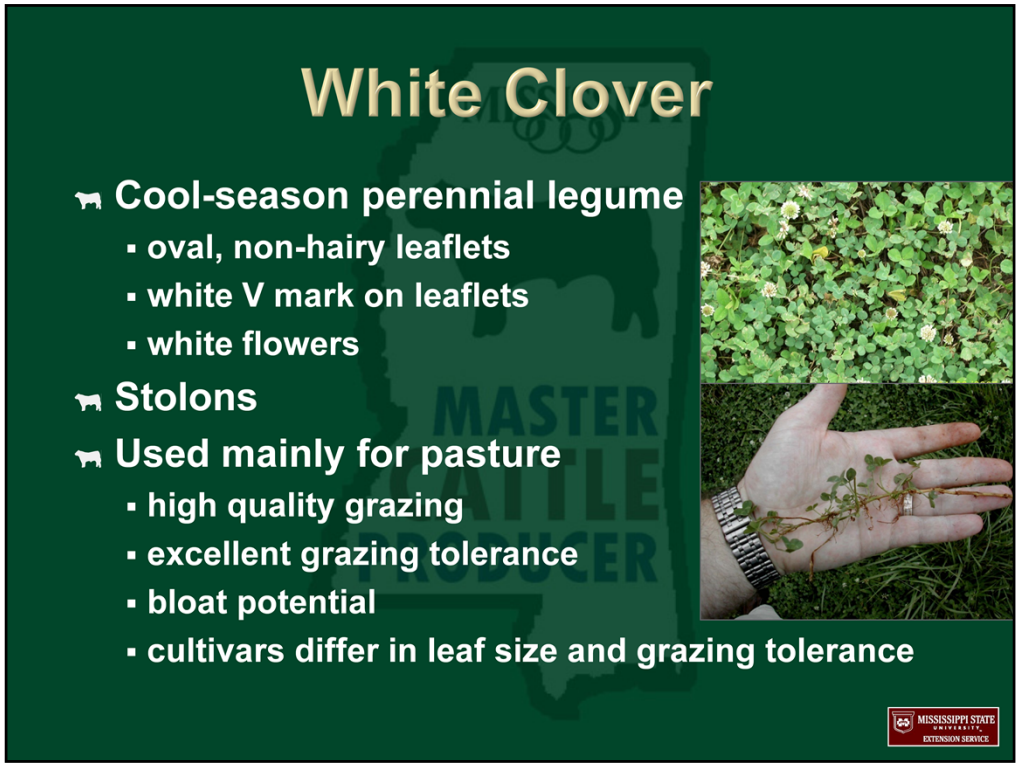
Establishment: Alfalfa can be adapted throughout the state. It is best planted during September to October. Plant seed at a rate of 15 to 20 lb/acre in a well-prepared bed using a cultipacker-seeder at ¼ to ½ inch deep. Alfalfa needs well-drained soils. Several diseases and pests such as *Sclerotenia* crown and stem rot, alfalfa weevil, and leafhoppers can be a problem if they are not controlled. Nematodes are a major problem in the sandy Coastal Plain soils.

Fertilization: Alfalfa is very sensitive to soil acidity and aluminum. Nitrogen fertilization is not needed, but alfalfa requires phosphorus, potassium, sulfur, and boron fertilization. Alfalfa usually fixes from 150 to 200 lb/acre of nitrogen each year.

Grazing/Hay Management: Successful production requires a high level of management. Alfalfa productivity in South Mississippi can occur from March to November, and in North Mississippi can be from April to October. It can be used for pasture, hay, or silage. Alfalfa is best harvested in the early bloom stage. Rotational grazing with at least 2 to 4 weeks of rest is recommended. Start grazing at 10 to 16 inches forage height, and end grazing at 2 to 3 inches for grazing type alfalfas. Alfalfa becomes dormant during the summer.

Forage Quality: Alfalfa forage quality varies with maturity as follows: bud (CP 22-26%, TDN 64-67%); early flower (CP 18-22%, TDN 61-64%); mid bloom (CP 14-18%, TDN 58-61%); full bloom (CP 9-13%, TDN 50-57%).

Varieties/Cultivars: Grazing and traffic tolerant varieties available. Round-Up Ready (glyphosate tolerant) varieties provide a better management option for weed control and establishment.



White Clover (*Trifolium repens*)

Plant Characteristics: White clover is a cool-season perennial legume. It grows 8 to 12 inches tall. White clover spreads by stolons and forms shallow roots at nodes. Leaflets are oval, non-hairy, and usually marked with a white V. White flowers are clustered into heads. Seed is extremely small.

Establishment: White clover is well adapted throughout Mississippi. White clover is not productive on droughty soils but will survive considerable dry weather. It has good tolerance to poor drainage. It has fair seedling vigor. Intermediate types typically reseed better than giant or ladino types. White clover can be established from seed with tall fescue in September to October at a seeding rate of 2 to 3 lb/acre. October/November and February/March overseeding of established grass pastures can be accomplished. Seeding depth is 0 to ¼ inch. White clover grows well in combination with tall fescue or dallisgrass but is more difficult to grow with bermudagrass or bahiagrass.

Fertilization: White clover has only fair tolerance to soil acidity. It responds very well to potassium. Phosphorus is essential for good production as well. White clover usually fixes from 75 to 150 lb/acre of nitrogen each year.

Grazing/Hay Management: White clover is used for mainly for pasture. Most forage production occurs from March to June and October to November with good moisture. It has excellent grazing tolerance. For rotational stocking, start grazing at 6 to 8 inches forage height, and end grazing at 1 to 3 inches forage height. Allow 1 to 2 weeks rest before grazing again. Grass competition from undergrazing shades white clover and is a major problem in maintaining productive stands. Virus diseases, leaf diseases, root diseases, and insect pests can attack white clover.

Forage Quality: White clover has high nutritive quality. Bloat can be a problem on white clover.

Varieties/Cultivars: Varieties include Durana, Patriot, Old white dutch, Ladino, Osceola, and Regal. Cultivars are often classified as ladino (giant, hay), intermediate, or small (white dutch) types based on leaf size. They may also be categorized as grazing types based on grazing tolerance.

Red Clover (*Trifolium pratense*)

Plant Characteristics: Red clover is a cool-season short-lived perennial legume usually lasting for 2 years. It often acts as an annual in South Mississippi. Red clover grows erect 2 to 3 feet tall. It is very leafy with hairy, oval leaflets marked with a white V. Pinkish-violet flowers are clustered into large heads.

Establishment: Red clover is adapted throughout Mississippi, typically lasting longer further north. Red clover tolerates poor drainage better than alfalfa but is less tolerant of extremely wet conditions than white clover. Seedling vigor is better than any other clover. Red clover can be established from seed on a prepared seedbed in September to October at a seeding rate of 6 to 8 lb/acre drilled or 12 to 15 lb/acre broadcast. February to March establishment may be possible in North Mississippi. October/November and February/March overseeding of established grass pastures can be accomplished. Seeding depth is ¼ to ½ inch. Red clover grows well in combination with tall fescue, dallisgrass, or johnsongrass.

Fertilization: Red clover has only fair tolerance to soil acidity. It responds well to potassium and phosphorus fertilization. Red clover usually fixes from 75 to 200 lb/acre of nitrogen each year.

Grazing/Hay Management: Red clover is used for pasture, hay, and silage. It has a lengthy growing season, with best yields where well adapted. Most forage production occurs from March to June. Hay yields typically average 2 to 4 tons/acre. Harvest hay in the early bloom stage. Red clover will provide more grazing than white clover during summer. It has only fair grazing tolerance and will not tolerate continuous, close grazing over long periods of time. For rotational stocking, start grazing at 8 to 10 inches forage height, and end grazing at 3 to 5 inches forage height. Allow 10 to 20 days rest before grazing again. Powdery mildew, northern and southern anthracnose, and bean yellow mosaic virus can attack red clover.

Forage Quality: Red clover is generally 14 to 16% CP and 57 to 62% TDN.

Varieties/Cultivars: Varieties include Bulldog (improved grazing persistence and hay yields), Bytown, Florex, Prosper I, Tristan, Redmor, Redland III, and Royal Red. Cultivars are available with resistance to one or more diseases.

Arrowleaf Clover (*Trifolium vesiculosum*)

Plant Characteristics: Arrowleaf clover is a cool-season annual legume. It has long, branching, hollow stems growing 2 to 4 feet long. Leaflets are arrow-shaped, non-hairy, and usually marked with a white V. Flowerheads are large, often 3 inches long, and mature from bottom to top. Flowers are predominantly white but can be pink- and purple-tinged. Arrowleaf clover seed are twice the size of white clover seed. Over 70% of seed have very hard seed coats requiring scarification (scratching) for satisfactory germination.

Establishment: Arrowleaf clover is well adapted throughout Mississippi, except on calcareous (limestone or chalky) soils or wet areas. Drought tolerance and seedling vigor are fair. Arrowleaf clover can be established from scarified seed with a special seed inoculant in September to early November at a seeding rate of 5 to 10 lb/acre. Seed will germinate at lower temperatures than crimson clover. Arrowleaf clover reseeds easily. Seeding depth is 0 to ½ inch.

Fertilization: Arrowleaf clover has only fair tolerance to soil acidity or low fertility. It responds well to phosphorus and potassium fertilization. Arrowleaf clover usually fixes from 50 to 150 lb/acre of nitrogen each year.

Grazing/Hay Management: Arrowleaf clover is used for pasture and hay. Most forage production occurs from March to early-July in North Mississippi and February to early-June in South Mississippi. It continues to develop new leaves and remain productive longer in the spring when grazed to a height of 2 to 4 inches than where large amounts of forage accumulate. For hay production, graze until early to mid-April, then harvest at early to mid-bloom in May. Hay yields typically average 2 to 3 tons/acre. Do not expect regrowth after hay cutting. Arrowleaf clover has good grazing tolerance. For rotational stocking, start grazing at 8 to 10 inches forage height, and end grazing at 2 to 4 inches forage height. Allow 10 to 20 days rest before grazing again. Viral diseases, crown and stem rot, and nematodes can be problematic for arrowleaf clover. Leaves turn a distinctive purplish-red color in response to stress.

Forage Quality: Arrowleaf clover is generally 14 to 17% CP and 56 to 61% TDN. Bloat is rarely a problem due to the presence of condensed tannins.

Varieties/Cultivars: Varieties include Apache (bean yellow mosaic virus tolerant), Amclo (early-maturing), Yuchi (mid-maturing), and Meechee (late-maturing).

Crimson Clover (*Trifolium incarnatum*)

Plant Characteristics: Crimson clover is a cool-season annual legume that grows 1 to 3 feet tall. Leaflets are dark green, oval, and without a V mark. Leaves and stems have dense hairs. Flowers are brilliant crimson. Flowerheads are long, maturing from bottom to top. Yellow, rounded crimson clover seed are 2.5 times the size of arrowleaf clover seed. Combine harvested seed do not need scarification.

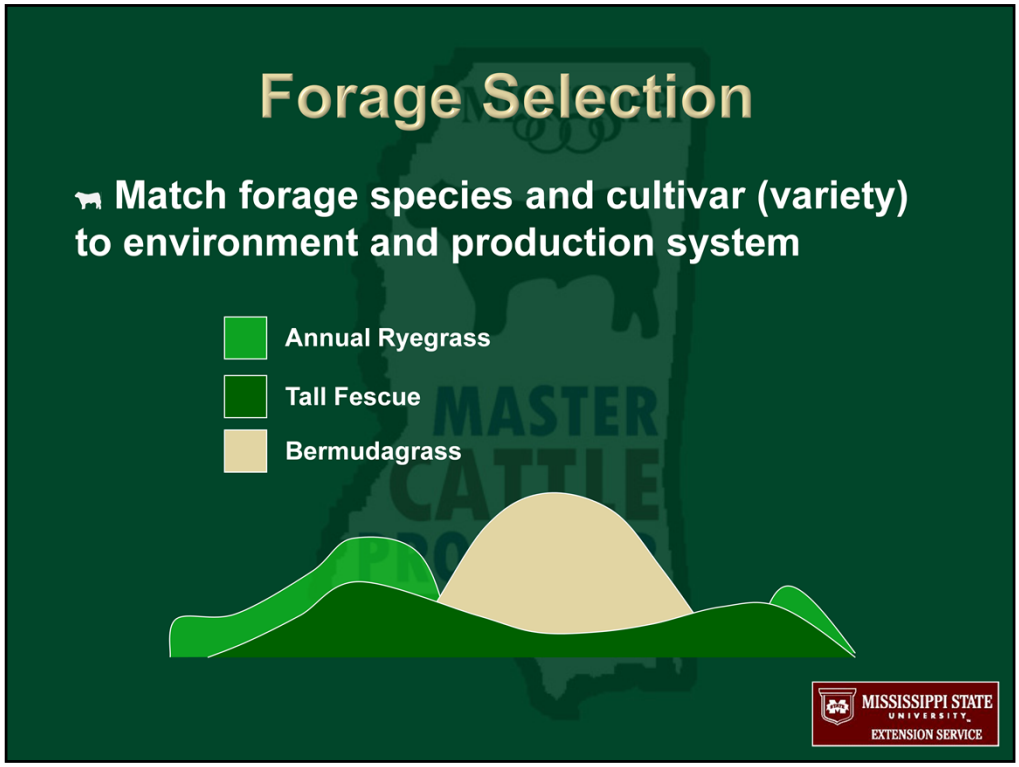
Establishment: Crimson clover is well adapted throughout Mississippi, except on calcareous (limestone or chalky) soils or wet areas. Drought tolerance is fair. Crimson clover can be established from seed in late-August to October at a seeding rate of 20 to 30 lb/acre. Seeding depth is ¼ to ½ inch. Clover head weevils often cause heavy seed losses and poor natural reseeding. Seedling vigor is good.

Fertilization: Crimson clover has good tolerance to soil acidity or low fertility. Crimson clover usually fixes from 50 to 150 lb/acre of nitrogen each year.

Grazing/Hay Management: Crimson clover is used for pasture, hay, and roadside beautification. Most forage production occurs during November and from March to April in North Mississippi. In South Mississippi, forage productivity is in late November to December and February to early-April. Crimson clover produces more forage at low temperatures than other clovers. It can be grazed throughout winter, but if hay is desired, cattle must be removed by mid-March. Crimson clover has only fair grazing tolerance. For rotational stocking, start grazing at 8 to 10 inches forage height, and end grazing at 3 to 5 inches forage height. Allow 10 to 20 days rest before grazing again. Cool, wet weather often results in crown and stem rot, especially where there is a thick layer of leaves. Moderate stocking in winter reduces the problem.

Forage Quality: Crimson clover, like other clovers, has high nutritive quality.

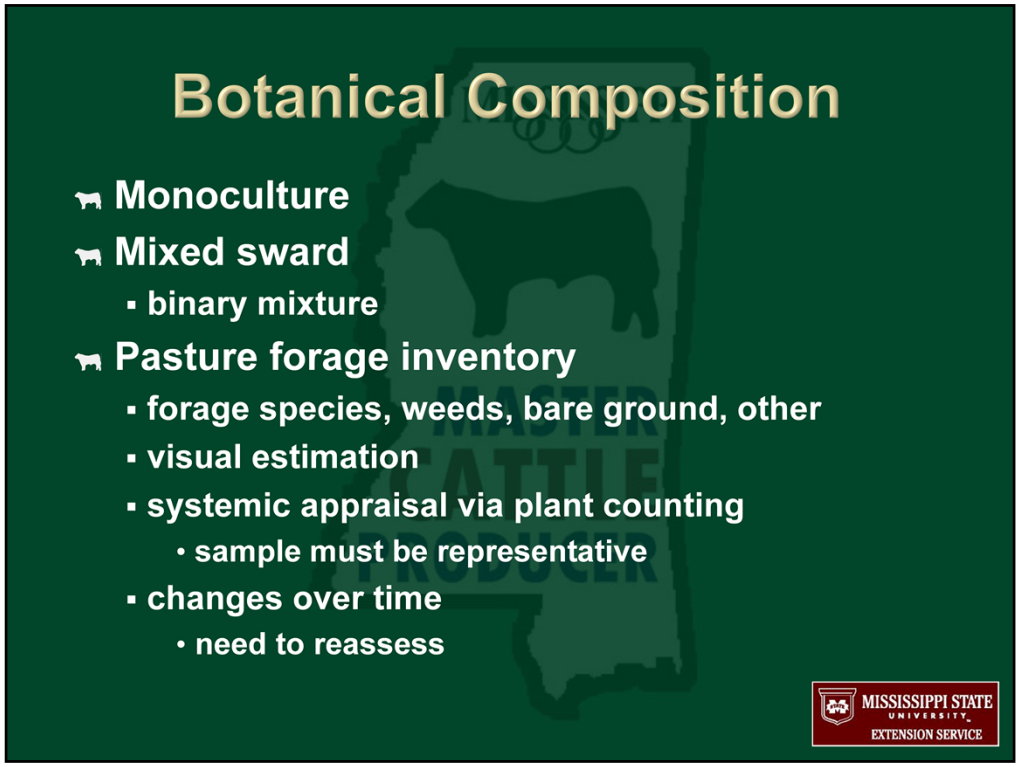
Varieties/Cultivars: Cultivars include Dixie, Auburn, Autauga, Chief, Talladega, and Tibbee.



Forage quality, quantity, and timing of growth determine the appropriateness of using them in specific forage systems. The distribution of forage growth varies greatly among forage species. It is extremely important for planning a grazing program. Relative growth rates of warm-season grasses, such as bermudagrass, are greater than cool-season grasses, such as annual ryegrass or tall fescue, at high temperatures. However, cool-season grasses are productive over a wider temperature range as illustrated above.

Consider production goals and grazing management system that will be utilized in forage selection decisions. Some forages are more tolerant of close grazing than others. Some forages are easier or less expensive to establish or maintain than others. In mixed forage swards, also consider compatibility of multiple forage species managed together in a pasture or hay field.

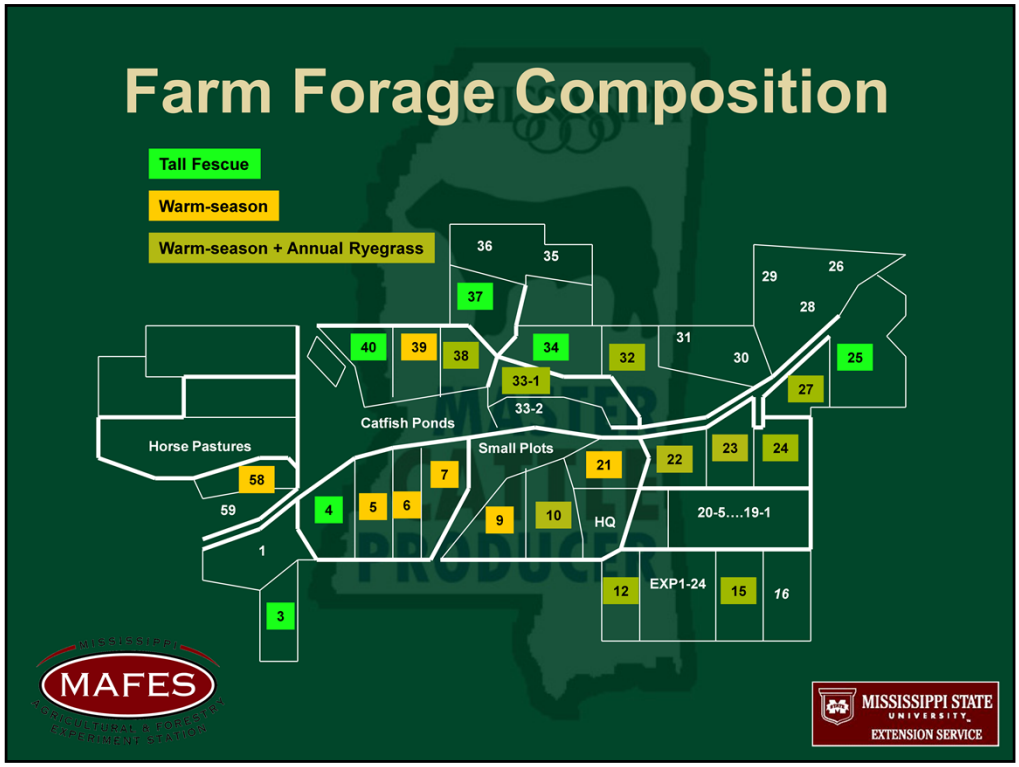
Base forage selection in part on forage adaptation. If forages are not well adapted to an area, they may fail or perform poorly. Forage adaptation is primarily dependent on climate and soils. Temperature, drought, rainfall distribution, growing season, and photoperiod are climate factors affecting forage adaptation. Climate extremes are more likely to affect forage adaptation than average conditions. Soil pH, drainage, water holding capacity, native fertility, and potential for pests also affect forage adaptation. Resistance to pests such as nematodes and leaf hoppers and diseases impact forage adaptation.



Botanical composition is the forage species make-up of an area. A monoculture is a single forage species grown as a crop in a paddock or field. Many hayfields are managed as monocultures.

Mixed swards are paddocks or fields that include multiple forage species managed together as one crop. Many pastures are managed as mixed swards, although monocultures are sometimes established for specific grazing purposes. A binary mixture is a mixed sward that primarily contains two forage species for cultivation. Mixed sward pastures often include tall and short plant species that respond differently to grazing intensity. Mixed swards may also contain both cool- and warm-season forages, such as bermudagrass and tall fescue grown together. In these situations, one forage dominates yields during its primary growing season while the other forage dominates during a different period. There may be overlap among growing seasons or dormancy periods. Mixed swards can also contain combinations of grasses and legumes. Fertilization and harvest practices can favor one forage over others in mixed swards. The botanical composition of a pasture influences the degree of forage selectivity possible.

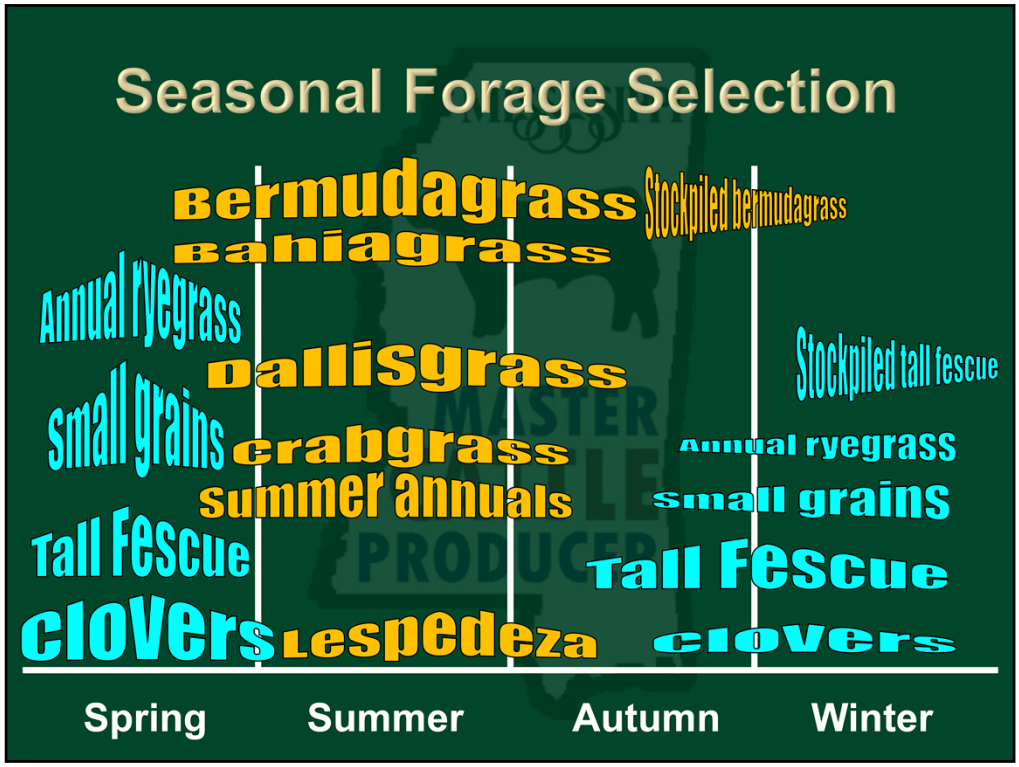
To evaluate botanical composition, create forage inventory records for each pasture and hayfield. Estimate the percentages of plants of each forage species, weeds, bare ground, and other acreage in these inventories. A systematic approach to pasture inventory may include walking a diagonal across the pasture and counting the items by category in this path every set number of steps. Sampling must be representative of pasture make-up to be meaningful. For example, excluding low lying areas may result in inaccurate assessments. Botanical composition needs to be reevaluated periodically as forage stands change with seasons and over years.



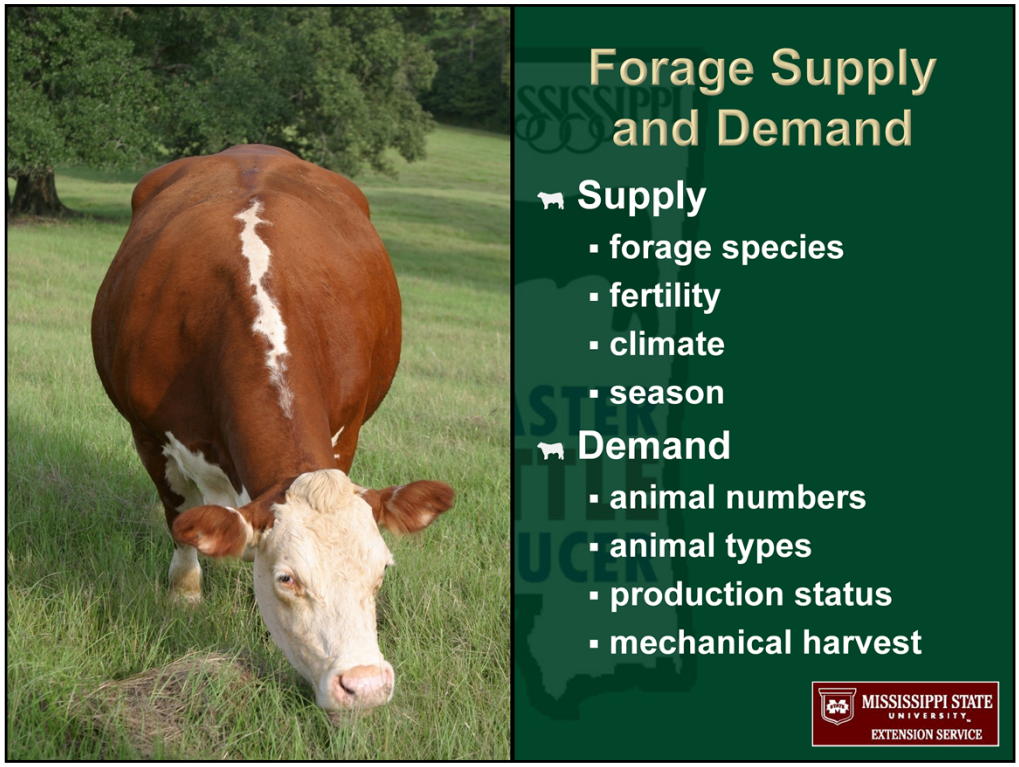
The forage composition of all acreage used for pasture or stored forage production should be assessed. Many Mississippi beef cattle operations have an overabundance of warm-season forages relative to cool-season acreage. This creates a situation where excess warm-season forage must be harvested for hay or wasted. Cool-season forage in this situation often would not be adequate to meet cattle nutrient needs without supplementation of additional forage/feed. Therefore, instead of cattle harvesting forage via grazing as much as possible, large amounts of forage are mechanically harvested, stored, and then fed to livestock in the winter months. This is an inefficient system.

To correct this problem, pasture must be renovated to shift the balance of forage species. Forage renovation should be planned and done in stages. There is more production risk in renovating large proportions of acreage at once than renovating the same amount of total acreage in smaller steps over more growing seasons. If a large proportion of acreage is renovated at once and forage establishment is not successful, then total forage availability on the ranch can become limiting. Herd size would then need to be reduced or additional forage and feed brought onto the ranch to make up for forage shortfalls.

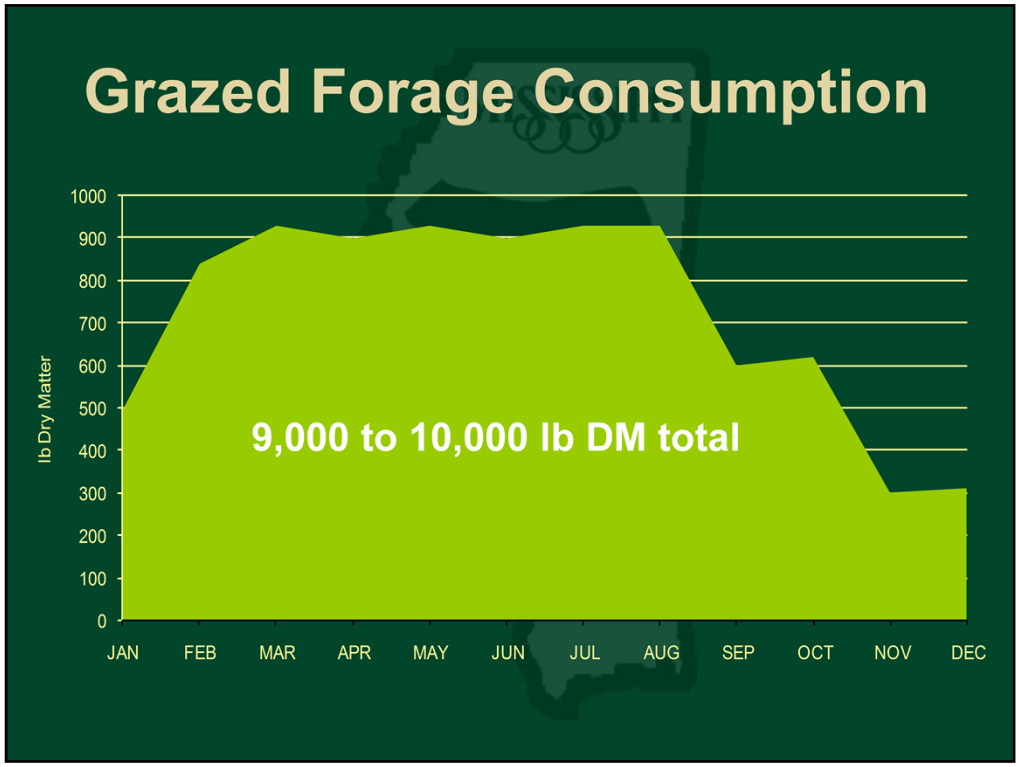
The schematic above illustrates farm forage composition at one point in time for a livestock unit in the Mississippi Agricultural and Forestry Experiment Station system.



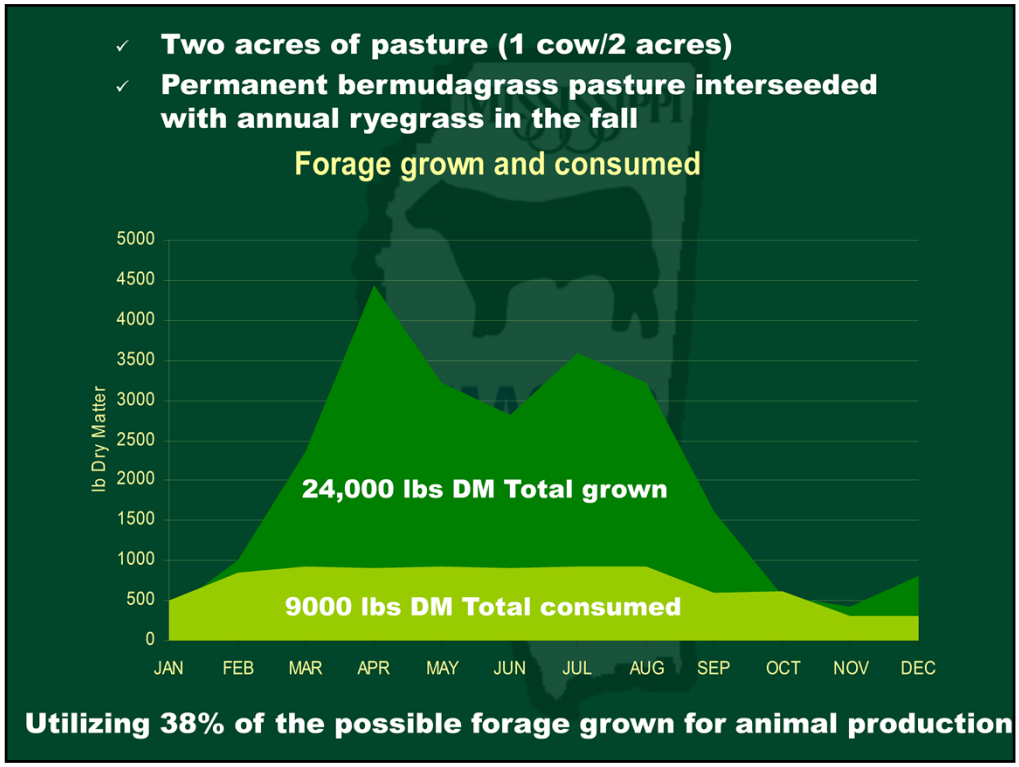
A wide selection of forages can be grown in Mississippi. Example forages are listed above and shown within various seasons during which most of their productivity is expected. These growing seasons may differ from year to year based on rainfall and temperature differences and also within Mississippi due to differences in local conditions. Specific forage selection depends upon the specific location within the state, local soil types, and other environmental conditions. Use of only one forage is not adequate to provide year-round grazing. By developing forage systems using a variety of forages based on their seasonal productivity and quality, beef cattle operations can supply adequate forages to their cattle for grazing during most months of the year. Stockpiled or stored forages can be used to supply forage to cattle during periods of low forage productivity or dormancy. A good goal is to reduce the need for winter feeding by planning grazing systems that minimize the need for stored forage and supplemental grain feeding.



Forage supply must be adequate to meet forage demand by cattle and other grazing livestock. Forage supply and demand change constantly. Factors affecting forage supplies include forage species (differ by yield potential and seasonal productivity), soil fertility (low fertility reduces forage yields), climate (some forages are better adapted to and perform better in certain climates), and season (time of year and environmental factors impact forage yields and quality). Forage demand varies with animal numbers, types, weights, stage of production, and desired rate of gain. Mechanical harvest of fields for hay, baleage, or greenchop is another potential forage use. When forage supply exceeds forage demand at a point in time, increasing stocking rates or mechanically harvesting forage for later use or sale can help balance forage supply and demand to avoid undergrazing and forage maturity problems. When forage demand exceeds forage supplies, reduce stocking rates or utilize stored forages and other feeds to balance forage supply and demand.



The graph above shows an example of forage dry matter (DM) consumption by a typical Mississippi beef cow over a year. In this illustration, grazed forage intake decreases during autumn, is least in winter, and peaks during spring and summer. This corresponds with an abundance of lush spring grazing and warm-season forage production and a decline in forage availability in pastures during autumn and into winter. Hay feeding is often used to replace grazing during periods of low pasture forage availability. For a more efficient forage system, target ways to increase pasture forage availability during autumn and early winter through forage selection and management.



This graph shows the wide gap in forage produced and forage consumed that is common on many beef cattle operations. The excess production not utilized by livestock could be grazed by increasing stocking rates and using more efficient grazing methods. Alternately, excess forage yields could be mechanically harvested for stored forage. Developing a better balance of seasonal forage production through forage selection and management would also help to improve the efficiency of this forage system.

Forage availability is the most important factor affecting forage intake on pasture. Intake is restricted when insufficient forage is available such as during a drought. On good quality pasture, intake is adequate when available forage is 1,000 to 1,500 pounds per acre dry forage. A range of 150 to 300 pounds of dry matter for each inch of usable pasture growth is common, but considerable variation will occur based on forage species, growing conditions, and density. Cattle harvest forages with their tongues, so very short forage height can limit bite size. With low levels of available forage, the amount that can be collected with each bite is small and the animal will have to walk further to take more bites, thus allowing less time for chewing and ruminating.

The proportion of leaf to stem can greatly affect the bite size as the animal seeks out leaves. Higher proportions of stems effectively reduce bite size even though total forage available is adequate. When stocking rate is high, cattle on rotationally stocked pastures may be forced to eat more stem or low quality forage, which can reduce intake. This is in contrast to a continuously grazed pasture where they usually have a greater opportunity for selectivity unless the pasture is overstocked and has low forage availability. Warm-season perennial grasses (bermudagrass, bahiagrass, dallisgrass) with a higher proportion of stem may require the animal to harvest more but smaller bites to obtain the desired forage. Cattle eat little dead material if green leaf is available, thus bite size may be restricted as the grazing animal seeks out green leaves. Increased grazing time is often not enough to compensate for the effects of reduced bite size on forage intake when cattle are grazing short pasture.

Several methods are available to determine available forage. Clipping and weighing the forage in a given area is the most accurate method but requires drying and weighing clipped forage. This method is time consuming. The falling plate meter measures the height of forage while it is depressed with a weighted plate. It takes density into account and is therefore more accurate than measuring the height. The rising plate meter is a similar tool for evaluating forage availability. Measuring the height of existing forage using calibrated rulers (“grazing sticks”) is usually an easy method but is less reliable because it does not take stand density into account. For detailed instructions on assessing available forage, refer to Mississippi State University Extension Service Publication 2458, “Assessing Needs and Feed Sources: How Much Forage Do I Have?”.

Available Forage

Forage Species	Dry matter, lb/inch/acre	
	Average	Range
Alfalfa or alfalfa-grass mixture	225	75 to 400
Arrowleaf clover	200	100 to 300
Bermudagrass	260	150 to 500
Crimson clover	200	100 to 300
Native warm-season bunchgrasses	100	50 to 250
Red clover	220	100 to 300
Annual ryegrass	250	75 to 400
Oats, rye, wheat	150	75 to 250
Tall fescue	210	100 to 350
Tall fescue with white clover	190	80 to 325

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Forage availability values listed above are only to be used as guides. They represent average values taken from many sources. These estimates assume reasonably thick, well fertilized, actively growing forage stands. The ranges listed cover thin, non-fertilized, often unmanaged stands up to fertilized, thick stands with rapid growth and high yields.

Forage Dry Matter Percentage

Dry matter range, %	Forage description
8 to 15	Young, green, succulent (i.e., small grains, tall fescue, annual ryegrass, especially in seedling stages
15 to 20	Young, green leafy grasses in spring or when growth is rapid and succulent; white clover in mature stages; alfalfa in prebud stage
20 to 30	Older, slightly brown, or slow-growing plants; headed cool-season grasses; actively growing bermudagrass; alfalfa at 10% bloom
40 to 50	Growth that is more than 40% brown; stockpiled growth in winter and dormant grasses; may be stored in an airtight solo or tightly wrapped bales
40 to 80	Plants that have been cut for storage; feels slightly damp or pliable, but too wet to bale
80 to 85	Hay freshly baled; mold forms if stored below 80% dry matter
85 to 92	Hay stored inside after several months; in samples that are air dried in cloth bags, the leaves will break easily when crumbled or twisted

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Cattle nutrient requirements and forage intake needs are often expressed as dry matter percentages or amounts. Good measurements or estimates of forage dry matter percentage allow management of forage supplies to meet cattle intake needs. Cattle must consume larger quantities of fresh forage to obtain the same amount of dry matter as in drier forages such as hay. Approximate hay needs per head per day are 28 to 30 pounds for mature bulls, 25 to 28 pounds for cows nursing calves, 15 to 20 pounds for dry cows, 18 to 23 pounds for bred yearling heifers, 10 to 12 pounds for replacement heifers, and 10 to 14 pounds for stocker steers.

The forage dry matter percentage estimates listed here serve only as a rough guide. Variations may occur with certain forage species, environmental conditions, or management. These estimates assume that no dew or raindrops are on the forage.

Forage Intake Capacity of Beef Cows

Intake estimates assume that protein requirements are met in the total diet. When protein requirements are not met, forage intake will be lower than the values in the table.

Forage Type and Maturity	Stage of Production	Forage Dry Matter Intake Capacity, % of body weight
Low quality forage (< 52% total digestible nutrients)	Non-lactating	1.8
	Lactating	2.2
Average quality forage (52 to 59% total digestible nutrients)	Non-lactating	2.2
	Lactating	2.5
High quality forage (> 59% total digestible nutrients)	Non-lactating	2.5
	Lactating	2.7
Lush, growing pasture	Non-lactating	2.5
	Lactating	2.7
Silage	Non-lactating	2.5
	Lactating	2.7

Source: Hibbard and Thrift, 1992.

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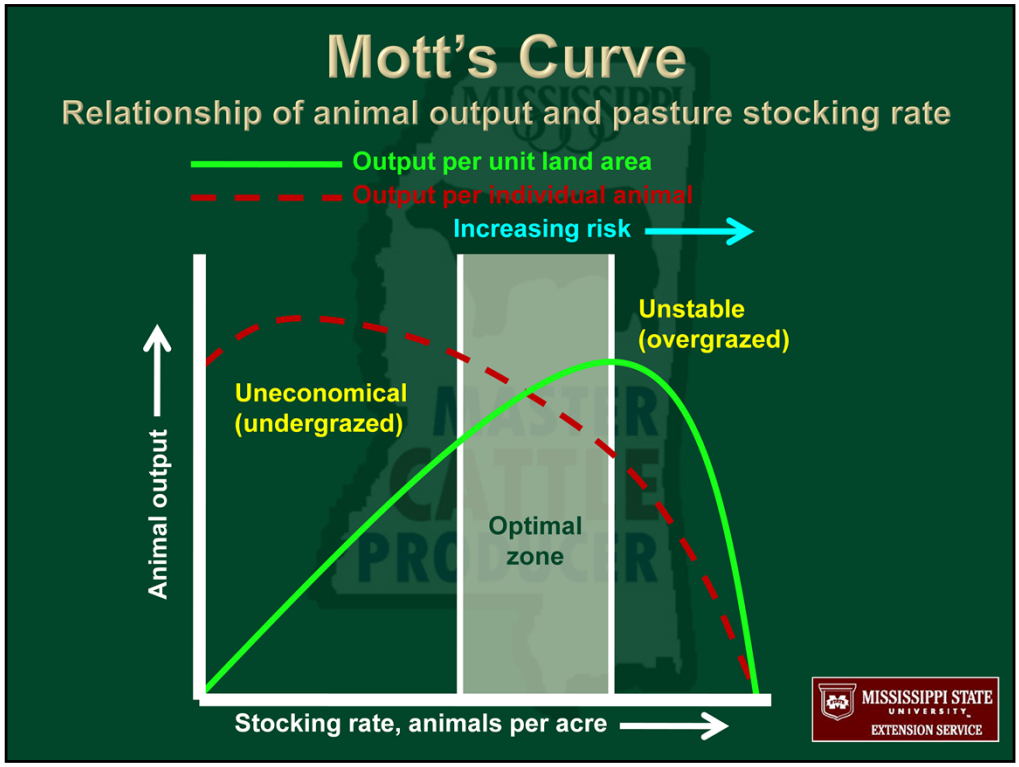
Forages typically make up the majority of cattle diets on both cow-calf and stocker cattle operations in Mississippi. Many factors affect forage dry matter intake, including animal weight, condition, stage of production, milk production level, environmental conditions, forage quality, and amount and type of forage or feed offered. For instance, cows nursing calves tend to consume greater quantities of forage than dry (non-lactating) cows. There are physical limits as to how much forage beef cattle can consume at once due to gut fill. Forage intake capacity is affected by stage of production and forage type and maturity as shown in this table. Cattle consume greater amounts of forage as it increases in quality. Very lignified (very mature) forages tend to take longer to digest than less fibrous forages. The rate of digesta passage is slowed and forage dry matter intake decreases when low quality forages are consumed.

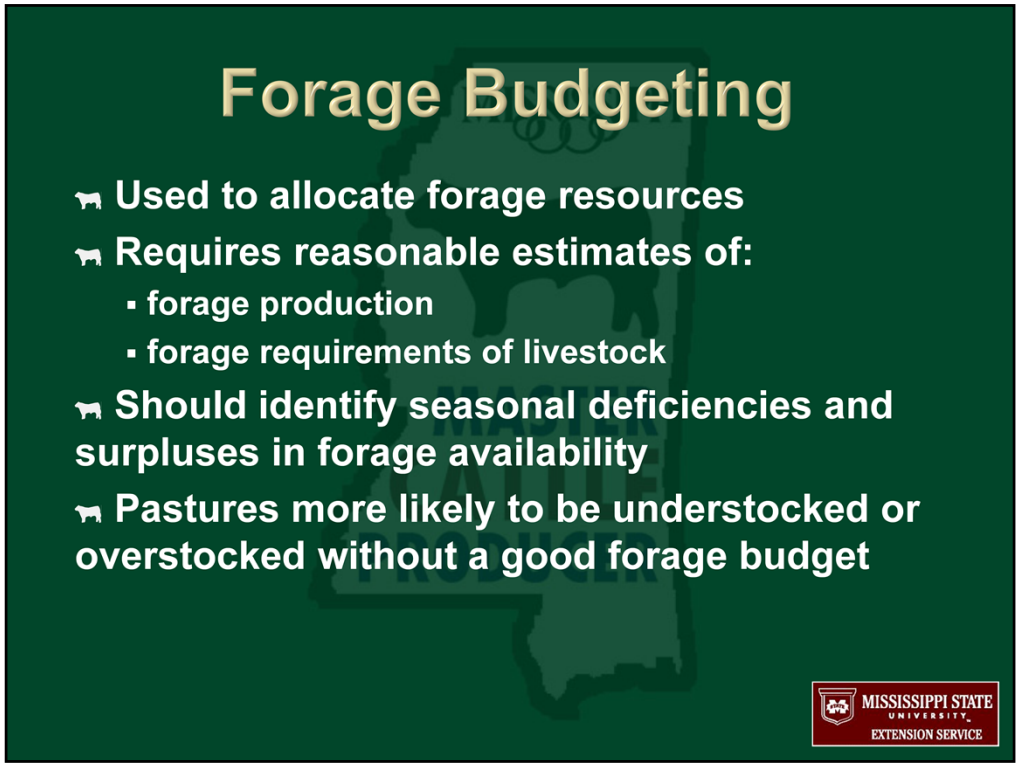


"Mott's curve" shows the relationship between animal output (per animal and per unit of land area) and pasture stocking rate. G. O. Mott, University of Florida, is credited with first designing this graph.

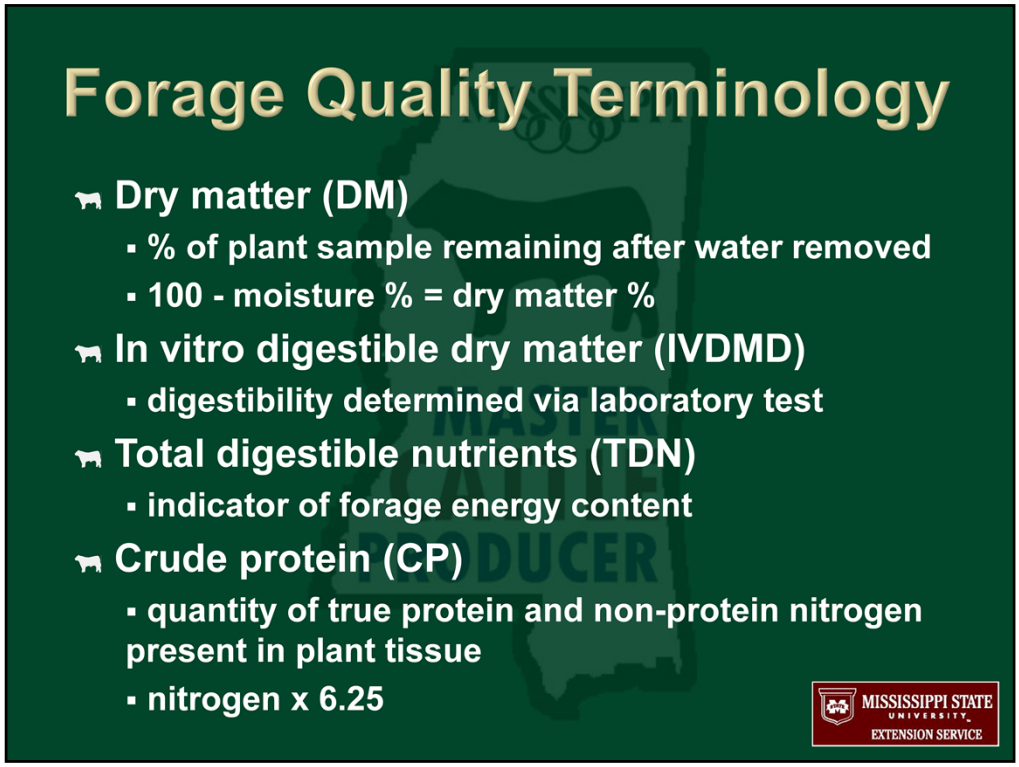
As forage production increases, a need is created to increase stock numbers to utilize the forage growth. At a low stocking rate, available forage and productivity per animal tend to be high, but output per acre is low. Stocking a pasture below the optimum rate for output per acre allows for selective grazing (selection of higher quality forage) that improves animal productivity. Yet output per animal can be compromised at very low stocking rates (undergrazing situations) if forage growth becomes excessive and increasing forage maturity lowers forage quality to the point where selective grazing does not overcome forage quality declines. Animal dry matter intake and nutrient intake decline with the accumulation of stems and dead forage, lowering animal output.

As stocking rate increases, less forage is available per animal. Animals compete for forage and have less opportunity to select green, leafy forage, so animal performance falls. At the same time, animal output per acre initially increases with stocking rate due to increased forage utilization. As stocking rate continues to increase, animal gains continue to decline to the point that animal output per acre eventually peaks with animal additions to the pasture and then declines as the additional animals carried by the pasture does not compensate for the reduced rates of gain.

At very high stocking rates, plant leaf area is not sufficient for adequate photosynthesis, plants are defoliated below their growing points in some cases, plants are weakened, and forage growth is depressed. In addition to less forage production, closely grazed pastures may have more internal parasites. This overgrazing results in both low rates of animal weight gain and low gains per acre.



Forage budgets are useful for identifying the pasture and stored forage needs of a livestock operation. Much like a financial budget that helps manage money supply and demand, the forage budgeting process helps manage forage supply and demand. Forage budgeting is used to allocate forage resources to avoid understocking and wasting forage or overstocking and reducing animal performance and ranch carrying capacity. Accurate forage budgeting requires reliable estimates of forage production (yields and timing of forage growth) and forage intake requirements of livestock. In addition to forage yields, forage nutrient content (quality) must be considered in planning to meet animal nutrient demands. Very good ranch records are needed to develop and maintain effective forage budgets. Forage budgets identify seasonal deficiencies and surpluses in forage availability. The surpluses are then utilized during the deficiency periods to best match forage supply and demand. Forage budgeting worksheets are available to assist producers with forage production and utilization planning.

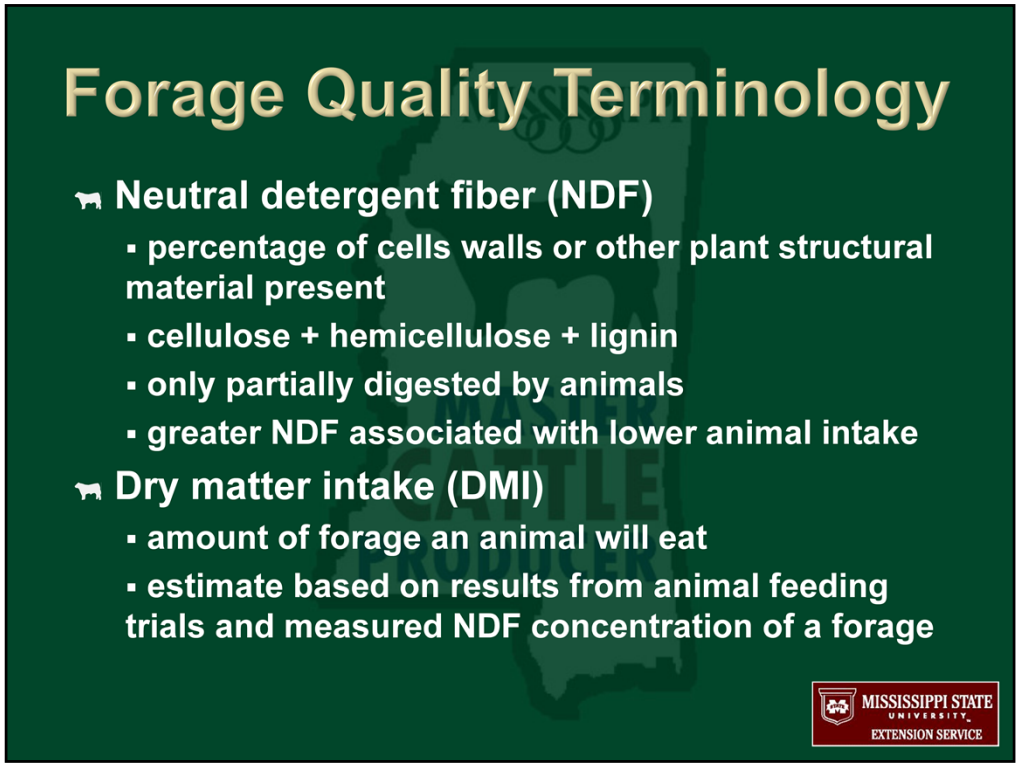


Knowing forage quality in terms of nutrient contribution to beef cattle diets is critical to planning an accurate and efficient nutritional program. Forage testing is highly recommended to determine forage quality. It is important to understand forage quality terminology to effectively interpret forage nutrient analysis reports.

Dry matter indicates the percentage of plant remaining after moisture is removed. By subtracting the dry matter percentage from 100, moisture percentage is obtained. Moisture percentage must be in the proper range for good ensiling of silages. Moisture levels that are excessive in hay crops can lead to hay heating, quality losses, and even hay fires.

Total digestible nutrients (TDN) is a commonly used energy value for assessing forages and other feedstuffs for use in beef cattle diets. Fiber and crude protein (CP) values are used to calculate TDN.

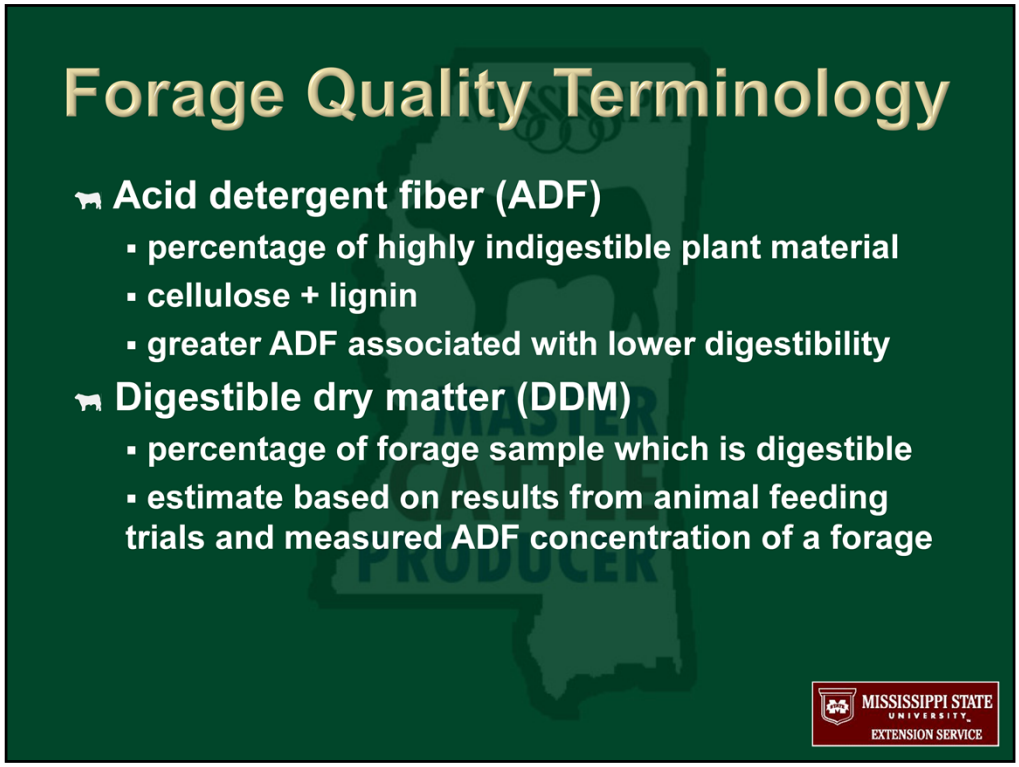
Crude protein level of forages is the quantity of true protein and non-protein nitrogen (urea) present in plant tissue. It is determined by multiplying the nitrogen content by 6.25.



Neutral detergent fiber (NDF) is commonly noted on forage test results. It refers to fiber that is insoluble in neutral detergent and includes cellulose, hemicellulose, and lignin. Neutral detergent fiber represents all plant cell wall material, is only partly digestible by animals, and is negatively correlated with dry matter intake. As NDF increases in the diet, dry matter intake (DMI) decreases.

Effective fiber is expressed as effective NDF (eNDF). Effective NDF refers to the percentage of the NDF that effectively stimulates chewing and salivation, rumination, and rumen motility. Longer forage fiber lengths stimulate cud chewing (rumination) and saliva production.

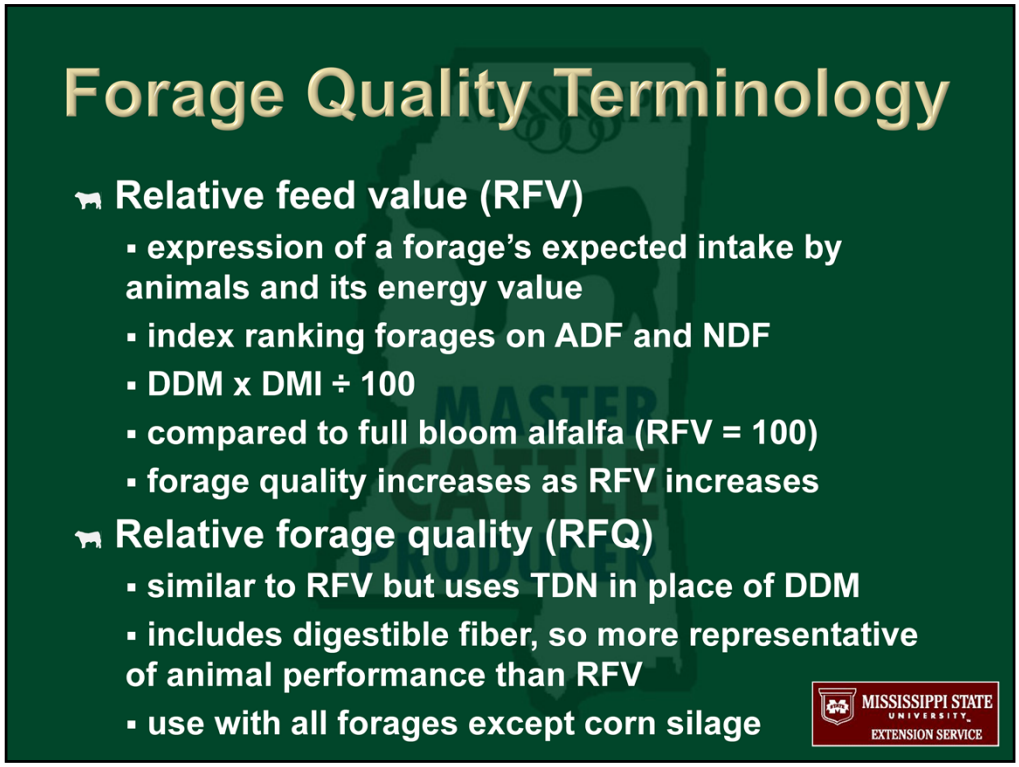
Daily dry matter intake of forage and feed is the amount of forage and feed (excluding the moisture content) consumed in a day. Cattle require certain amounts of specific nutrients such as protein, calcium, and vitamin A on a daily basis. To meet specific nutrient requirements, the percentage of nutrients in the diet for cattle is based on the quantities of forages and feeds consumed daily.



Acid detergent fiber (ADF) is composed of highly indigestible plant material, generally only the lignified or otherwise undigestible portions of plant cell walls. It is the portion of fiber that is insoluble in acid detergent (i.e., cellulose and lignin). Acid detergent fiber is negatively correlated with digestibility. Generally, as ADF increases, forages or feeds become less digestible.

Legumes tend to have lesser NDF and ADF values than grasses, and increasing forage maturity increases NDF and ADF values.

Digestible dry matter (DDM) is the percentage of a forage sample which is digestible. It is an estimate based on the results from animal feeding trials and forage ADF concentrations. Generally, as ADF increases, DDM decreases.



Relative feed value (RFV) and relative forage quality (RFQ) are forage quality terms that account for animal responses to forage quality. Relative feed value accounts for a forage's expected intake by animals and its energy value. It is an index value that ranks forages on ADF and NDF as compared to full bloom alfalfa, which is assigned a RFV of 100. Relative forage quality is similar to RFV but uses TDN in place of DDM in calculations. Because RFQ calculations include digestible fiber, this index is expected to be more representative of animal performance on the forages tested. Relative forage quality is appropriate for use with all forages except corn silage. Greater RFV and RFQ values indicate greater forage quality.

Forage Quality Standards

Forage Type	Standard	Total Digestible Nutrients[1]	Crude Protein[1]	Moisture	pH
Silage[2]	Excellent	65% or above	8% or above	70% or below	4.2 or below
	Good	60 to 64%	7 to 8%	71 to 74%	4.3 to 4.7
	Fair	55 to 59%	6 to 7%	75% and above	4.8 to 5.1
	Poor	Below 55%	Below 6%	75% and above	5.2 or above
Grass Hay[3]	Excellent	58% or above	12% or above		
	Good	55 to 57%	10 to 11%		
	Fair	52 to 54%	8 to 9%		
	Poor	Below 52%	Below 8%		
Legume Hay[3]	Excellent	64% or above	18% or above		
	Good	60 to 63%	16 to 17%		
	Fair	57 to 59%	14 to 15%		
	Poor	Below 57%	Below 14%		

[1] Dry matter basis.

[2] Determine silage quality by total digestible nutrients rating. If silage does not meet either crude protein or moisture requirement for quality, lower one standard.

[3] Determine hay quality by total digestible nutrients rating. If hay does not meet crude protein requirement or is less than 83% dry matter, lower one standard.

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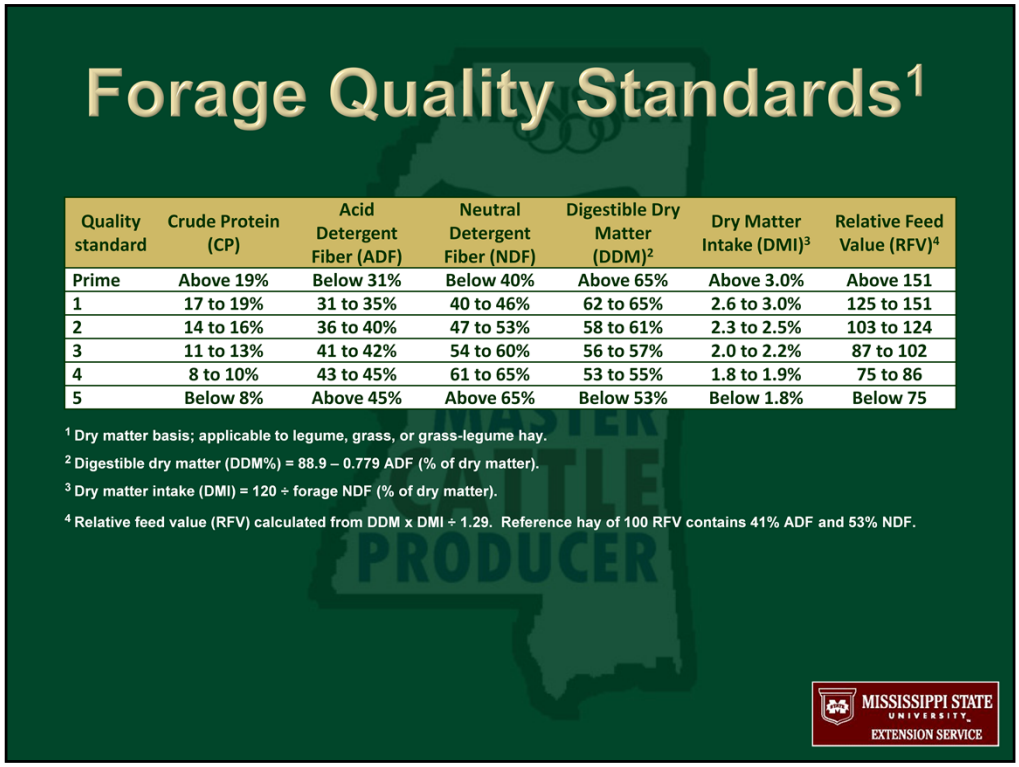
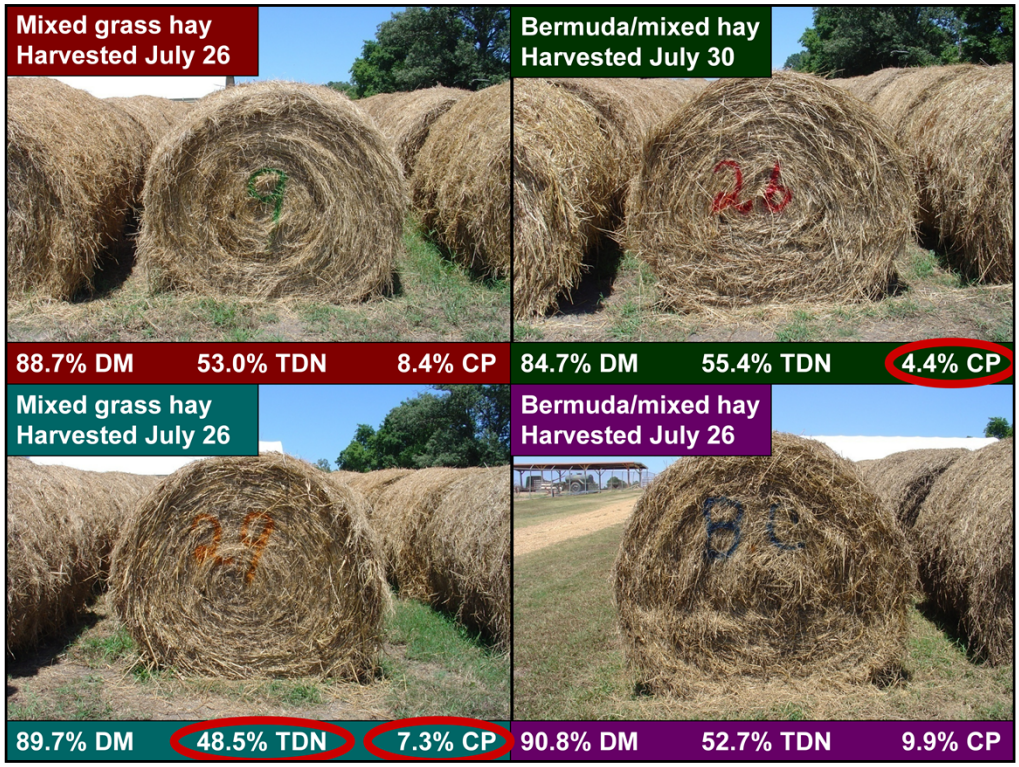
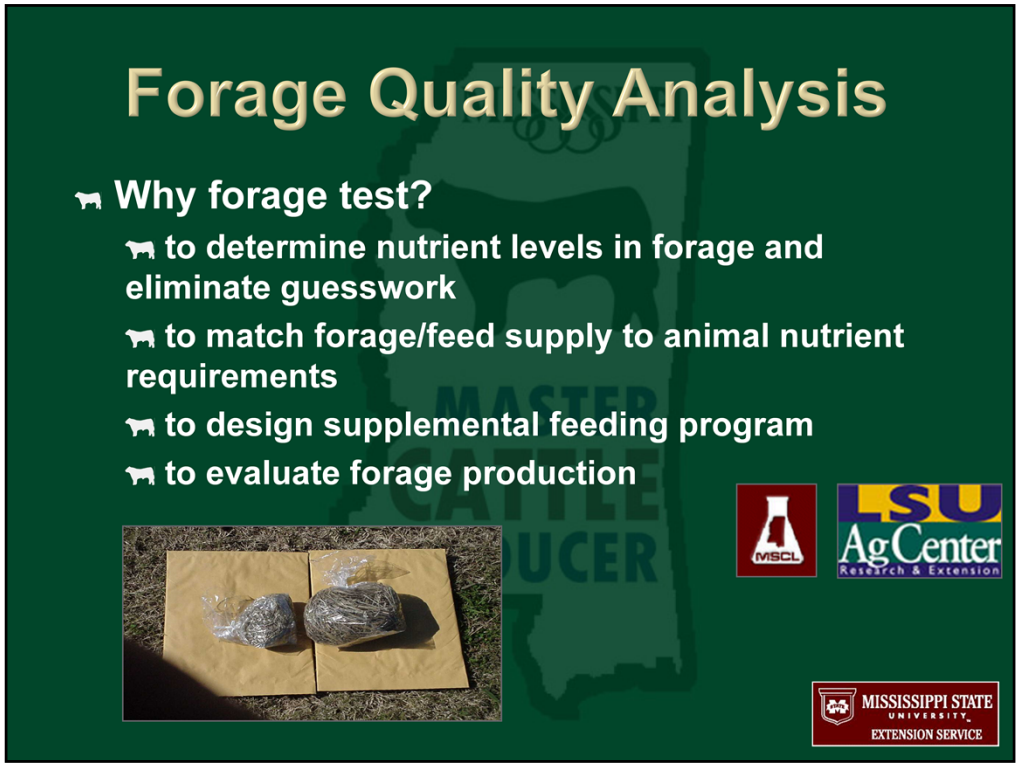
General forage quality standards for beef cattle nutrition programs are provided here for various stored forage classifications. Feeding poor quality forages below 8% crude protein or below 52% total digestible nutrients on a dry matter basis will limit forage intake and result in poor animal performance. Match supplementation programs to forage quality for best animal performance results.



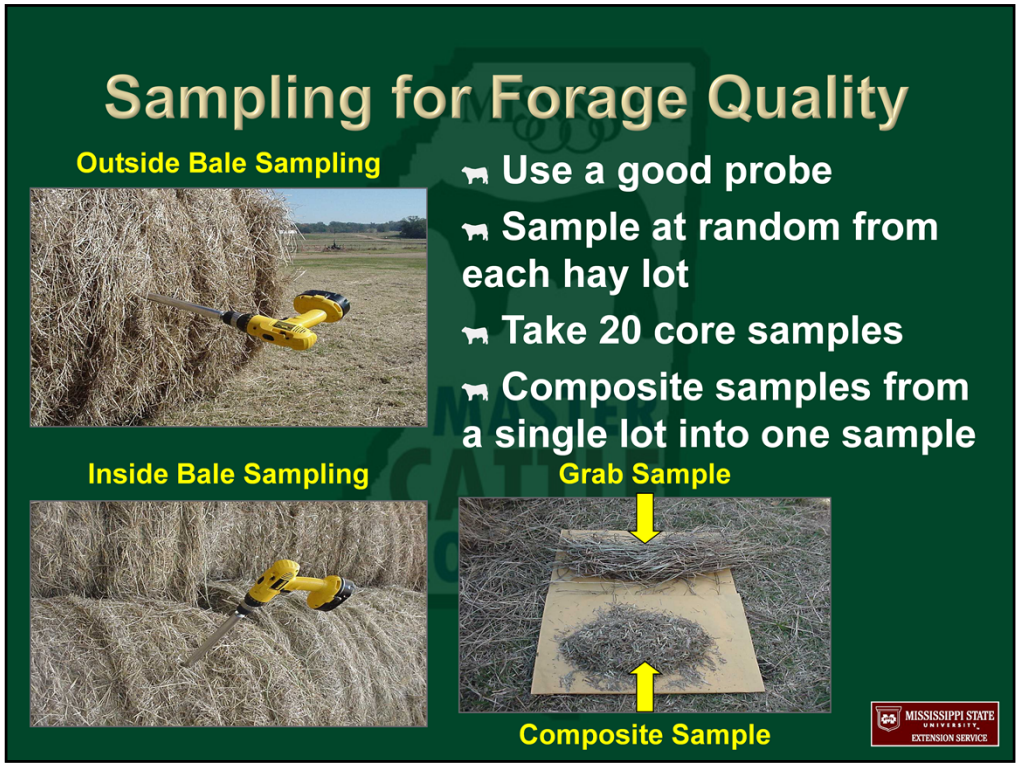
Forage quality classifications are presented again but in a different form. Prime quality is the best quality forage, whereas 5 represents the lowest (poor) quality forage. Forage quality improves with greater crude protein and digestible dry matter levels. Forage quality decreases with greater fiber levels. Greater dry matter intakes are expected on better quality forages.



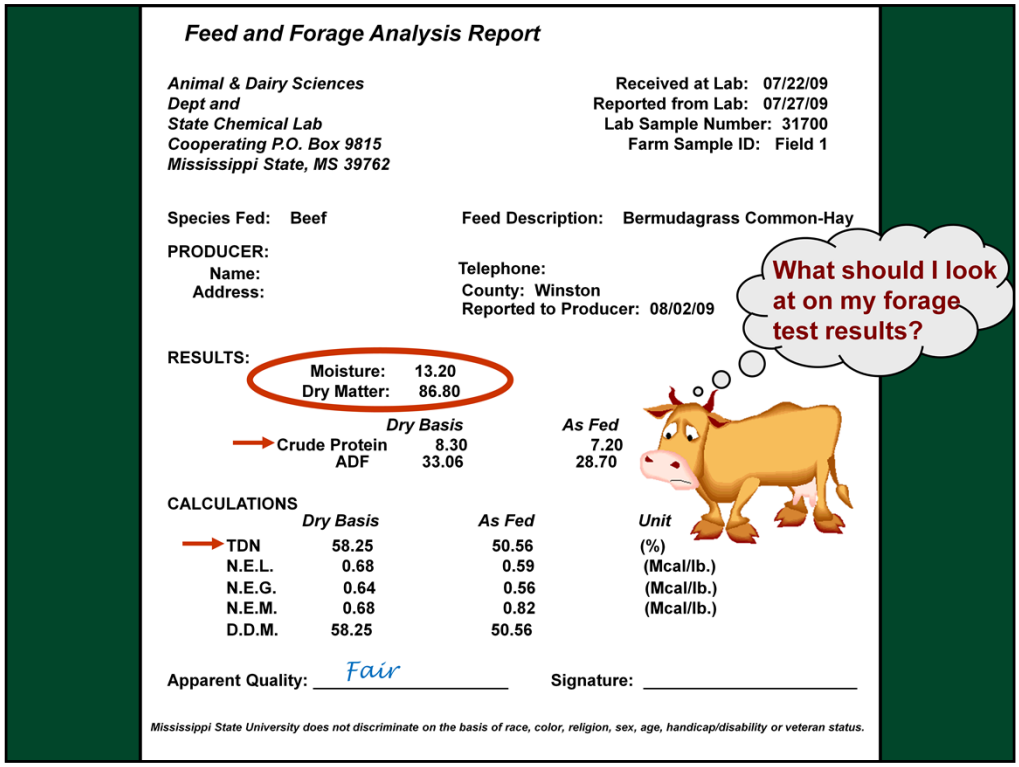
Four hay bales produced on the same farm one summer are shown with nutrient analysis results. Each hay lot is uniquely identified to be able to match the harvest date, field of origin, and forage species with the forage quality analysis results. The bales in the upper left and lower right corners could be rated as fair quality for both TDN and CP. The bale in the upper right corner might be classified as good quality based on TDN alone but is actually poor quality due to very low CP. The bale in the lower left corner is poor quality for both TDN and CP. Based on these results, forage fertilization and harvest maturity may need improvement. Forage intake may be limited with the poor quality hay and may hurt animal performance. These low quality bales should not be offered to cattle with high nutrient demands, such as lactating cows or growing cattle. Appropriate supplemental feeding programs needed differ among these hay lots and depend upon the class of cattle to be fed.



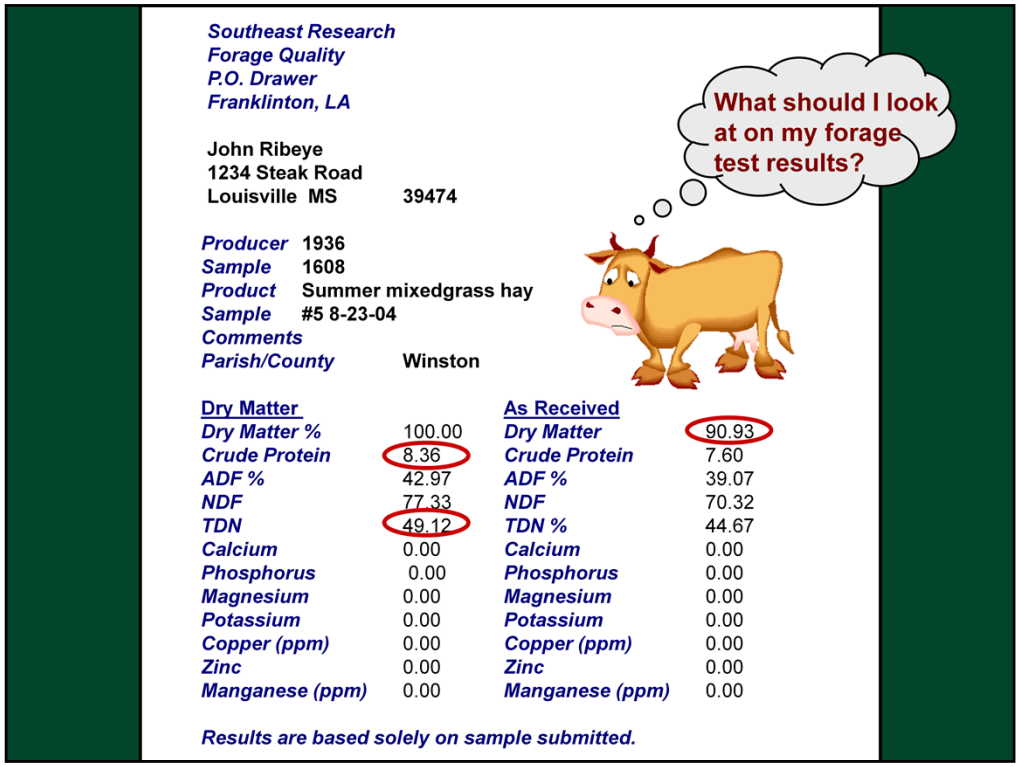
Forage quality analysis is often referred to as forage testing. It involves determination of nutrient levels in forages. This eliminates guesswork when trying to match forage and feed supplies to animal nutrient requirements, designing supplemental feeding programs, and evaluating forage production. Although many forage producers advertise forages as "leafy", "green", or "high quality" based on visual appraisal, this can be inaccurate, not reflective of forage nutrient content, and misleading. Laboratory analysis is the recommended method of determining forage nutrient content. Most Mississippi forage samples are submitted to either the Mississippi State University Chemical Laboratory or the Louisiana State University AgCenter Forage Quality Laboratory for analysis. Samples can also be sent to private labs for this analysis. Fees, analysis options, and lab procedures may differ among labs.



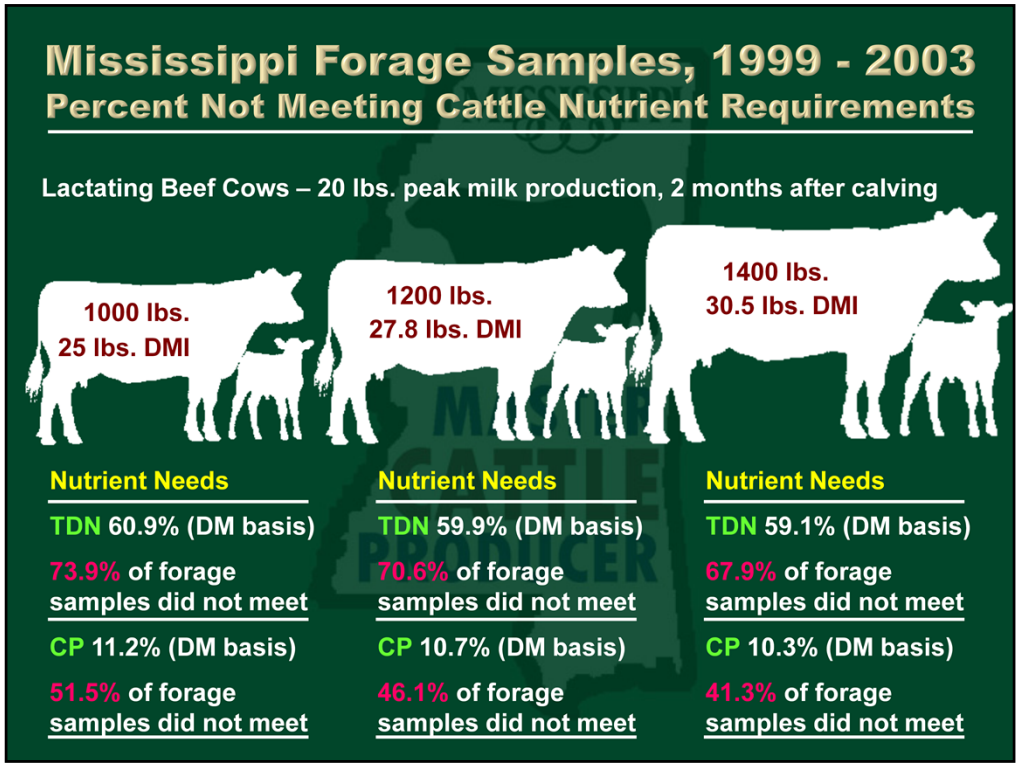
Follow any specific sampling and submission instructions provided by the specific laboratory selected. Forages samples submitted for nutrient quality analysis should be as fresh and representative as possible. This requires proper sampling technique. Use a forage probe with a sharp cutting device ⅜ to ¾ inch diameter to core bales instead of using grab samples. Sample at random from each hay lot. A hay lot should represent a single cutting, field, and cultivar, and a quantity of no more than 200 bales. Supply adequate amounts of sample for analysis, at least ½ pound of sample per lot. Combine at least 20 core samples from each hay lot into one sample for submission. For hay bales stored under cover, sample at a 45 degree angle from the top of the bale. For samples stored outside without cover, sample at a 90 degree angle from the top of the bale (on the side of the bale) due to possible weathering. Uniquely identify each sample so that results can be matched with the correct hay source. Package samples securely, and ship promptly and properly to the chosen laboratory for analysis. Include a completed Sample Submission Form and any necessary payments with each submission. Ship any perishable samples under refrigeration. If in doubt about sampling or shipping procedures, contact the laboratory that will analyze the samples or a local Extension office for instructions.



This is an example forage analysis report from the Mississippi State Chemical Laboratory in Mississippi State, MS. Specific items of interest include the forage moisture content, crude protein percentage (dry matter basis), and total digestible nutrients percentage (dry matter basis). Forage moisture content is equal to 100 minus the dry matter percentage, 100 – 86.8 = 13.2 in this example. Hay moisture levels over 18 percent for large round bales and over 20 percent for small square bales can lead to hay heating (maximum temperature usually reached 1 week after baling but can occur up to 3 weeks later), possible fire (fire likely at 150 to 180°F), and quality losses (protein breakdown at 120°F, sugar caramelization at 140°F). Refer to forage quality standards and beef cattle nutrient requirements tables to interpret crude protein and total digestible nutrient levels in the context of livestock nutrition. Before submitting samples to the MSU Chem Lab, fill out the Sample Submission Form available online at http://msucares.com/livestock/beef/mshay.html or at a local Extension office.



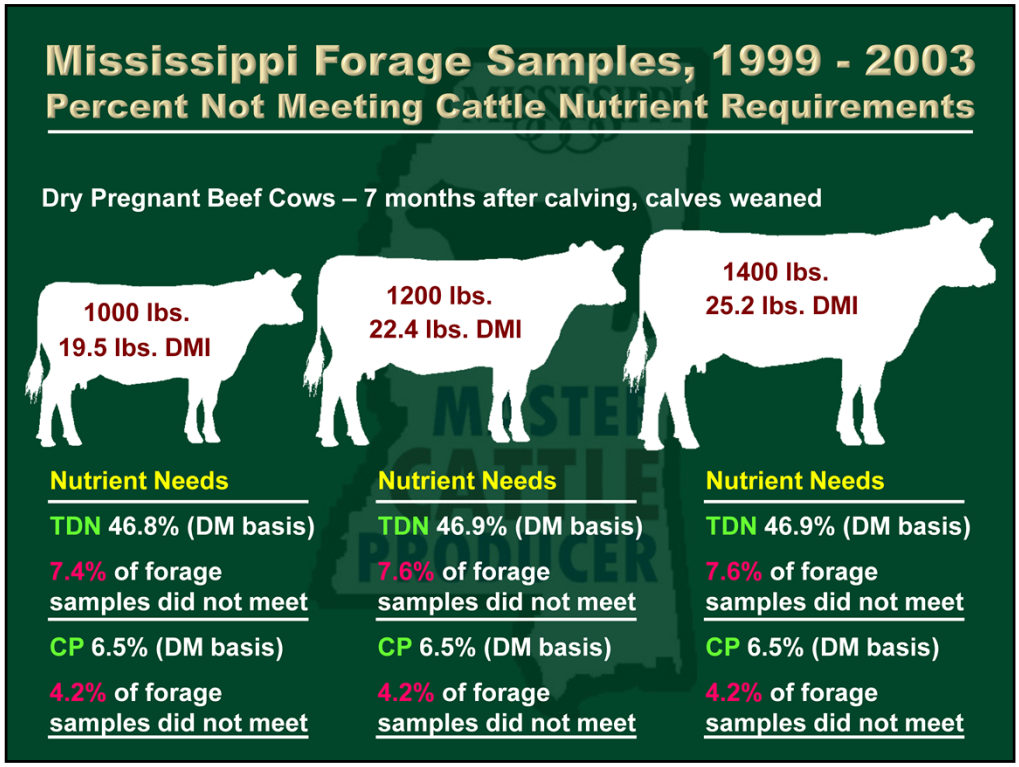
This is an example forage analysis report from the LSU AgCenter Forage Quality Laboratory in Franklinton, LA. The LSU Lab uses NIRS (near-infrared reflectance spectroscopy) and conventional wet chemistry testing. Samples can be analyzed for dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP) and minerals (Ca, P, Mg, K, Cu, Zn, Mn). The standard procedure for samples received by the laboratory includes DM (oven dried) and CP, NDF, ADF and TDN (Total Digestible Nutrients) estimated with NIRS. Wet chemistry is performed on samples unsuitable for NIRS analyses. Similar to the MSU Chem Lab report, specific items of interest include the forage moisture content, CP percentage (dry matter basis), and TDN percentage (dry matter basis). Forage moisture content is equal to 100 minus the dry matter percentage, 100 – 90.93 = 9.07 in this example. Refer to forage quality standards and beef cattle nutrient requirements tables to interpret crude protein and total digestible nutrient levels in the context of livestock nutrition. This report shows zeros for forage mineral levels because mineral analysis was not requested for this particular sample. Mineral analysis is available upon request when submitting forage samples for nutrient analysis, often at additional expense. Before submitting samples to the Forage Quality Laboratory, fill out the Sample Submission Form available online at http://msucares.com/livestock/beef/mshay.html or at a local Extension office.



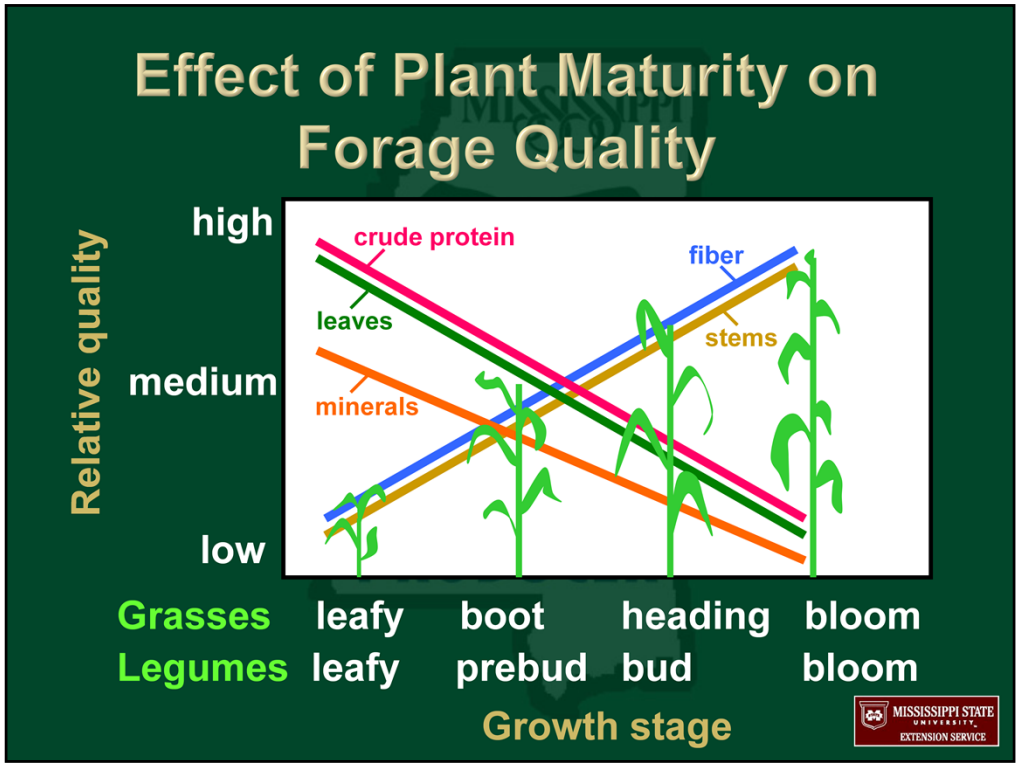
Energy is more likely than protein to be deficient in forage-based beef cattle diets in Mississippi. Recent 5-year forage test data from the Mississippi State Chemical Laboratory and the Louisiana State University AgCenter Forage Quality Laboratory support this claim.

Consider the nutrient demands of a typical 1200-pound beef cow. Assuming peak milk production of 20 pounds per day, this average cow should consume just under 28 pounds of dry matter each day (DMI = dry matter intake = 28) in the first two months after calving. The animal's nutrient requirements will be approximately 60 percent TDN and 11 percent crude protein on a dry matter (DM) basis. While 46.1 percent of Mississippi forage samples tested over a 5-year period would not have met the crude protein requirements of the cow in this example, 70.6 percent of forage samples would not have met the TDN requirements.

Five months after calving, the example cow will need 55 percent TDN and 8.5 percent crude protein on a DM basis to support lactation. Only 19.7 percent of forage samples would not have met this crude protein requirement, but 45.7 percent would not have satisfied the TDN requirement. In many other production scenarios, energy content of forages will need supplementation to meet animal nutrient requirements. Monitoring TDN levels in hay and providing acceptable energy in the entire diet is critical for good cattle performance.



The same cow from the previous example will have much lower nutrient requirements once her calf is weaned. A dry (non-lactating) beef cow seven months after calving will need to consume just over 22 pounds of daily DM (DMI = 22) with approximately to 47 percent TDN and 6.5 percent crude protein on a DM basis. The 5-year forage test results indicate that most of the forage samples analyzed would meet these lower dry cow requirements (92.4 percent of samples would have both adequate TDN and crude protein). In this case, feeding lower quality hay to dry cows and saving the better quality hay for cattle with higher nutrient requirements would be appropriate. However, be sure to not undernourish pregnant cattle, as this may have long-term consequences for their unborn calves.



Stage of maturity is the most important factor affecting forage quality and one that can be controlled by management.

Grass stages of maturity are:

Vegetative – leafy growth; few stems; no reproductive (seedhead) growth

Late vegetative – stem elongates

Boot – stem elongated; top of stem swollen

Early bloom – seedheads (flower heads) begin to emerge

Mid-bloom – at least 25% of seed emerged; pollen beginning to shed

Full-bloom – most seedheads emerge; peak pollen shed

Milk – all seedheads emerge; seed forming; seed soft and immature

Dough – seed becoming harder and has a doughlike consistency

Mature – seed hard and ready for harvest

Legume stages of maturity are:

Vegetative – leaf and stem growth; no buds, flowers, or seed pods

Bud – buds begin to swell and become apparent at a few nodes

Late bud – several nodes with buds; buds more swollen

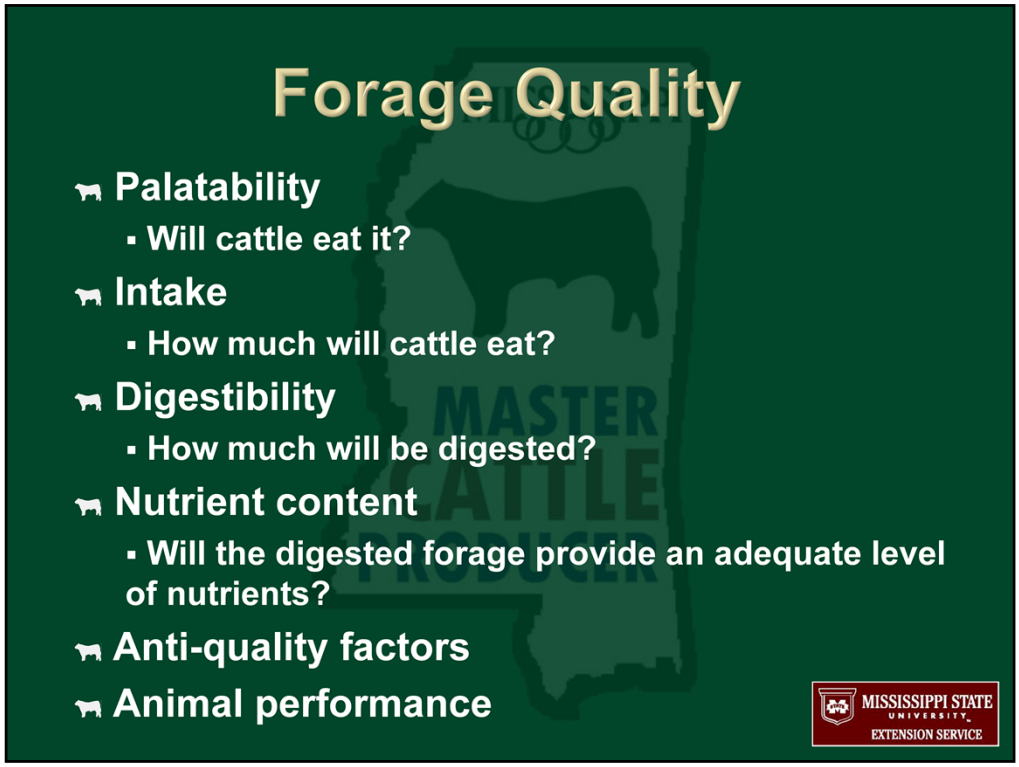
Early flower – a few buds open; flower color apparent

Late flower – many flowers apparent

Early seed – green seed pods apparent on a few flowers

Late seed – many green seed pods apparent; some seed pods turning brown

Mature – seed pods brown to black and dry; ready to harvest as moisture content permits



Forage quality is often defined in terms of leafiness, stem thickness, color, smell, or content of protein, fiber, or lignin. Forage chemical composition is useful in assessing forage quality, but it is the response of animal on a diet that includes forages that ultimately determines forage quality.

Palatability refers to how acceptable a forage or feed is to an animal. Palatability and intake can become an issue with lower quality forages. Make sure cattle receiving lower quality forages have acceptable levels of intake. Animals may spend time seeking out certain forage species and avoiding others, thus affecting bite size and effective forage availability. Cattle generally prefer grasses and legumes over browse. The presence of tannins in forages such as arrowleaf clover can reduce palatability. Nitrogen fertilization will generally increase forage protein content and can increase forage palatability. Cattle may even refuse unpalatable feeds, and palatability problems with hay can lead increase feeding waste.

Forage quality can be evaluated by forage digestibility and nutrient content. More digestible forages pass through the rumen faster and allow for more forage intake by reducing gut fill. Greater forage digestibility and nutrient content allow for more nutrients from forage to be utilized by the animal. Aim for large total nutrient yields (quantity and quality) instead of just large forage yields (quantity).

Not all forage components are beneficial when consumed by livestock. Anti-quality factors in forages include alkaloids, nitrates, and prussic acid. These compounds can reduce animal performance and negatively impact animal health.

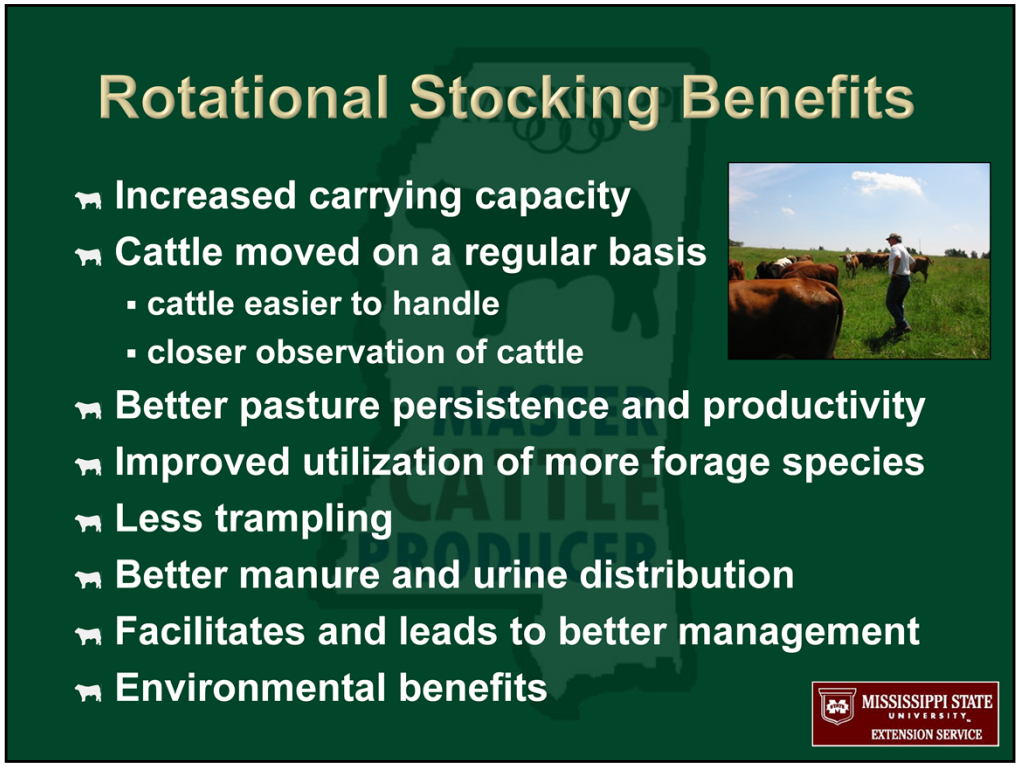
Animal performance on forage-based diets is the essential measure of forage quality. Forage quality is best defined in terms of animal performance such as average daily gain, reproductive rate, or milk production.

For detailed information on forage quality, refer to Mississippi State University Extension Service Publication 2539, “Hay Testing and Understanding Forage Quality” and Publication 2620, “Interpreting Forage and Feed Analysis Reports”.

Forage can be harvest by grazing livestock or by machinery. A grazing system is a defined, integrated combination of animal, plant, soil, and other environmental components and the grazing method(s) by which the system is managed to achieve specific results or goals. A grazing method is a defined procedure or technique of grazing management designed to achieve a specific objective(s). One or more grazing methods can be utilized within a grazing system. Examples of grazing methods include continuous stocking and rotational stocking. The method of grazing used generally has less influence on livestock production than the stocking rate. The objective of a grazing method should be to manage the pasture and other feed inputs to efficiently produce animal products. Effectively managing forage quantity and quality over the grazing season is of much greater importance than which grazing method is used.

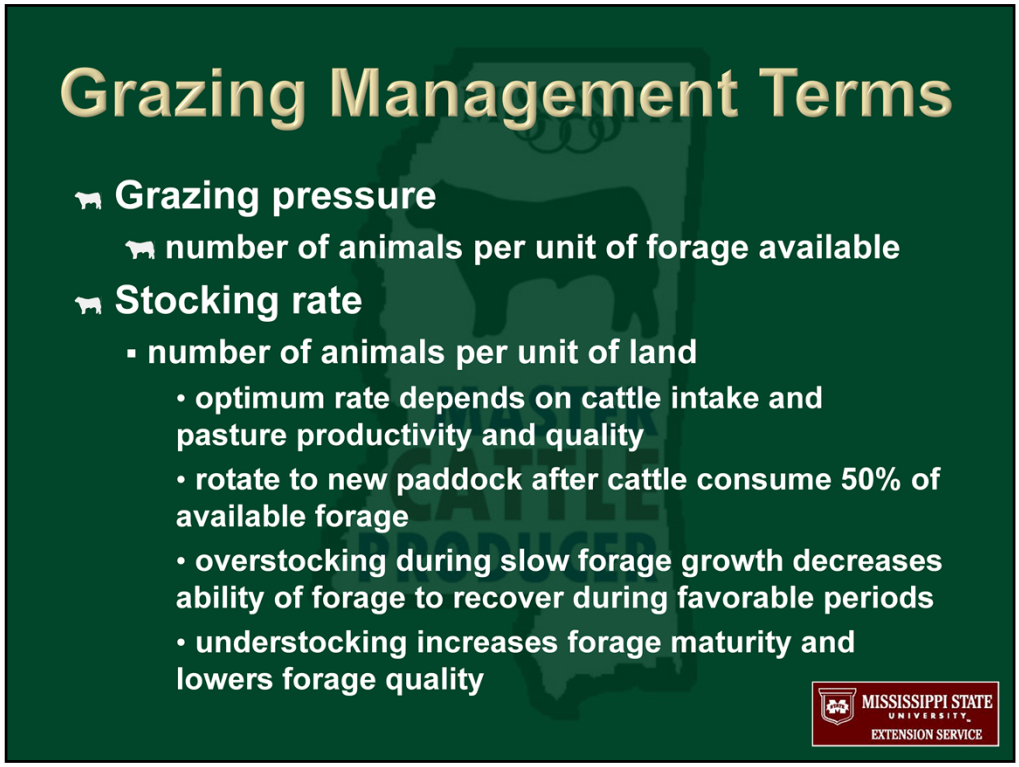
The amount of dry matter utilized depends on both grazing method and grazing time. A range of 40 to 70% pasture utilization is common. Utilization in the upper portion of this range is possible with greater stocking rates and shorter grazing times. Forage utilization by other means often results in the following utilization rates: hay, 70 to 80%; strip grazing 75 to 80%; and silage or greenchop, 85 to 90%.

For detailed information on beef cattle grazing management, refer to Mississippi State University Extension Service Publication 2629, “Beef Cattle Grazing Management”.

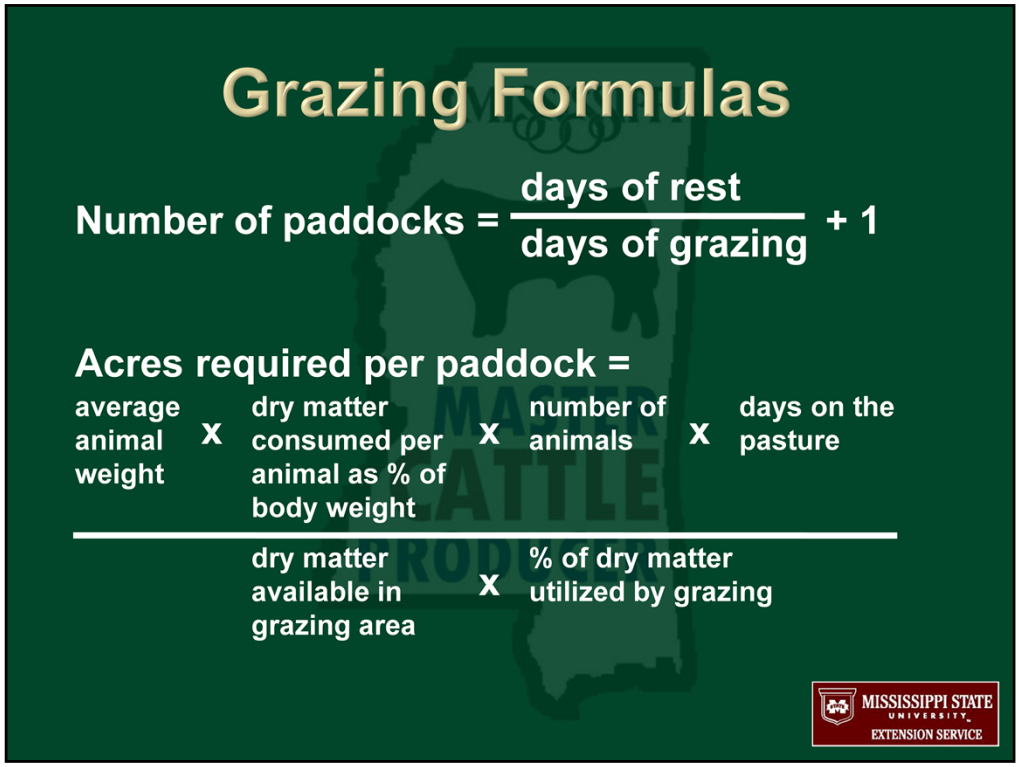


With rotational stocking, grazing control and decision making are switched from the animal to the manager. Having more control over grazing animals through rotational stocking allows the manager to better utilize forage supplies. A major benefit of rotational stocking is increased pasture carrying capacity when proper management is used. By moving cattle on a regular basis with rotational stocking, cattle become easier to handle. Managers observe cattle more often and can identify and address animal health or other problems more quickly. Pasture plants that are sensitive to close continuous grazing are more persistent and productive in rotational stocking systems. Utilization of more forage species is improved with rotational stocking as weeds are eaten more than would otherwise occur. This reduces plant competition and favors pasture dominance by desirable forage species. Less forage is wasted by trampling with rotational stocking. Excess forage in ungrazed paddocks can be harvested for hay during periods of forage surplus growth. Manure and urine distribution is more uniform with rotational stocking. Fencing paddocks separately based on forage species dominance and concentrating animals in smaller areas for shorter periods facilitate better pasture management and forage utilization. Better overall forage management often results with rotational stocking due to closer observation of both pastures and cattle. Environmental benefits of rotational stocking result from strategic fencing of cattle out of surface water sources and stream banks, protecting water quality and reducing erosion.

Rotational stocking is not without its challenges. Concerns with rotational stocking can include unproductive or low quality forage species, poor forage stands, low soil fertility, soil acidity, unsatisfactory layout, overstocking, rest period too long, and cost.



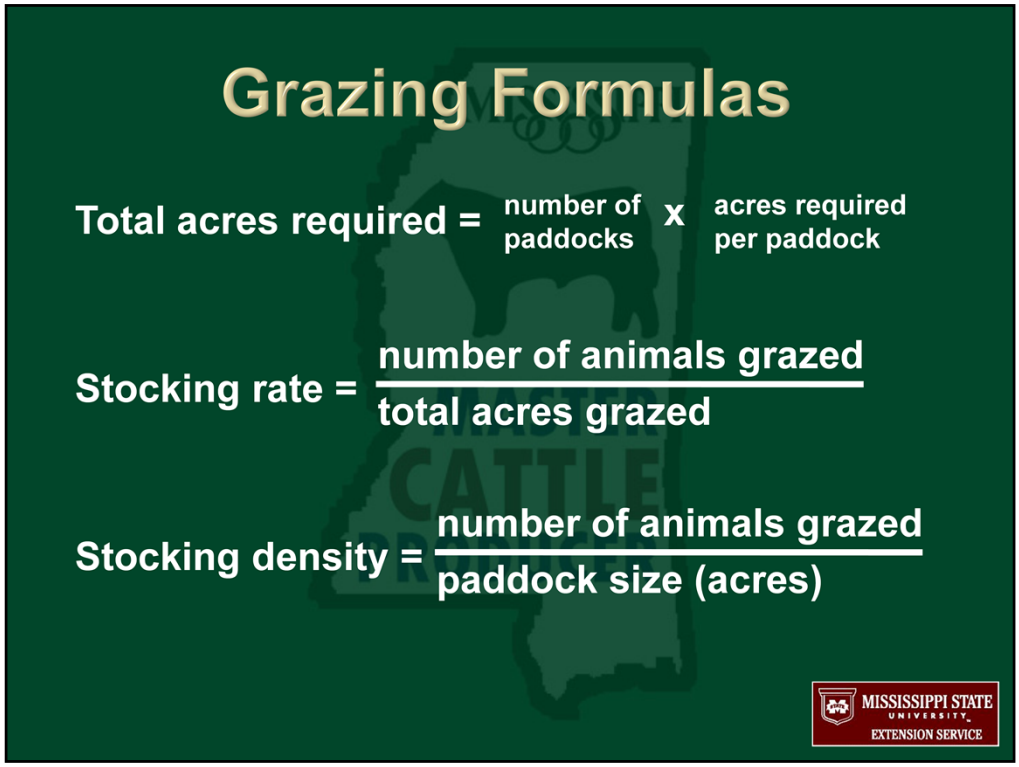
It is important to recognize and understand grazing management terminology to properly plan and implement grazing management recommendations. Grazing pressure and stocking rate are often confused or considered to be the same. Yet there is a distinct difference in these 2 concepts. Grazing pressure is the number of animals per unit of forage available. Stocking rate is the number of animals per unit of land. Optimum stocking rates depend on cattle intake and pasture productivity and quality. One rule of thumb sometimes used to manage stocking rate is to rotate grazing animals to a new paddock after they consume 50% of available forage in a paddock. The effectiveness of this rule depends on factors such as initial forage availability, height of forage growing points, and grazing tolerance of forages. Some forages could be more closely grazed than others. Overstocking occurs when stocking rate is too high. Overstocking during slow forage growth decreases the ability of forage to recover during favorable growing conditions. Overstocking decreases animal performance if forage availability limits intake. Understocking occurs when stocking rate is too low. Understocking increases forage maturity, lowers forage quality, and can decrease animal performance.



Grazing formulas help in planning grazing management.

To determine the number of paddocks needed, divide the number of paddock rest days by the number of grazing days and then add 1 to the result. For example, 8 paddocks are needed for 4-day grazing periods with 28-day rest periods.

To compute the number of acres needed per paddock, multiply the following: average animal weight, dry matter consumed per animal as a percentage of body weight, number of animals, and days on the pasture. Then take the result and divide by the following: dry matter available in grazing area multiplied by the percent of dry matter utilized by grazing. For example, forty 600-pound steers consume 3% of their body weight in dry matter per day and will be on the pasture for 4 days. Pasture utilization is approximately 60% with 12 inches of forage growth and a thick stand (12 x 225 lb/inch). The number of acres needed per paddock in this scenario is 1.8 acres.



Total acres required equals the number of paddocks times the number of acres required per paddock. Using the values from the previous examples (8 paddocks and 1.8 acres per paddock), the total acres required in this example is 14.4 acres.

Stocking rate equals the number of animals grazed divided by the total number of acres grazed. Continuing the example above with 40 steers, the stocking rate is 2.8 steers per acre.

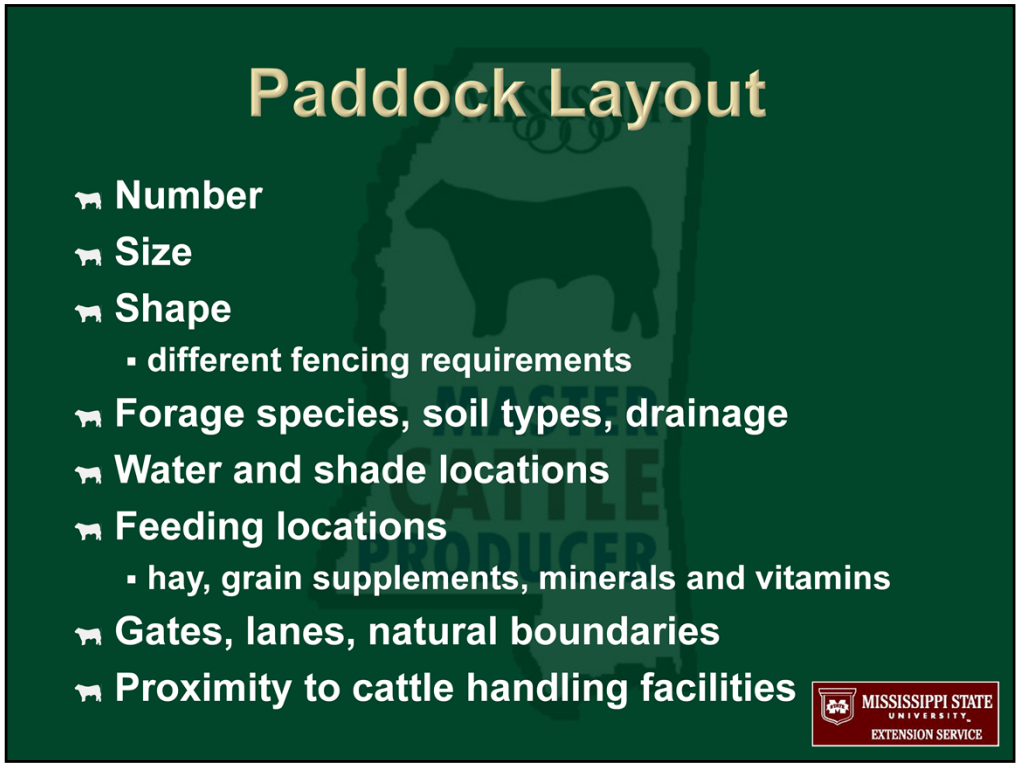
Stocking density equals the number of animals grazed divided by the paddock size in acres. Continuing the same example, the stocking density is 22 steers per acre.

Fences can significantly increase livestock grazing efficiency. Proper fencing layout is a powerful management tool in efficient grazing systems. Livestock protection and confinement are not the only reasons to consider fencing. An effective rotational or other intensively managed grazing system can be an affordable way to provide forage to grazing livestock and reduce herd nutrition costs year round.

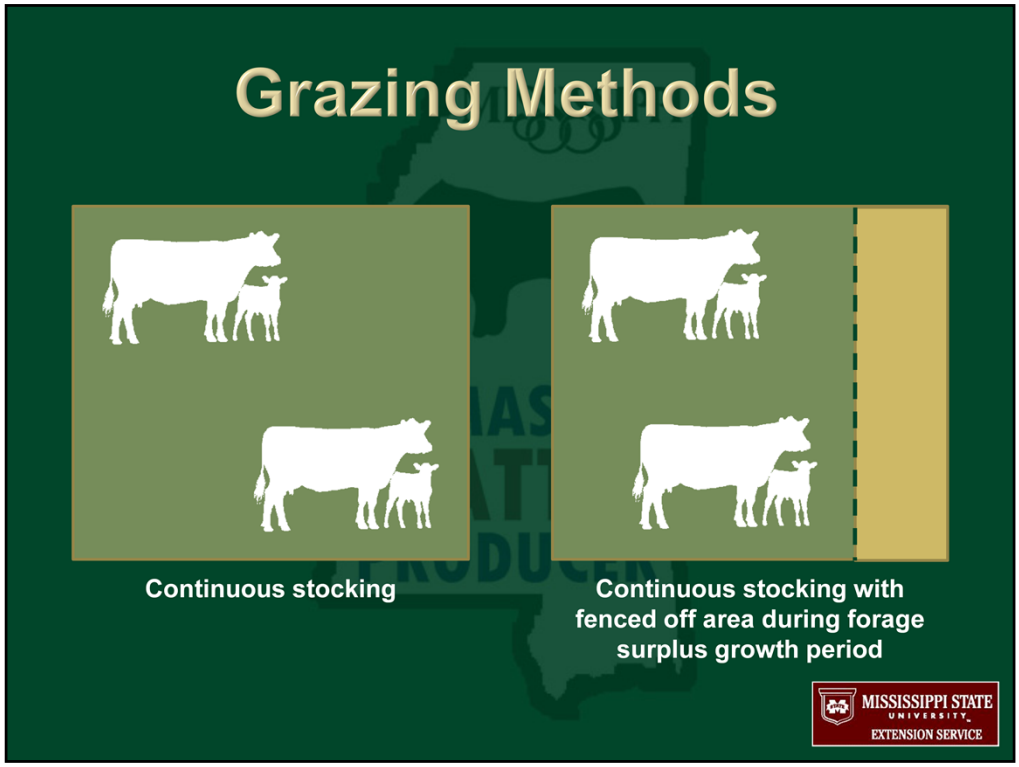
The first step in planning livestock fencing is determining the purpose and goals of the fencing program. Fencing needs vary depending on the type of grazing management system and livestock species, class, and age. Determine the operation size, number of animals, type of forage system, and number of paddocks needed before investing in fencing materials and supplies. Many effective fencing options are available to livestock producers. Whether used as permanent or temporary confinements, fences should be carefully planned and constructed for efficient use, long life, and low maintenance.

In addition to keeping livestock out of the neighboring pastures and off the major highways, fencing is a key component of good grazing management. Fencing allows control over the movement of livestock and the productivity, quality, and utilization of forage crops. Low-cost, semi-permanent and temporary electric fencing systems make controlling and efficiently using pasture resources easier than ever. Well-designed fencing, water, and shade systems can make a big difference in animal comfort and productivity as well as labor efficiency. These systems should be functional at the arrival of livestock and must be monitored and maintained throughout the year.

For detailed information on fencing, refer to Mississippi State University Extension Service Publication 2538, “Livestock Fencing Systems for Pasture Management”.

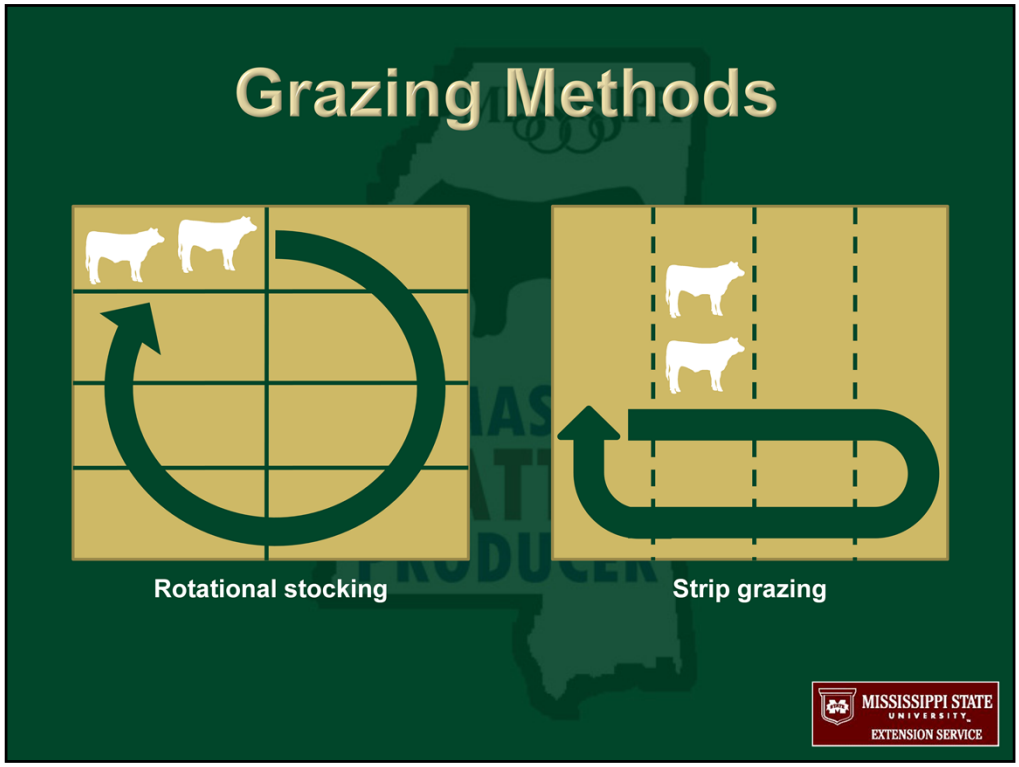


Paddock layout is critical when planning forage utilization programs. The number and size of paddocks needed depends upon the total acreage available, number of cattle to be grazed, intended stocking densities, number of paddock rest days desired in between grazing rotations, and resources available to establish adequate fencing, water, and shade for each paddock. The perimeter of each paddock needs to be fenced. The amount of fencing material needed depends on paddock shape. To fence 1 acre, 744 feet of fencing is needed for a circle compared with 1,040 feet of fencing needed for a rectangle with a length 4 times its width. Paddock shapes in order from most efficient perimeter fencing requirements to least efficient are circle, square, rectangle with length 2 times width, equilateral triangle (sides of equal length), right triangle (2 sides of equal length and a 90 degree angle in 1 corner), and rectangle with length 4 times width. Forage species, soil types, and drainage affect ideal size and placement of paddocks for grazing systems. The locations of water, feeding areas, and shade affect grazing distribution within paddocks. Cattle tend to congregate in these areas. Cattle should not have to travel long distances to access water or shade. Provide adequate quantities of shade and water sources capable of supplying adequate water to meet the needs of the cattle to be grazed. Location of gates affects ease of moving cattle in and out of paddocks. Cattle move easiest along fencelines into corners. Gate placement in the middle of a fence makes cattle rotation more difficult. The inclusion of lane systems further eases cattle movement among paddocks. Natural boundaries such as tree lines may influence paddock layout. Paddocks should not be so far from cattle handling facilities that routine and emergency handling becomes difficult.



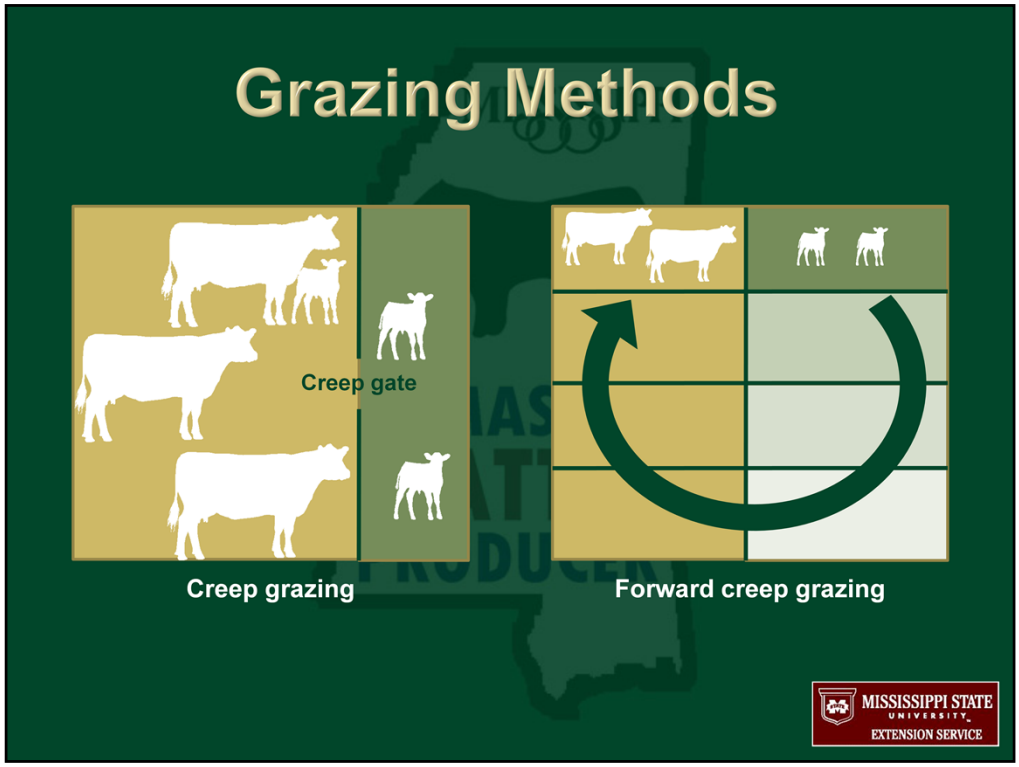
Continuous stocking (continuous grazing) is a method of grazing livestock on a specific unit of land where animals have unrestricted and uninterrupted access throughout the time period when grazing is allowed. Set stocking is the practice of allowing a fixed number of animals on a fixed area of land during the time when grazing is allowed.

Areas can be fenced off from continuous stocking during periods of surplus forage growth to help keep the forage being grazed from becoming overmature. The stockpiled forage can then be either grazed at a later date or harvested for hay. Stockpiling forage (deferred grazing) is where forage is allowed to accumulate for grazing at a later period.



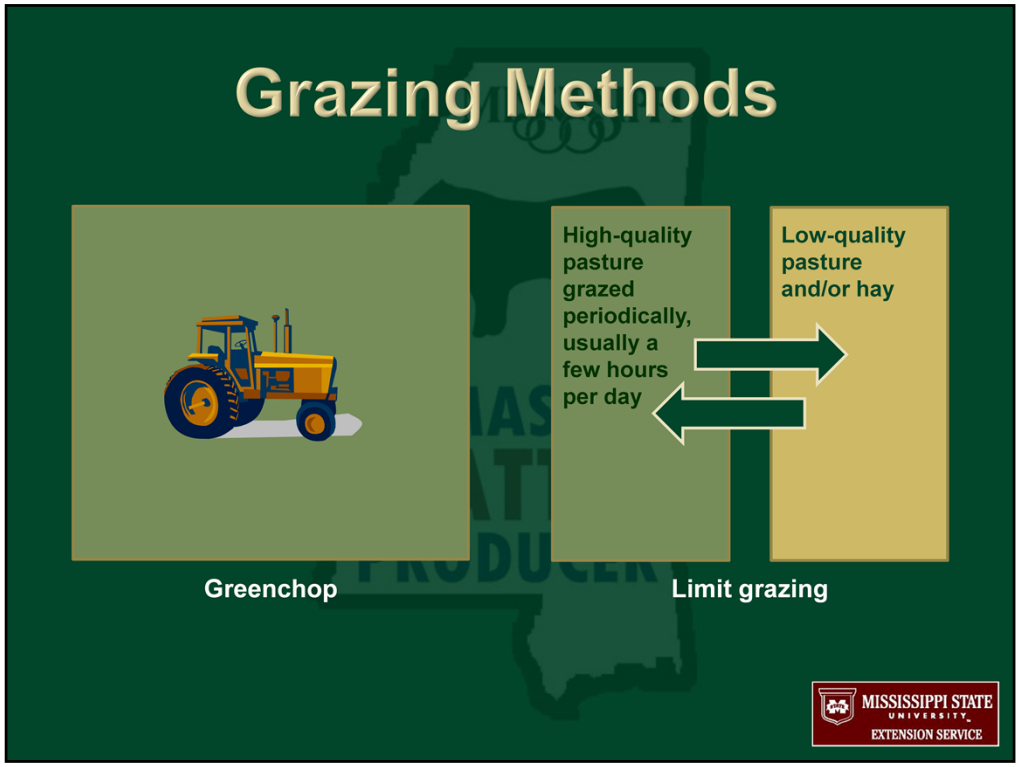
Rotational stocking (rotational grazing) is a grazing method that utilizes recurring periods of grazing and rest among 2 or more paddocks in a grazing management unit through the period when grazing is allowed.

Strip grazing involves confining animals to an area of grazing land to be grazed in a relatively short period of time, where the paddock size is varied to allow access to a specific land area. Mob grazing is a variation of strip grazing where a large number of animals are grazed on a relatively small number of acres to rapidly remove forage from the paddock. Mob grazing is useful when forage growth needs to be removed prior to sodseeding another forage crop in the same paddock.



Creep grazing is a form of preweaning supplementation of nursing calves. It is the practice of allowing nursing calves to graze areas that their dams cannot access at the same time. This is accomplished through use of a creep gate that the calves can pass through freely but their dams cannot.

Forward creep grazing is a method of creep grazing in which dams and calves rotate through a series of paddocks with calves as first grazers and dams as last grazers. Calves, therefore, have more opportunity for selectivity than their dams. This is a specific form of forward grazing. Forward grazing (leader-follower, preference-follower, top and bottom grazer, first-last grazing) is a method of utilizing 2 or more groups of animals, usually with different nutritional requirements, to graze sequentially on the same land area.



Greenchop is where green, actively growing forage is chopped mechanically and fed to livestock. This method reduces waste by grazing animals so that more animals can be fed per acre. However, forage selectivity is decreasd, and individual animal performance is often less. Equipment, fuel, and labor costs are greater with this forage harvest method.

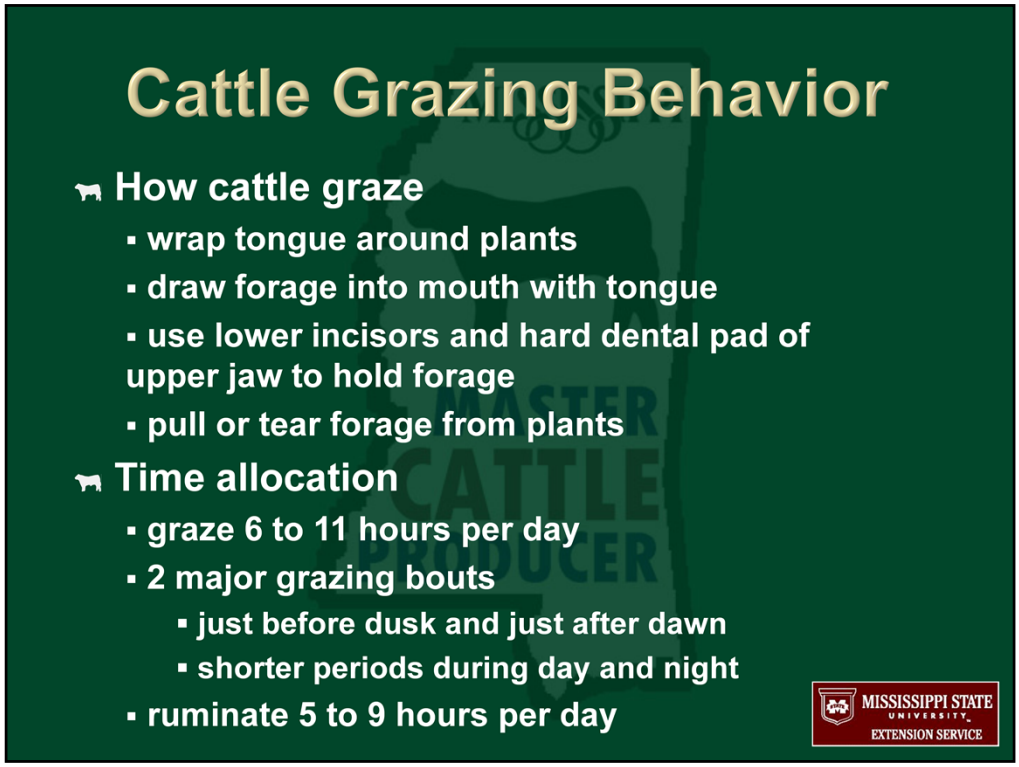
Limit grazing is where livestock are maintained on lesser quality pasture but allowed to access a higher quality pasture (typically winter annual grass pasture) for a few hours each day or every few days. Waste from trampling is reduced with this method. This method provides good nutrition at relatively low cost as the area needed for high quality pasture is relatively small. Cattle learn to move to and from paddocks with relative ease after a routine is established.

Grazing animals affect pasture productivity and forage species populations via defoliation, treading, and excretion.

Defoliation is the harvest of plant shoots or leaves by the grazing animal. It has the largest influence on a pasture of the 3 factors listed here. Cattle graze by wrapping their tongues around plants and then pulling to consume forages. Defoliation effects on pastures depend on forage species present, extent of selective grazing of different plant species, defoliation frequency, extent of defoliation, stage of plant development, and environmental conditions at time of defoliation. Reduced leaf area from grazing affects plant food production and storage, shoot development, leaf and root growth, light intensity in the lower portion of the forage canopy, soil temperature, and soil moisture. Overgrazing results in weak plants, reduced root systems, lower forage yield, greater soil erosion and water run-off, thinned forage stands, and more weeds. Undergrazing wastes forage and reduces overall forage nutritive quality. Overgrazing and undergrazing each favor some forage and weed species over others.

Trampling of pastures by livestock hooves damages plants, compacts soil, and reduces water infiltration on clay soils. Treading damage is most severe during extremely wet periods, on clay soils, on recently tilled soils, and with short forage.

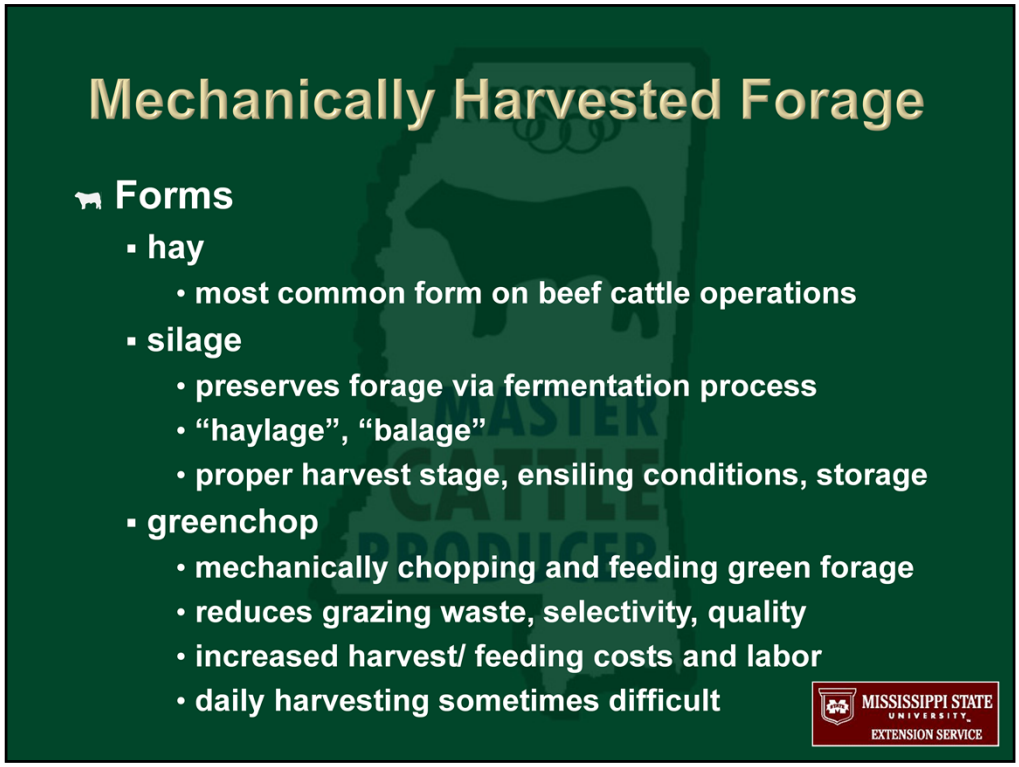
Cattle normally urinate 6 to 11 times daily and defecate 10 to 18 times daily. This excretion concentrates nutrients on only about 20% of the pasture. Nutrients are further concentrated in areas where cattle congregate such as under shade and in water and feeding areas. Specifically, nitrogen is concentrated in urine spots and phosphorus is concentrated in manure patches. Cattle tend to graze around these excretion sites, reducing the amount of grazeable forage in a pasture.



Cattle that are mature ruminants can consume up to 20% of their weight in fresh forage each day. Cattle move slowly over pastures taking approximately 30 to 60 bites per minute. They use their tongues to draw forage into their mouths and pull or tear it from the plants by holding it firmly between their lower incisor teeth and hard upper dental pad (gums). Cattle normally graze for 6 to 11 hours per day. Forage characteristics can affect grazing time. For example, grazing time and forage intake is reduced on toxic endophyte-infected tall fescue as compared with non-toxic tall fescues. Cattle usually have 2 major grazing bouts during a 24-hour period, just after dawn and just before dusk. Shorter grazing periods occur throughout the day and night. After a grazing bout, cattle rest (often lying down) and ruminate (chew their cud). During rumination, cattle regurgitate forage harvest during grazing. They then chew the bolus of forage regurgitated, mixing it with saliva. The forage is then swallowed again for further digestion in the rumen. Cattle typically ruminate for 5 to 9 hours daily.

When animals have access to a number of different pasture plant species or maturities, they show distinct preferences. Pastures must have sufficient leafy, green forage available to allow animals to quickly satisfy their appetites by selective grazing. Grazing animals find dead leaves less acceptable and often avoid them when other forage is available. When grazing animals are given access to fresh pasture, they consume the best quality forage first. Continuous stocking allows animals to selectively graze unless the stocking rate is too high. Rotational stocking often reduces the opportunity for animals to select only the leafiest forage, resulting in decreased overall quality of forage consumed and sometimes lower animal gains, especially on low quality forages.

In addition, different grazing animal species have different forage preferences. Cattle generally prefer grasses and legumes. Cattle consume approximately 65 to 75% grasses, 20 to 30% broadleaf weeds and legumes, and 5 to 10% browse (shrubs or trees). Deer typically prefer legumes to grasses. White tail deer consume approximately 10 to 30% grasses, 30 to 50% broadleaf weeds and legumes, and 30 to 50% browse. Horses are more selective than cattle, tend to spot graze, and bite off forage very closely. Horses consume approximately 70 to 80% grasses, 15 to 25% broadleaf weeds and legumes, and 0 to 5% browse. Goats select higher quality leafy forage than cattle during grazing. They consume the more nutritious parts of coarse weeds, brush, grasses, and legumes. Goats consume a wider range of plants than cattle and tolerate bitter tastes including plants containing large amounts of tannins. The biting action and small mouths of sheep and goats allow more selective and closer grazing than the tearing action of cattle. Goats consume approximately 20 to 30% grasses, 10 to 30% broadleaf weeds and legumes, and 40 to 60% browse. Sheep consume approximately 45 to 55% grasses, 30 to 40% broadleaf weeds and legumes, and 10 to 20% browse.

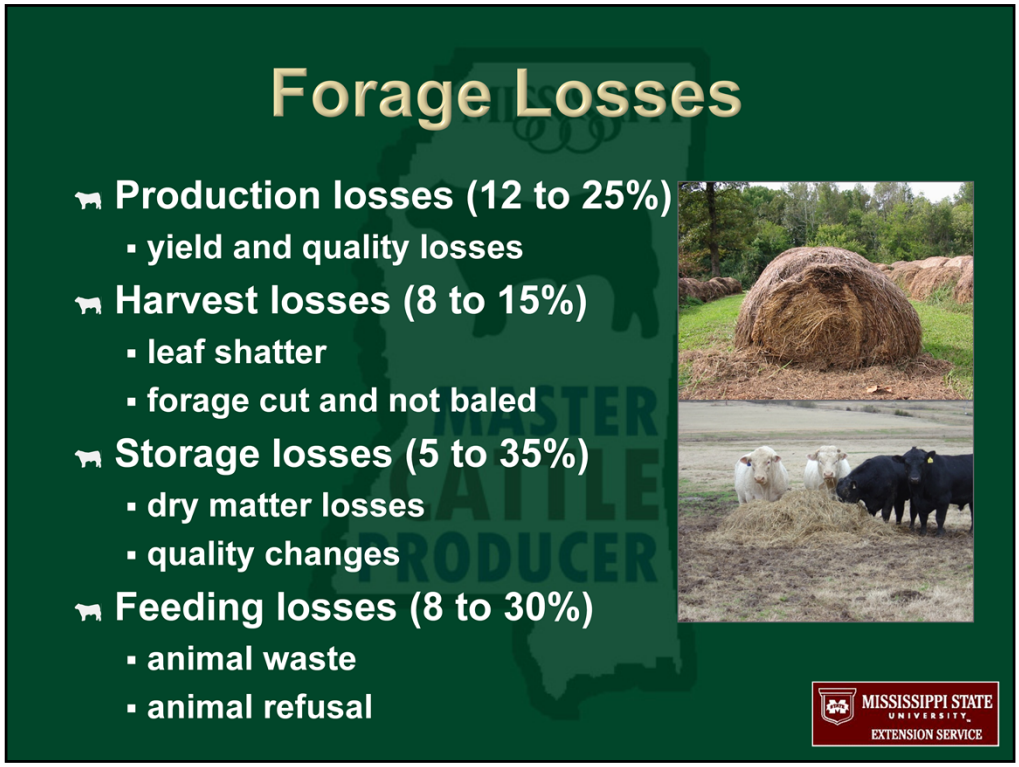


Forage can be provided to cattle in many forms including grazing, hay, silage, and greenchop. Allowing animals to harvest forage reduces machinery and related harvest and feeding expenses, allows for animal selectivity, and can be a very efficient method of forage utilization when managed properly. However, mechanical harvest of forage provides options for long-term storage of forage and can be used to match forage supply and demand throughout the year. Mechanical harvest also allows utilization of forage from fields that are not fenced or do not have adequate water supplies to contain grazing animals.

Hay is the most common form of stored forage on Mississippi beef cattle operations. Hay is cut, dried forage that is often packaged in large round and large or small rectangular ("square") bales.

Forage silage is also called haylage or balage (round bale silage). It is a preserved form in which forage undergoes an anaerobic (without oxygen) fermentation process called ensiling. It is critical to ensure proper harvest stage, ensiling conditions, and storage for silage. Some balage is wrapped in single large round bales, whereas other balage is wrapped in long cylindrical tubes. Wrap balage with ultraviolent resistant plastic at between 45 to 65% moisture. Make sure silage is protected in air tight silos, pits, or wraps. Prevent damage to plastic wrap, and promptly patch holes in balage wrap. Feed silage promptly once exposed to air.

Greenchop is produced by mechanically chopping green forage for immediate feeding to livestock. Greenchop should be fed promptly after harvest. This method reduces grazing waste but also limits animal selectivity and ultimately quality of forage consumed and animal performance. Increased harvest and feeding costs and labor associated with greenchop and challenges with daily harvests have prevented widespread adoption of this forage harvest and feeding method amongst cattle producers.



Forage losses increase the cost of providing adequate forage to livestock and occur at many stages. Poor forage production, storage, and feeding management results in poorly utilized forage systems. In some cases, only a small proportion of forage produced or that could be produced is utilized by animals due to these losses.

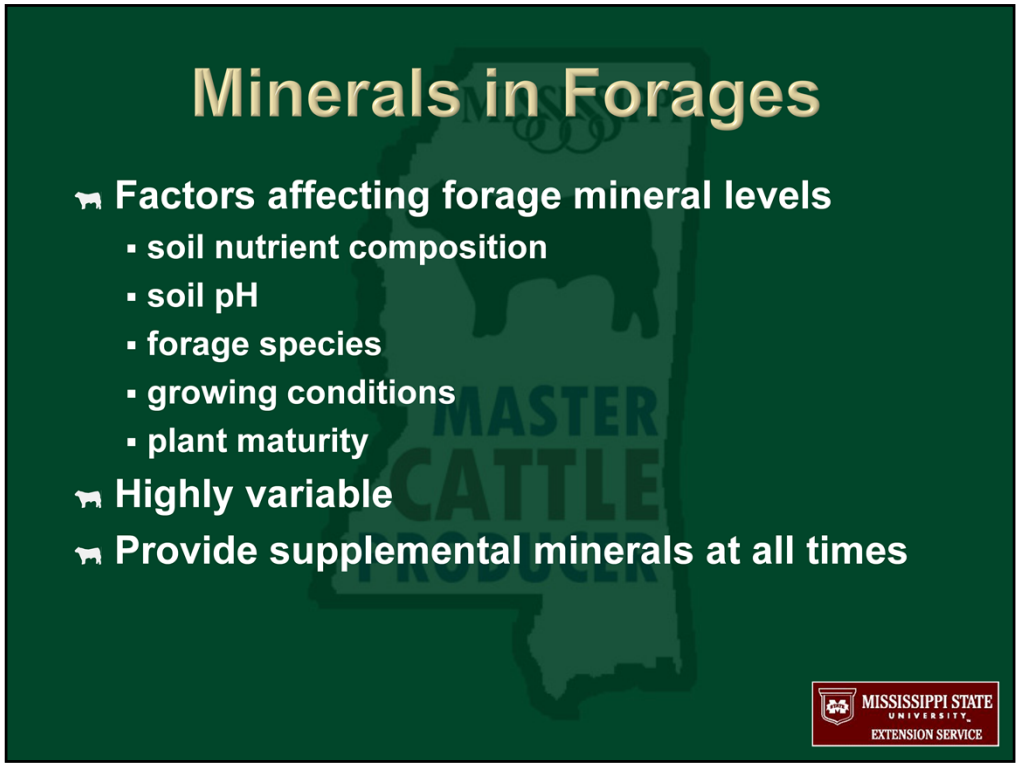
Forage management and environmental conditions affect forage yields and quality during forage production. Less than ideal growing conditions or management can reduce forage yields and/or quality.

In addition, forage produced is not necessarily consumed by livestock due to harvest, storage, and feeding losses. During harvest leaf shatter can result in losses. Not all forage cut is baled because harvest machinery is not 100% efficient. Use management intensive grazing methods to improve forage harvest and utilization over continuous stocking.

Storage losses vary widely by storage method. Protecting hay from weather damage and soil contact helps to conserve forage dry matter and quality. It only takes a few inches of weathering to result in large hay losses. Only 4 inches of weathering on a 4' x 4' bale results in 31% bale spoilage. Five to 6 inches of spoilage is common in Mississippi after several months of unprotected storage. As bale diameter increases, the proportion of spoilage decreases. Contact with soil increases hay losses. If covered storage is limited, put the highest quality hay under cover. For detailed information on hay storage losses, refer to Mississippi State University Extension Service Publication 2540, "Hay Storage: Dry Matter Losses and Quality Changes".

Feeding losses occur when animals waste or refuse to eat forage. Feeding losses from trampling, refusal, and leaf shatter can exceed 50% of hay dry matter in extreme cases. To minimize feeding losses, use hay rings, wagons, or other hay feeding equipment designed to reduce trampling and waste. Excessive hay losses can result when hay is fed without the use of a hay rack or feeder. Do not allow cattle unlimited access to hay. Up to 40% of hay offered to cattle can be wasted when fed in this manner. Feed hay stored outside before hay stored under cover to further reduce losses. Hay grinding is an alternative method of hay feeding that facilitates limit feeding and tends to lower hay feeding losses. Damaged hay decreases animal acceptance and performance. Both cattle and horses will refuse moldy, weather-damaged hay. Produce palatable forage without anti-quality factors and store to protect from spoilage to lessen animal refusal problems. Feeding high quality hay can result in less animal refusal.

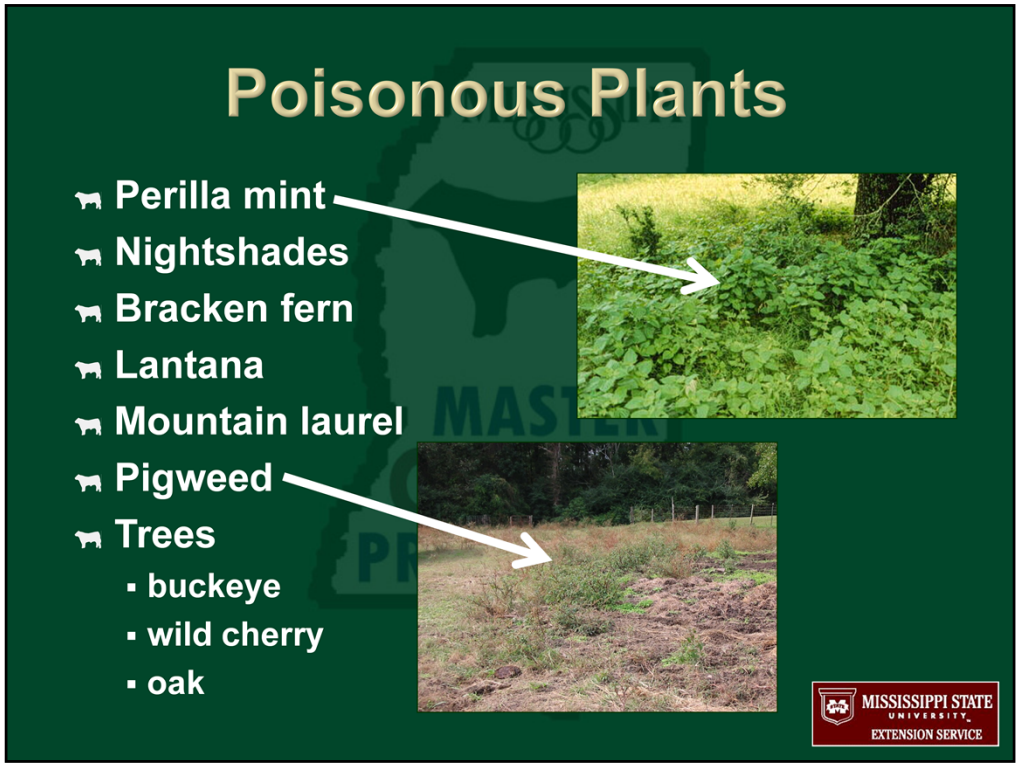
Total forage dry matter losses from field curing, harvesting, storage, and feeding losses may be 71% with lax management or 29% with good management.



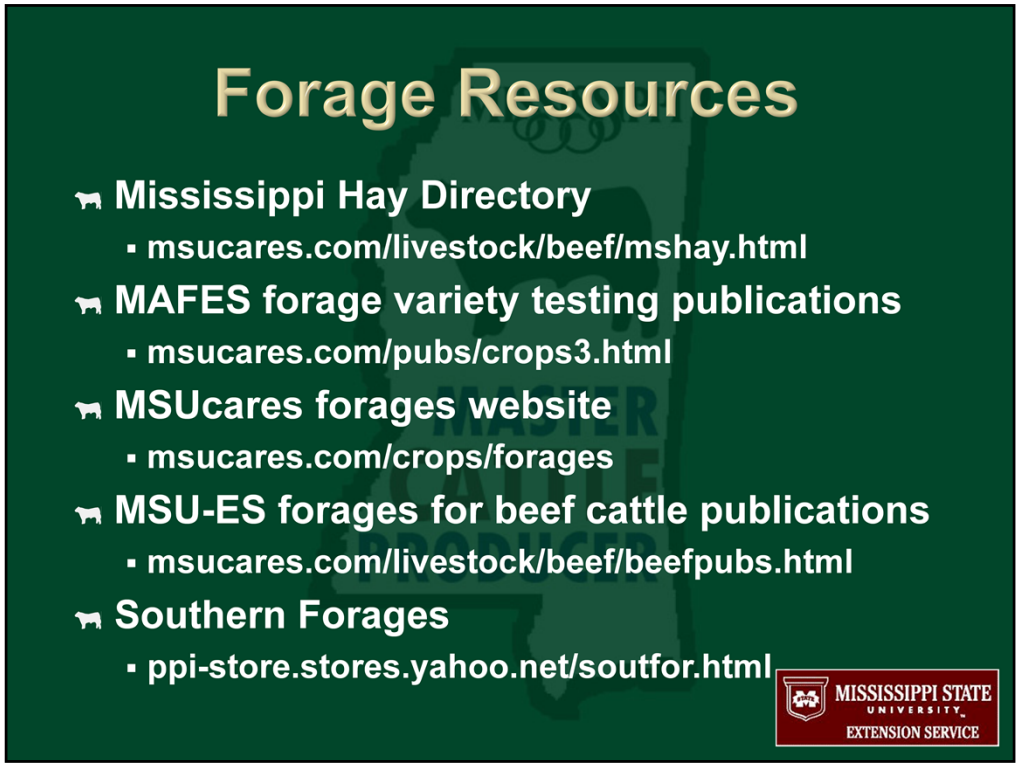
Mineral content in forages varies with species, plant part, maturity, quantity of calcium available in the soil for plant uptake, and climate. Mineral and vitamin composition of supplements should also be adjusted for forage conditions. For example, increased magnesium supplementation is justified during grass tetany season but should be reduced during other periods to match cattle nutrient needs better and avoid unnecessary reductions in supplement palatability often associated with high levels of magnesium. In selecting a mineral and vitamin supplement, consider the class of cattle being supplemented; forage conditions; mineral and vitamin levels in feedstuff and water sources; and expected intake levels of forages, feeds, and mineral and vitamin supplements.

Forages are generally greater in calcium concentrations than concentrate (grain-based) feedstuffs, with legumes (such as clovers and alfalfa) typically providing greater calcium levels than grasses. Forages are generally low in phosphorus as compared to concentrate feedstuffs such as cereal grains and oilseed meals (cottonseed meal, soybean meal). Drought conditions and increased forage maturity further deplete forage phosphorus concentrations. Increased phosphorus supplementation may be needed to supply increased dietary phosphorus levels when grazing or feeding stored mature forages or during periods of drought. Forages are good sources of potassium, often ranging from 1 to 4 percent potassium. Potassium content can be very high in lush pasture, potentially contributing to grass tetany onset. Mature and stockpiled forage contain lowered concentrations of potassium. Copper is more available in concentrate diets than in forage diets. Forages vary greatly in copper content and may contain variable levels of molybdenum, sulfur, and iron, which reduce usable copper levels. In some regions of the U.S., chronic selenium toxicity (alkali disease) occurs as a result of cattle consuming forages grown on high selenium soils. Other regions of the U.S., including the southeastern U.S., are predisposed to selenium deficiency risk based on low soil and forage selenium content. In selenium deficiency-prone areas, use the maximum legal selenium supplement level in the feed.

Vitamin supplementation is generally not as critical as mineral supplementation for beef cattle grazing actively growing forages. However, increased rates of vitamin A and E supplementation may be necessary when feeding dormant pastures or stored forages.



Perilla mint (purple mint) (pictured right), nightshades, bracken fern, lantana, mountain laurel, and pigweed are examples of poisonous plants that can cause problems in cattle when consumed. Buckeye (horse chestnut), wild cherry (black cherry), and oak trees can also cause potential livestock disorders if their leaves or nuts are consumed. In most cases grazing cattle with a good supply of forage and or hay will not consume poisonous plants. However, during conditions of limited forage availability, search pastures for poisonous plants common in Mississippi and check cattle for health or performance problems on a regular basis.



The Mississippi State University Extension Service hosts an Internet-based hay directory for Mississippi producers.

Mississippi Hay Directory

http://msucares.com/livestock/beef/mshay.html

Mississippi Agricultural and Forestry Experiment Station **forage variety testing** program publications are on the Internet at http://msucares.com/pubs/crops3.html.

The forages homepage on MSUcares is http://msucares.com/crops/forages.

Mississippi State University Extension Service **forages for beef cattle publications** are available online at http://msucares.com/livestock/beef/beefpubs.html. This includes the publications referenced in this training module.

The book, ***Southern Forages***, was used extensively as a reference for this training module. It can be ordered online at http://ppi-store.stores.yahoo.net/soutfor.html**.**

Ball et al., 2007. Southern Forages. 4th ed. Intl. Plant Nutr. Inst. Norcross, GA.