Lesson 1: Planning the Crop

Use of forages for feeding livestock has been in place since humans first domesticated animals. Forages, especially native grasses, are very hardy and easily grow under any number of different conditions. The first farmers in Missouri profited from the abundant native plants to help feed their animals. Today, over half the feed given to Missouri livestock is produced in the state.

Forages are economically important in the production of animal and animal products. When planted on lower quality farmland, forages can increase the land's economic importance by producing a crop that can be converted into meat and milk products.

Forages, hay and pasture crops, are the most widely produced crops in the United States with 475 million acres of pasture and rangeland and 61 million acres of hay. As noted in the first lesson of Unit I, Missouri ranks second in the nation for hay production, excluding alfalfa, and fourth in all hay production. This and the fact that Missouri is second in the production of beef cows emphasize the importance of forage production within the state.

What Is a Forage?

Forage is the vegetative material (leaves and stems) of plants used as livestock feed. In Missouri, forages primarily consist of multiple varieties of grasses and/or legumes but can include grain crops such as corn and grain sorghum or stalks from harvested crops. Forages are used in three different forms, or forage productions systems: (1) fresh (pasture), (2) dried (hay), and (3) ensiled (silage or haylage). This lesson will focus primarily on the production of pasture and hay forages as silage is discussed in Unit VI, Corn and Grain Sorghum Production.

Differences of Forage Crops

Forage crops are typically grown for the intended purpose of being used as livestock feed. Producers must be aware of the differences in hay, pasture, and silage/haylage crops to make effective management decisions.

The hay crop is managed in much the same way as a grain crop. It requires knowledge in management skills, the necessary equipment for seedbed preparation and/or maintenance, fertilization, planting, harvesting, transporting, and short-term or long-term storage capabilities. Hay is primarily harvested by mechanical methods but can be grazed. Grazing is most often used in hay production to delay or eliminate a cutting (one complete harvest cycle). Hay crops require special attention when cutting, drying, and storing to maintain crop nutrients. Exposure to rainfall after cutting and before and after baling should be avoided because excessive moisture can rot hay. Also, the nutritional content and palatability of baled hay will gradually be depleted with long-term storage, so timely use or marketing is recommended.

Pasture production also requires specific knowledge and management skills. Equipment needs are generally less because harvesting is done primarily through livestock grazing. Due to this harvest method, permanent pasture crop areas must be fenced and maintained. There are existing perennial grasses and legumes that can be either improved or nonimproved. Improvements to pastures include fertilizer applications and seedings of additional grasses and/or legumes, especially varieties that extend the grazing season and improve nutritional value. Unimproved permanent pastures use natural grassland vegetation but still require good grazing management decisions to maintain a good crop.

Temporary or rotational pastures are seeded annually for summer and winter grazing needs or as needed in a crop rotation system. Wheat and small grains are commonly used for winter and early spring grazing, whereas millet and sorghum are seeded for summer grazing. The stalk fields remaining after grain harvest of these and other grain crops can be grazed as temporary forage pastures. These temporary pasture crops will generally require the installation of temporary fencing.

Silage is preserved in moist, succulent conditions by partial fermentation in a tight container. The moisture content at harvest is generally greater than 50%. A forage harvester is used to chop the crop for easier handling and better packing in a silo. There is little to no loss from shattering, leaching, or bleaching. Weather conditions are less dependent on extended periods of favorable weather. Plants used as silage must contain sufficient carbohydrates for fermentation and low amounts of calcium and protein. A relatively new method of harvesting is round bale silage. This method uses forage of a relatively high moisture content. It is baled with a round baler and then stored in a sealed container, usually a plastic bag. Baled silage is more likely to spoil than silage in traditional silos.

Haylage is forage that could have been cut for hay but is stored with a higher moisture content than hay, but with less moisture than silage. The moisture content at harvest is generally below 50%. The lower moisture limits bacterial action. High levels of carbon dioxide from respiration create good preservation conditions. Livestock find haylage more palatable than high moisture silage.

Evaluating a Forage Site

Introduction of forages into an agricultural system can be a very complex undertaking. There is a large variety of forages available to producers. The types of forage systems that can be in operation (pasture, hay, silage, or a combination system) are important to evaluate current site characteristics to determine what forage system can be started. When evaluating a site, a producer must consider the following questions:

- What is the intended use of the forage crop from the site?
- What are the existing forages on the site or what was the previous crop?
- Does the site's topography limit forage species and/or intended use of a crop?
- Does the site's soil (type and fertility) limit forage species and/or intended use of a crop?

Intended Use of Forage

Site evaluations must first consider the intended use of the forage to be produced, whether for hay, pasture, or silage/haylage. By considering the intended use, specific characteristics of existing or planned forage varieties can be evaluated.

Producers must keep in mind that forages used in hay and silage/haylage sites are to be harvested for later feed use or sale. Therefore, these crops need to have higher yield characteristics to offset harvesting and marketing costs. Hay and silage/haylage crops must also be able to withstand harvesting pressure or the repeated cutting or harvesting of a crop. The ability to withstand this pressure will affect the quickness of regrowth, amount of forage developed between cuttings, future season cuttings, and the longevity of the forage stand.

Pasture forages should be evaluated knowing they are to be consumed directly by animals. This intended use requires forage varieties adapted for rapid growth and tolerant of hoof traffic and soil compaction. If current forage varieties do not have these characteristics, the site will need to be improved. These forages should be able to use the poorer soils and topography that are typically associated with pasture sites.

Existing Forages or Previous Crop

Producers must consider any existing forages or what crop was previously planted when evaluating the selected forage site. If new forages are to be introduced into an existing forage stand, the producer should introduce forage species that complement the existing crop and will enhance the overall forage quality. When dealing with previous crops, producers must be aware of any carryover herbicides, pesticides, insecticides, and fertilizer applications that could affect new forage growth. Producers must know the regrowth ability of the previous crop, especially in new forage stands. These stands are developed as pure quality stands, and any regrowth of the previous crop would reduce the quality and may become a weed problem.

Topography

Topography deals with the visual surface of the land. Elevation is one consideration. Because some plant species tend to be elevation specific, they may grow better at some elevations. The elevation in Missouri is fairly consistent so this is not a major concern in this area. Another consideration is slope of the land. Slope will determine the erosion hazard and the amount of available topsoil. Other considerations, such as stoniness, weeds, amount of brush, and the amount of boggy or marshy soils are all considerations that may limit available existing forage and possible improvements. This will be a determining factor for forages planted for harvest or pasture and will affect the amount of time and money needed to establish a forage crop.

Soil

The condition of the soil or soil quality is an additional factor to be considered in forage establishment and production. This includes soil type and texture, drainage, and fertility. Soil type and texture will determine the types of forages that will be most productive. For example, most legumes prefer deep loams, but there have been acceptable results with any well-drained soils. Grasses tend to be less particular about soil conditions; some are better suited to wet soils and others are adaptable to dry, unirrigated soils.

Soil drainage is another important factor. Many forages can tolerate a short duration of flooding. However, long-term, poorly drained soils will affect the forage species to be planted. Legumes, such as alfalfa, require well-drained soils, while birdsfoot trefoil is tolerant of wet, moderately well-drained soils and alsike clover is very tolerant of wet locations. With grasses, tall fescue is tolerant of wet soils where reed canarygrass is best adapted to wet, marshy areas.

Soil fertility is another consideration. Recommendations for planting can be based upon soil tests. Legumes typically require 6.5 to 7.5 pH with alfalfa being the most sensitive. Grasses are more tolerant and prefer 5.5 to 7.0 pH with some species accepting pH ranges as low as 4.0 or as high as 9.0. Nitrogen (N) is used as a starter to aid in forage establishment. Legumes require 10 to 20 pounds per acre and grasses need 20 to 40 pounds per acre. The incorporation of phosphorous and potassium before planting is needed because these minerals are not mobile in the soil. Optimum P for grasses and legumes is 140 pounds per acre and optimum K is 200 pounds per acre.

Summary

Forage production is a major industry in relation to the use of forages in livestock production. Forages, especially native grasses, are very hardy and easily grow under many different conditions. The decision to establish a forage crop and the factors in determining the types of forages to establish are all major considerations in this decision. Management decisions include the intended use of the forage, existing forages, previous crops, topography, and soil.

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Lesson 2: Selecting a Variety

Forage plants are suitable for specific production situations. Each has distinct advantages and disadvantages. The selection of forage crops to be produced should be based upon certain characteristics along with their adaptation to the soil, climatic conditions, and intended use. The following lesson will discuss various forages and how they can be used in hay and pasture production.

Cool-season Grasses

Cool-season grasses are plants exhibiting vigorous growth habits in the spring and fall months. These plants turn green and initiate new growth as temperatures warm in the early spring, typically in late February or early March, or when soil temperatures reach 40°F. As soil and air temperatures rise and spring rains occur, cool-season grasses begin a period of rapid growth. Optimum growth occurs when air temperatures reach 59°F to 77°F in late spring and then when they fall to this same temperature in early to mid-fall months.

During summer months, cool-season plant growth slows and plants become brown and dormant. This occurs due to their inefficient use of water and sunlight energy during hot and dry weather conditions. The temperature at which summer dormancy occurs varies by grass species. Irrigation can prolong cool-season grass growth in the summer months; however, growth potential will not reach that of early spring and fall production. Some cool-season grasses may remain green during mild winters, extending grazing use in fall and spring.

Table 2.1 lists the most common cool-season perennial and annual grasses grown in Missouri along with the advantages and disadvantages of each.

Table 2.1 - Cool-season Grasses

Name	Advantages	Disadvantages
Kentucky Bluegrass *Poa pratenis* Perennial	▸ Well adapted to the glacial and loessal (windblown) soils ▸ Most productive during cool, moist spring and early summer ▸ Palatable to all livestock ▸ Nutritious, rich in minerals and vitamins ▸ Ideal companion for common white clover ▸ Spreads by underground rhizomes, maintains dense stand on suitable soil ▸ Best used for pastures	▸ Dormant and unproductive during late summer ▸ Requires high phosphorus and lime soils ▸ Consistently low yields ▸ Unsatisfactory yields for hay
Orchardgrass *Dactylis glomerata* Perennial	▸ Adapted best to rich soils; relatively well adapted to light, medium fertility and moist, heavy soils ▸ More tolerant to heat, drought, and low fertility than bromegrass ▸ Shade tolerant ▸ Rapid establishment ▸ Rapid regrowth after cutting or grazing ▸ Good second and third growth ▸ Used primarily for pasture with legumes	▸ Moderately winter hardy ▸ Coarse and unpalatable at maturity ▸ Less nutritious than bromegrass or timothy ▸ Very competitive with legumes ▸ High nitrogen requirement for good production in pure stands
Reed Canarygrass *Phalaris arundinacea* Perennial	▸ Long lived, sod-forming, leafy perennial ▸ Flood tolerant and high yielding ▸ Good growth during summer ▸ Drought resistant ▸ Palatable to most livestock	▸ Requires heavy nitrogen applications ▸ Germinates slowly and competes poorly ▸ Expensive ▸ Must be carefully managed to maintain palatability (mow before seed heads emerge)

Name	Advantages	Disadvantages
Smooth Bromegrass *Bromus inermis* Perennial	▸ Best adapted to high to moderate rainfall and cool summer temperatures ▸ Best adapted to deeper, better soils ▸ Very winter hardy and drought resistant ▸ Palatable to all livestock ▸ Fits well into grass-legume mixtures ▸ Used for pasture or hay	▸ Seed fluffy and difficult to sow ▸ Slow establishment ▸ Cannot stand extended periods of hot, dry weather ▸ Weakened by heavy grazing ▸ Low productivity when grown along with nitrogen ▸ Low productivity in second and third growth
Tall Fescue *Festuca arundinacea* Perennial	▸ Adapted to a wide range of soil and climatic conditions ▸ Well adapted to shallow, droughty ridge soil due to high drought resistance ▸ Survives on wet, poorly drained soil ▸ Easy to establish satisfactory stand ▸ Can be grazed closely ▸ Combines well with legumes ▸ Good regrowth after harvesting ▸ Resists trampling damage in low, wet areas ▸ Best used for pasture	▸ Lack of palatability, especially for hay and silage ▸ Fescue toxicity ▸ Possibility of physiological disorders in livestock, e.g., "fescue foot" ▸ Very competitive with associated legumes ▸ Dormant during periods of high temperatures
Timothy *Phleum pratense* Perennial	▸ Winter hardy, well adapted to cool humid climate ▸ Adapted to a wide range of soil conditions - best growth on clay or silt loam soils that are moderately well drained ▸ Seed usually plentiful and low priced ▸ Rapid stand establishment ▸ Good yields starting in first hay year ▸ Little competition with legumes in mixtures ▸ An ideal companion for birdsfoot trefoil ▸ Easy to harvest and cure ▸ Widely used for pasture, hay, and silage	▸ Less productive than orchardgrass or tall fescue ▸ Susceptible to heat and low moisture conditions ▸ Low palatability and feed value at mature stages ▸ Easily weakened by heavy grazing or frequent cutting ▸ Produces an open sod
Small Grains (Barley, Oats, Rye, Triticale, Wheat) Annuals	▸ Easy stand establishment ▸ Provides early spring, late fall, and winter grazing ▸ Well adapted for double crop	▸ Must be planted annually ▸ Costly ground preparation ▸ Soil erosion

Warm-season Grasses

<u>Warm-season grasses</u> are plants that exhibit vigorous growth in the early spring and summer months. These grasses begin to turn green and initiate new growth as the soil temperatures reach 60°F in the spring. Optimum growth of these grasses occurs when air temperatures reach and maintain a 77°F to 104°F range.

Annual warm-season grasses are often used as pasture, hay, or silage crops throughout Missouri. Their rapid production of high-quality forage during late spring and summer makes them potentially important in summer grazing systems. They work well in rotation with row crops; however, the costs to establish them annually make these crops an expensive source for animal gain compared to perennial forage crops. For the advantages and disadvantages of the most common warm-season perennial and annual grasses grown in Missouri see Table 2.2.

Cool-season and Warm-season Grasses Complement Each Other

A combination of cool- and warm-season grasses will provide a continuous supply of available forage for grazing due to their different growth habits. Warm-season grasses begin their most vigorous growth in the summer whereas cool-season grasses grow best in spring and fall. Ideally, one-third of grass pasture mixtures should be made up of warm-season varieties. The growth periods of these two grasses complement each other and extend the length of crop production in the state of Missouri.

Table 2.2 - Warm-season Grasses

Name	Advantages	Disadvantages
Bermudagrass *Cynodon dactylon* Perennial	▸ Adapted to deep, sandy loam and medium-textured soils. ▸ Prefers pH of 5.5 or above. ▸ Drought resistant	▸ Intrusive into crop fields. ▸ Marked decrease in quality in late summer and fall ▸ Requires more irrigation than other warm-season grasses ▸ Not as winter hardy as other types
Big Bluestem *Andropogon gerardi* Perennial	▸ Adapted to moist, well-drained loams of relatively high fertility ▸ Good summer forage production ▸ Highly palatable to all classes of livestock ▸ Makes good quality hay if mowed before seed heads emerge ▸ Tolerant of close grazing with good recovery if protected during first part of season	▸ Slow establishment ▸ Warm-season producer only
Caucasian Bluestem *Bothriochloa caucasica* Perennial	▸ Suited to marginal cropland ▸ Used in land reclamation ▸ High crop yields ▸ Excellent stand persistence ▸ Withstands heavy stocking rates	▸ Not adapted to extremely sandy, loose soils ▸ Not tolerant of wetland soils ▸ Lacks winter hardiness, not adaptable to northern Missouri
Eastern Gama Grass *Tripsacum dactyloides* Perennial	▸ Prefers loamy soils with adequate moisture ▸ Tall perennial grass ▸ "Ice Cream" grass - high nutrition and palatability ▸ High production	▸ Doesn't grow as well in upland soils ▸ Because of early growth and palatability, best grown in well-managed pure stand instead of mixture
Indiangrass *Sorghastrum nutans* Perennial	▸ Provides quick ground cover after seeding ▸ Productive hay crop	▸ Not widely grown ▸ Excessive nitrogen or untimely application will stimulate weedy grasses detrimental to stands ▸ Should not be grazed until it reaches 8 to 10 inches in height ▸ Avoid overgrazing
Little Bluestem *Schizachyrium scoparium* Perennial	▸ Adapted to a wide range of soils ▸ Valuable in watershed protection ▸ Good hay and pasture qualities	▸ Does not do well in wet soils ▸ Requires precise grazing/haying management
Sideoats Gramagrass *Bouteloua curtipendula* Perennial	▸ Grows in shallow soils ▸ Good pasture source for livestock and wildlife ▸ Stand should be well established before use ▸ Good nutrient quality	▸ Not adapted to wet, sandy, or saline soils ▸ Harvest should not be over one-half the growing leaf material
Switchgrass *Panicum virgatum* Perennial	▸ Adapted to soils that are medium textured to sandy ▸ High yield late spring/ early summer ▸ Easy to seed ▸ Abundance of high-quality seed ▸ Easy to establish satisfactory stand	▸ Warm-season producer only ▸ Less palatable at maturity ▸ Poor competition with other grasses ▸ Poor regrowth potential

Name	Advantages	Disadvantages
Pearl Millet *Digitaria sanguinalis* Annual	▸ Tolerant of acidic sites. ▸ Drought tolerant	▸ Needs well-drained soils
Sorghum-Sudan grass & Hybrids *S. bicolor* Annuals	▸ Provides abundant grazing during warm summer months ▸ Best adapted to deep, moderately to highly fertile soils ▸ Drought resistant ▸ Can be used as warm-season emergency or supplemental pasture, hay, green chop, or silage	▸ Has to be established annually ▸ Warm growing season required for best results ▸ Susceptible to low temperatures ▸ Heavy nitrogen user ▸ Prussic acid poisoning of livestock ▸ Difficult to cure as hay ▸ Nitrate poisoning in dry seasons

When cool- and warm-season grasses are combined in pasture situations, they provide other benefits as well. Combining complementary varieties provides a good balance of nutritional quality throughout the grazing season and reduces the risks of crop losses from changes in weather conditions, plant-specific diseases, insect outbreaks, and various factors that may affect pure crop stands.

Forage Legumes

Another plant type commonly used in forage production are forage legumes. Legumes are broad-leafed plants capable of “fixing” their own nitrogen. These plants tend to be higher in digestible proteins than grasses and typically are a higher-producing forage when compared to grasses.

Alfalfa is the most productive legume, with potential yields of up to 6 tons per acre on good soils. Alfalfa is productive into the midsummer under nondrought conditions. This legume establishes a deep taproot and can be productive for 5 or more years under proper management conditions. When selecting alfalfa, use productive, disease-resistant varieties that are adapted to Missouri conditions. Good management practices for alfalfa include timely harvesting at the proper growth stage; control of insects, diseases, and weeds; and nutrient replacement.

Although the other major legumes are not as productive as alfalfa, each has potential benefits in forage systems. Depending upon soil conditions, erosion hazards, climate, and use, each legume has specific characteristics that fit into diverse growing conditions. Refer to Table 2.3 for the advantages and disadvantages of growing some of the most common forage legumes in Missouri.

Forage Legumes That Complement Various Grasses

Just as a combination of cool- and warm-season grasses can be beneficial to the forage producer, utilizing legumes with grasses can improve forage stands. Legumes can lengthen the growing season of cool-season grasses because they often grow longer into the summer months. Legumes also enhance the soil quality by increasing nitrogen levels in the soil and provide added nutrients for the growth of grass species.

When combined with grasses, legumes provide more available nutritional components for livestock in both pastures and harvested forages. With a higher protein yield per acre, the added nutrition can lead to increases in average animal gain and weaning weights. Also, better nutritional forage can increase animal conception rates and decrease herd health problems.

Forage improvement with legumes is never final. Even under the best weather and management conditions, legumes will not last indefinitely. Drought is very damaging, especially to ladino, alsike, and red clover. Legumes can be reduced or lost in pastures that are overgrazed, lack fertility, are improperly fertilized, or are plagued with diseases or insects. Pastures and fields that receive too much or too little rainfall can severely affect legume growth.

Using Small Grains in a Pasture Management System

A variety of small grains can be used in forage systems, both during forage establishment and to augment existing pasture quality. One grain most commonly used is wheat. Another small grain used, especially in areas with a colder climate, is

Table 2.3 - Forage Legumes

Name	Advantages	Disadvantages
Alfalfa *Medicago sativa* WS Perennial	▸ Adapted to wide range of climatic conditions ▸ Grows best on deep, well-drained, fertile soils ▸ Provides abundance of nutritious feed ▸ Long-lived stands, if properly managed ▸ Drought resistant ▸ Can be grown alone or in grass mixtures	▸ Does not thrive on acid or nonfertile soils ▸ Relatively expensive seed ▸ Problem of bloat if pastured ▸ Stands reduced or destroyed by winter killing
Birdsfoot Trefoil *Lotus corniculatus* CS Perennial	▸ Adapted to a wide range of soil conditions (moisture, pH, and fertility) ▸ Feeding value comparable to alfalfa ▸ Can reseed itself under favorable conditions ▸ Good growth in summer due to deep root system ▸ Can persist better under heavier grazing than alfalfa or red clover ▸ No bloat problem	▸ Difficult to establish good stands ▸ Slow establishment ▸ Slow recovery after grazing ▸ Weak-stemmed when grown alone and lodges easily ▸ Seed shatters easily
Clover, Alsike *Trifolium hybridum* CS Perennial	▸ Can use as specialty legume for wet, poorly drained soils ▸ Cheaper than topdressing w/nitrogen on grass pastures ▸ Highly palatable ▸ Winter hardy	▸ One cut, does not produce in summer except under very moist conditions ▸ Short-lived on droughty, upland soils
Clover, Ladino *Trifolium repens f. Giganteum* CS Perennial	▸ Hardy, less injured by winter heaving ▸ Tolerates wetter soils than alfalfa ▸ Very productive ▸ High in minerals, rich in protein and vitamins, and low in fiber ▸ Reestablishes by natural seeding ▸ Ideal legume in many grass-legume pasture mixtures	▸ Susceptible to long periods of severe drought ▸ Possibility of bloat problems ▸ Poor germination if planted too deep ▸ Continuous grazing will kill out the stand ▸ May have laxative effect on animals
Clover, Red *Trifolium pratense* CS Perennial	▸ More winter hardy than alfalfa ▸ Grows better than alfalfa or sweet clover on slightly acidic or poorly drained soils ▸ High nutritious yields after first year ▸ Rapid stand establishment	▸ Short-lived in pasture mixtures (most red clovers are biennial) ▸ Reduced production during drought ▸ Expensive seed
Clover, Sweet *White - Melilotus alba* *Yellow - Melilotus officinalis* CS Biennial	▸ Adapted to a wide range of soil and climatic conditions ▸ Winter hardy ▸ More resistant to heat and drought than alfalfa ▸ High yielding and excellent for pasture when many pasture plants are present ▸ Low-priced seed	▸ Less palatable due to coumarin content ▸ Spoiled hay or silage may cause "bleeding disease" in cattle ▸ Makes poor hay ▸ Poor recovery after cutting ▸ Very susceptible to black stem, root rot, and virus diseases
Clover, White *Trifolium repens* CS Perennial	▸ Excellent pasture, combines well with grasses ▸ Can be grown on a variety of soils ▸ Reestablishes itself by natural seeding ▸ Will stand close grazing	▸ Sensitive to drought ▸ Lower yields than ladino ▸ Can cause bloat ▸ Difficult to establish
Lespedeza, Korean *Kummerowia stipulacea or K. striata* WS Annual	▸ Productive warm-weather annual ▸ Especially suitable for use on pasture soil of low fertility ▸ Resistant to drought ▸ Fast to obtain good stands ▸ Relatively low seed price ▸ Good quality hay, easy to cure ▸ Excellent source of livestock pasture	▸ Slow growth in spring ▸ Not tolerant to cold weather ▸ High summer temperatures and high humidity necessary for best growth ▸ Slow development (best stands develop after third year)

winter rye because it is the most winter hardy of the small grains. Winter barley and oats are also used with forages; however, rye, barley, and oats are less desirable than wheat as a companion crop because their heavy, early growth competes with young forage seedlings. Pearl millet and winter vetch can also be used.

There are a number of benefits to including small grains in existing pasture systems. Because of the winter growth patterns of small grains, they can provide high-quality pasture forages in winter and spring months. Small grains will also increase pasture yields and can extend the pasture grazing periods.

Using small grains as cover crops for new pastures also provides benefits. Most studies show that cover crops such as wheat reduce weeds, control erosion, and furnish winter protection to young forage seedlings.

Forages Used for Silage or Haylage

Basically, any crop that can be fed green as pasture or harvested for hay can be used for silage or haylage. The difference between these two types of stored feeds is the moisture levels at which they are stored; silage is stored at 60 to 65% moisture and haylage is stored at 40 to 50% moisture.

Some grasses typically grown for silage and haylage are smooth bromegrass, timothy, ryegrass, millets, orchardgrass, sudangrass, and reed canary grass. Legumes used include alfalfa, sweet clover, red clover, ladino clover, alsike clover, soybeans, field peas, vetch, lespedeza, and birdsfoot trefoil. Common grains used are corn, grain sorghum, wheat, oats, barley, rye, and triticale.

Summary

Understanding the growth habits of cool- and warm-season grasses allows a producer to choose pure varieties or mixtures that best fit individual production needs. Each grass type has its advantages and disadvantages and a producer should be knowledgeable of these in order to raise a successful crop. The same applies to forage legumes. By combining legumes and grasses, producers can gain many benefits from pastures and harvested forages. Likewise, small grains can provide added nutrition to existing pastures or protection for new forage crops. Basically, any crop that can be fed green as pasture or harvested for hay can be used for silage or haylage.

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Lesson 3: Selecting a Tillage and Planting Method

Proper seedbed preparation is essential for young plants. There are several types of tillage and planting systems used to establish a forage stand. Pasture improvements should be made to maintain the crop. Soil tests must be done to determine nutritional needs.

Establishing a Forage Stand

Establishing a good stand is critical for profitable forage production. There are three basic types of tillage systems used to prepare the seedbed for forage planting. These types include some type of complete tillage method, reduced tillage, and no-till methods.

When using a complete tillage system, it is usually necessary to deep plow first with an implement such as a moldboard plow to make a mellow, compact, weed- and grass-free seedbed. If limestone and basic applications of mineral fertilizers are needed, they should be applied before plowing and then turned under. Plowing several weeks before seeding will allow time for rain as well as disking, harrowing, and rolling to compact the soil. It will also allow weed seeds to germinate for killing. Starter fertilizers should be applied just before or at the time of seeding. Seeding may then be accomplished by using a drill to apply the seed or broadcasting the seed using a fertilizer type applicator.

Using a reduced tillage method to establish a forage stand may involve the use of a field chisel, followed by drilling or broadcasting the seed. If seeds are broadcast, some type of roller should be used to compress the seed into the soil for better germination.

The no-till method is useful in new plantings on areas that are prone to wind erosion and on steep slopes. This method injects the seed into the soil using some type of "no-till" seeder without any previous tillage. The advantage of this method is the reduced number of trips across the field, which saves costs and reduces the occurrence of soil erosion. Existing vegetation must be effectively killed with postemergence herbicide before planting.

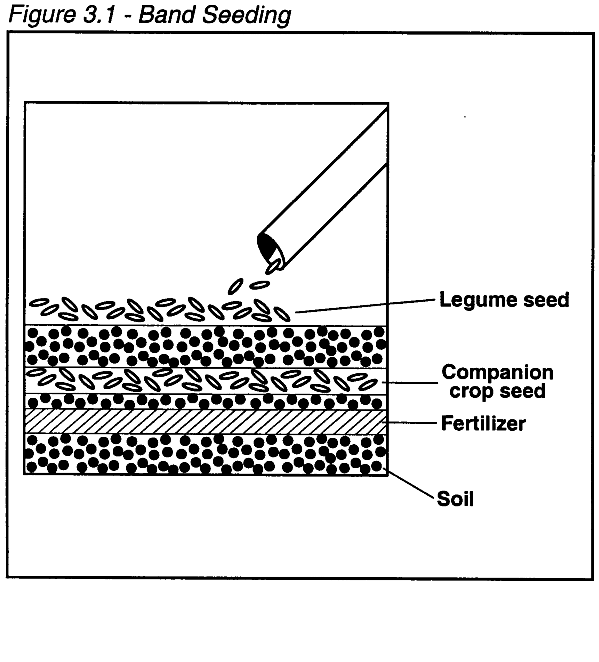
There are four general planting methods used to seed forages: (1) broadcasting, (2) conventional grain drill usage, (3) use of a specialized type of roller, such as a Brillion seeder, and (4) the no-till seeding.

Broadcasting is the least desirable seeding method, especially for late summer seedings, but it is probably the most widely used. Efficiency of broadcast seeding can be greatly increased by rolling or cultipacking the seedbed before planting the seed. Broadcasting can be a satisfactory method of sowing some grasses and legumes on fall-seeded grains in midwinter. A midwinter seeding made when the soil is honeycombed with frost will soon be covered with sufficient soil for germination.

A conventional grain drill equipped with a grass seeding attachment may be used for forages. These are usually short metal tubes that scatter the seed in front of furrow openers. Seeds of similar sizes and weights can be mixed and seeded together. It is difficult to use lighter seed such as orchardgrass mixed with a legume and obtain a uniform distribution with frequent mixing or stirring. The practice of banding, placing the seed directly over the fertilizer, aids in making a stronger and more vigorous forage stand while reducing the seeding rate about one-fourth. Refer to Figure 3.1 for an example of band seeding.

Seeders that will seed and pack in one operation, such as the Brillion seeder, consist of two sets of corrugated rollers with a seed box mounted on top

Figure 3.1 - Band Seeding



of the frame directly between the two rollers. Seed is dropped between the corrugated rollers that pack the soil below the seed and then around it. These seeders do an excellent job of seeding primarily because they ensure a firm seedbed and even distribution of seed that is not sown too deeply in the soil.

The fourth method is no-till seeding, which was discussed earlier as a tillage method. A no-till seeder is used without any previous tillage.

Renovating a Forage Stand

Most Missouri pastures have adequate grass stands but they need legumes added or reestablished. If the soil is capable of growing legumes, they can easily be established in grass stands. Adding a legume to a grass is cheaper than topdressing the grass with nitrogen.

Pasture improvement with legumes is never final. Even under the best weather and management conditions, legumes will not last indefinitely. Legumes are lost from forages by overgrazing, disease, insects, lack of fertility, excess moisture, drought, or any combination of these.

Legumes can be established in grass sods with plowing and without completely losing 1 year's production. Before renovation, check for a broadleaf weed problem. Spray before beginning the renovation, usually in the spring or early summer, before legume establishment is started. There are three general methods of reestablishing legumes in grass sods with a minimum of production loss. However, with any of these methods, success of the new seedlings will depend on adequate moisture, light, and fertility.

Method 1 - Overgraze grass during fall and early winter. Apply lime, phosphorous, and potassium as recommended by soil tests before or during this period. Do not use nitrogen in the fertilizer mix because it stimulates the older grass and decreases the young legume's chances of becoming established.

Broadcast the legume early enough in winter so that freezing or thawing will cover the seed. February seedings have a 50% chance of success than April seedings. Early grass growth should be immediately removed by grazing to allow the legume to establish roots. This step is very necessary for success. Repeat this procedure as needed throughout late March (in southern Missouri) and in April and early May. Clipping will seldom substitute for grazing.

Method 2 - Till the sod in late fall or early winter so that 40 to 50% of the sod is disturbed. During the winter, the legume seed is either broadcast or drilled into the partially opened sod. Do not apply nitrogen fertilizer. Remove the early grass growth by clipping or grazing.

Method 3 - Use a chemical to retard the grass growth. Chemical expenses can be partially offset by not having to till. Seeding is done with no-till equipment.

In most cases, a nonselective herbicide is used. This is a contact killer, so seeding must occur during the growing season - early spring or late summer. Apply the herbicide according to label directions. Too heavy a chemical rate is costly and retards the grass too much, allowing summer weeds to invade. This can be as detrimental to new seedlings as competition of the existing grass sod.

Fertilizer Application Needs for Forage Establishment

Proper soil pH and fertility are essential for optimum economic forage production. Take a soil test to determine soil pH and nutrient status at least 6 months before seeding. This allows time to correct deficiencies in the topsoil zone. The topsoil in fields with acidic subsoils should be maintained at higher pH values than fields with neutral or alkaline soils. Producers maintain topsoil pH at levels of 6.0 to 6.8 depending on whether it is a legume or grass being seeded and depending on the soil type.

Adequate lime is necessary for forage establishment and production. It serves to correct soil acidity and supplies calcium and magnesium. Lime also affects the availability of most of the other essential elements needed for forage production. Phosphorous availability, in particular, increases as the pH is increased. If the soil is extremely acid, it is best to apply part of the lime at least 6 months before seeding.

Seeds can germinate with or without fertilizer but young plants will soon use the small amounts of nutrients in the seed. They are then dependent on the level of fertility around them for development.

Most research shows that available phosphorous applied at seeding time and proper placement are the key elements in establishing legumes and grasses. A small amount of banded nitrogen and potassium may also be beneficial at seeding time but do not include more than 50 to 60 pounds of a combination of nitrogen and potash in a starter fertilizer.

Nitrogen encourages aboveground vegetative growth. Phosphorous encourages root development, particularly the lateral and fibrous rootlets. Quick root development is especially important in fall-sown forages. A sturdy root will counteract winter injury and prepare the plant for rapid spring growth.

A starter fertilizer should consist primarily of phosphorous (40 to 80 pounds) and a small amount of nitrogen (20 to 30 pounds). It may contain some potash but excessive amounts at seeding may damage legume and grass seedlings. Established stands of legumes and grasses need a liberal supply of potash.

After forage stands are established, use soil tests to determine the amount of phosphorous and potassium to use for topdressing. It is best to take a new soil test every 3 to 4 years.

Summary

Establishing or re-establishing forages does not necessarily have to be a complicated process. If recommended practices are followed and adequate moisture, light, and fertility are available for the young plants, excellent stands may be produced. Seeding methods must involve proper seedbed preparation. This may be done with conventional tillage equipment or equipment that involves little or no tillage. Seeds may be broadcast or drilled. Soil tests must be done prior to seeding to establish proper nutrient levels and repeated every 3 to 4 years to maintain a good stand of forage.

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Lesson 4: Scouting and Maintaining the Crop

Once the forage crop is established, the producer cannot think of it as a "leave-alone" crop. Proper maintenance of the forage crop is essential to maintain a high-quality product that efficiently uses economic inputs for economic gain. A regular scouting and maintenance program will promote positive production while decreasing the amount of inputs required. Systems allowed to run down will require more money for repair than a system that is continually maintained.

Pests Associated with Forage Production

Biennial and perennial weeds are probably the biggest weed problems for grass hay and pasture producers. Both biennials and perennials produce seed each year, potentially starting new infestations. Perennial weeds reproduce from underground roots, or rhizomes. The rooting structure can survive for several years in the soil and are often unaffected by occasional mowing or livestock grazing.

A good insect management program requires proper identification of the insect species causing the damage. Two major pests of alfalfa in Missouri are the alfalfa weevil and potato leafhopper. Alfalfa weevil adults lay eggs in the older alfalfa stems in late fall and early spring, and the larva damage mainly the first cutting. Potato leafhoppers migrate to Missouri in June from southern states. The immature or nymph stage stunts plants and yellows leaves. It also lowers yield and protein content by sucking juices from young upper stems. Grasshopper infestations in Missouri are sporadic and generally cause more damage in dry years. They can do considerable damage in a very short time. The two most common species in Missouri are the differential grasshopper and the redlegged grasshopper. Their damage consists of large, irregular holes extending from the margin to the center of the leaf. The tips of alfalfa and other plants may also be injured. Another infrequent pest of alfalfa is the blister beetle. These insects cause only limited plant damage to alfalfa but when ingested by livestock, the animals become sick and even die. In Missouri, few if any blister beetles are present in the first cutting of alfalfa but may be common in alfalfa harvested during July or August.

Pest Control Options

Healthy, properly maintained forage systems are less likely to be susceptible to the encroachment of weeds, and they are better able to withstand minor insect damage with little effects to the overall plant population. Without proper management, broadleaved weeds can directly compete with forage grasses and pasture to reduce their nutritional value and longevity. Weeds can replace desirable grass species, filling gaps or voids and reducing yield and overall quality of the hay or pasture. In addition, some plants have toxic properties that can cause livestock injury or loss under certain circumstances.

Several pest control options exist for the producer. Forage monitoring is the regular inspection of forage areas subjected to insect infestations in the past. Areas such as fencerows and areas near waterways should concern a producer because these sites typically attract insects. A monitoring program helps to determine the economic injury level and the economic/action threshold. Economic injury level is the term used to describe the lowest pest population density at which an economic impact is felt. The economic/action threshold describes the pest population density at which control measures should be enacted. To conduct a monitoring program, a producer does a walk-through inspection of forage systems and sets insect traps throughout it.

If an insect infestation is too big to handle with a simple monitoring method, use more advanced technology. Mechanical means such as tilling, mowing, or weed pulling can be used. This technique works best on small infestations that can be easily controlled. For larger infestations, cultural control, and pesticide methods can be applied. Cultural control is the manipulation of the environment to reduce a favorable climate for pests. Examples of cultural control include crop rotation, trap crops, and controlled burn. A more drastic solution is the use of pesticides as a means of controlling pests. Pesticides can be a chemical or an organic mixture.

Brush Control

The use of brush control management strategies is meant to restore the balance of the forage species used in either a pasture or a harvest situation. Brush plants use three to five times more water and nutrients than forage plants for growth and production. Brush plants also compete for sunlight energy with forages and tend to choke out slower-growing forage species. Regulating their growth, therefore, is essential to crop maintenance.

Brush can be controlled in pasture and forage crop situations in many ways. Mechanical methods such as mowing, chain sawing, root plowing, and bulldozing are effective, but some can be costly in equipment needs or labor hours. Prescribed burning is also an option; however, weather, safety factors, and local regulations must be considered if this method is chosen.

The use of chemical methods is another possibility. The effectiveness of this technique will vary depending on the application of the herbicide at the correct rate under favorable weather conditions and during the time that the brush species is at its weakest stage of growth. Because different plants react differently to herbicides, using chemical methods may not ensure the results that a producer needs.

Another option to consider is grazing management. By using this method, healthy forage ecosystems choke out encroaching brush plants. If this method is chosen, rotational grazing restricts the animals from overgrazing. Stressed forage systems are more susceptible to brush and weed infestations.

Perhaps the best method is a combination of the ones listed above. A producer should tailor a brush control program based on the extent of the problem and then plan and expect long-term results. System recovery from brush encroachment will take time, and expecting instantaneous results is impractical.

Maintaining or Renovating a Forage System

To improve forage yield and animal performance, the pasture or field needs to have ongoing maintenance and periodic renovation. Pasture or field renovation means renewing the area with the introduction of desired forage species into present plant stands. This may involve fertilizing and liming according to soil tests, partially destroying the sod by disking, controlling weeds and brush, reseeding, and prescribed burning.

Spreading fertilizer is based on soil tests and prescribed nutrient requirements for those forage species present. Liming amends and adjusts the pH of the soil. Soil tests should be done early so any needed lime can be applied well ahead of seeding. The benefits of lime move downward very slowly, perhaps no more than 1 inch per year. Disking incorporates organic material into the soil and breaks up the surface area for better water and air penetration. Renovation is more successful if tillage can be done in the late fall.

Suppressing and/or destroying unwanted plants can be accomplished in a variety of ways. A producer can use mechanical means such as mowing, pulling, cutting, and tilling. Cultural methods such as rotational grazing allows livestock to overgraze in the fall and tillage will be more effective at tearing the sod. Chemical means, such as herbicides, will destroy unwanted plant species.

To introduce other forage species into an existing ecosystem a producer can use the techniques of overseeding and no-till planting. Overseeding involves broadcasting grass or legumes into a forage stand that may be thinned or overgrazed. This is typically done in late winter or early fall. No-till planting involves the use of a no-till drill, a device that places seed into the soil at the optimal depth without tilling the soil surface. This allows for lower seeding rates, the precise placement of seed, a reduction in the loss of organic material, *a* reduction in water loss experience during tillage, and a reduction in erosion from tillage. Seeding in January and February on frozen ground will obtain excellent stands. New seedlings are occasionally injured by a late freeze, but this is usually less of a threat than seeding too late. Late seedings lack soil contact for good germination, and summer stress kills many undeveloped seedlings.

Prescribed burning to renovate forages is commonly reserved for warm-season grasses. This practice removes previous years' growth, keeps invading woody plants in check, and reduces competition from invading cool season grasses. Usually conducted in the spring, prescribed burning encourages fast and vigorous growth right after the burn by releasing nutrients locked up from previous years' growth. If a producer decides to use this technique, safety must always be kept in mind. Select conditions and procedures that will cool the fire. Wind, relative humidity, and air temperature must be considered; cool, damp conditions work best for prescribed burns. Fire barriers to stop the path of a blaze must be established beforehand. Always seek the advice of persons experienced in planning and conducting prescribed burns.

Fertilizer Requirements for an Established Stand

Plant nutrition is an important consideration in maintaining a forage stand. Many factors come into play when planning for the nutrition of a forage. To determine a forage's nutrient status and nutritional needs, a number of tests must be conducted. Plant and soil analyses are used to optimize plant yields based upon nutrients available and to maximize economic and nutrient inputs. A soil analysis typically samples just the surface, though deeper subsoil samples are taken for deep-rooted perennials. A plant analysis looks at samples of plant tissue to determine the plant's current nutrient status. Because it will look at more nutrients than soil tests, plant deficiencies can be detected.

Phosphorus is especially critical when legumes are established. Unless the soil tests medium to high, better stands are usually obtained if some phosphorus is applied just before or at the time of seeding. Potassium is not as critical as phosphorus at the time of establishment, but legume persistence is greater if adequate potassium is used in a topdressing program. Nitrogen should not be used when establishing legumes in a grass sod. It increases the growth and vigor of the grass and increases the competition for the new legume seedling. Boron is important to alfalfa and should be applied in the topdress fertilizer at a rate of 1 pound per acre per year. However, boron is toxic to alfalfa seedlings and should not be applied at seeding.

One part of keeping plants healthy once the proper nutrients have been applied involves keeping the nutrients in the plants. Protecting soil and water resources is important because nutrients such as nitrogen and potassium are very soluble and tend to move readily into the water table, and/or streams, ponds, etc. Therefore, it is important to apply correct amounts of these nutrients at the proper stage of plant growth to minimize losses to water movement.

Summary

Maintaining the forage crop is essential to the productivity of the forage system. Pests, which include weeds and insects, must be identified and controlled by the most economic and effective means possible. Control options may include mechanical, cultural, biological, or chemical means. Regulating the growth of brush is also essential to crop maintenance. Methods for maintaining and renovating forage systems include tillage, fertilization, reseeding, and controlling weeds, insects, and brush. Fertilization to improve the nutrition of the forage is essential for maintenance of the forage stand.

Credits

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Lesson 5: Selecting a Grazing System

When choosing grazing systems, the producer should consider the best options for maximum production. Considerations should include water resources and stocking rate of livestock on the grazing operation. The number of "cow-calf" days for a specific pasture needs to be determined as well as any variables that may affect grazing patterns.

Grazing Systems Used to Maintain Optimum Production

There are basically three types of grazing systems: (1) continuous, (2) rotational, (3) and management intensive. Each grazing system has advantages and disadvantages.

Continuous grazing is the most traditional method used for animals. This method uses a single or few pastures for full-season grazing. Cattle may be left on these pastures year-round and fed hay in those pastures when grass or other forages are not available. The advantages of continuous grazing are lower setup costs (water and fence), less required management (labor), and animals can eat their choice of plants if the pasture is not overstocked. Disadvantages include less beef produced per acre, poor forage utilization (animals only use about 30 to 35% of the available grass), less desirable plants begin to dominate, and difficulty in maintaining legumes and reestablishing weakened areas.

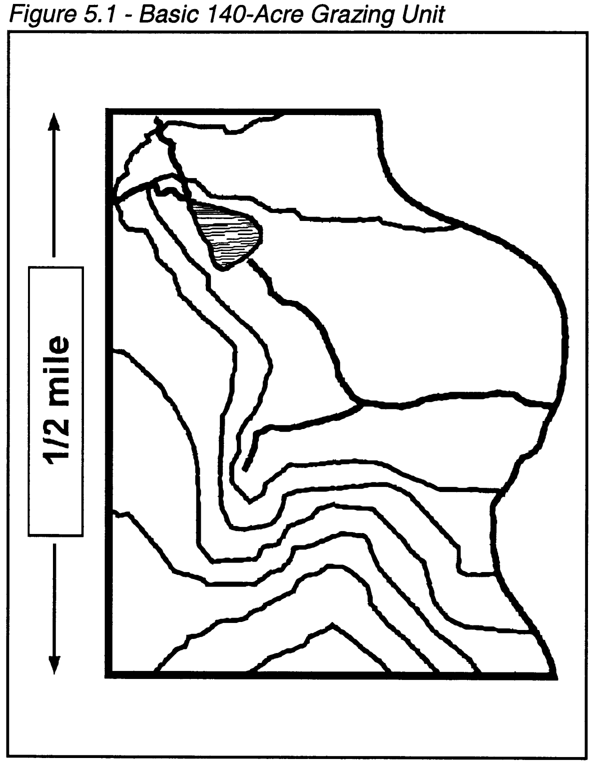
Rotational grazing involves moving a herd of animals from between two to seven smaller pastures. The advantages of this system allow the producer to match grazing to plant growth, provide rest periods for desirable plants, increase forage and animal production, reduce brush invasion, and set aside fields for haying or fall stockpiling. Disadvantages include more time and labor to manage the operation and additional expenses in fencing, waterers, and maintenance.

Management intensive grazing (MIG) involves the use of eight or more pastures. Animals are rotated as with the rotational grazing system only more separate pastures or paddocks are used. Animals are moved more frequently using a shorter duration of time for grazing per pasture, typically about 5 days. Advantages include maintenance of a desired pasture composition of plants, less damage to the soil with compaction, increased production per acre over the other two systems of grazing, longer periods of regrowth for each pasture, and more contact with the animals by the operator allowing for the identification and correction of potential problems with the herd.

Influence of Water Resource Locations on Grazing Patterns

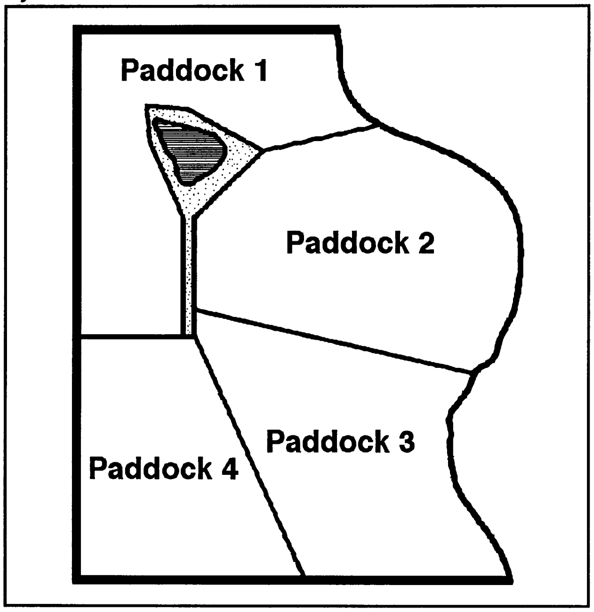
The first step in planning a grazing system is to evaluate the resource base available to the producer. One of the most basic resources would be the water supply. In a continuous grazing system using one pasture, the water source may be a stock tank fed by a deep well or a body of water such as a pond. Animals would have access to the water at all times and crowding is not much of a consideration with herd size. Refer to Figure 5.1. This drawing represents a 140-acre pasture with a water source in the upper corner and seeded with mixed cool and warm season grasses.

Figure 5.1 - Basic 140-Acre Grazing Unit



The same pasture could be used for a rotational grazing program; however, some modifications must be made. Individual pastures must be fenced and the water supply must be made available to each pasture. Figure 5.2 shows this

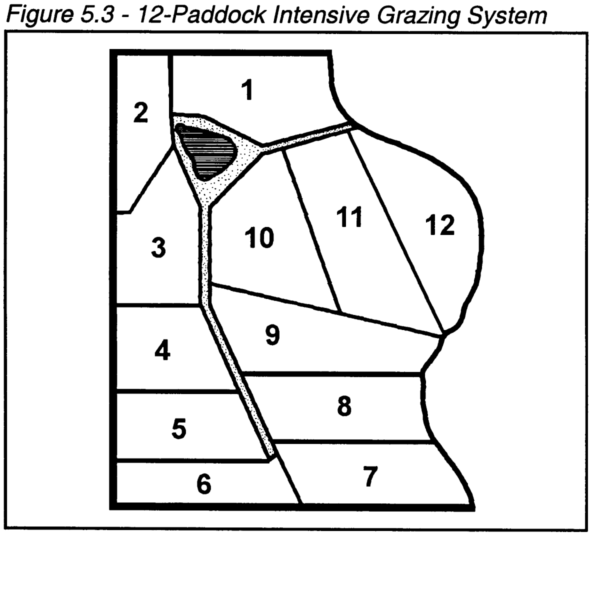
Figure 5.2 - Simple 4-Paddock Rotational Grazing System



modification. Animals are allowed to leave each pasture and follow an alleyway to the water supply, which is the same pond used with a single pasture, conventional grazing system. All of the gates to unused pastures simply remain closed. Transferring animals from pasture to pasture is relatively easy.

Further subdivision to make the shift from rotational grazing to management intensive grazing can be made with or without additional water development. Figure 5.3 shows an additional alleyway design and fencing, decreased pasture size, increased pasture number, and the animals still have access to the water supply.

Figure 5.3 - 12-Paddock Intensive Grazing System



Although many producers make the initial subdivisions without making additional water source development, they often find that later steps in subdividing would have been easier if water supply improvement had been done in the first stages of development. Improving water distribution with the addition of water lines and water tanks in individual pastures greatly increases the flexibility the manager has in fence placement and keeping paddocks similar in shape and size.

If the decision is made to use alleyways, certain effects must be accepted. Alleyways are likely spots for erosion to occur and for weeds such as thistles or nettles to take hold. Both are the result of bare ground created by continual animal traffic. Livestock will likely deposit manure in an alleyway when they travel to water rather than depositing it on the productive part of the pasture. Also, beef cows grazing in a paddock system that have water available in every paddock will drink 15 to 20% more water on a daily basis than cattle that have to use an alleyway for water access.

Determining Livestock Carrying Capacity of a Grazing System

Determining the appropriate stocking rate for a particular grazing unit is a key decision affecting the profitability and viability of a grazing operation. Livestock intake and performance are very dependent upon forage available to the animal on a daily basis. Setting the stock rate too low results in wasted forage and lost profit potential. Setting the stocking rate too high results in lowered intake and animal output and diminished profits.

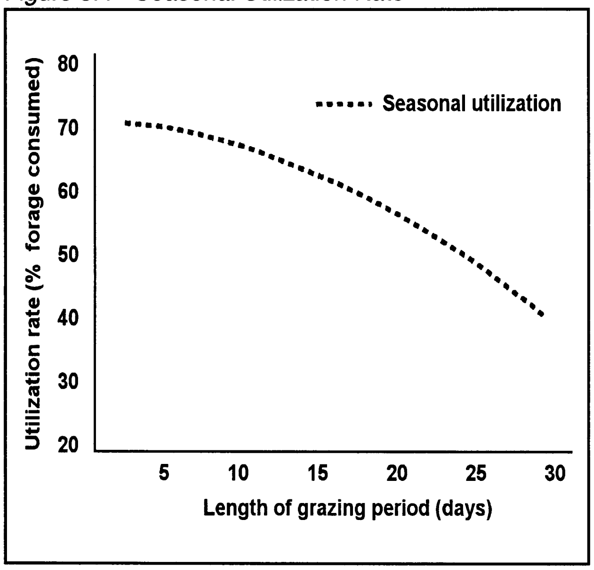
Carrying capacity is the stock rate that is economically and environmentally sustainable for a particular grazing unit throughout the grazing season. Carrying capacity is largely determined by four factors: (1) annual forage production, (2) seasonal utilization rate, (3) average daily intake, and (4) length of the grazing season. These terms can be expressed in the mathematical formula below.

$$\text{Carrying capacity} = \frac{\text{Annual forage production} \times \text{Seasonal utilization rate}}{\text{Average daily intake} \times \text{length of growing season}}$$

Annual forage production is the total amount of forage dry matter produced per acre annually. This would include both hay and pasture harvested from grazed animals. This term in the formula would be expressed as pounds of forage per acre.

Seasonal utilization rate is the percentage of the annual forage production that will actually be harvested by the grazing livestock. This is dependent upon rotation frequency and level of animal performance. Figure 5.4 should be used to estimate approximate seasonal utilization rate based on average grazing period length. For example, on a 3-day rotation a seasonal utilization rate would be about 68%. Utilization rate is unitless decimal fraction in the formula.

Figure 5.4 - Seasonal Utilization Rate



Animal daily intake should be set at the level that will be required to yield the desired animal performance level. This may be the most difficult part of the entire process. To determine the appropriate intake value accurately, some estimate of forage digestibility and energy is required. These values cannot be reliably determined without careful forage sampling and laboratory analysis. Average forage intake values for high, medium, and low performance of steers or cow-calf pairs would be 3.5, 3.0, or 2.5%, as a percentage of the animal's body weight. For example, a 1200-pound cow of medium milking ability would consume about 36 pounds of forage dry matter per day. In the formula, the intake is expressed as pounds of forage/pound of liveweight.

Length of the grazing period depends on how many paddocks are available and the required rest period. The rest periods are going to vary for different species and changing environmental conditions.

As an example, assume that an average acre will produce 7600 pounds of forage annually. If an average 3-day grazing period is used, Figure 5.4 shows that the corresponding seasonal utilization rate is approximately 68%. The livestock will be steers with a gain of 1.5 - 2 pounds per day per head. This would be a moderate performance level so intake is entered at 3% of body weight, which is .03 pounds of forage per pound of body weight. It is important to enter intake in the formula as .03, not as 3% so that units cancel out. Anticipate grazing the steers from April 20 to October 1 for a total of 164 days.

Make the following calculations.

$$\frac{7600 \text{ lb. forage/acre X .68}}{\text{.03 lb. forage/lb. live weight X 164}} = \text{1050 lb. live weight/acre}$$

The 1050 pounds of live weight/acre is an indication of the carrying capacity of this unit. If 525-pound steers are purchased, can two steers be stocked on 1 acre? Only on the first day of the grazing season. It is hoped that the steers are gaining weight each day and the forage availability in August is lower than that in May. If expected average daily gain is 1 3/4 lb./head/day, the average weight of steers at mid-season will be 668 pounds (525 + [82 days x 1 3/4 lb./day]). Initial stocking rate could be set at 1.6 steers/acre (1050 lb. live weight/acre divided by 668 lb. live weight/steer).

Remember, this is a guideline to help make initial stocking decisions, not a magical recipe for universal financial success.

Calculating Cow-calf Days for Warm- and Cool-season Grasses

When determining "cow-days" for a specific pasture there is also a formula. However for those who prefer not to work with equations, forage allocation can be made even simpler. An average for each forage stand density is 215 pounds/acre-inch for thin pasture, 333 pounds/acre-inch for average pasture, and 450 pounds/acre-inch for thick pasture. Assume that a 1000-pound lactating cow will consume about 3% of her body weight, a cow-day can be figured to be equal to 30 pounds of forage consumed. By dividing 30 pounds of forage per cow-day into the pounds of forage per acre-inch, the cow-day yield of thin, average, and thick pasture is about 7, 10, and 15 cow-days/inch, respectively, of pasture consumed.

This becomes a simple method of allocating pasture by following these steps.

1. Look at the pasture and determine it to be thin, average, or thick.
2. Measure or estimate the height of the pasture to be allocated.
3. Subtract from the total height the height of stubble you want the animals to leave.
4. Multiply the difference between starting height and ending height by the cow-days/inch to figure available cow-days/acre.
5. Divide the number of cows in the herd by cow-days/acre to determine how much area should be allocated.

Here is an example. Look at the pasture and determine if it is thin, average, or thick. For this example, we will use average grass, which gives us a cow-day/inch factor of 10. Next, measure the height of the forage to be 8 inches. It has been decided to leave a 3-inch residual. So from that subtraction, the result will leave 5 inches to be grazed. Five inches grazed times 10 cow-days/acre-inch would equal 50 cow-days/acre. If there are 100 cows, 2 acres/day would need to be allocated.

This works well for 1,000-pound cows, but what about other classes of livestock? Grazing management is an imprecise science because of ever-changing conditions, so these figures will always be an approximation, not perfection. When there is livestock of different weights, divide the estimated total weight of all the livestock in the herd by 1,000 and the result will be fairly close to cow-day equivalents.

Influence of Different Grazing Patterns on Cow-Calf Days

As can be seen from the previous discussion, there are several variables that may affect cow-days of grazing. Certainly the size of the pastured area will depend on the number of animals in the herd. If paddocks or pastures in an intensive grazing system are small, the herd size should be decreased from that of a conventional large pasture system, for example.

The amount of forage or stand density would play a major role in how long the herd may be left on a given pasture. If the forage was thin due to lack of moisture during the growing season, the cow-days would be shortened. Animal size (weight) also influences how may pounds of forage would be consumed per day.

Summary

When choosing a grazing system, a producer may employ a continuous system, a rotational grazing program, or an intensive grazing system. The size of the individual pastures determines the system used. An important consideration that must be given to each of these systems is the water resource available. Arrangements must be made for the herd to have free access to water in each of the grazing methods. How long the herd may be allowed to graze would be determined by the annual forage production of the pasture unit, the seasonal utilization rate or each pasture, the average daily intake of the animals, and the length of the grazing season. There are some simple steps that may be used to determine cow-days on a pasture, but differences such as size of the animal, forage density, and size of the pastured area must be taken into consideration.

Credits

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Lesson 6: Harvesting for Seed

Forages used in pasture and feed systems originate through the production of forage seed. Most forage seed is produced in the western United States, although native grasses tend to be produced in local areas. Forage seed production is a precise science that requires specific management practices. This lesson will discuss unique factors that must be considered and management practices used when producing forage for seed as opposed to producing forage for hay and pasture.

Producing Forage Seed

The goal of forage seed production is a consistent high-quality product. This goal is dependent upon the environmental conditions existing in the production location, the cultivar physiology (physical makeup of a variety), and market availability.

When considering environmental conditions, it must be noted that most seed crops are grown in regions other than where they are to be used. Therefore, producers must know the existing conditions in the production location to raise a successful crop. Conditions that have the greatest effect on forage seed production are photoperiod (the daily amount of time plants are exposed to light), seasonal temperatures, and the average amount and occurrence of rainfall. Optimum seed production occurs in areas with warm summer temperatures and low humidity. Rainfall during seed maturation and harvest will decrease quality and yield.

Cultivar physiology plays an important part in forage seed production because producers must be aware of the selected variety's reproduction needs. In selecting cultivars, care must be taken to match them to the region of production. For example, forage cultivars developed in the Midwest are best adapted to Midwest conditions.

Once the desirable environmental conditions for one or more forage cultivars has been determined, then the final consideration needs to be if there is an available market for the crop. Most markets for forage seeds are determined by the location of seed processing mills. If a seed processing mill is nearby creating a local market for forage seeds, the producer may choose to raise a forage seed crop. However, if the nearest mill and market are some distance away, transportation and other costs incurred to sell the crop may be too high to gain an acceptable profit.

Additional considerations producers should consider when producing forage seed is the intended use of the forage after harvest and the value of the forage crop versus the seed crop.

Additional Costs Incurred

Since the object of crop production is to make a profit, then all costs must be considered to determine if an acceptable return will be received on the investment. Forage seed production incurs more costs than hay and pasture production due to additional management, inputs, machinery, storage, and transportation needs.

Management costs for seed crops are higher due to more intensive management of pests and crop conditions to produce a high-yielding and quality crop. Likewise, input costs are higher because more expenses are incurred from fertilizers, irrigation, herbicides, insecticides, and labor than are usually associated with hay and pasture production. Machinery costs are also increased due to the need for specialized harvesting equipment that is not used in typical forage crop production. Specialized storage in silos or bins, necessary to keep seed at the proper humidity, can also increase production costs. As mentioned previously, transportation can be more costly depending upon the location of the nearest market. Expenses can include fuel costs and maintenance of owned or leased trucks and/or trailers to haul seed, or the cost to contract services.

Additional Management Factors

A key element to healthy plant growth is fertilizer. Grasses and legumes have different fertilizer requirements. Nitrogen (N) is extremely important to grass growth. The time of nitrogen application depends upon the growth habit of the plant. Grasses that grow and develop flower buds during summer respond to one application of nitrogen in early summer. Cool-season grasses need split applications of nitrogen, both in the spring and in the fall, because initial flower growth begins in the fall. Timing of nitrogen is highly dependent upon the growth habits of individual species and cultivars. The amount of nitrogen that a grass requires is influenced by current soil fertility. As the crop ages, more nitrogen is required to keep seed production high. Legumes also require nitrogen, but their needs differ from those of grasses. Legumes need to be inoculated with nitrogen-fixing rhizobia to aid in plant growth. Legumes need phosphorus (P), potassium (K), calcium (Ca), and other nutrients for proper growth. Depending on the species, the legume may require less of these nutrients for plant growth than for harvest.

As an area is prepared for planting, it will become evident that a pest management strategy should be started. Pests can plague a field in the form of weeds, insects, and disease. Each brings with it different problems that must be effectively controlled to cultivate a crop from seeding to harvest.

Weeds compete with forage plants for soil and water resources. Because of open areas from row planting, weeds are able to become established in seed production fields. Weed seeds decrease overall seed quality grade and reduce the price gained at market. It is necessary to practice some sort of weed control system. Control methods include roguing, mechanical control, chemical control, and biological control.

Insects also pose a threat and tend to cause more problems in legumes than in grasses. Some insects attack foliage and others attack the flowers of the forage, greatly affecting the yield. Several control options are available. A producer can manipulate the environment by rotating crops and planting varieties that are selected against the pests. Also, insecticide/chemical control agents and biological control agents offer other solutions.

Plants are susceptible to diseases in their environment. To avoid any problems, it is best to select cultivars that are resistant to diseases. Grasses tend to be more prone to disease than legumes, particularly foliar rusts. Treatment usually consists of fungicides; however, close monitoring of the crop is necessary to detect any potential problems before they become established in the plant.

Harvesting Forage Seed

Harvesting forage seeds is similar to harvesting grain crops, but some specialized equipment and methods are required to optimize yields. When combining forage seed, it can either be directly combined or swathed.

Direct combining requires seed to be at or near maturity. This method tends to have higher losses due to "shattering" of the ripened seed. Shattering occurs when the seed breaks away easily from the floral attachments and is lost. This method is lower cost because it only requires one trip across the field. There is also less chance of seed sprouting.

Swathing is done when seed heads are light green to yellow because they are at a less mature stage. Swathing forages while still green, then allowing them to cure in the field before combining, increases seed yields. The forage should be cut high off the ground with a windrow on top of the stubble to promote good air circulation. Combine the windrows when the crop is thoroughly dry. This method is higher costs because it requires more trips across the field. There is also a chance of sprouting damage.

Summary

Raising and harvesting forage seed is a precise science. The producer must consider environmental factors, forage species and specific cultivars, and available market. Additional costs include management, input, machinery, specialized storage, and transportation. Management factors to consider are a crop establishment plan, fertilizer, soil and water management, pollination management, and pest management. Harvesting the seed can be done by direct combining or swathing, cutting, and combining.

Credits

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Lesson 7: Harvesting for Feed

The goal of most forage programs is to maximize economic yields of nutrients while ensuring stand persistence. Frequent cutting produces high-quality forage whereas less frequent cutting generally results in increased stand longevity. Therefore, harvesting requires a compromise between quality and persistence. Decisions on when to cut have to be made based on a sound understanding of how a plant grows and survives.

Determining Harvest Timing

Several factors can determine harvest timing. One of the most important aspects is the stage of maturity of the plant. The harvest of feed is generally based upon vegetative and seed productive stages of the plant. Harvest should occur at the onset of the reproductive stage. The plant should be actively growing vegetatively and not be expending energy toward reproductive growth. Table 7.1 gives the recommended stages of maturity for the harvesting of several grasses and legumes. The description of a stage of maturity refers to the whole field, not to an individual plant. An accurate method to determine the stage of development is to count 100 stems randomly selected from the field and determine the average stage of development. Legumes are higher in nutrient value, so a grass/legume mixture should be harvested when the legume is at the proper stage of maturity, regardless of the species of grass.

Table 7.1 - Recommended Stage of Maturity

Plant	Recommended Stage of Maturity for Harvest
Alfalfa	Bud to 1/10th bloom*
Red Clover	¼ to ½ bloom
Timothy	Late boot stage
Bromegrass	Seed heads emerge
Orchardgrass	Blooms emerge
Reed Canarygrass	Seed heads emerged
Tall Fescue	Boot stage

*1 in every 10 buds is in bloom

Weather patterns also affect the time of harvest. For optimum forage harvest, weather during harvest should be dry and warm. To ensure top quality hay, there should be a minimum of 3 days of dry weather during the actual harvest from cutting to baling. Excess humidity in the air will increase the length of drying time. Warm breezes and sunshine will shorten the days required to dry. Silage and haylage will not require as long to dry down to storable moisture content.

Forage Quality at or During Harvest

Though a producer's job is mostly finished by harvesting time, there are still several factors that affect the quality of a harvest. Factors include the prime growth stage, mechanical damage, climatic losses, and moisture content. To harvest the best possible crop and to maximize the investment return, avoid any negative factors affecting forage quality.

Harvests that occur after the prescribed growth stage will have several negative characteristics. The total digestible nutrients (TDN) in the plant will decrease, as will the protein content. Other available nutrients will also decrease. Harvesting before the prime growth stage will reduce the quantity of forage harvested and the nutrients stored in leaves and stems will not be maximized to the fullest.

Mechanical damage is a major cause of dry matter loss that occurs during raking and baling. This primarily affects the leaves, the highest quality part of the plant.

Climatic losses, attributed to rain and sun, can also affect crop quality. Downed hay (cut hay that has not been baled and stored) is susceptible to losses from leaching caused by rain. Hay left down and exposed to the sun for too long can experience significant losses from blanching. Blanching is the bleaching away of nutrients from the leaf and stem of the plant.

Plants that are harvested can still lose up to 60% of their moisture through respiration, so keeping the moisture content of plants in mind after harvest is important. Dry matter loss averages 5 to 6% but can go as high as 15%. The losses are nonrecoverable. Hay should be baled between 18 and 22% moisture content and is safe for inside storage at 15 to 18%. Moisture levels higher than 22% in the bale lead to dry matter and quality loss due to heating and molding of the hay. Therefore, losing as little amount of moisture as possible is important.

Moisture is especially important for the forage ensiling process. Haylage is forage stored at moisture levels of 40 to 50%. Silage is forage stored at moisture levels of 60 to 65% moisture. Most green chop forages (grasses and legumes) are typically stored as haylage.

Harvesting Methods

Harvesting methods vary depending on the needs and resources of the individual producer. Each method needs to be evaluated for profitability to the operations.

Mowing is the process of removing the top part of a plant from its root system, about 3 to 6 inches above the ground level. If a plant is harvested below 3 inches, the plant is weakened by removing valuable leaf tissue necessary for regrowth. Plants cut more than 6 inches will not maximize the amount of forage harvested.

Conditioning is a method of speeding up the forage drying process. There are two types of conditioning - mechanical and chemical. Mechanical conditioning is a system of rollers that crush the plant stems, allowing for more surface area to be exposed to evaporation and drying. This is particularly effective on coarse plant stems by opening more surface area to moisture loss. The drying rate can increase by up to 80% in first cuttings. A disadvantage of mechanical conditioning is that a slight loss in dry matter may occur and finer stemmed plants may slide through the rollers without being crushed, voiding the effects of conditioning. Chemical conditioning is applied at the time of mowing and removes the plant's waxy coating so moisture can easily escape. This method is used primarily with alfalfa but is also efficient on legume crops. The drying rates in second and third cuttings are increased. However, additional equipment is needed to apply the chemical during cutting and this method does not work well with grasses.

A mower conditioner combines the mowing and conditioning process in one machine. This method causes less damage to forage due to a single cutting/crimping process and fewer trips across the field, providing savings on fuel, maintenance, and labor costs. However, if the rollers are adjusted incorrectly, increased losses in dry matter may occur. This equipment is also more costly than a mower.

Swath manipulation is the mechanical method of turning or spreading forage to enhance even drying. There are three types of swath manipulation: raking, swath inversion, and tedding. Raking is a method of mechanically inverting forage into tight windrows. The windrows are efficiently inverted and fluffed for drying and the rolls provide better pickup for the baler. If the hay crop is thick, wet sections in the middle may not dry completely and dry matter may be lost, especially leaves in legumes. Inversion, a process similar to raking, involves inverting the mowed swath on belts, the bottom moving to the top and the top to the bottom. This method is gentler as it inverts and fluffs the windrows and does not toss the hay during pickup, which can knock leaves off the legumes. This method is not as efficient as tedding. Tedding uses a machine with rotating tines that stirs, spreads, and fluffs the hay. This method allows for uniform drying by spreading out the hay and may decrease drying time by up to 2 days. However, it is more damaging to legumes with fragile leaf structures, leading to nutritional loss.

A popular harvest method for hay is baling. Rectangular bales are commonly baled at 14 x 18 x 36 inches in size and weigh between 50 to 80 pounds. They provide ease in stacking and feeding and are easier in transportation and marketing operations. However, rectangular bales are more labor intensive in hauling and stacking, and indoor storage is needed to maintain highest quality. Large, high-density bales are becoming popular with sizes ranging from 24 to 50 inches wide and tall, 48 to 98 inches long, and weighing between 440 and 2000 pounds. These higher-capacity bales are more efficient to harvest and transport. However, specialized equipment is needed for harvesting and feeding, which increases the cost. Wind damage can also occur if the bales are not covered.

Round bales are typically reserved for on-farm use. They range in size from 36 to 72 inches in diameter, 48 to 64 inches in length, and weigh between 440 and 2000 pounds. These bales are less labor intensive than small rectangular bales and can be stored outside. The bales can be placed in convenient locations around the farm to provide small feeding units for planned consumption time. However, they are not easily transported or stored indoors. Additionally, these bales can lose nutritional value with outside storage unless they are wrapped or bagged. Disposal of the used plastic wrap or bag is also an environmental concern.

Silage chopping is done with a forage harvester that is used to chop the crop. A pickup or cutting mechanism carries the forage into the machine where rotating knives cut the forage into small pieces. The chopped forage is then blown through a spout to a trailing wagon or truck. Chopped forage is stored in tower silos, bunker silos, or silage bags. Labor requirements are usually less than for hay harvest. Losses can occur from drift between the blower and the trailing vehicle. Forage harvesters require more power to operate.

Forage Quality During Storage

Moisture content in baled hay of more than 22% can lead to dry matter and quality loss from heating and molding. Most green chop forages (grasses and legumes) are typically stored as haylage. Moisture levels below 40% in haylage decrease the anaerobic fermentation process. Moisture levels more than 50% can lead to spoilage in the stored forage.

Nutritional value of properly stored forages will be maintained for approximately 1 year without noticeable losses. As more drying occurs, dry matter will decrease, thus reducing some nutritional value. Forages stored outside or without protection from the elements will be subject to greater losses from leaching of nutrients from rain, mold, and spoilage.

Storage Methods

Baled hay is typically stored inside livestock barns or specialized pole hay barns at 18 to 20% moisture levels. Storing hay inside will cause less exposure to weather and the hay will maintain higher quality longer. In addition, the hay is more accessible for feeding when stored in barns. Hay stored inside is, however, more labor intensive and costs may be increased for buildings, labor, and maintenance. Wet hay will experience loss from microbial activity, spoilage, and mold. The internal heating of wet bales could cause a fire.

Outside storage is another option. Round bales are typically stored outside due to size and handling needs. Sometimes, rectangular bales are also stored outside. This method is less labor intensive and does not require the capital outlay of barns. However, additional protection is needed that can require specialized equipment. Round bales should be wrapped with a protective plastic covering. All bales should be covered with a tarp to provide protection from the weather. A protective layer, such as gravel or old tires, must be placed on the ground to protect the hay from spoilage and loss due to contact with the soil. Additionally, large bales are more difficult to move and require specialized equipment. This is especially true for transporting bales long distances, which can make this an expensive option. Nutritional value is lost quicker in hay stored outside due to continued exposure to weather.

Methods of storage for silage and haylage include tower silos, silage bunkers, and silage bags. Tower silos are constructed of concrete or steel and range in capacity from 50 to 4000 tons. They maintain the quality of the forage, provide protection from the weather, and take up less ground space than the other options. Crops can be stored between 50 and 65% moisture. The weight of the silage packs the forage to reduce trapped air. They are easily adaptable for automated feeding equipment. Some loss to spoilage may occur at the top of the silo. Additional labor is required to unload the silage by hand or move the chute if automated equipment is used. There are dangers of gas buildup in tower silos and they have an initial higher cost to build.

Silage bunkers are usually made of concrete, with a concrete floor and concrete sidewalls. The sidewalls vary from 10 to 20 feet high. They are economical and easy to store and remove forage for feeding. Crops can be stored between 50 and 75% moisture. Packing of the forage is usually done by a tractor to reduce trapped air. They are not typically protected from the environment unless a plastic covering is used, which will add additional costs. Fermentation does not occur as well as when other storage methods are used. Unloading is typically done with a front-end loader or tractor.

Silage bags are made of plastic and enclose the forage. The average bag size is 150 to 200 feet long and approximately 9 feet in diameter. Bags are often used as a short-term method of storage. They take up more storage space than a tower silo. Bags must be maintained to minimize damage to the plastic to avoid spoilage, which can reach as high as 50%. Additional labor is required to dispose of bags and plastic remnants. A tractor with a front-end loader is needed for unloading.

Methods to Enhance Poor Quality Forage

Forage quality is defined in different ways. For our purposes, forage quality will be defined in a practical sense to address grazing systems in Missouri and surrounding states. Forage quality is considered as the value of pasture grasses and legumes as nutrients for grazing animals. Forage quality can also be described in terms of protein, fiber, and other components important to the nutrition of animals. Most ruminant nutritionists would consider high-quality forage to be one with high protein and low fiber.

In a pasture, there are three major factors that affect forage quality. The first factor is plant species. Legume species tend to have higher quality than grass species. In keeping with our definition of high-quality forage, adding legumes to a pasture would increase the protein and lower the fiber.

In Missouri, it is possible to maintain at least 20 to 50% legumes in a pasture, keeping much of the forage in a leafy, vegetative stage of growth. To keep legumes in a pasture, the pasture (or paddock in an intensive grazing system) must be rested for reseeding and restoring carbohydrates. In addition, the pastures or paddocks should not receive high rates of nitrogen fertilizer unless the forage will be cut for hay or "mob grazed." High rates of nitrogen cause grasses to form a canopy over the legumes.

The second major factor affecting quality is plant maturity. As a plant matures from the leafy, vegetative stage into the steamy, reproductive stage, protein decreases and fiber increases. Under proper management, maturity is controlled as pastures or paddocks are more uniformly grazed; the result is higher-quality pasture. Some legumes such as birdsfoot trefoil, annual lespedeza, and red clover should be allowed to mature for natural reseeding and for stand persistence. Fortunately, these species retain relatively good forage quality even at advanced stages of maturity.

The third factor affecting forage quality is the plant part. Leaves contain more protein and less fiber than stems and are therefore of higher quality. Plant part is important to consider in legume hay production because leaves can be shattered during raking and baling, thereby lowering the quality. Plant part is perhaps more important to consider in a grazing pasture. As cattle graze plants such as vegetative alfalfa, their first bite contains a high proportion of intact leaves. Their second bite contains large amounts of stem, which is lower-quality forage. When they graze vegetative tall fescue however, their first and second bite both contain leaves.

Some of the other factors that affect forage quality, but to a lesser degree, include climate and biological stress. Temperature affects fiber concentration. As a rule, cooler temperatures cause lower fiber concentrations, and therefore, higher digestability. Biological stress includes plant diseases and insects. Diseases and insects usually lower forage quality by reducing the number of leaves or cause the plant to produce lignin and antiquality components. Examples of antiquality components include alkaloids in reed canarygrass that cause animals to be sensitive to the sun, resulting in skin disorders, and the tall fescue endophyte that results in fescue foot conditions.

When considering how to improve the quality of forage in storage, two factors should be examined. The first factor involves the method of storage. This factor is probably the most overlooked. Too often, bales of hay are left in the field or grouped at the edge of the pasture and left unprotected. Nutrients are rapidly depleted by the effects of sun and moisture to these uncovered bales. Providing a covering or a wrap as well as placing them in some type of storage facility would greatly enhance their quality.

The second practice that may be used to enhance quality of stored forages would be the practice of injecting anhydrous ammonia into the bale. There are two excellent reasons to ammoniate low-quality forage. First, ammonia breaks cell wall linkages and increases digestibility. Second, ammoniation requires hay to be covered and indirectly provides protection from the elements. In case of tall fescue, there is a third reason to ammoniate. Ammonia neutralizes the toxic effect of some compounds in fescue and results in an increase in daily gains by at least 50%.

Summary

Profitability of the forage crop is highly dependent on harvesting at the appropriate time. Maturity level and weather conditions are the primary factors to consider. Forage quality at the time of harvest can be affected by the growth stage of the plant, mechanical damage, climatic losses, and moisture content. There are a variety of harvesting methods; each should be weighed for the economic yield of nutrients and maintenance of the crop. After harvest, the moisture content and nutritional value must be monitored for quality. The storage method chosen will also affect the nutritional value of the forage. Forage quality can also be enhanced by choosing a legume to include in the forage, harvesting the forage at the proper stage of maturity, and using measures to maximize leaf retention. Stored forage can also be improved through proper storage techniques and ammoniation.

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Lesson 8: Marketing the Crop and Figuring Crop Costs

The final step after planting, growing, and harvesting a forage crop is to develop a successful marketing strategy. The producer's goal is to receive the maximum return per acre of forage production for that year's production.

Local Forage Marketing Options

There are two basic ways to market forages. One method is to market it through feeding the forage to animals such as beef or dairy cows. The animals convert the nutritive value of the forage into meat or milk for later sale. The other method that will be discussed in more detail is marketing the forage to sell to buyers.

Hay can be used as a cash crop. Options for marketing grass or legume hay include quality-tested hay auctions, tele-auctions, computer posting, sale to hay dealers, and neighbor-to-neighbor sales.

There are few quality-tested hay auctions in Missouri. Most are in states where forages play a more major role in their agriculture's economy. Wisconsin and California would be good examples. These two states are major dairy or milk-producing states. More high-quality forages are sold and fed to cattle in these two states than almost all other states combined. Many tons of forages are marketed through this method in these states.

Tele-auction is the method of selling hay over the telephone using conference calling. Bidders know the quality and the amount of hay they are bidding on and therefore can buy it without having to see the forage. Shipment is then made from the seller to the buyer.

Some producers in Missouri are familiar with computer posting. The Missouri Department of Agriculture is involved in a joint venture with the University of Missouri-Columbia to market hay through an Agriculture Electronic Bulletin Board (AgEBB) computer web site. This site may be accessed through <www.agebb.missouri.edu>. This listing includes seller names, cities, counties, and phone numbers. Sellers can be listed by either region or forage type. Bale type is included as small square, large square, small round, large round, baleage, or some other form. The number of bales and approximate weight of each bale of forage are listed. Additional information includes whether the hay has been analyzed, its crude protein, acid detergent fiber (ADF), relative feed value, and percent total digestible nutrients. An area for notes may list such information as "first cutting" or "do not call before 6 p.m." Hay listings will be left on the system for 60 days unless updated.

Some forages are sold to hay dealers who then transport the forage to another area for resale. These dealers are called entrepreneurs, or speculators. Their goal is to buy at a lower price and then resell at a higher price to cover their input costs and make a profit.

The most popular method in Missouri to market hay or forages is the neighbor-to-neighbor (private treaty) method of sale. This may also be known as word-of-mouth advertising and sales. Most of the forage sold by this method stays in the local area. The buyers can view the quality and amount of hay before buying. Transportation costs are lower with this method. A large amount of forages sold through this method goes directly from the field to the buyer immediately after cutting and baling.

Effect Forage Quality Has on Price

Forage quality plays a major role in the pricing structure of hay sales. A large amount of hay and other forages are bought and sold around the state. Quality factors are as important when purchasing hay as when producing it. When buying hay, visual appraisals of quality can be deceiving. High-quality hay tends to sell at a premium. Market hay grades are based on forage quality and reflect forage species, composition, and maturity. Legumes tend to grade highest, followed by legume/grasses, grasses, and finally heavily weathered forages.

To get the best price, the forage should be quality tested to provide comprehensive information to buyers. Description characteristics include color, odor, mold, heating, mixture, dust, and foreign material. The seller should also provide a chemical description. The producer must know how to take an accurate forage sample from the center of the hay bale.

Forages differ greatly in chemical composition and digestibility. Forages used to be evaluated strictly on the proximate analysis or crude fiber system. More recently, detergent analysis systems, which include acid detergent fiber (ADF) and neutral detergent fiber (NDF), provide better estimates of fiber and digestibility. The detergent system measures basic components of the plant and relates them to the animal's digestion and production. Mobile near infrared reflective spectroscopy (NIRS) vans used for determining forage digestibility permit on-site testing of hay. Hay samples can also be sent to laboratories for thorough analysis for nutritional ration balancing. One such laboratory is the Livestock Nutrition Laboratory, P.O. Box 1655, Columbia, Missouri, 65201.

Variable and Fixed Costs Associated with Forage Production

As defined in an earlier lesson, variable costs are those costs that may change each year depending on the level of production. These costs are also known as operating costs. Fixed costs are expenses that are not affected by the level of production and will remain the same no matter how much production is planned or achieved per acre. These costs are known as ownership costs.

Table 8.1 gives some examples of fixed and variable costs for certain types of forage production operations. These figures were obtained from the MIR (mail-in-record) enterprise records from 1996-98.

Table 8.1 - Missouri Average Forage Costs 1996-98

	Alfalfa Hay	Mixed Hay	Clover Hay	Fescue Seed	Corn Silage	Grass Hay
Average Operating Costs/Acre						
Seed	$ 1.31	$ 5.97	$ 2.51	$ .22	$22.30	$ 1.75
Plant food (fertilizer and lime)	21.47	16.96	8.21	11.74	40.94	10.67
Crop chemicals	6.77	1.95	6.71	6.48	21.72	2.21
Labor	18.00	26.19	12.72	8.85	36.17	14.40
Machinery, fuel, oil & repair	22.24	22.75	20.43	6.78	37.26	11.79
Machinery hire and services	7.06	7.25	.92	2.26	12.23	5.00
Miscellaneous	11.56	11.68	4.40	1.39	14.76	2.40
Operating interest	2.44	2.55	2.07	2.11	4.16	2.59
Total Operating Cost/Acre	$90.85	$95.30	$57.97	$39.83	$189.54	$50.81
Average Ownership Costs/Acre						
Machinery depreciation & interest	$ 34.34	$18.33	$21.40	$6.62	$35.62	$13.39
Land costs, taxes & interest	65.60	49.22	50.01	28.06	69.00	41.63
Total Ownership Costs/Acre	$99.94	67.55	$71.41	$34.68	$104.81	$55.02
Average Total Costs/Acre	$190.79	$162.85	$131.13	$78.18	$293.61	$107.13
Average Cost/Ton	$79.17	$83.94	$66.90	$ .34	$25.56	$52.26
Average Machinery Investment/Acre	$74.00	$41.00	$41.76	$11.86	$41.11	$49.04
Average Real Estate Investment/Acre	$788.00	$536.00	$600.00	$336.02	$880.56	$690.14

Calculation of Cost Per Acre

Refer to the examples of cost calculation earlier in this lesson in the three tables for 1996, 1997, and 1998 economic information received from the Missouri mail-in-record analysis.

Summary

There are several methods of marketing forages. Some are more common in Missouri than others. Some of these methods include quality auctions, tele-auctions, computer posting, sale to hay dealer, and private treaty sales. Most hay in Missouri is marketed through the private treaty, or word-of-mouth sales. The quality of the forage is the major factor that would determine the price or value of the forage. If the forage was tested, the chemical description should be included when advertising for sale. Examples of fixed and variable costs for forage production for cost calculation and figuring returns per acre may be obtained from extension offices MIR analysis.

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