UNIT IX - FORAGE PRODUCTION

Lesson 1: Planning the Crop

Competency/Objective: Evaluate local growing conditions for forage production.

Study Questions

1. **What is a forage?**
2. **What is the difference between the types of forages?**
3. **What factors are involved in evaluating a forage site?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. Activity Sheet
   a) AS 1.1: Evaluating Topography and Soil Quality for Forage Crops

UNIT IX - FORAGE PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

Provide an overview of Missouri forage production and how it compares to other types of crop production. The use of forages for the feeding of livestock has been in place since humans first domesticated animals. The first producers in Missouri rapidly capitalized upon the abundant native plants in animal production. Today, over half of the feed given to Missouri livestock is produced in the state.

Forages are the most widely produced crops in the United States with 475 million acres of pasture and rangeland and 61 million acres of hay. They are economically important to Missouri producers as a cash crop as well as in the production of animal and animal products. Also, pasture crops use land that is generally unsuitable for other types of crop production. Forages, especially native grasses, are very hardy and easily grow under a number of different conditions.

B. ***Motivation***

Bring in samples of different plant species (grasses, legumes, forbs, woody plants, flowers, etc.). Have students select the forages from these plants.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Define the term forage and discuss the three utilized forms in crop production. Ask students to develop a definition of forages; write the student responses on the board and discuss them.

   What is a forage?

   a) Forage - the vegetative material (leaves and stems) of plants used as livestock feed
      1) Primarily grasses and/or legumes (multiple varieties in Missouri)
      2) Can include grain crops such as corn and grain sorghum or stalks from harvested crops
   b) Types of forages
      1) Fresh - pasture
      2) Dried - hay
      3) Ensiled - silage or haylage

2. Have examples of baled hay and fresh pasture grasses. Have students develop a list of factors important to each.

   What is the difference between the types of forages?

   a) Hay
      1) Requires knowledge in management skills, multiple types of equipment, fertilization, planting, harvesting, transporting, and storage capabilities
      2) Primarily mechanically harvested crop, can be grazed
      3) Requires special attention when cutting, drying, and storing to maintain nutrients in crop

(a) Exposure to rainfall after cutting and before and after baling should be avoided; excessive moisture can cause hay to rot.
(b) Excessive storage time can deplete nutritional content and palatability; timely use or marketing is recommended.

b) Pasture
1) Requires specific knowledge and management skills but less equipment needs
2) Primarily harvested through livestock grazing
3) Requires fenced and maintained crop area
4) Permanent pasture - using existing perennial grasses and legumes with or without improvements
(a) Improved pasture - including fertilizer applications and additional seedings of grasses and/or legumes, especially varieties that extend the grazing season and improve nutritional value
(b) Unimproved pasture - natural grassland vegetation requiring good grazing management
5) Temporary or rotational pasture - seeded annually for summer and winter grazing needs or as needed in a double-crop rotation
(a) Wheat and small grains used for winter and early spring grazing
(b) Millet and sorghum used for summer grazing
(c) Stalk fields used after harvest for grazing
(d) Generally need temporary fencing

c) Silage and haylage
1) Silage is preserved in moist, succulent conditions by partial fermentation in a tight container.
(a) The moisture content at harvest is generally greater than 50%.
(b) A forage harvester is used to chop the crop for easier handling and better packing in a silo.
(c) There is little to no loss from shattering, leaching, or bleaching.
(d) There is less dependence on having extended periods of favorable weather.
(e) Plants used as silage must contain sufficient carbohydrates for fermentation and low amounts of calcium and protein.
(f) A new method of harvesting is round bale silage using a round baler and storing in a sealed container, usually a plastic bag.
2) 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.
(a) The moisture content at harvest is generally greater than 50%.
(b) Low moisture limits bacterial action.
(c) High level of carbon dioxide from respiration creates good preservation conditions.
(d) Haylage is more palatable than high moisture silage.

3. Ask students individually or in groups to list things they would want to consider about a site for both a hay field or pasture. As a class, compare student/group lists and use these to continue the discussion. Have students post their group lists on the board and discuss them. Have students complete AS 1.1 to develop skills in choosing a site for forage crops.

What factors are involved in evaluating a forage site?

a) Intended use of forage
1) Hay and silage/haylage
(a) Harvested for later feed use or sale
(b) Need to have higher yield characteristics to offset harvesting and marketing costs
(c) Be able to withstand harvesting pressure
2) Pasture
(a) Consumed directly by animals
(b) Needs to be adapted for rapid growth

(c) Tolerant of hoof traffic and soil compaction
(d) Can utilize poorer soils (poor drainage, dry, etc.)

b) Existing forages or previous crop
1) Existing forages
(a) Introduce species that are complementary to the existing crop
(b) Enhance overall forage quality
2) Previous crop
(a) Aware of previous herbicides, pesticides, insecticides, and fertilizer applications
(b) Establishment of pure forage stand; all previous crops to be effectively removed from field

c) Topography (land limitations)
1) Elevation
(a) Plant species tend to be elevation specific; grow better at some elevations
(b) Not a major concern in Missouri with consistent elevation
2) Slope
(a) Determines erosion hazard
(b) Determines amount of available topsoil
3) Other considerations
(a) Stoniness, weeds, amount of brush, and amount of boggy or marshy soils
(b) Determining factors for forages for harvest or pasture
(c) Affect amount of time and money to establish forage crop

d) Soil
1) Type and texture
(a) Legumes
(1) Prefer deep loams
(2) Well-drained soils also acceptable
(b) Grasses
(1) Less particular about soil conditions
(2) Some better suited to wet soils, others suited to dry soils
2) Drainage
(a) Many forages tolerant of short duration flooding
(b) Determines forage species that can be planted
(1) Legumes
a. Alfalfa requires well-drained soils.
b. Birdsfoot trefoil tolerates wet, moderately well-drained soils.
c. Alsike clover tolerates wet locations.
(2) Grasses
a. Tall fescue - tolerant of wet soils
b. Reed canarygrass - adapted to wet/marshy areas
3) Fertility - recommendations for planting based upon soil tests
(a) pH
(1) Legumes - 6.5 to 7.5 pH with alfalfa being the most sensitive
(2) Grasses - more tolerant; prefer 5.5 to 7.0, some with pH ranges as low as 4.0 or as high as 9.0
(b) Nitrogen (N) - Used as a starter to aid in forage establishment
(1) Legumes - 10 to 20 lb/acre
(2) Grasses - 20 to 40 lb/acre
(c) Incorporate phosphorous (P) and potassium (K) before planting - not mobile in the soil
(1) Optimum P - 140 lb/acre (legumes and grasses)
(2) Optimum K - 200 lb/acre (legumes and grasses)

F. ***Other Activities***

Have a local forage extension specialist discuss with the class important factors in establishing forages.

G. ***Conclusion***

Forage production is a major secondary industry in relation to the utilization of forages in livestock production. 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.

I. ***Answers to Activity Sheet***

Answers will vary.

J. ***Answers to Evaluation***

1. Fresh (pasture); Dried (hay); Ensiled (silage or haylage)
2. Permanent and temporary or rotational
3. Intended use of forage; existing forages; topography; soil
4. The nutritional content and palatability of baled hay will be gradually depleted with long-term storage.
5. b
6. d
7. c

UNIT IX - FORAGE PRODUCTION Name _____

Lesson 1: Planning the Crop Date _____

EVALUATION

Complete the following short answer questions.

1. What are the three different forage production systems?

   a.

   b.

   c.

2. What are the two types of pastures?

   a.

   b.

3. What four factors should be considered before introducing forages into an agricultural system?

   a.

   b.

   c.

   d.

4. Why is timely use or marketing recommended for baled hay?

Circle the letter that corresponds to the best answer.

5. Pastures are **generally** harvested _____.

   a. The same way as a grain crop
   b. Through livestock grazing
   c. After exposure to rainfall
   d. By mechanical methods

6. Hay is **primarily** harvested _____.

   a. The same way as a grain crop
   b. Through livestock grazing
   c. After exposure to rainfall
   d. By mechanical methods

7. Silage is harvested at a moisture content _____%.

a. Less than 50
b. Less than 40
c. Greater than 50
d. Greater than 60

Lesson 1: Planning the Crop Name _____

Evaluating Topography and Soil for Forage Crops

Objective: Students will be able to evaluate sites for planning forage crops.

Directions: Using the most recent copy of the Missouri Farm Facts, available from the Missouri Department of Agriculture, determine the acreage, yield, and production of forages in your county. Obtain a topographical map of Missouri or a County Soil Survey and evaluate what type of topography and soil is in your county. Determine how this affects the yield and production of forages in your county. Compare this information to other counties in Missouri.

UNIT IX - FORAGE PRODUCTION

Lesson 2: Selecting a Forage

Competency/Objective: Identify the different types of forages and select forages appropriate for intended use.

Study Questions

1. **What are cool-season grasses grown in Missouri?**

2. **What are warm-season grasses grown in Missouri?**

3. **How do cool- and warm-season grasses complement each other?**

4. **What are forage legumes grown in Missouri?**

5. **How do forage legumes complement various grasses?**

6. **What types of small grains are used in a pasture management system?**

7. **What species can be used for silage or haylage?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.

2. *Crop and Grassland Plant Identification Manual.* University of Missouri-Columbia: Instructional Materials Laboratory, 1997.

3. Extension publications on the various forages to use as possible handouts for students. Available at <http://muextension.missouri.edu/xplor/agguides/crops/#Forages>

   GO4510 - Crownvetch
   GO4511 - Orchardgrass
   GO4515 - Annual Lespedeza
   GO4550 - Alfalfa
   GO4610 - The Bluegrasses
   GO4620 - Bermudagrass
   GO4638 - Red Clover
   GO4639 - White, Ladino, and Sweet Clover
   GO4640 - Birdsfoot Trefoil
   GO4646 - Tall Fescue
   GO4649 - Reed Canarygrass, Ryegrass, and Garrison Creeping Foxtail
   GO4661 - Warm-Season Annual Forage Crops
   GO4671 - Eastern Gama Grass
   GO4673 - Big Bluestem, Indiangrass, and Switchgrass
   GO4674 - Caucasian Bluestem

4. Activity Sheet

   a) AS 2.1: Identify Characteristics of Cool- and Warm-Season Grasses

UNIT IX - FORAGE PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

In evaluating a site for forage use, one major consideration is matching a forage or combination of forages to the site characteristics. It is important to understand the different qualities of forages and conditions and compatibilities between the various species.

B. ***Motivation***

Bring in samples of grasses and legumes (live or preserved mounts) from the local area. Include examples of warm-season grasses, cool-season grasses, forage legumes, and small grains. Have the class separate the plants into the above categories. (An alternative to this motivation would be to have the class collect different forages from the local area by visiting nearby farms, parks, and/or public areas. Keep samples from each location separate for identification practice and to compare what natural forages are being grown and/or what forages have been planted to improve any of the locations.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Begin discussion with the growth habits of cool-season grasses. Use examples from the motivation to point out cool-season grasses. Have students identify these using Table 2.1 and discuss which advantages and disadvantages apply to each grass in regard to the location where it was found.

What are cool-season grasses grown in Missouri?

a) Growth habit of cool-season grasses - grass plants exhibiting vigorous growth habits in the spring and fall months
   1) Plants turn green and initiate new growth.
      (a) Late February or early March
      (b) When soil temperatures reach 40°F
   2) Plants begin rapid growth period.
      (a) Soil and air temperatures rise.
      (b) Spring rains occur.
      (c) Optimum growth occurs when air temperature reaches 59° to 77°F in late spring and early to mid-fall.
   3) Plant growth slows down and plants become brown and dormant during summer.
      (a) Inefficient use of water and sunlight energy during hot, dry weather
      (b) Dormancy temperature variable by species
      (c) Irrigation prolonging growth but growth potential less than spring and fall

b) Most common cool-season grasses grown in Missouri (Table 2.1)
   1) Perennials
      (a) Kentucky bluegrass (*Poa pratensis*)
      (b) Orchardgrass (*Dactylis glomerata*)
      (c) Reed canarygrass (*Phalaris arundinacea*)
      (d) Smooth bromegrass (*Bromus inermis*)
      (e) Tall fescue (*Festuca arundinacea*)

(f) Timothy (*Phleum pratense*)

2) Annuals - small grains

2. Discuss the growth habit of warm-season grasses and display samples of these grasses from the motivation. Ask students to find the name of each in Table 2.2 and discuss the advantages and disadvantages in regard to the location where they were growing.

What are warm-season grasses grown in Missouri?

a) Growth habit of warm-season grasses - plants exhibiting vigorous growth in spring and summer
   1) Plants - green, new growth when soil temperature at 60°F
   2) Optimum growth with air temperature between 77°F and 104°F
   3) Annual warm-season grasses
      (a) Used as pasture, hay, or silage
      (b) Rapid production important for summer grazing systems
      (c) Work well in crop rotation systems but expensive source for animal gain

b) Most common warm-season grasses grown in Missouri (Table 2.2)
   1) Perennials
      (a) Bermudagrass (*Cynodon dactylon*)
      (b) Big bluestem (*Andropogon gerardi*)
      (c) Caucasian bluestem (*Bothriochloa caucasica*)
      (d) Easter gamagrass (*Tripsacum dactyloides*)
      (e) Indiangrass (*Sorghastrum nutans*)
      (f) Little bluestem (*Schizachyrium scoparium*)
      (g) Sideoats grama (*Bouteloua curtipendula*)
      (h) Switchgrass (*Panicum virgatum*)
   2) Annuals
      (a) Pearl millet (*Digitaria sanguinalis*)
      (b) Sorghum - sudangrass and hybrids

3. Have students analyze the grasses collected in the motivation and determine if species found at the same location were complementary. If not, have them suggest what would be good grasses to add to the location. Have students complete AS 2.1.

How do cool- and warm-season grasses complement each other?

a) Provide a continuous supply of available forage for grazing due to different growth habits
   1) Warm-season grasses grow best in summer.
   2) Cool-season grasses grow best in spring and fall.
   3) One-third of grass pasture mixes should be warm-season grasses.

b) Complementary grasses in pasture situations
   1) Provide balanced nutritional quality throughout the grazing season
   2) Reduces risks of crop losses
      (a) Weather conditions
      (b) Plant specific diseases
      (c) Insect outbreaks
      (d) Other factors that affect pure crop stands

4. Display samples of forage legumes from collected species and discuss advantages and disadvantages of each found in Table 2.3 in the Student Reference regarding where they were growing. Have students determine if legumes were naturally occurring or purposely planted at collected locations.

What are forage legumes grown in Missouri?

a) Forage legumes - broad-leafed plants capable of "fixing" their own nitrogen

1) Tend to be higher in digestible proteins than grasses
2) Higher producer of forage than grasses
3) Alfalfa
   (a) Most productive legume
   (b) Productive into midsummer under nondrought conditions
   (c) Establishes deep taproot
   (d) Management practices
      (1) Timely harvesting at proper growth stage
      (2) Insect, disease, and weed control
      (3) Nutrient replacement
4) Other legumes
   (a) Each with potential benefits
   (b) Diverse growing conditions

b) Most common forage legumes grown in Missouri
1) Alfalfa - WS Perennial
2) Birdsfoot trefoil - CS Perennial
3) Alsike clover - CS Perennial
4) Ladino clover - CS Perennial
5) Red clover - CS Perennial
6) Sweet clover - CS Biennial
7) White clover - CS Perennial
8) Korean lespedeza - WS Annual

5. Have students identify the differences in plant structures between grasses and legumes. Discuss how legumes can be used to complement and benefit grasses.

How do forage legumes complement various grasses?

a) Lengthening growing season of cool-season grasses because they grow longer into the summer
b) Enhancing soil quality by increasing nitrogen levels in the soil
c) Adding nutrients to soil for grass growth
d) Providing more available nutrition for livestock in both pastures and harvested forages
1) Higher protein yields per acre
2) Increased average animal gain
3) Increased weaning weights
4) Increased animal conception rates
5) Decreased herd health problems
e) Continuous forage improvement; legumes not indefinite
f) Drought very damaging, especially to clovers
g) Legumes reduced or lost in pastures
1) Overgrazing
2) Lack of fertility or improper fertilization
3) Diseases or insects
4) Too much or too little rainfall

6. Discuss the types of small grains used in new and existing pasture systems. Display samples of each for ease of identification.

What types of small grains are used in a pasture management system?

a) Wheat - most common
b) Winter rye - used in colder climates; most winter hardy of small grains
c) Winter barley and oats - along with rye, less desirable to use than wheat because their heavy, early growth competes with young forage seedlings
d) Pearl millet and winter vetch
e) Benefits of small grains in existing pastures

1) Provide high-quality pasture forages in winter and spring months
2) Increase pasture yields
3) Extend grazing period

f) Benefits of small grains as cover crops for new pastures
1) Reduce weeds
2) Control erosion
3) Furnish winter protection to young forage seedlings

7. Discuss the difference between silage and haylage and which species are best used in both. Display samples for identification and compare for firmness of leaves and stems, odor, and color.

What species can be used for silage or haylage?

a) Any crop that can be fed green as pasture or harvested for hay
1) Silage - forage stored at 60 to 65% moisture
2) Haylage - forage stored at 40 to 50% moisture

b) Typical crops
1) Grasses - smooth bromegrass, timothy, ryegrass, millets, orchardgrass, sudangrass, reed canarygrass
2) Legumes - alfalfa, sweet clover, red clover, ladino clover, alsike clover, soybeans, field peas, vetch, lespedeza, birdsfoot trefoil
3) Grains - corn, grain sorghum, wheat, oats, barley, rye, triticale

F. *Other Activities*

1. Have a forage producer speak to the class about his or her methods of variety selection.

2. Research and report on a forage of economic importance in your area. Include in your report what species or combination of species should be used based on an intended use. Defend why the selected species would be the best choice and make suggestions as to other species that could be used if applicable.

G. *Conclusion*

By understanding the advantages and disadvantages of cool- and warm-season grasses and forage legumes, a producer can choose pure varieties or mixtures that best fit individual production needs. Combining legumes, grasses, and small grains will benefit pastures and harvested forages by providing added nutrition to existing pastures.

H. *Answers to Activity Sheet*

1. Orchardgrass
2. Kentucky bluegrass
3. Timothy
4. Smooth bromegrass
5. Tall fescue
6. Small grains
7. Pearl millet
8. Sideoats gramagrass
9. Indiangrass
10. Caucasian bluestem
11. Switchgrass
12. Sorghum-sudangrass
13. Bermudagrass
14. Eastern gama grass
15. Little bluestem
16. Big bluestem

I. ***Answers to Evaluation***

1. b
2. d
3. b
4. a
5. b
6. b
7.

Type of Forage	Perennial	Annual	Grass	Legume	Warm Season	Cool Season
Alfalfa	X			X	X	
Bermudagrass	X		X		X	
Big Bluestem	X		X		X	
Birdsfoot Trefoil	X			X		X
Caucasian Bluestem	X		X		X	
Clover, Alsike	X			X		X
Clover, Ladino	X			X		X
Clover, Red	X			X		X
Clover, Sweet	X			X		X
Clover, White	X			X		X
Eastern Gama Grass	X		X		X	
Indiangrass	X		X		X	
Kentucky Bluegrass	X		X			X
Lespedeza, Korean		X		X	X	
Little Bluestem	X		X		X	
Orchardgrass	X		X			X
Pearl Millet		X	X		X	
Reed Canarygrass	X		X			X
Sideoats Gramagrass	X		X		X	
Small Grains		X	X			X
Smooth Bromegrass	X		X			X
Sorghum-Sudangrass and Hybrids		X	X		X	
Switchgrass	X		X		X	
Tall Fescue	X		X			X
Timothy	X		X			X

UNIT IX - FORAGE PRODUCTION Name_____

Lesson 2: Selecting a Variety Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Cool season grasses initiate new growth when soil temperatures reach _____ °F.

   a. 35
   b. 40
   c. 45
   d. 50

2. Warm season grasses initiate new growth when soil temperatures reach _____ °F.

   a. 45
   b. 50
   c. 55
   d. 60

3. In a warm- /cool-season grass mixture, approximately _____ of the stand should be warm season grasses.

   a. One-quarter
   b. One-third
   c. One-half
   d. Two-thirds

4. Forage legumes _____ digestible protein compared to grasses.

   a. Are higher in
   b. Are lower in
   c. Have the same amount of
   d. Do not require much

5. Forage legumes complement grasses by _____.

   a. Lengthening the growing season of warm season grasses
   b. Enhancing soil quality by increasing nitrogen levels
   c. Providing insect protection during the warm season
   d. Conserving soil moisture during the cold season

6. Haylage is forages stored at _____ percent moisture.

   a. 30 to 40
   b. 40 to 50
   c. 50 to 60
   d. 60 to 70

7. Place an X in the correct box to indicate if a variety is a perennial or annual, grass or legume, and warm season or cool season.

Type of Forage	Perennial	Annual	Grass	Legume	Warm Season	Cool Season
Alfalfa						
Bermudagrass						
Big Bluestem						
Birdsfoot Trefoil						
Caucasian Bluestem						
Clover, Alsike						
Clover, Ladino						
Clover, Red						
Clover, Sweet						
Clover, White						
Eastern Gama Grass						
Indiangrass						
Kentucky Bluegrass						
Lespedeza, Korean						
Little Bluestem						
Orchardgrass						
Pearl Millet						
Reed Canarygrass						
Sideoats Gramagrass						
Small Grains						
Smooth Bromegrass						
Sorghum-Sudangrass and Hybrids						
Switchgrass						
Tall Fescue						
Timothy						

Lesson 2: Selecting a Variety Name_____

Identify Characteristics of Cool- and Warm-Season Grasses

Objective: Students will become more familiar with the advantages and disadvantages of cool- and warm-season grasses.

Directions: Refer to the information given in Table 2.1 and 2.2 in Lesson 2 to answer the following questions.

Cool-Season Grasses

1. Which grass has rapid regrowth after cutting or grazing? _____
2. Which grass has consistently low yields? _____
3. Which grass is susceptible to heat and low moisture conditions? _____
4. Which grass is best adapted to deeper, better soils? _____
5. Which grass can be grazed closely? _____
6. Which grass has costly ground preparation? _____

Warm-Season Grasses

7. Which grass is tolerant of acidic sites? _____
8. Which grass grows in shallow soils? _____
9. Which grass should not be grazed until it reaches 8 to 10 inches in height? _____
10. Which grass is not tolerant of wetland soils? _____
11. Which grass has a high yield late spring/early summer? _____
12. Which grass is difficult to cure as hay? _____
13. Which grass prefers pH of 5.5 or above? _____
14. Which grass prefers loamy soils with adequate moisture? _____
15. Which grass is valuable in watershed protection? _____
16. Which grass is highly palatable to all classes of livestock? _____

UNIT IX - FORAGE PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

Competency/Objective: Identify the principles for establishing forages.

Study Questions

1. **What tillage and planting methods are appropriate for establishing a stand?**

2. **What tillage and planting methods are used to renovate a stand?**

3. **What factors should be considered when determining fertilizer application needs during forage establishment?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.

2. Activity Sheet

   a) AS 3.1: Forage Crossword Puzzle

UNIT IX - FORAGE PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

After the planning has been done and the variety of forage has been selected, the next step is selecting a tillage and planting method. This lesson will discuss these methods: establishing a forage and fertilizing the stand for growth.

B. ***Motivation***

Ask the students what types of equipment they think would be used to establish a forage stand. Ask them to list and describe the equipment and when it would be used.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. There are several methods used to establish a forage stand. Discuss the various types of equipment and methods used to prepare a seedbed and plant the seed. Refer to Figure 3.1 in the Student Reference for an example of a minimum or no-till drill. Figure 3.2 in the Student Reference shows an example of band seeding.

   What tillage and planting methods are appropriate for establishing a stand?

   a) Three basic types of tillage systems used to prepare the seedbed for forage planting
      1) Complete tillage method
         (a) Deep plow with equipment such as a moldboard plow.
         (b) Apply fertilizers before plowing.
         (c) Do several weeks before planting to allow rain, harrowing, and rolling to compact the soil.
         (d) Seed using a drill or broadcaster.
      2) Reduced tillage method
         (a) Use a field cultivator or chisel to roughen the ground.
         (b) Seeds may then be drilled or broadcast.
         (c) Use some type of roller to compress the seeds into the ground for better germination.
      3) No-till method
         (a) This method is useful in new plantings on areas that are prone to wind erosion and on steep slopes
         (b) A "no-till" seeder is used to incorporate the seed into the soil.
         (c) This results in reduced trips across the field, saving in costs, and reduces soil erosion.
         (d) Existing vegetation must be effectively killed with postemergence herbicide before planting.
   b) Four methods of planting forage seeds
      1) Broadcasting
         (a) Least desirable method because of germination efficiency
         (b) Increased efficiency by rolling or cultipacking the seedbed before planting
         (c) Can be used during midwinter to allow frost to honeycomb the soil allowing the seeds to be covered with sufficient soil for germination

2) Conventional grain drill
   (a) Uses grass seeding attachment - metal tubes scattering seed in front of furrow openers
   (b) Allows for banding - applying a band of fertilizer with the seed placement for efficient use
3) Seeders with corrugated rollers, such as the Brillion seeder
   (a) Allows seed to drop between two corrugated rollers that pack the soil below the seed and then around it
   (b) Ensures a firm seedbed and even distribution of seed that is not sown to deeply
4) No-till seeding - used without any previous tillage

2. Ask students if they can explain the concept of pasture or forage renovation. How might this be accomplished, what equipment may be used, and when is it best done? Complete AS 3.1.

What tillage and planting methods are used to renovate a stand?

a) Most renovations involve the addition of legumes to grass sod.
b) Adding a legume (because of its nitrogen fixing capabilities) is cheaper than topdressing the grass with commercial nitrogen fertilizer.
c) Renovating is never final; it must be done every few years to maintain stands.
d) Three basic methods are recommended to renovate forages.
   1) Method 1 - Overgraze grass during the fall and early winter.
      (a) Apply lime, phosphorous, and potash before or during renovation as soil tests recommend.
      (b) Broadcast legume seed early in winter to allow freezing and thawing to carry the seed into the soil.
      (c) February seeding will have a 50% chance of succeeding than an April seeding.
      (d) Remove early growth immediately by grazing to allow the legume to establish good root system.
   2) Method 2 - Till the sod in late fall or early winter so that 40 to 50% of the soil is disturbed.
      (a) Broadcast or drill seed into the partially opened soil.
      (b) Continue with steps as described in method 1.
   3) Method 3 - Use a nonselective herbicide to retard grass growth.
      (a) Seed with no-till equipment.
      (b) Use chemical and seed during the growing season - early spring or late summer.
      (c) Apply the herbicide according to label directions.

3. The last but most important step may be to make sure the seed has a chance of maximizing its potential with needed nutrients. Ask students if they can identify the first step in proper nutrient assessment. Soil tests must be used to guide the fertilizer program.

What factors should be considered when determining fertilizer application needs during forage establishment?

a) Test the soil to determine the pH level and nutrient status of the soil.
   1) This should be done at least 6 months prior to seeding.
   2) It allows time to correct deficiencies in the topsoil.
   3) The pH should be between 6.0 and 6.8 depending on the legume or grass and the soil type.
b) Adequate lime must be applied.
   1) Lime will also supply calcium and magnesium.
   2) Lime also affects the availability of other essential nutrients. For example, phosphorous availability is increased and the pH is increased.

3) Apply part of the lime at least 6 months prior to seeding.

c) Available phosphorous is a key element to establishing legumes and grasses.
d) Nitrogen should be applied later to aid in aboveground vegetative growth.
e) Phosphorous encourages root development.
f) Starter fertilizer should consist primarily of phosphorous and a small amount of nitrogen.
g) Established stand needs a liberal amount of potash to meet their potassium needs.
h) Topdressing of established stands should be done according to soil tests. Soil tests should be done every 3 to 4 years.

F. ***Other Activity***

Secure soil tests from some students' home farms with well-established and not-so-well established forages. Examine and explain the differences.

G. ***Conclusion***

This lesson is an important step in successful forage production. Knowing how to prepare the soil and the methods that may be used for seeding is crucial for this success. These seeding methods will vary with different parts of the state and with different soil types and conditions. The importance of soil tests should be stressed. Producers must know the pH of the soil and the nutrient availability when establishing the stand and when maintaining the forage stand.

H. ***Answers to Activity Sheet***

Across
1. Phosphorous
3. Nitrogen
4. Broadcast
7. Clipping
8. Banding

Down
2. Overgrazing
5. Legume
6. Lime

I. ***Answers to Evaluation***

1. Complete tillage, reduced tillage, no-till
2. Broadcasting, conventional drill, special seeders, no-till seeding
3. a. Overgraze grass during the fall and early winter.
   b. Till the sod in late fall or early winter so that 40 to 50% of the soil is disturbed.
   c. Use a nonselective herbicide to retard grass growth.
4. d
5. b

UNIT IX - FORAGE PRODUCTION Name _____

Lesson 3: Selecting a Tillage and Planting Method Date _____

EVALUATION

Complete the following short answer questions.

1. What are three tillage methods for preparing the seedbed for planting?

   a.

   b.

   c.

2. What are four general planting methods used to seed forages?

   a.

   b.

   c.

   d.

3. What are the three methods recommended to renovate forages?

   a.

   b.

   c.

Circle the letter that corresponds to the best answer.

4. Which element below is used to regulate the pH of the soil?

   a. Nitrogen
   b. Phosphorous
   c. Potassium
   d. Lime

6. How often should soil tests be taken to aid in the maintaining of a good forage stand?

   a. Every year
   b. Every 3 to 4 years
   c. Every 6 to 7 years
   d. Every 10 years

Lesson 3: Selecting a Tillage and Planting Method Name _____

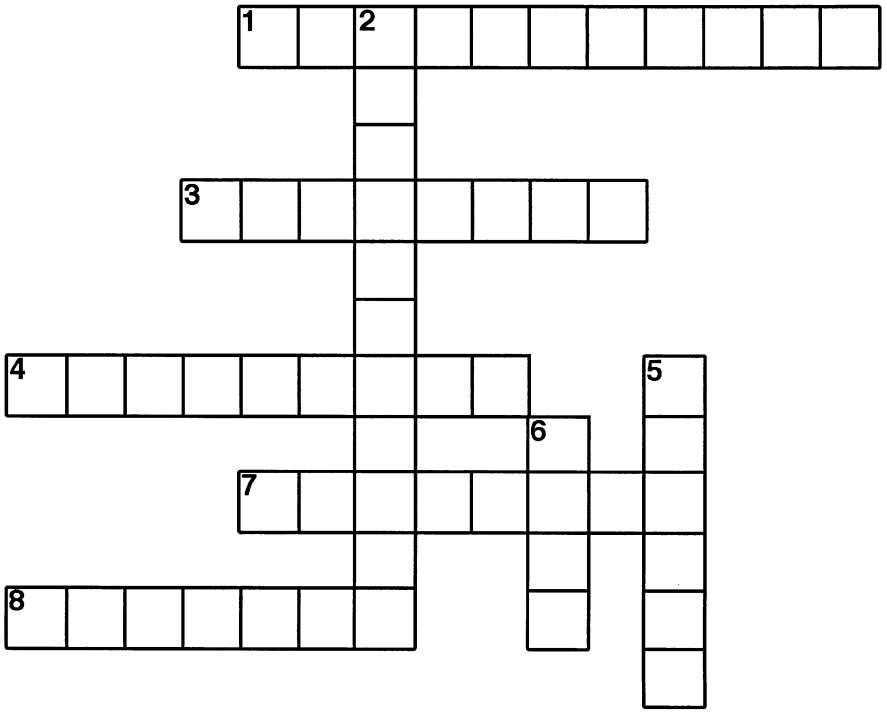
Forage Crossword Puzzle

Objective: Students will be able to recognize terms associated with forage production.

Directions: Complete the crossword puzzle below by filling in the blanks with the correct words associated with the down and across phrases.

Across
1. Nutrient that encourages root development
3. Nutrient that encourages aboveground vegetative growth
4. Spreading the seed on top of the ground
7. A method of removing early growth to allow root development
8. Placing the seed directly over the fertilizer

Down
2. One reason why legumes may be lost from a forage
5. Adding this is cheaper than topdressing grass with nitrogen
6. Should be applied before plowing and then turned under



UNIT IX - FORAGE PRODUCTION

Lesson 4: Scouting and Maintaining the Crop

Competency/Objective: Identify the principles for managing and maintaining forages.

Study Questions

1. **What pests are associated with forage production?**
2. **What pest control options are available?**
3. **What methods of brush control are available?**
4. **What methods of maintaining or renovating a forage system are available?**
5. **What are fertilizer requirements for an established stand?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.

UNIT IX - FORAGE PRODUCTION

Lesson 4: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons have discussed evaluating local growing conditions and selecting an appropriate species. Selecting the tillage and planting method for forages was also discussed. This lesson will review the proper methods for scouting and maintaining the forage crop.

B. ***Motivation***

Bring photos of different forage systems to class. Have examples of those systems that provide obvious examples of brush management problems. This could include forage systems that have not been maintained, systems with nutritional deficiencies, and systems with obvious weed and/or insect infestations. Have students discuss how these forage crop systems would impact quality, production, and economic viability to the producer.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Bring in samples of local weed species (live or mounted) and forage insect mounts. Have students reflect upon the impact these species have in forage production.

   What pests are associated with forage production?

   a) Biennial and perennial weeds
      1) These weeds produce seed each year, potentially starting new infestations.
      2) Perennials reproduce underground roots or rhizomes.
         (a) Survive several years in the soil
         (b) Often unaffected by occasional mowing or livestock grazing
   b) Insect identification and management
      1) Alfalfa weevil
         (a) Adult weevils lay eggs in older alfalfa stems in late fall and early spring.
         (b) Larva mainly damage first cutting.
      2) Potato leafhoppers
         (a) Migrate to Missouri in June from southern states
         (b) At immature or nymph stage stunting of plants and yellows leaves
         (c) Lowers yield and protein content by sucking juices from young upper stems
      3) Grasshoppers
         (a) Sporadic infestations and generally cause more damage in dry years
         (b) Most common species in Missouri
            (1) Differential grasshopper
            (2) Redlegged grasshopper
         (c) Large, irregular holes extending from the margin to the center of the leaf
         (d) Damaged tips of alfalfa and other plants
      4) Blister beetle
         (a) Cause limited plant damage
         (b) Sick or dead livestock if insect is ingested
         (c) Common in alfalfa harvested during July or August

2. Discuss the various pest control options available for the specific pest to be controlled.

What pest control options are available?

a) Forage condition
   1) Heathy, properly maintained forage systems
      (a) Less likely to be susceptible to encroachment of weeds
      (b) Able to withstand minor insect damage
   2) Without proper management
      (a) Broadleaved weeds can directly compete with forage grasses or pasture to reduce nutritional value and quality.
      (b) Weeds can replace desirable grass species.
      (c) Plants that have toxic properties can cause livestock injury or loss.

b) Forage monitoring
   1) Regular inspection of forage areas that pose a concern for pest populations
      (a) Fencerows
      (b) Near waterways
      (c) Areas where pests have been a problem in the past
   2) Monitoring programs
      (a) Determine economic injury level: the lowest pest population density at which economic impact is felt
      (b) Determine economic/action threshold: the pest population density at which control measures should be enacted
   3) Conducting monitoring programs
      (a) Walk-through inspections of forage systems
      (b) Use of insect traps located throughout the forage system

c) Methods of pest control
   1) Mechanical
      (a) Tilling
      (b) Mowing
      (c) Pulling of weed species
      (d) Best for small infestations, easily controlled infestations
   2) Cultural control
      (a) Manipulation of the environment to reduce a favorable climate for pests
      (b) Crop rotation
      (c) Trap crops
      (d) Controlled burn
   3) Pesticides - chemical or organic mixtures developed with the intention of controlling pests

3. The use of brush control management strategies are meant to restore the balance of the forage species used, either in a pasture or harvest situation. Brush plants utilize 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.

What methods of brush control are available?

a) Control methods
   1) Mechanical methods: effective but can be costly in equipment and labor hours
      (a) Mowing
      (b) Chain sawing
      (c) Root plowing
      (d) Bulldozing
   2) Chemical methods: effects vary
      (a) Depending upon application of correct herbicides at the correct rate
      (b) Must be under favorable weather conditions
      (c) Must be when the brush species is at its weakest stage of growth

(d) Various reactions to herbicides

3) Grazing management - healthy forage ecosystems choking out encroaching brush plants
   (a) Rotational grazing restricts animals from overgrazing.
   (b) Stressed forage systems are open to brush and weed infestations.

b) Combination of methods - best option
   1) Tailor a control program based on extent of problem.
   2) Plan and expect long-term results.

4. Ask students ways of maintaining or renovating a forage system. Discuss the need to renew pastures and fields with desired forage species to improve forage yield and animal production.

What methods of maintaining or renovating a forage system are available?

a) Testing the soil and amending it
   1) Spreading fertilizer - based on soil tests and prescribed nutrient requirements for those forage species present
   2) Liming - amends and adjusts pH of the soil
   3) Disking
      (a) Incorporates organic material into soil
      (b) Breaks up surface layer for better water and air penetration

b) Suppressing and/or destroying unwanted plant
   1) Mechanical
      (a) Mowing
      (b) Pulling
      (c) Cutting
      (d) Tilling
   2) Cultural - rotational grazing
   3) Chemical - herbicide used to destroy unwanted plant species

c) Introducing other forage species
   1) Overseeding
      (a) Broadcasting grass or legume seed into an existing forage stand that may be thinned or overgrazed
      (b) Typically done in late winter or early fall
   2) No-till planting
      (a) Places seed into the soil at the optimal depth without tillage of soil surface
      (b) Allows for lower seeding rates
      (c) Precise placement of seed
      (d) Reduction in loss of organic material and water loss from tillage
      (e) Reduction from tillage erosion
      (f) Seed in January and February on frozen ground

d) Prescribed burning
   1) Commonly used for warm-season grasses
   2) Removes previous years growth
   3) Keeps invading woody plants in check
   4) Reduces competition from invading cool-season grasses
   5) Usually conducted in the spring
   6) Encourages fast and vigorous growth right after the burn by releasing nutrients locked up from previous years growth
   7) Must be done with safety in mind
      (a) Procedures selected that will cool the fire
      (b) Wind conditions
      (c) Relative humidity
      (d) Air temperature
      (e) Cool, damp conditions - best
      (f) Fire barriers to stop the path of a blaze
   8) Seek the advice of experienced persons

5. Plant nutrition is an important consideration in the maintenance of a forage stand. Many factors determine nutrient needs of a forage. Discuss the various types of tests that can be performed to determine nutrient status and nutritional needs of forages.

What are fertilizer requirements for an established stand?

a) Forage nutrient status and needs
   1) Plant and soil analyses- used to optimize plant yields
      (a) Based upon available nutrients
      (b) Maximizes economic and nutrient inputs
   2) Soil analysis
      (a) Typically just the surface sampled
      (b) Deeper subsoil samples taken for deep rooted perennials
   3) Plant analysis
      (a) Samples of plant tissue are analyzed to determine current plant nutrient status.
      (b) Look at more nutrients than soil tests to detect plant deficiencies.

b) Important nutrients
   1) Phosphorus
      (a) Especially critical when legumes are established
      (b) Better stands usually obtained if applied just before or at the time of seeding
   2) Potassium
      (a) Not as critical at time of establishment
      (b) Legume persistence greater if used in a topdressing program
   3) Nitrogen
      (a) Should not be used when establishing legumes in a grass sod
      (b) Increases the growth and vigor of the grass and increases the competition for the new legume seedling
   4) Boron
      (a) Important to alfalfa and should be applied in the topdress fertilizer
      (b) Toxic to alfalfa seedlings and should not be applied at seeding

c) Protecting soil and water resources
   1) Leaching and erosion of nutrients - Nitrogen and phosphorus are very soluble and tend readily move into the water table and/or streams, ponds, etc.
   2) It is important to apply correct amounts of these nutrients at the proper plant stage of growth so as to minimize losses to water movement.

F. ***Other Activities***

1. Have a local forage extension specialist discuss the importance of scouting and maintaining forage crops to the class.

2. Tour local forage crops. Have students identify good scouting/maintenance practices and those areas needing improvement.

G. ***Conclusion***

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 that are allowed to run down will require more money for repair than a system that is continually maintained.

H. ***Answers to Activity Sheet***

I. ***Answers to Evaluation***

1. Biennial, perennial
2. Any two of the following:
   a) Alfalfa weevil
   b) Potato leafhopper
   c) Grasshopper
   d) Blister beetle

3. Any three of the following:
   a) Less likely to be susceptible to encroachment of weeds
   b) Able to withstand minor insect damage
   c) Broadleaved weeds compete with forage grasses or pastures to reduce nutritional value and quality
   d) Prevent weeds from replacing desirable grass species
   e) Toxic plants causing injury or loss to livestock

4. Any two of the following:
   a) Regular inspection of forage areas (in fencerows, near waterways, in areas where pest occurred before)
   b) Monitoring programs to determine level of economic injury
   c) Monitoring programs to determine level of economic/action threshold
   d) Walk-through inspections
   e) Use insect traps

5. Any two of the following:
   a) Mechanical (tilling, mowing, pulling weed species)
   b) Cultural control (manipulate environment, crop rotation, trap controls)
   c) Pesticides

6. Any two of the following:
   a) To restore balance of forage systems
   b) Because brush plants use three to five times more water and nutrients and water than forage plants
   c) Because brush plants compete for sunlight energy; choke out forage species

7. Any two of the following:
   a) Mechanical (mowing, chain sawing, root plowing, bulldozing)
   b) Chemical
   c) Grazing management
   d) Combination of methods

8. Any three of the following:
   a) Testing soil and amending it
   b) Suppressing and/or destroying unwanted plant
   c) Introducing other forage species
   d) Prescribed burning

9. Plant analysis and soil analysis
10. Any three of the following: phosphorus, potassium, nitrogen, boron

UNIT IX - FORAGE PRODUCTION Name_____

Lesson 4: Scouting and Maintaining the Crop Date_____

EVALUATION

Complete the following short answer questions.

1. Name two types of weeds that cause the biggest problem for forage production.

   a.

   b.

2. Name two insects that cause damage to forage production.

   a.

   b.

3. List three reasons why maintaining forage condition is important to forage production.

   a.

   b.

   c.

4. Describe two activities that occur during "forage monitoring."

   a.

   b.

5. List two methods of pest control.

   a.

   b.

6. List two reasons why it is important to control brush.

   a.

   b.

7. List two methods of controlling brush.

   a.

   b.

8. List three methods of maintaining/renovating forage systems.

   a.

   b.

   c.

9. List two types of analyses that can help determine forage nutrient status and nutritional needs.

   a.

   b.

10. List three important nutrients for forage systems.

    a.

    b.

    c.

UNIT IX - FORAGE PRODUCTION

Lesson 5 : Selecting a Grazing System

Competency/Objective: Identify various forage grazing methods.

Study Questions

1. **What are the various grazing systems currently used to maintain optimum production?**
2. **How do water resource locations influence grazing patterns?**
3. **What determines the livestock carrying capacity of a grazing system?**
4. **How are cow-calf days calculated for warm- and cool-season grasses?**
5. **How do different grazing patterns influence cow-calf days?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. Transparency Masters
   a) TM 5.1: Basic 140-Acre Grazing Unit
   b) TM 5.2: Simple 4-Paddock Grazing System
   c) TM 5.3: A 12-Paddock Intensive Grazing System
3. Activity Sheet
   a) AS 5.1: Determining Carrying Capacity

UNIT IX - FORAGE PRODUCTION

Lesson 5: Selecting a Grazing System

TEACHING PROCEDURES

A. ***Review***

The previous lessons dealt with establishing the forage, selecting the forage and its variety, preparing soil and planting, and maintenance. This lesson will discuss considerations that must be made when grazing the forage and how to maximize its production.

B. ***Motivation***

Ask students if they can list factors to consider when determining the grazing of a specific forage. If they had a pasture of a certain size, how would they manage its production with a herd of 100 cows? Would they divide it into paddocks? How many cows would it support?

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask students to identify grazing systems they are familiar with.

What are the various grazing systems currently used to maintain optimum production?

a) Continuous grazing systems - traditional method of using single or few pastures for full season grazing
   1) Advantages
      (a) Higher initial animal performance due to selective grazing
      (b) Low maintenance
   2) Disadvantages
      (a) Pasture composition altered by selective grazing
      (b) Poor forage utilization

b) Rotational grazing systems - sequenced movement of animals between two to seven smaller pastures
   1) Advantages
      (a) Match grazing to plant growth
      (b) Provides rest periods for desirable plants
      (c) Increases forage and animal production
      (d) Reduces brush invasion
      (e) Set aside fields for haying and fall stockpiling
   2) Disadvantages
      (a) Requires more time and labor to manage
      (b) Requires additional expenses in fencing, waterers, and maintenace

c) Management intensive grazing (MIG) system - a form of rotational grazing using a short duration (5-day) rotation between pastures
   1) Advantages
      (a) Maintains desired pasture composition
      (b) Causes less damage from compaction
      (c) Higher production per acre than traditional rotation grazing
      (d) Provides for longer regrowth periods
      (e) Allows operator more contact with animals allowing for identification and correction of potential problems

2) Disadvantages
   (a) Requires more time in planning and management
   (b) More expenses in fencing construction and maintenance

2. Any forage system used for grazing must consider what water resources are available for the herd. Refer to TMs 5.1, 5.2, and 5.3 to explain grazing systems.

How do water resource locations influence grazing patterns?

a) In a continuous grazing system, the water resource may be a pond or deep well with total herd access.
b) In a rotational grazing system, modifications must be made with fencing to allow the herd to move from a specific paddock or section of pasture to the water supply.
c) Additional modifications to increase paddock numbers may require the producer to extend water lines and provide water tanks to individual pastures.
d) The use of alleyways may cause certain problems.
   1) Soil erosion for animal traffic in a concentrated area
   2) Weed infestation such as thistles and nettles
   3) Manure in alleyway instead on pasture, losing its nutritive effect

3. The type of livestock grazing system used will partly depend upon the carrying capacity of the pasture, which is the ability of a forage system to support a specific number of animals throughout a grazing season. Ask students how the livestock carrying capacity of a grassland is determined. Have students complete AS 5.1.

What determines the livestock carrying capacity of a grazing system?

a) Carrying capacity = $\frac{\text{Annual forage production x Seasonal utilization}}{\text{Average daily intake x Length of grazing season}}$
b) Annual forage production - amount of forage dry matter produced per acre
c) Seasonal utilization rate - percentage of the forage produced that will be consumed by the animals in 1 year
d) Average daily intake - percentage of the animals' body weight consumed in forages on a daily basis
e) Length of the grazing season - days of grazing per year

4. Producers with planned forage systems need to be able to determine how many animals the system will support for grazing.

How are cow-calf days calculated for warm- and cool-season grasses?

a) Steps to calculate "cow-days"
   1) Look at the pasture and determine if it is thin, average, or thick.
   2) Measure or estimate the height of the pasture.
   3) Subtract from the total height the height of the stubble the animals should leave.
   4) Multiply the difference between starting height and ending height by the cow-days per 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.
b) Adjustments for different classes of livestock and different weights

5. Adjust the number of days the animals may be on the pasture, depending on certain differences among herds.

How do different grazing patterns influence cow-calf days?

a) Size of the pastured area

b) Amount of forage or stand density
c) Size or weight of the animals

F. ***Other Activities***

1. Plan a field trip to a well-managed intensive grazing program within an acceptable driving distance if available. If not, obtain pictures (slides) to show the class such a grazing program. Pictures or slides of pastures showing extreme differences in grazing stages would be valuable.

2. Have the students research types of forages that complement each other in a grazing system. Use the *Missouri Grazing Manual* (M157) available from the University of Missouri Extension as a reference.

G. ***Conclusion***

Forage producers have several methods of grazing their pastures. It could be with conventional grazing with a large herd on one large unit of land or the grazing area could be divided into smaller, separate pastures or paddocks for a managed grazing program. The producer must understand how these grazing systems are different and plan for these differences to maximize the use of the forages available to the animals.

H. ***Answer to Activity Sheet***

$$\frac{7200 \times .60}{.03 \times 179} = \frac{4320}{5.37} = 804.47 \text{ pounds of liveweight/acre}$$

I. ***Answers to Evaluation***

1. Continuous - Grazing the herd in one large pasture with a central water source.
   Rotational - Dividing the large pasture into two to seven smaller units and provide access to water source.
   Management intensive grazing - Dividing the large pasture into eight or more smaller units and providing access to the water source.

2. (a) Supplied by a pond or water tank in the continuous grazing system,
   (b) Allow animals access to the water source through an alleyway from the smaller pastures in a rotational or management intensive grazing system,
   (c) Run water lines and provide water tanks in the individual paddocks in a management intensive grazing system.

3. Annual forage production, seasonal utilization rate, average daily intake, and the length of the plant growing season.

4. Any two of the following: size of the pasture, forage density, and/or animal size (weight).
5. c
6. b

UNIT IX - FORAGE PRODUCTION Name _____

Lesson 5: Selecting a Grazing System Date _____

EVALUATION

Complete the following short answer questions.

1. List and define the three basic grazing systems used in Missouri.

   a.

   b.

   c.

2. Explain three ways that water may be made available to animals on different grazing systems.

   a.

   b.

   c.

3. List the four factors used to determine the carrying capacity of a grazing system.

   a.

   b.

   c.

   d.

4. What are two major factors that influence the number of cow-days of grazing on a given pasture?

   a.

   b.

Circle the letter that corresponds to the best answer.

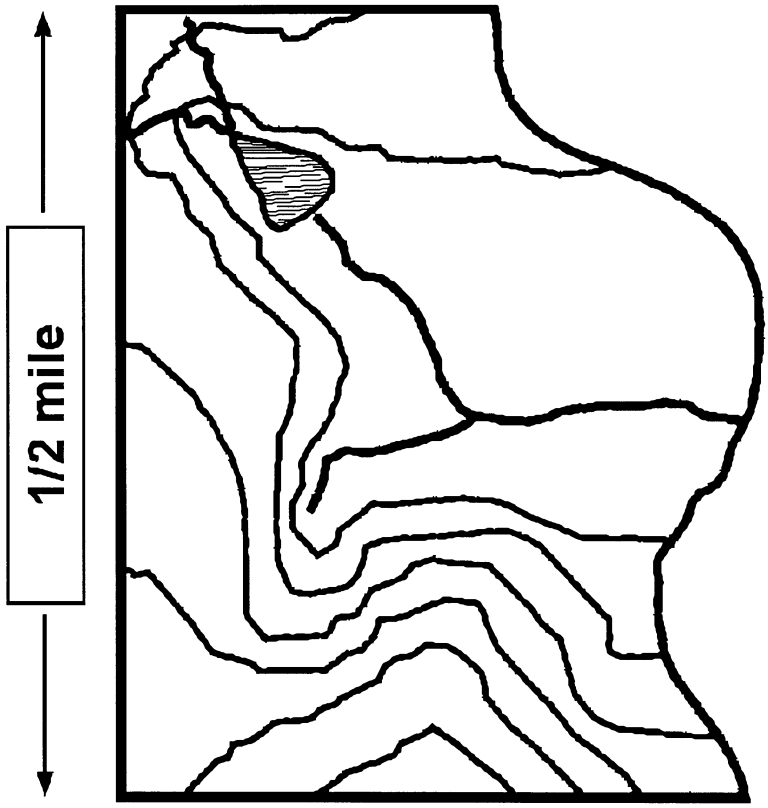
5. Animals that have water available in their individual grazing pasture and do not have to travel an alleyway to the water source drink about _____ percent more water on a daily basis.

   a. 5-10
   b. 10-15
   c. 15-20
   d. 25-30

6. A 1,000-pound lactating cow should eat about _____ pounds of forage per day.

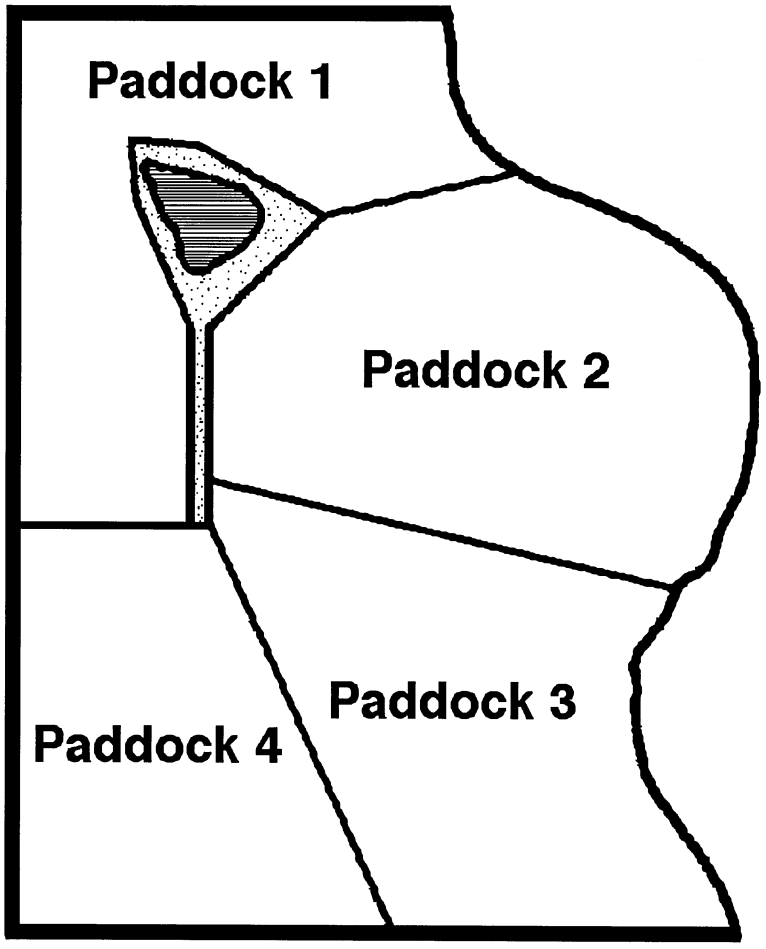
   a. 20
   b. 30
   c. 40
   d. 50

Basic 140-Acre Grazing Unit



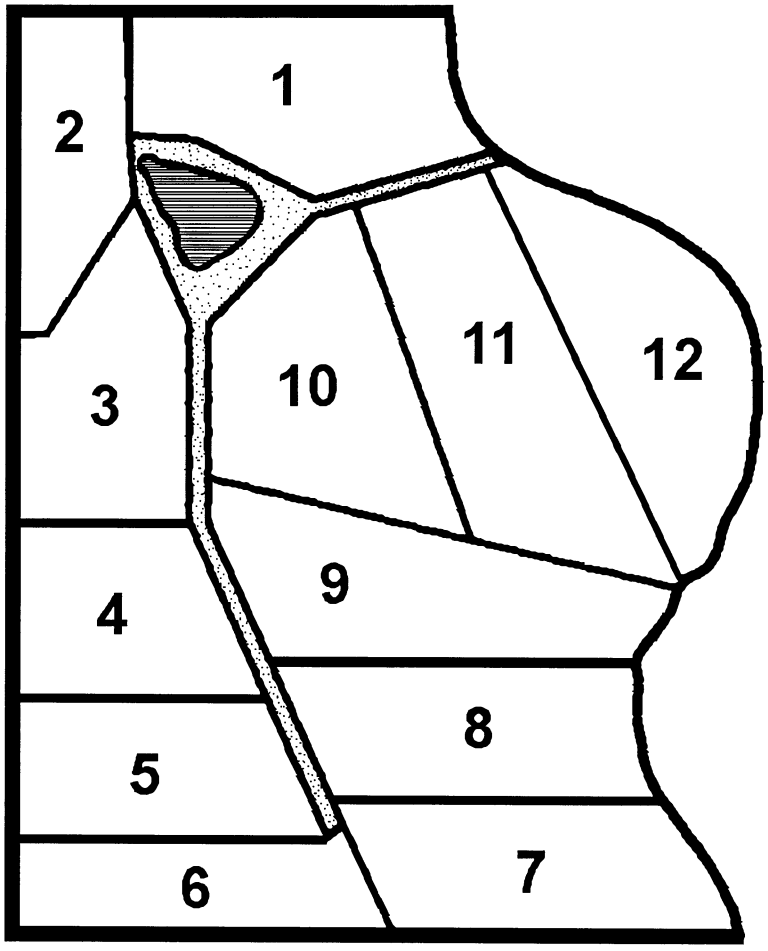
TM 5.2

Simple 4-Paddock Rotational Grazing System



TM 5.3

12-Paddock Intensive Grazing System



Lesson 5: Selecting a Grazing System Name_____

Determining Carrying Capacity

Objective: Students will be able to determine the number of animals that may be supported by an acre of forage.

Directions: Read the information given in the scenario. Use the formula given in the Student Reference and determine the carrying capacity (pounds of liveweight/acre) for a given pasture.

The producer has a forage pasture that will produce about 7200 pounds of forage annually. Our planned grazing period will be 15 days in length, yielding a seasonal utilization rate of 60 percent (see Figure 5.4 in the Student Reference). The livestock will be steers gaining 1.5-2.0 lb./head/day; therefore, their intake is entered at 3 percent of bodyweight or .03 lb. of forage/lb. of liveweight. We anticipate grazing the steers from April 15 to October 10, or a total of 179 days.

The carrying capacity for an acre of this forage will be _____.
(Show work below)

UNIT IX - FORAGE PRODUCTION

Lesson 6: Harvesting for Seed

Competency/Objective: Identify the principles for producing forage seed.

Study Questions

1. **What are the factors to consider for producing forage seed?**
2. **What additional costs are incurred in producing forage seed?**
3. **What are additional management factors to consider when producing forage seed?**
4. **What are the factors to consider for harvesting forage seed?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. Activity Sheet
   a) AS 6.1: Forage Seed and Plant Identification

UNIT IX - FORAGE PRODUCTION

Lesson 6: Harvesting for Seed

TEACHING PROCEDURES

A. ***Review***

Forages used in pasture and feed systems originate through the production of forage seed. Most seed is produced in the western United States, although native grasses tend to be produced in local areas. Seed production is a precise science that requires specific management practices.

B. ***Motivation***

If there is a local seed processing mill, ask a representative to come and speak to the students about the types of forage seed produced in your area. If there are no seed processing mills nearby, have the students do research on the Internet to locate places in the state or country and/or companies that process seeds.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the basic factors that a producer must consider when producing forage seed. Have students complete AS 6.1.

   What are the factors to consider for producing forage seed?

   a) Environmental conditions
      1) Seed crops grown in areas other than where they are used
      2) Important to know the following environmental conditions of the place where the forage is to be used:
         (a) Photoperiod - the daily amount of time plants are exposed to light
         (b) Season temperatures
         (c) Average amount and occurrence of rainfall
   b) Cultivar physiology
      1) Producers must be aware of the selected variety's reproductive needs.
      2) Care must be taken to match cultivars to the region of production.
   c) Available market - determined by the location of seed processing mills
      1) If nearby, a market exists for producers.
      2) If some distance away, costs incurred may be too high to attain a profit.
   d) Additional considerations
      1) Intended use of the forage after harvest
      2) Value of the forage crop versus the seed crop

2. Ask the students what additional costs may be incurred to produce forage seed. List their ideas on the board and discuss them.

   What additional costs are incurred in producing forage seed?

   a) All costs must be considered to see if an acceptable return is to be achieved.
   b) Forage seed production incurs more costs than hay and pasture production.

2) Input costs - more expensive costs incurred from fertilizers, irrigation, herbicides, insecticides, and labor
3) Machinery costs - increased due to need for specialized equipment
4) Specialized storage - silos and bins necessary to keep seed at proper humidity
5) Transportation - costly depending on location of nearest market

3. Discuss management factors to consider when producing forage seed. These include crop establishment plan, fertilizer, soil and water management, pollination management, and pest management. Discuss the costs that are involved with these additional factors.

What are additional management factors to consider when producing forage seed?

a) Fertilizer
   1) Grasses
      (a) Nitrogen important
      (b) Application dependent on growth habit of plant
         (1) Warm season - one application in early summer
         (2) Cool season - one in spring and one in fall
      (c) Amount influenced by:
         (1) Current soil fertility
         (2) Age of plant - more needed when older
   2) Legumes
      (a) Should be inoculated with nitrogen-fixing rhizobia
      (b) Require phosphorus (P), potassium (K), and calcium (Ca) for proper growth
b) Pest management
   1) Weeds
      (a) Compete with forage plants for soil and water resources
      (b) Become established because of open areas due to row planting
      (c) Control methods
         (1) Hand pulling (roguing)
         (2) Mechanical control
         (3) Chemical control
         (4) Biological control
      (d) Decrease overall seed quality grade
   2) Insects
      (a) Affect crop yield
         (1) Some attack foliage.
         (2) Some attack flowers of forage.
      (b) More problematic in legumes than grasses
      (c) Control methods
         (1) Manipulate environment
            a. Rotating crops
            b. Planting varieties resistant to pests
         (2) Insecticide/chemical agents
         (3) Biological agents
   3) Diseases
      (a) To avoid, select cultivars resistant to disease.
      (b) Treat with fungicides.
      (c) Closely monitor to detect potential problems.

4. Discuss methods to harvest forage seed and the advantages and disadvantages of each method.

What are the methods for harvesting forage seed?

a) Direct combining
   1) Requires seed to be at or near maturity
   2) Tends to have higher losses due to shattering

3) Lower cost - one trip over field
4) No chance for seed sprouting

b) Swathing
1) Done when seed heads are light green to yellow
2) Allowed to cure in the field before combining
3) Increases seed yields
4) Cut high off the ground
5) Higher cost - more trips across field
6) Chance of sprouting damage

F. ***Conclusion***

Raising and harvesting forage seed is a precise science. The producer must consider environmental factors, forage species and specific cultivars, plant genetics, and manage for numerous pests.

G. ***Answers to Activity Sheet***

Answers will vary.

H. ***Answers to Evaluation***

1. Answers should include the following:
   a) Environmental conditions
   b) Cultivar physiology
   c) Available market
2. Any three of the following costs:
   a) Management
   b) Input
   c) Machinery
   d) Specialized storage
   e) Transportation
3. Fertilizer and pest management
4. Swathed

UNIT IX - FORAGE PRODUCTION Name _____

Lesson 6: Harvesting for Seed Date _____

EVALUATION

Complete the following short answer questions.

1. Identify three factors to consider for producing forage seed.

   a.

   b.

   c.

2. List three costs incurred in producing forage seed.

   a.

   b.

   c.

3. List management factors to consider when producing forage seed.

   a.

   b.

4. When combining forage seed, it can be directly combined or _____.

Lesson 6: Harvesting for Seed Name _____

Forage Seed and Plant Identification

Objective: Students will be able to identify major forage seeds and forage plants in their area.

Directions: Collect five of the most important forage plants in your local area and their seeds. Using a piece of 8 1/2 x 11 white paper, place as much of the top portion of each plant on the paper as well as 10 to 15 of the forage's seeds in the lower right corner. Larger sheets of white poster paper may also be used.

Label the bottom of each page with the common plant name and laminate the entire page. Try to include as much of the vegetative and seed producing portion of the plant as possible. List each forage below and place a check mark in the appropriate column when completing the collection of the plant and seed.

Plant Name	Seed	Vegetative Plant
1.		
2.		
3.		
4.		
5.		

UNIT IX - FORAGE PRODUCTION

Lesson 7: Harvesting for Feed

Competency/Objective: Identify the principles for harvesting and storing forages for feed.

Study Questions

1. **What factors determine harvest timing?**
2. **What factors affect forage quality at or during harvesting?**
3. **What are the advantages and disadvantages of various harvesting methods?**
4. **What forage quality factors are affected during storage?**
5. **What are the advantages and disadvantages of various storage methods?**
6. **What methods are used to enhance poor quality forage?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. Activity Sheet
    a) AS 7.1: Testing Forages for Moisture Content

UNIT IX - FORAGE PRODUCTION

Lesson 7: Harvesting for Feed

TEACHING PROCEDURES

A. ***Review***

The importance of seed production to develop high-quality forages for use in livestock production was previously discussed. This lesson will focus upon proper harvesting of those forages.

B. ***Motivation***

Bring in samples of harvested forages (hay or silage). Make sure the samples are a sampling of good, fair, and poor quality. Have students visually evaluate the samples and suggest explanations for the differences in quality.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. One of the most critical factors in determining the quality of harvested forages is that of harvest timing. Discuss with the students the factors that determine the best time to harvest.

   What factors determine harvest timing?

   a) Stage of maturity
      1) Harvest based upon vegetative and seed productive stages of the plant
      2) Harvest occurring at the onset of the reproductive stage
         (a) Plant should be actively growing vegetatively.
         (b) Plant should not be expending energy toward reproductive growth.
      3) Recommended stages of maturity for harvest
         (a) Alfalfa - bud to 1/10th bloom (1 in every 10 buds is in bloom)
         (b) Red clover - 1/4 to 1/2 bloom
         (c) Timothy - Late boot stage (inflorescence enclosed within the sheath of the uppermost leaf)
         (d) Bromegrass - seed heads emerged
         (e) Orchardgrass - blooms emerged
         (f) Reed canarygrass - seed heads emerged
         (g) Tall fescue - boot stage
         (h) Grass/legume mixes
            (1) Harvest at the desired stage of the legumes' growth regardless of the grass.
            (2) Legumes are higher in nutrient value, so increased awareness is placed upon them in a mixture.
   b) Weather patterns - for optimum forage harvest, should be dry and warm
      1) Minimum of 3 days of dry weather is needed from cutting to baling.
      2) Humidity increases the length of drying time.
      3) Warm breezes and sunshine will shorten the days required to dry.
      4) Silage and haylage will not require as long to dry down to storable moisture content.

2. Losses in nutrient quality are found in forage crops harvested only 10 days past prime harvest. Therefore it is critical to time harvesting operations to meet this crucial stage of growth. Discuss the forage quality factors for harvesting. Have students complete AS 7.1

What factors affect forage quality at or during harvesting?

a) Growth stage
   1) Harvested **after** the prime growth stage
      (a) Drop in total digestible nutrients (TDN)
      (b) Decrease in protein content and other available nutrients
   2) Harvested **before** the prime growth stage
      (a) Reduced quantity of forage harvested
      (b) Nutrient storage in leaves and stems not maximized
b) Mechanical damage
   1) Dry matter losses occur during raking and baling processes
   2) Primarily affect leaves (highest quality part of the plants)
c) Climatic losses
   1) Rain - Downed hay (cut hay prior to baling and storing) is susceptible to nutrient losses from leaching.
   2) Sun - Hay left down for too long can experience significant losses from blanching (the bleaching away of nutrients from the leaf and stem of the plant).
d) Moisture content
   1) Harvest plants continue to respire after cutting, losing up to 60 percent moisture.
      (a) Dry matter (DM) loses up to 15%.
      (b) DM loss averages 5 to 6%.
      (c) Losses are nonrecoverable.
   2) Hay should be baled between 18 to 22% moisture content.
      (a) Hay is safe for storage inside at 15 to 18% moisture content.
      (b) Moisture levels higher than 22% lead to dry matter and quality loss due to heating and molding of the hay.
   3) Forage is ensiled two ways.
      (a) Haylage - Forage is stored at 40 to 50% moisture.
      (b) Silage - Forage is stored at 60 to 65% moisture.
      (c) Most green chop forages (grasses and legumes) are stored typically as haylage.

3. Ask students to discuss methods of harvesting forages they have observed or been involved with. Have them discuss the advantages and disadvantages of those methods.

What are the advantages and disadvantages of various harvesting methods?

a) Mowing - cutting off plants about 3 to 6 inches above the ground level
   1) If a plant is harvested below 3 inches, the plant is weakened by removing valuable leaf tissue necessary for regrowth.
   2) Plants cut over 6 inches do not maximize the amount of forage harvested.
b) Conditioning - method to speed up the drying process
   1) Mechanical
      (a) Roller system that crushes the plant stems
      (b) More surface area exposed to evaporation and drying
      (c) Advantages
         (1) Effectively crushes coarse plant stems, opening more surface area to moisture loss
         (2) Effectively increases drying rate by up to 80 percent in first cuttings
      (d) Disadvantages
         (1) Slight loss in dry matter may occur.
         (2) Finer stemmed plants may slide through rollers without being crushed, thus voiding effects of conditioning.
   2) Chemical
      (a) Removes waxy coating on plants so moisture can escape easily
      (b) Applied at the time of mowing; primarily used with alfalfa

(c) Advantages
(1) Efficient with legume crops
(2) Increases drying rates in second and third cuttings
(d) Disadvantages
(1) Additional equipment needed to apply chemical during cutting
(2) Does not work well with grasses

c) Mower conditioner - mowing and conditioning process in one machine
1) Advantages
(a) Less damage to forage due to single cutting/crimping process
(b) Fewer trips across field saving on fuel, maintenance, and labor costs
2) Disadvantage -
(a) Rollers adjusted incorrectly - great losses in dry matter
(b) More costly than a mower

d) Swath manipulation - mechanical turning or spreading of forage to enhance even drying
1) Raking - hay crop mechanically inverted into tight windrows
(a) Advantages
(1) Efficiently inverts and fluffs windrows for drying
(2) Rolls windrows for better pickup with the baler
(b) Disadvantages
(1) If crop is thick, wet sections in the middle may not dry completely.
(2) There is loss of dry matter, especially leaves in legumes.
2) Swath inversion - (similar to raking) mowed swath moved on belts and inverted with the bottom moving to the top and the top to bottom
(a) Advantages
(1) Gentler method, does not "beat" hay during pickup, knocking leaves off of legumes
(2) Inverts and fluffs windrows
(b) Disadvantage - not as efficient as tedding in drying time
3) Tedding - a machine with rotating tines that stirs, spreads, and fluffs the hay
(a) Advantages
(1) Allows for uniform drying by spreading out the hay
(2) Spreads swaths and may decrease drying time by up to 2 days
(b) Disadvantages
(1) Beating action is more damaging to legumes with fragile leaf structures.
(2) Leaf loss leads to nutritional loss.

e) Baling
1) Rectangular bales
(a) Common size - 14 x 18 x 48-50 inches; weighing between 80 and 120 pounds
(1) Advantages
a. Ease of handling in stacking and feeding
b. Easier in transportation and marketing operations
(2) Disadvantages
a. More labor intensive in hauling and stacking
b. Indoor storage needed to maintain highest quality
(b) Large, high density bales - sizes ranging from 24 to 50 inches wide and tall by 48 to 98 inches long; weighing 440 to 2000 pounds
(1) Advantage - harvested and transported more efficiently
(2) Disadvantages
a. More specialized equipment is needed for harvest and feeding, which increases the cost.
b. Wind damage can occur if bales are not covered.
2) Round bales - typically used for on-farm use; sizes range from 36 to 72 inches in diameter, 48 to 64 inches in length; weighing 440 to 2000 pounds
(a) Advantages
(1) Less labor intensive than small rectangular bales
(2) Can be stored outside in convenient locations for consumption
(b) Disadvantages

(1) Not easily transported or stored indoors
(2) Can lose nutritional value with extended outside storage unless wrapped or bagged
(3) Disposal of used plastic wrap or bags can create environmental concern

f) Silage chopping - forage harvester used to chop the crop
1) Advantage - Less labor required than hay harvest
2) Disadvantages
(a) Losses can occur from drift between the blower and the trailing vehicle
(b) More power to operate equipment

4. Ask students what factors they believe are important to storage quality. Discuss how the moisture content and nutritional quality affect overall profitability.

What forage quality factors are affected during storage?

a) Moisture content
1) Levels more than 22% in baled hay lead to dry matter and quality loss from heating and molding.
2) Levels below 40% in haylage decrease the anaerobic fermentation processes.
3) Levels over 50% can lead to spoilage in ensiled forage.

b) Nutritional quality
1) Maintained for approximately 1 year without noticeable losses if properly stored
2) Decreasing dry matter as more drying occurs, thus reducing some nutritional value
3) Forages stored outside or without protection from the elements
(a) Subject to greater losses from nutrients being leached out from rain
(b) Losses resulting from mold and spoilage

5. Have students once again refer to the samples brought in for the motivation exercise. Ask them if storage could have affected the quality of the samples.

What are the advantages and disadvantages of various storage methods?

a) Inside storage - rectangular baled hay typically stored in livestock barns or specialized pole hay barns at 18 to 20% moisture
1) Advantages
(a) Less exposure to weather; maintains higher quality longer
(b) May be more accessible for feeding (in livestock barns or during bad weather)
2) Disadvantages
(a) More labor intensive
(b) Increased costs for buildings, labor, and maintenance
(c) Wet hay
(1) Experiences loss from microbial activity, spoilage, and mold
(2) Could cause fire from internal heating

b) Outside storage - baled hay
1) Round bales stored outside due to size and handling needs; rectangular bales, outside
2) Advantages
(a) Less labor intensive
(b) Does not require the capital outlay of barns
3) Disadvantages
(a) Additional protection requiring specialized equipment
(1) Round bales should be wrapped with a protective plastic covering.
(2) All bales should be tarped to be protected from the weather.
(3) Gravel, old tires, etc. must be placed on the ground to protect the hay from spoilage and loss due to soil contact.
(b) More difficult to move; requires specialized equipment

(c) Expensive to move long distances
(d) Nutritional value lost quicker due to exposure to weather

c) Methods of storing silage and haylage
1) Tower silos
(a) Constructed of concrete or steel
(b) Range in capacity from 50 to 4000 tons
(c) Storing crops at 50 to 65% moisture
(d) Weight of the silage packing forage to reduce trapped air
(e) Advantages
(1) Good maintenance of forage quality
(2) Protection from weather
(3) Take up less ground space than other options
(4) Easily adaptable to automated feeding equipment
(f) Disadvantages
(1) Some loss to spoilage at top of silo
(2) Inconvenient to load/unload; requires some labor inside of silo
(3) Gas buildup
(4) Higher cost
2) Silage bunkers
(a) Usually made of concrete, with concrete floor and sidewalls
(b) Sidewalls vary from 10 to 20 feet high
(c) Storing crops between 50 to 75% moisture
(d) Forage packing by tractor to reduce trapped air
(e) Unloading by a front-end loader or tractor
(f) Advantages
(1) Economical
(2) Easy to store and remove forage for feeding
(g) Disadvantages
(1) Typically not protected from environment, unless covered with plastic, which adds additional cost to storage
(2) Does not allow for fermentation as well as other storage methods
3) Silage bags
(a) Made of plastic that encloses the forage
(b) Average bag size - 150-200 feet long and approximately 9 feet in diameter
(c) Often used as short-term method of storage
(d) Front-end loader or tractor needed for unloading
(e) Advantages
(1) Does not require permanent structures
(2) Different types and qualities of forages can be stored separately
(f) Disadvantages
(1) They take up more storage space than tower silo.
(2) Specialized equipment is required for bagging forage.
(3) Bags must be maintained to minimize damage.
(4) Spoilage can reach 50%.
(5) Additional labor is required to dispose of bags and plastic remnants.

6. To improve lower quality forages, the producer must understand what constitutes quality forage and how quality can be improved.

What methods are used to enhance poor quality forage?

a) Quality forage is defined in terms of the value of pasture grasses and legumes for grazing animals.
1) Forage quality is described in terms of protein, fiber, and other components.
2) High-quality forage is one with high protein and low fiber.
b) Three major factors affect the quality of forage.
1) Plant species - Legumes are higher in quality than grasses.

2) Plant maturity - As plants becomes mature, the leafy vegetative stage changes into more stems, resulting in lower protein and higher fiber.
3) Plant part - The leaves are more nutritious than the stems. Raking and baling techniques may save leaves, increasing its value.

c) Other factors that affect quality are climate and biological stress.
1) Cooler temperatures result in lower fiber concentrations yielding higher digestibility.
2) Diseases and insects usually cause leaf loss and lower nutritive value.

d) Stored forage value can be increased.
1) Cover or wrap bales and place inside a facility to decrease nutrient loss due to expose to sun and moisture.
2) Inject anhydrous ammonia into the bale to break down lignin and increase digestibility. This also neutralizes the toxic effect of some compounds in the plant and increases daily gain.

F. ***Other Activities***

1. Have the students determine the ground space requirements of storage methods for silage and haylage. Information for space requirements for tower silos, bunkers, and bags can be found on the Crop Storage Insititue's web page at <http://www.cropstorage.com/home.html>.

2. Use the evaluation score card hay from contests and have the students evaluate different samples of hay.

G. ***Conclusion***

Although it is important to have high-quality forages from good seedstock, this will not matter if the forage is not properly harvested and stored. For maximization of harvested forages, the producer must know at what point harvesting should occur, use those methods for harvesting that will maximize resources while decreasing drying time, and store the forages for maximum retention of quality and nutrition.

H. ***Answers to Activity Sheet***

Answers will vary.

I. ***Answers to Evaluation***

1. b
2. e
3. f
4. d
5. a
6. d
7. c
8. Primary growth stage; mechanical damage; climatic losses; moisture content
9. It is gentler and does not damage legume leaves as much
10. 22
11. 1 year
12. Outside
13. Tower silos
14. Reduce trapped air
15. Plant species, plant maturity, and plant part
16. Lower temperatures will promote vegetative leaf growth, reducing fiber, increasing digestibility. Insects and diseases cause leaf loss, lowering the nutritive value of forages.

17. Ammoniation is the process of injecting anhydrous ammonia into the bale of hay. The hay should be covered with a wrap or tarp when this process is done. The ammonia helps break down the fiber, increasing digestibility and reducing toxic compound effects.

UNIT IX - FORAGE PRODUCTION Name_____

Lesson 7: Harvesting for Feed Date_____

EVALUATION

Match the following forages to the ideal stage of maturity for harvest.
(Answers may be used more than once.)

_____ 1.	Alfalfa	a.	Blooms emerged
_____ 2.	Red clover	b.	Bud to 1/10th bloom
_____ 3.	Timothy	c.	Boot stage
_____ 4.	Bromegrass	d.	Seed heads emerged
_____ 5.	Orchardgrass	e.	¼ to ½ bloom
_____ 6.	Reed canarygrass	f.	Late boot stage
_____ 7.	Tall fescue		

Answer the following short answer questions.

8. What are the four factors that affect forage quality at harvesting?

   a.

   b.

   c.

   d.

9. Why is swath inversion preferred over raking?

10. Moisture levels over _____ % in baled hay lead to dry matter and quality loss.

11. Nutritional values of properly stored forges will be maintained for approximately _____ without noticeable losses.

12. Is nutritional value lost quicker in baled hay that is stored inside or outside?

13. Which method of storage for silage or haylage provides the best protection from the weather?

14. Packing the forage in silage bunkers is usually done by a tractor to _____ _____.

15. What are the three major plant factors that affect the quality of forages?

    a.

    b.

    c.

16. Explain how climate and biological factors may affect forage quality.

17. Explain what is meant by "ammoniation" of forages and its value to forages.

Lesson 7: Harvesting for Feed Name _____

Testing Forage for Moisture Content

Objective: Students will be able to test forage samples for moisture content

Materials:

Small scale (grams)
Paper plate
Glass or jar
Microwave oven
Forage samples

Directions:

1. Weigh paper plate and record weight.
2. Place 100 grams of selected forage (fresh cut, haylage, silage) on the plate and scale.
3. Spread out the forage evenly on the plate.
4. Fill the glass or jar 3/4 full with water.
5. Place the glass in the back corner of the microwave. (NOTE: Keep water level constant during testing.)
6. Set the microwave to 80 to 90% power.
7. Place the forage sample in the microwave and heat for 8 minutes.
8. Remove the sample, weigh, and record the weight, then mix the sample.
9. Check water level, then place sample in microwave and dry for 2 minutes.
10. Remove the sample and check weight. If the weight has not changed by more than 1 gram, record weight as dry weight. If there is a change of greater than 1 gram, repeat step 9 until a change of less than 1 gram is obtained.
11. Use the following calculation to determine percent moisture (remember to subtract weight of plate): percent moisture = (wet weight) - (dry weight)/wet weight * 100
12. Record sample percent moisture.

UNIT IX - FORAGE PRODUCTION

Lesson 8 : Marketing the Crop and Figuring Crop Costs

Competency/Objective: Describe marketing opportunities and calculating cost per acre.

Study Questions

1. **What forage marketing options are available locally?**
2. **What effect does forage quality have on price?**
3. **What are the variable and fixed costs associated with forage production?**
4. **How are the costs per acre of forage production calculated?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. Activity Sheet
    a) AS 8.1: Figuring Crop Costs

UNIT IX - FORAGE PRODUCTION

Lesson 8: Marketing the Crop and Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

The previous lesson identified factors that are important in harvesting and storage techniques to help ensure the highest quality forage is available for the producer. Methods of enhancing forage of lesser quality were also discussed. This lesson will complete the forage unit with information about securing the highest value for the producer.

B. ***Motivation***

Obtain several samples of forage (alfalfa hay would be a good example) to exhibit different levels of quality. Have the students examine the differences in quality and explain which one would command the higher price and why.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask the students to develop a list of marketing option for forages. What would they do with 100 extra bales of good quality hay they may have on hand?

   What forage marketing options are available locally?

   a) Two basic ways for the crop producer to market forages
      1) Feed to animals and produce meat and milk
      2) Sell to a buyer
   b) Marketing options for forages
      1) Quality-tested hay auctions - common in states such as Wisconsin and California where forage plays a major role in the state's economy
      2) Tele-auctions
         (a) Hay is sold through a bidding process using conference calling.
         (b) Buyers know the quality and amount of hay they are bidding on without seeing the forage.
         (c) Shipment is made from the seller to the buyer.
      3) Computer posting
         (a) Joint venture between Missouri Department of Agriculture and the University of Missouri-Columbia to market hay through web site <http://www.agebb.missouri.edu>.
         (b) Web site lists seller names, cities, counties, and phone numbers.
         (c) Information on the web site includes bale type, number of bales, and approximate weight.
         (d) Additional information includes whether the hay has been analyzed, its crude protein, acid detergent fiber (ADF), relative feed value, and percent total digestible nutrients.
         (e) Notes may list information such as "first cutting" or times to contact.
         (f) Listings are left on the web site for 60 days unless updated.
      4) Hay dealers
         (a) Hay is purchased from the producer and then it is transported to another area for resale.

(b) Dealers are called entrepreneurs or speculators and buy hay at a lower price to resell at a higher price.

5) Neighbor-to-neighbor
   (a) Forage in the local area
   (b) Quality and amount of forage viewed before buying
   (c) Transported directly from the field to the buyer

2. Experienced forage producers can easily recognize the quality of forage and determine an appropriate price. Discuss with the students how to recognize quality forage and how the forage quality is determined.

What effect does forage quality have on price?

a) Quality plays a major role in the pricing of forages.
b) Quality factors are as important when purchasing hay as when producing it.
c) Visual appraisal can be deceiving when buying hay.
d) Market hay grades are based on forage quality and reflect species, composition, and maturity.
e) Legumes tend to grade highest, followed by legume/grasses, grasses, and finally heavily weathered forages.
f) Sellers who want the highest price should provide some comprehensive information to the buyer.
   1) Color
   2) Odor
   3) Mold
   4) Heating
   5) Mixture
   6) Dust
   7) Foreign material
g) Forages used to be evaluated strictly on the proximate analysis or crude fiber system.
h) More recently, detergent analysis systems provide better estimates.
   1) Acid detergent fiber (ADF)
   2) Neutral detergent fiber (NDF)
i) Detergent systems measure basic components of the plant and relate these to the animal's digestion and production.
j) Mobile near infrared reflective spectroscopy (NIRS) vans permit on-site testing of hay.
k) Samples can also be sent to testing labs for analysis. (Livestock Nutrition Laboratory, P.O. Box 1655, Columbia, Missouri, 65201.)

3. Ask students if they can give you an idea of how much it would cost to produce a ton of hay. Producers must know their input costs to be able to price hay and make a profit or reasonable return for their labor. Refer to the tables of average Missouri costs in the Student Reference.

What are the variable and fixed costs associated with forage production?

a) Variable costs are those costs that may change each year depending on the level of forage production.
b) Variable costs are also known as operating costs.
c) Fixed costs are expenses that are not affected by the level of production and will remain the same no matter how much forage was produced.
d) Fixed costs are also known as ownership costs.
e) The costs for different types of forages can be compared by using the MIR (mail-in-record) tables.

4. Refer students to the forage production costs on an acre basis demonstrated in Figure 8.1 using examples derived from the Missouri mail-in-record (MIR) system. Have students figure crop costs by completing AS 8.1.

How are the costs per acre of forage production calculated?

a) Costs per acre of forage production is calculated by adding the total variable costs (operating costs) and the total fixed costs (ownership costs) per acre.
b) Refer to the cost calculations earlier in this lesson for economic information for 1996, 1997, and 1998. Obtain current MIR analysis for up-to-date information.

F. ***Other Activity***

Have the students figure net returns by giving them some sample fixed and variable costs and a current market value for hay (per ton). Ask them to determine how many tons of hay they would have to produce and sell to make $10,000 net profit.

G. ***Conclusion***

The various methods of marketing forages must be understood by producers if they expect to make a reasonable return on their investment of capital and labor. The quality of the forage will be the most important factor to consider when determining the value or price to receive when selling what is produced. A chemical appraisal should be used along with a visual evaluation when determining quality. Producers must also know what the variable and fixed costs per acre of forage are to know what must be received as a seasonal return on their investment.

H. ***Answers to Activity Sheet***

	Cost/Acre	80 Acre Total Cost
Variable costs		
Seed	$ 1.75	$140.00
Fertilizer	10.90	872.00
Crop chemicals	2.35	188.00
Machinery fuel, oil, and repairs	11.50	920.00
Machinery hire	5.00	400.00
Labor costs	14.00	1,120.00
Taxes and insurance	1.50	120.00
Operating interest	2.50	200.00
Total operating costs	$ 49.50	$ 3,960.00
Fixed costs		
Machinery depreciation and interest	$ 14.30	$ 1,144.00
Land costs and interest	46.25	3,700.00
Total ownership costs	$ 60.55	$4,844.00
Total all costs	$110.15	$8,812.00

Gross receipts: 200 tons of forage x $60/ton = $12,000.00
Net receipts: $12,000 (gross receipts) - $8,812.00 (total cost of production) = $44.06/ton
Break-even price: $44.06/ton ($8,812 divided by 200 ton)

I. ***Answers to Evaluation***

1. b
2. c
3. d
4. Variable costs will change with levels of production. An example would be seed, chemical, and machinery costs. These costs are also known as operational costs.
   Fixed costs will remain the same per acre no matter what the level of production. An example would be the machinery depreciation cost/acre. These costs are also known as ownership costs.

5. Any four of the following: seller name, phone number, city, county, number of bales, types of bales, type of hay species, additional notes or comments such as "first cutting" or "do not call before 6 p.m."

UNIT IX - FORAGE PRODUCTION Name _____

Lesson 8: Marketing the Crop and Figuring Crop Costs Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following states would be most likely to market forages through a quality-tested hay auction process?

   a. Illinois
   b. Wisconsin
   c. Tennessee
   d. Colorado

2. Which method of hay sales would be the most commonly used in Missouri?

   a. Computer posting
   b. Tele-auctions
   c. Private treaty
   d. Buying from hay dealers

3. The type of forage that would most likely grade highest and receive the best price would be _____.

   a. Grass hay
   b. Legume/grass hay
   c. Heavily weathered forages
   d. Legume hay

Complete the following short answer questions.

4. Explain the difference between variable and fixed costs.

5. List four items of information that would most likely be posted with a computer-advertised hay sale.

   a.

   b.

   c.

   d.

Lesson 8: Marketing the Crop and Figuring Crop Costs Name _____

Figuring Crop Costs

Objective: Students will determine the total cost of production and net returns for a forage.

Directions: As a forage producer, you have an 80-acre piece land that is in grass hay. Figure the individual costs of the items below for the 80-acre forage. Also determine the gross receipts, net receipts, and the break-even price.

	Cost/Acre	80 Acre Total Cost
Variable costs		
Seed	$ 1.75	
Fertilizer	10.90	
Crop chemicals	2.35	
Machinery fuel, oil, and repairs	11.50	
Machinery hire	5.00	
Labor costs	14.00	
Taxes and insurance	1.50	
Operating interest	2.50	
Total operating costs	$ 49.50	
Fixed costs		
Machinery depreciation and interest	$ 14.30	
Land costs and interest	46.25	
Total ownership costs	$ 60.55	
Total all costs	$110.15	

If the 80 acres of grass forage produced 2.5 tons per acre and the producer sold the hay for $60 per ton, what would be the gross receipts for the hay and the net receipts for the 80 acres of production?

Gross receipts: _____ tons of forage x $60/ton = $_____

Net receipts: $_____ (gross receipts) - $_____ (total cost of production) = $_____/ton

What would be the break-even price per ton the producer must receive for the forage? $ _____