UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 1: Planning the Crop

Competency/Objective: Evaluate local growing conditions and determine fertilizer needs for wheat and small grain production.

Study Questions

1. **What environmental conditions are necessary for wheat and small grain production?**

2. **What factors are considered when evaluating field history?**

3. **What are the fertilizer requirements for wheat and small grains?**

References:

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

2. Transparency Masters

   a) TM 1.1: Production of Wheat in Missouri
   b) TM 1.2: Wheat Growing Regions in the United States

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

Although wheat and small grains, such as barley and oats, are not major crops in Missouri when compared to soybeans and corn, they do make a significant contribution to Missouri's agricultural economy. Refer to TM 1.1 to show wheat production statistics in Missouri. This lesson will examine the environmental conditions, the field history factors, and fertilization requirements for their growth.

B. ***Motivation***

Secure samples of hard red winter, hard red spring, soft red winter, and durum wheat along with barley and oats for students to identify. Ask them to also identify major uses of these grains.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Students should know what environmental conditions are necessary for the production of wheat and small grains. Refer to TM 1.2 to demonstrate areas of the country where wheat is planted.

   What environmental conditions are necessary for wheat and small grain production?

   a) Growing season
      1) Wheat and small grains are cool-season crops but resist both cold and hot weather.
      2) They can endure freezing temperatures in winter, late frosts in spring, high temperatures in summer, and droughts.
      3) Because of their winter growth habit, wheat and small grains in Missouri are planted in the fall, become established before winter, and "green up" and continue to grow in the spring.
      4) These crops need the cold to joint and flower.
      5) Their extended root systems enable the plants to obtain moisture from deep in the soil during times of drought, adapting to Missouri conditions.
      6) The germinating embryo has a hormonal-controlled conversion from its juvenile stage, or vegetative growth stage, to its reproductive stage.
      7) Vernalization process ensures the growing point of the plant remains underground during winter temperatures, protecting itself from freezing and death.
         (a) Only leaves are produced aboveground, while the growing point and buds remain underground.
         (b) This growth habit is typical of grasses.
      8) Winter wheat
         (a) Optimum temperatures for growth is 70 to 77°F but can grow with temperatures as low as 37°F and as high as 90°F.
         (b) Wheat is planted in late September to early October in northern Missouri and by mid-October in southern Missouri.
         (c) Planting should be delayed until after the "fly-free" (Hessian fly) date, which ranges from Sept. 28 at the Iowa line to Oct. 17 at the Arkansas line.
      9) Spring wheat - rarely used in Missouri due to hardiness of winter varieties
      10) Oats
         (a) Shorter growing season than other grains
         (b) Adapted to cooler climates, therefore doing better in northern Missouri

(c) Most planted in the spring in Missouri

11) Winter barley
   (a) Similar temperature requirements as wheat
   (b) Less winter hardy than wheat and should be planted earlier
   (c) Not usually planted north of Highway 36 in Missouri
   (d) If for pasture - early planting in central and southern Missouri
   (e) If harvested for feed - later planting to avoid barley yellow dwarf virus (BYDV) injury

12) Spring barley - rarely used in Missouri due to hardiness of winter varieties

b) Rainfall
   1) Wheat and small grains have the ability to resist drought to overcome moisture stress.
   2) Most growth occurs during the fall and spring when moisture is more plentiful.
   3) Late planting will limit fall growth when moisture is available.

c) Soil type and typography
   1) Grains grow on a wide range of soil types but must be well-drained soils.
   2) Major losses occur from standing water.
   3) Soil depressions from combines, grain carts, and tractors may cause places for water to stand, limiting yields.
   4) Wheat and small grains cannot stand "wet feet."
   5) Best soil types are loams and clay loams.

2. It is important to know what cropping and cultural practices were performed on a given field when determining if wheat or other small grains are being considered for planting. Discuss the factors to consider when evaluating field history.

What factors are considered when evaluating field history?

a) Most recent crop grown on that field
   1) Producers can determine what type and amount of fertilizer is needed for the new crop.
   2) Insight is provided as to nutrients that may be available such as additional nitrogen following a soybean crop.

b) Tillage history and/or planting methods
   1) Project what pest problems may appear or need to be addressed.
   2) Include history of herbicide and pesticide use.
   3) Erosion problems may call for a no-till planting method.

3. Adequate nutrients must be available for optimum yields. Producers need to know that N, P, and K are the most needed nutrients to be addressed. Soil tests should be taken, interpreted, and recommendations followed.

What are the fertilizer requirements for wheat and small grain?

a) Lime
   1) Should not be overlooked
   2) Needed in areas of high soil acidity (low pH levels)
   3) Oats - tolerate lower pH levels

b) Nitrogen
   1) This element is the most frequently lacking for optimum wheat production.
   2) Nitrogen levels will vary depending on organic matter, soil texture, and carryover from previous crop.
   3) Take soil samples after July 1 for fertilizer applied before fall planting.
   4) Take soil samples after November 1 for topdressing of nitrogen done in the spring.
   5) Each 1% of organic matter supplies 8-12 pounds of nitrogen per acre.
   6) A previous soybean crop can supply as much as 20-40 pounds of nitrogen per acre.
   7) Nitrogen fertilization should be regulated closely.
      (a) Excessive nitrogen can cause increased lodging.

(b) Too much starter nitrogen may cause excessive vegetative growth and delay winter dormancy stage. This can cause winter injury and reduce winter survival.

(c) Too much nitrogen can accumulate in foliage, and when pastured it can be toxic to livestock.

8) Spring topdressing is the recommended time of application for fall-seeded small grains.

c) Phosphorus

1) Wheat and small grains respond well to applications of phosphorus when soil tests indicate its need.
2) Phosphorus is important to root growth.
3) Oats can tolerate poorer conditions than wheat and barley as far as phosphorus levels.
4) Unless adequate root development takes place, plants may be lost to heavage (plants being lifted out of the soil and exposed to winter injury).
5) Phosphorus may be broadcast and then incorporated, injected preplant, or banded at planting.
6) Banding or injecting is recognized as being more efficient than broadcasting.
7) Combining nitrogen and phosphorus applications at planting time can save time and money.

d) Potassium

1) Wheat and small grains respond less to potassium applications than phosphorus.
2) Sandy soils are often low in potassium, requiring its addition to meet nutrient needs.
3) Potassium may be applied at planting time as a starter or broadcast and incorporated prior to planting.
4) Limit applications in direct contact with the seed to avoid germination damage.

e) Selection of nutrient sources should be based on cost, availability, and adaptability.

F. *Other Activities*

1. Discuss where the types of wheat are grown throughout the United States and the world and how it relates to the topography, soil conditions, etc., of that region.

2. Secure pictures of fertilization problems with wheat and small grains (lack of nitrogen, phosphorus, and potassium) for visual recognition of those problems.

G. *Conclusion*

Wheat and some other small grains such as barley and oats hold an important place in Missouri's agricultural production. For successful production of these grains, the producer must know the environmental conditions that would provide optimum conditions for acceptable yields. The producer must also know how and when to fertilize these grains.

H. *Answers to Evaluation*

1. c
2. b
3. a
4. c
5. Knowing the most recent crop and previous tillage and planting methods
6. September 28 at the Iowa line to October 17 at the Arkansas line.
7. The ability of a plant to have its growing point underground during the winter and until the advent of warmer temperatures in the spring

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 1: Planning the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. In 1999, Missouri ranked _____ among all states in the production of wheat.

   a. 5th
   b. 8th
   c. 11th
   d. 16th

2. For each 1% of organic matter in the soil, _____ pounds of nitrogen per acre may be available for wheat or small grain use.

   a. 3 to 4
   b. 8 to 12
   c. 18 to 22
   d. 20 to 40

3. The best soils for wheat and small grains are _____.

   a. Loams and clay loams
   b. Sandy clay and clay
   c. Silt and sandy loams
   d. Loamy sand and clay

4. Which nutrient is most important to the development of the root system for wheat and small grains?

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

Complete the following short answer questions.

5. List two important factors to consider when evaluating the history of a field that may be used for the planting of wheat or other small grains.

   a.

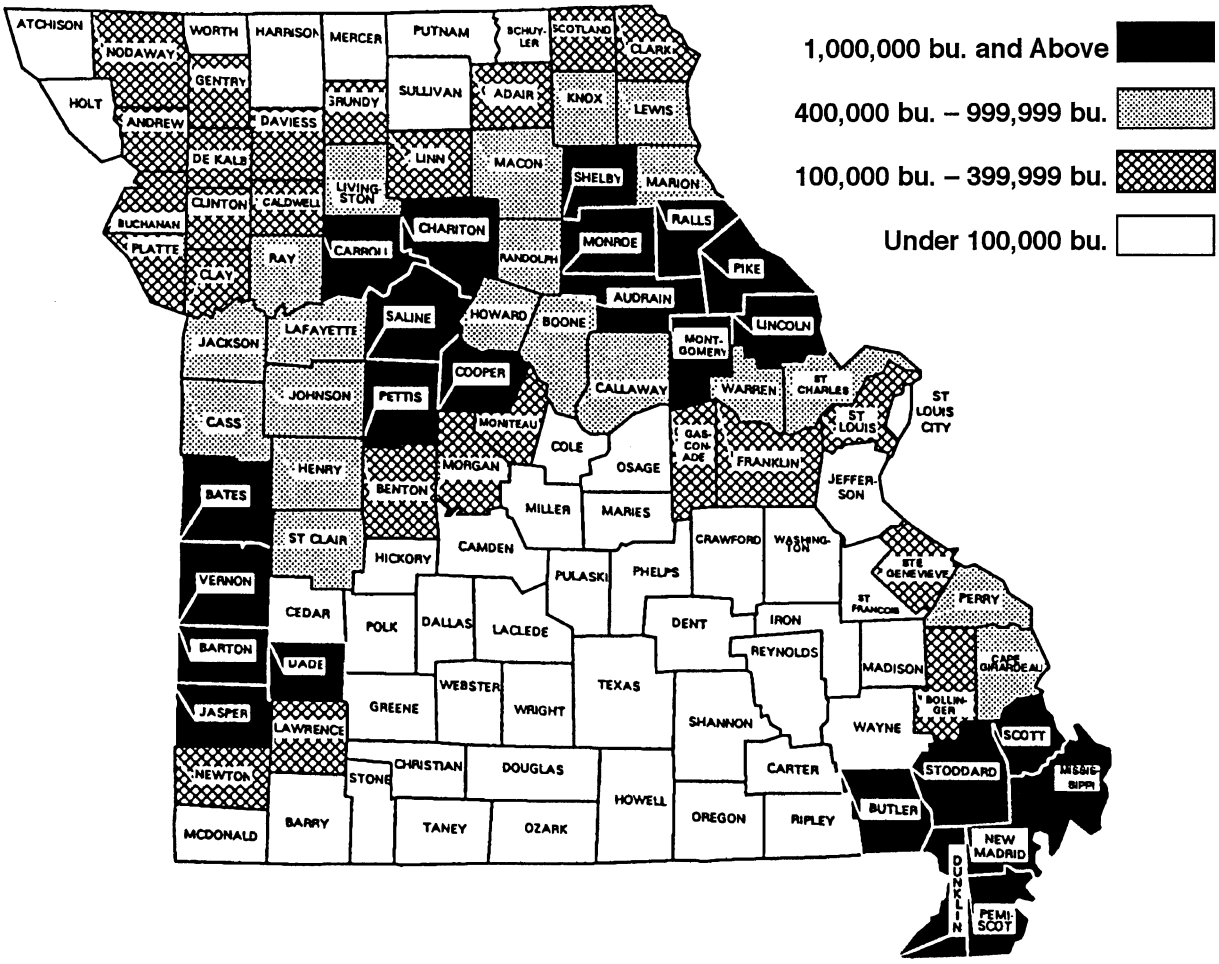
   b.

6. What is the range of dates in Missouri after which producers may be safe to plant their wheat and avoid infestations of the Hessian fly?

7. What is vernalization?

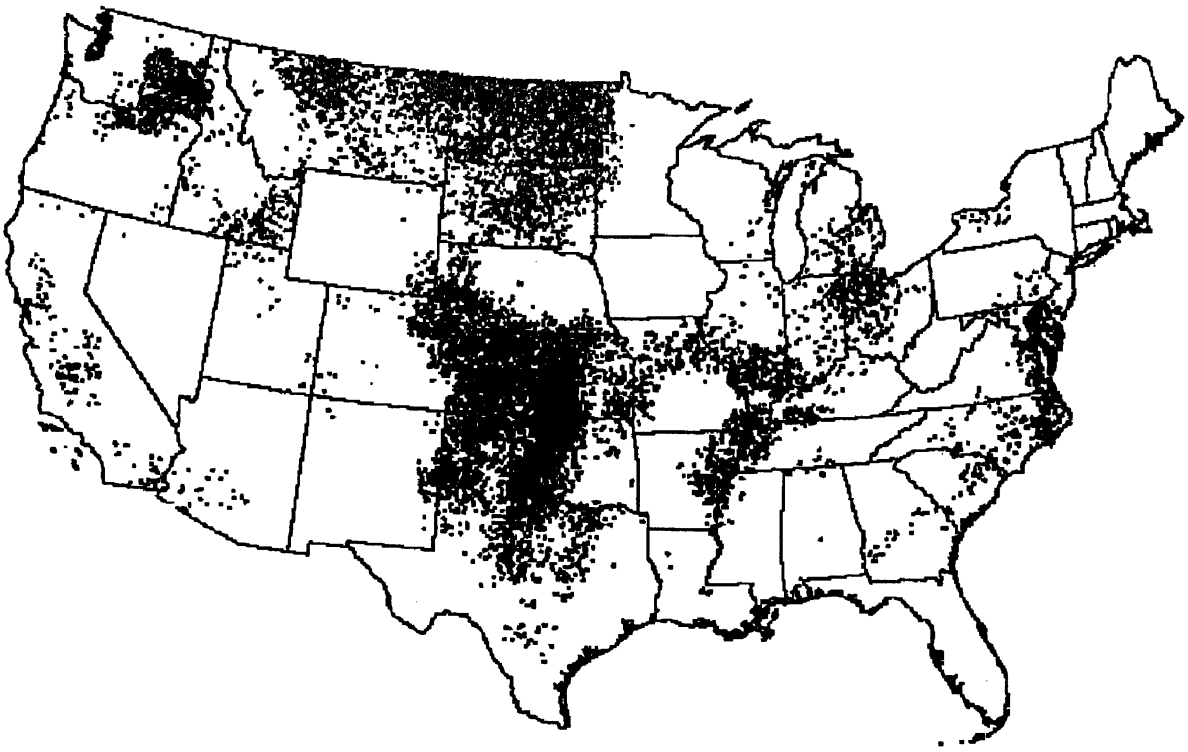
TM 1.1

Production of Wheat in Missouri (1998)



Source: 1999 Missouri Farm Facts

Wheat Growing Regions in the United States



Source: U.S. Department of Agriculture, Economic Research Service, 1998.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 2: Selecting a Variety

Competency/Objective: Select wheat and other small grain varieties.

Study Questions

1. **What are the different classes of wheat?**
2. **What are wheat varieties?**
3. **What are the different classes of other small grains?**
4. **What are the factors to consider when selecting a seed variety?**
5. **What diseases are prevalent locally?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VIII.
2. Activity Sheets
   a) AS 2.1: Solve the Puzzle
   b) AS 2.2: Wheat Variety Crop Performance
   c) AS 2.3: Wheat and Small Grain Diseases

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

The previous lesson discussed considerations crop producers must make when deciding if the area and land are suitable for raising wheat or other small grains. The climate, topography, and soil conditions must be examined. Discussion was also centered around meeting the nutritional needs of wheat and other small grains, especially nitrogen, phosphorus, and potassium. This lesson will discuss the selection of varieties.

B. ***Motivation***

Secure samples of several wheat varieties. Have the students grind each sample into a fine flour, removing the bran portion of the grain. Students should examine and describe their observations between the different types of wheat.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Samples of the classes of wheat could be distributed during this discussion. Students should understand that each class has its own particular value, reason for production, and production location. Complete AS 2.1 to familiarize students with terms used with wheat classifications.

What are the different classes of wheat?

a) Differences between classes of wheat are determined by the following items.
   1) Growth habit
      (a) This refers to when the wheat is planted and its growth cycle.
      (b) Winter wheat is planted in the fall, spring wheat planted in the spring.
   2) Kernel color
      (a) Either red or white with red being predominant
      (b) Only advantage of white wheat - improvement of flour yield due to less seedcoat fragments needing to be removed during milling
   3) Kernel hardness
      (a) Classified as "hard" or "soft" depending on endosperm granularity
      (b) Hard wheat has protein-like material on the surface of the starch granules.
      (c) Soft wheat does not have this starch on the surface and when milled will yield a fine granulated flour; hard wheat is more coarse.
      (d) Soft wheat granules are harder to control and will clog flour sifters.
      (e) Most bread is made from hard wheat.
      (f) Soft wheat is used mostly in cookies, cakes, and doughnuts.

b) Wheat grown in the United States is divided into the following five classifications using the above factors.
   1) Hard red winter
      (a) Grown in Missouri as well as in Nebraska, Kansas, Oklahoma, and Texas
      (b) Used for livestock feeds as well as bread making
   2) Hard red spring
      (a) Grown primarily in north central states such as North Dakota and Minnesota
      (b) Winters in this region too severe for winter wheat production

3) Soft red winter
   (a) Grown from Texas through parts of Missouri to the Great Lake states and east to the Atlantic Coast
   (b) Mostly concentrated in Illinois, Indiana, and Ohio
4) White
   (a) Both a winter and a spring variety
   (b) Produced in the Pacific Northwest and some in southern Michigan and western New York
   (c) Used mostly for cereals
5) Durum
   (a) Grown in North Dakota, with some in Minnesota, Montana, South Dakota, and Arizona
   (b) Contains more protein than the other classes of wheat
   (c) Qualities make it desirable for making spaghetti, noodles, and macaroni

2. Before selecting a variety of wheat or another type of small grain, the producer should gather and analyze information from commercial companies and University of Missouri performance trials to determine which variety they should choose. An example of seed company information is illustrated in the Student Reference. Complete AS 2.2 to familiarize students with performance data.

What are wheat varieties?

a) Descriptions of varieties may be obtained from the commercial seed dealers or use the Internet and visit the company's web site.
b) Universities test several varieties each year and publish their results.
   1) Results may be obtained from University Extension centers or from the AgEBB web site under "performance trials."
   2) Performance tests are conducted in similar locations each year.
c) Performance trials for Missouri wheat are conducted on both hard red and soft red winter wheat varieties.
d) Results vary each year depending on fall moisture, severity of the winter, and spring growing conditions.
e) Seed company information includes a rating on factors such as drought tolerance, yield, lodging resistance, winter hardiness, and test weight as well as a narrative with additional information.

3. Other small grains such as barley and oats are raised in Missouri. Students should be familiar with the physical identification of these grains as well as know the different types within those species. Refer to IML's *Crop and Grassland Plant Identification Manual* for diagrams of these small grains.

What are the different classes of other small grains?

a) Barley
   1) A hardy plant that is one of the four major feed grains grown in the United States.
   2) There are two basic types of barley based on the rows of grain seen when the heads of the stalks are viewed from above.
      (a) Two-row with 5-30 kernels of grain on each head of grain
      (b) Six-row with 25-60 kernels per grain head - the type most raised in Missouri
b) Oats
   1) Grown primarily in the north central states because it requires moisture and relatively cool weather
   2) May be planted in the fall or spring
   3) Spring planted in Missouri
   4) Four varieties in the United States
      (a) White

(b) Red
(c) Gray
(d) Black

4. This discussion will center on factors that producers will need to consider when trying to decide on a particular variety. There are many other factors as important as yield.

What are the factors to consider when selecting a seed variety?

a) Yield - most varieties today similar in yield
b) Disease and stress resistance
    1) Factor will vary from year to year and location around the state.
    2) Select a variety that does best in producer's region of the state.
c) Height and lodging
    1) Generally, the taller varieties are more prone to lodging.
    2) Lodging reduces both grain yield and grain quality.
    3) Stiffer-straw varieties should be used where soil fertility increases.
    4) Fertilization and irrigation rates affect lodging also.
d) Maturity
    1) Barleys mature earliest, oats later than other grains.
    2) Wheat has early-, mid-, and late-season varieties.
    3) Early maturing varieties may avoid heat and drought of midsummer.
    4) Early season varieties can be used for double cropping.
    5) Later maturing varieties may have increased yields if temperatures and moisture are favorable during the season.
e) Winter hardiness
    1) Barleys are usually less winter hardy than wheat.
    2) If winters are severe in the area, select a variety with a higher winter hardiness rating.
f) Yield potential
    1) Yield varies from area to area and year to year.
    2) Review data from test trials to aid in variety selection.
g) Intended use
    1) Varieties are classified as either feed or malting types.
    2) If raised for livestock feeds, select a variety with a higher test weight.
h) Grain quality
    1) Test weight is a price-determining factor.
    2) Choose varieties with good test weight records.
    3) Quality is a function of bran-to-endosperm ratio.
        (a) Endosperm is the source of protein and starch.
        (b) Bran is the covering or coating of the kernel.
    4) Higher test weights equal higher quality and command a higher market price.

5. There are about 50 different pathogens that may attack wheat. Even with this large number, only a few cause problems in a given year. These are grouped into four categories. Annual losses from disease in Missouri range from 10 to 25%. Producers and students should be familiar with the major diseases that may present a problem in their location in the state. Complete AS 2.3, which helps students identify symptoms of diseases in wheat and small grain.

What diseases are prevalent locally?

a) Seedling blights and root rots
    1) *Helminthosporium* crown and root rot
    2) *Fusarium* root rot
    3) *Gibberella* root rot
    4) *Pythium* root rot
    5) *Rhizoctonia* root rot

6) Wheat take-all
7) Symptoms of these diseases
   (a) Circular patches of dwarfed, reddish-brown plants scattered throughout the field
   (b) Dark brown lesion on surface of the coleoptile of the plant, progressing inward and spreading into the roots
   (c) Infection of the crowns, roots, and basal portions of the stem
   (d) Distinct rotting of affected parts, typically a dry rot, causing failure to emerge

b) Leaf diseases
1) Leaf rust
   (a) Mainly on leaves, but may occur on stems especially between flag leaf and head
   (b) Small, round or oblong raised orange-red pustules on the surface of the leaf
   (c) Most abundant on the upper leaf
2) Stripe rust
   (a) Pustules are light yellow, arranged in distinct straight-sided stripes about 1/16 inch wide or irregular length.
   (b) Leaves may die.
   (c) Disease is not common in Missouri.
   (d) Spores are blown in from southern wheat growing regions.
3) Powdery mildew
   (a) Affected plants are usually in parts of the field where growth is dense and air is moist, and conditions are ideal for infestation.
   (b) Small, irregular or circular light gray spots appear on the upper surface of the leaves.
   (c) Spots enlarge as fungus grows.
   (d) Spots take a flowery appearance due to the production of an enormous number of spores.
   (e) Lower surface of leaves turn yellow and older spots turn brownish.
4) Septoria leaf blotch
   (a) Disease first appears as light green to yellow spots between the veins of the leaves.
   (b) Lesions spread rapidly to form light brown irregular blotches with a speckled appearance.
   (c) Small submerged brown pycnidia in the blotches are the final diagnostic symptom.
   (d) Disease also attacks leaf sheaths, stems, and flumes.
5) Downy mildew (crazy top)
   (a) Infected plants are erect, yellowish green, somewhat dwarfed, and they tiller excessively.
   (b) Thickened leaves become twisted, curled, and stiff.
   (c) Stems are thick and deformed.
   (d) Heads may be distorted and open; chaff is fleshy and green.
6) Tan spot (yellow leaf spot)
   (a) Disease appears early in the season.
   (b) First spots are yellow-brown, bordered by yellow.
   (c) Spots are oval to elongated, usually less than 1/16 inch long, found on both surfaces of leaves.
   (d) Spots increase in size as season advances.
   (e) Dead brown area of spot may be 1/4 inch wide and 3/4 inch long and tapered.
7) Cephalosporium stripe (fungal stripe, C-stripe)
   (a) This is a vascular disease.
   (b) Infected seedlings show yellowing, but most symptoms appear after jointing.
   (c) Long, chlorotic stripes form on sides of leaf midribs and run the entire length of the leaf.
8) Stem rust
   (a) Disease usually appears in Missouri every year, but severity of attack varies.

(b) Red spore stage is encountered during growing season and may occur on any aboveground part of the plant.
(c) Elongated, ragged pustules on stem, leaf sheath, blade, or chaff appear in mid-June.
(d) Pustules rupture, exposing powdery, brick-red mass of summer spores.
(e) As wheat matures, black pustules filled with black spores appear.

c) Wheat head diseases
1) Loose smut
(a) Disease is recognized by characteristic dusty black appearance of diseased heads.
(b) Glumes and grain are completely transformed to black powder, which shatters, leaving a bare spike at harvest.
2) Common bunt (covered smut, stinking smut)
(a) Heads are affected by bunt when they emerge from the boot and have a blue cast.
(b) Infected kernels are transformed into smut balls during growth.
(c) Smut balls consist of masses of foul-smelling, dark brown powder-like spores of the fungus.
3) Scab (head blight)
(a) Premature ripening of one or more spikelets of a head occurs any time after flowering.
(b) When wheat is in dough stage, light yellow color of diseased spikelets shows in sharp contrast with healthy green of rest of the head.
(c) Light pink or salmon color may appear at bases of infected spikelets.
(d) Kernels become grayish-white, badly shrunken and wrinkled, with rough, flaky seed coat called "tombstone."
4) Glume blotch
(a) Causative fungus attacks heads most often.
(b) Brownish blotches appear near the tip of the chaff.
(c) Severely infected heads are chocolate brown and produce shriveled kernels.
(d) Blotch may also may be found on leaves and joints.
(e) It is hard to distinguish from Septoria leaf blotch on leaves.
5) Basal glume rot
(a) Dull, brownish-black discolored area is found at the base of each of the glumes covering a kernel.
(b) Discoloration is more pronounced on the inside than on outside of the diseased glume.
(c) Some kernels are brown or black at germ ends.
6) Black chaff
(a) Attacks wheat as well as barley, rye, and some grasses
(b) Known as bacterial blight on barley and rye
(c) Occurs chiefly on the chaff of glumes
(d) Longitudinal, dark, sunken stripes or spots, more abundant and noticeable as a rule on the upper than the lower halves of the glumes
(e) In moist weather, tiny yellow beads of bacteria oozing to the surface of black lesions and dry as minute, yellow scales
7) Black point (kernel smudge)
(a) Diseased kernels are discolored and appear weathered.
(b) Black point describes the darkened and sometimes shriveled embryo end of the seed.
(c) Germination is decreased.
8) Black (sooty) head mold
(a) Superficial head molds develop on the heads, especially if rainfall is high after emergence.
(b) Infections then progress to the seed, causing black point disease.
9) Ergot

(a) Empty florets occur in addition to kernels that are replaced by a plump, hard, purplish body larger than healthy kernels, usually two to five per head.
(b) Ergot is more common on barley but can be on wheat, oats, and some grasses.

d) Viral diseases of wheat
1) Barley yellow dwarf virus (BYDV)
(a) BYDV is the most widespread virus disease of wheat in Missouri.
(b) Stunting and yellowing are the most noticeable symptoms.
(c) Symptoms are usually observed in late spring at about jointing.
(d) Leaf yellowing begins at leaf tips and along midribs.
(e) Flag leaves may have a reddish-purple tip.
(f) BYDV also causes "red leaf" in oats and "yellow dwarf" in barley.
2) Soilborne wheat mosaic (SBWM)
(a) Disease occurs on fall-sown wheat (also rye, barley, and some grasses).
(b) SBWM is detected in spring by presence of light green to yellow patches in the field, from small areas to areas 50 feet or more in diameter.
(c) Plants are dwarfed, tiller excessively, and have mottled leaves consisting of light green or pale yellowish stripes or blotches that tend to run parallel with the long axis of the leaves.
(d) Occurrence of the disease depends on weather of fall and winter, which influences the growth and dormancy of the plants.
3) Wheat yellow mosaic (WYM)
(a) WYM is another soilborne virus common in Missouri.
(b) WYM more commonly seen in southeast Missouri but can occur in other areas.
(c) WYM tends to be more uniformly spread than soilborne mosaic.
(d) Symptoms appear in early spring as yellow-green mottling, dashes, and streaks on leaves.
(e) Streaks running parallel to veins taper and form chlorotic spindles.
(f) Reddish streaking at the leaf tips often precedes necrosis.
(g) Some stunting and poor tillering occur.
4) Wheat streak mosaic virus (WSMV)
(a) Most infections occur in the fall, but symptoms are observed after the arrival of warm spring weather.
(b) Yellowish streaking and mottling of leaves occur.
(c) Plants may be stunted.
(d) Leaf margins often are rolled toward the midrib.
(e) As plants approach maturity, mottling disappears, leaves tend to turn brown and die.
(f) Heads that form may be totally or partially sterile.

e) General control measures for wheat and small grain diseases
1) Use sound seed from recommended varieties.
2) Clean the seed and discard shriveled seed.
3) Use a recommended, EPA-registered fungicide for a seed treatment.
4) Use resistant varieties.
5) Eradicate disease hosts (other plants).
6) Use foliar application of fungicides.
7) Practice crop rotation.
8) Practice crop sanitation by plowing under crop residues.

F. ***Other Activity***

Secure pictures of wheat and other small grains exhibiting symptoms of some of the more common diseases in your area. Have students practice identifying these diseased conditions. A useful reference is the *Compendium of Wheat Diseases* by APS Press, which is available for free loan from MRCCTE at the University of Missouri-Columbia.

G. ***Conclusion***

We have discovered that wheat can be classified into five major types, based on their growth habits, kernel color, and kernel hardness. These classifications include hard red winter, soft red winter, hard red spring, white, and durum wheat. Wheat and other small grain varieties should be selected after careful consideration of the information that may be supplied by commercial seed companies and from data supplied from University of Missouri performance trials. Varieties should be selected to suit your area of the state. Barley producers in Missouri usually grow the 6-row type of barley; however, there is another type called the 2-row type of barley. There are several diseases of wheat and small grains that are placed into one of four categories: diseases that affect the seeds and roots, leaf diseases, diseases of the heads, and viral diseases.

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

AS 2.1

Scrambled words: Hessian, Winter, Durum, Spring, Red, Cereal, Hard
Phrase: Wheat Related Words

AS 2.2

Answers will vary.

AS 2.3

1. c
2. e
3. h
4. g
5. a
6. j
7. i
8. d
9. f
10. b

I. ***Answers to Evaluation***

1. d
2. b
3. c
4. Any four of the following: disease and stress resistance, height and lodging, maturity, winter hardiness, yield potential, intended use, and grain quality

5. Any four of the following:
   Use sound seed from recommended varieties.
   Clean the seed and discard shriveled seed.
   Use a recommended, EPA-registered fungicide for a seed treatment.
   Use resistant varieties.
   Eradicate disease hosts (other plants).
   Use foliar application of fungicides.
   Practice crop rotation.
   Practice crop sanitation by plowing under crop residues.

6. d
7. b
8. c

11. c
12. a
13. b
14. c

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 2: Selecting a Variety Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What percent of wheat production in the United States is winter wheat?

   a. 20 - 30
   b. 40 - 50
   c. 50 - 60
   d. 70 - 80

2. Most of the durum type of wheat is grown in which state?

   a. Kansas
   b. North Dakota
   c. Arizona
   d. Oklahoma

3. What is the major type of barley grown in Missouri?

   a. Two-row
   b. Four-row
   c. Six-row
   d. Eight-row

Complete the following short answer questions.

4. List four of the major factors to consider when selecting a variety of wheat or other small grains.

   a.

   b.

   c.

   d.

5. List four general control measures that may be used to reduce or eliminate wheat and other small grain diseases.

   a.

   b.

   c.

   d.

Match the disease name in the left column with the type of disease in the right column. Answers will be used more than once.

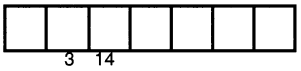
6. _____	Barley yellow dwarf virus	a.	Seedling blights and root rots
7. _____	Stripe rust	b.	Leaf diseases
8. _____	Loose smut	c.	Head diseases
9. _____	Wheat yellow mosaic	d.	Viral diseases
10. _____	Downy mildew		
11. _____	Ergot		
12. _____	Wheat take-all		
13. _____	Tan spot		
14. _____	Black point		

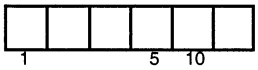
Lesson 2: Selecting a Vareity Name_____

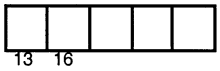
Solve the Puzzle

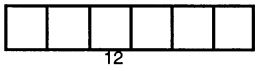
Objective: Students will demonstrate a knowledge of terms used in wheat and small grain production.

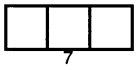
Directions: Unscramble each of the clue words below. Use the letters in the numbered cells to solve the phrase below.

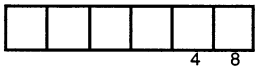
NAISESH 

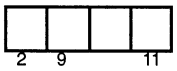
NIWRTE 

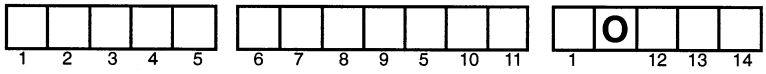
RUUMD 

PRSIGN 

DRE 

AERECL 

RADH 



Lesson 2: Selecting a Variety Name _____

Wheat Variety Crop Performance

Objective: Students will analyze performance results for wheat varieties in Missouri.

Directions: Obtain the most recent Missouri Crop Performance data conducted by the Agricultural Experiment Station at the University of Missouri available on the Internet at <http://agebb.missouri.edu/cropperf/wheat/index.htm>. The instructor will assign a variety to each student or group of students. Answer the following questions.

Variety name: _____

1. What is the grain yield for this variety for the current year? _____
2. What was the grain yield for the previous 2 years? _____
3. What is the test weight in pounds per bushel?_____
4. What is the percent of grain moisture? _____
5. What is the percent of winter survival rate? _____
6. What is the plant height? _____
7. What is the lodging rate? _____

Obtain information about this variety from the local Agri Service Center or from the company web site on the Internet. How does the data from the seed company agree or differ from the performance test information conducted by the University of Missouri?

Lesson 2: Selecting a Variety Name_____

Wheat and Small Grain Diseases

Objective: Students will recognize symptoms of common diseases of wheat and other small grains.

Directions: Match the wheat and small grain disease with its symptom by placing the correct symptom letter by the disease name.

1. _____ Fusarium root rot
2. _____ Leaf rust
3. _____ Powdery mildew
4. _____ Downy mildew
5. _____ Loose smut
6. _____ Scab
7. _____ Ergot
8. _____ Common bunt
9. _____ Stem rust
10. _____ Barley yellow dwarf virus

a. Dusty black appearance of diseased heads.

b. Most widespread virus disease in Missouri. Wheat is stunted and yellowed.

c. Circular patches of dwarfed, reddish brown plants. Rotting of affected parts.

d. Heads have a blue case. Kernels develop a foul-smelling smut ball.

e. Small, round, raised orange-red pustules on surface of the leaf.

f. Usually appears every year on Missouri wheat. Red spores in pustules in early stages of growth that turn black as wheat nears maturity.

g. Erect, yellowish-green, somewhat dwarfed plants. Excessive tillering. Leaves are thick, twisted, and curled.

h. Small circular gray spots on leaves. Develops a floury appearance.

i. Empty florets. Kernels replaced with plump, hard, purplish body that is larger than a healthy kernel. Mostly found in barley.

j. Premature ripening of one or more spikelets on the head anytime after flowering.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

Competency/Objective: Determine tillage or planting methods.

Study Questions

1. **What are tillage methods?**
2. **What are factors to consider when choosing a tillage method?**
3. **What are planting methods?**
4. **What are the recommended seeding rates for each tillage and planting method?**
5. **How is a wheat or small grain planting calendar used?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VIII.
2. Transparency Master
   a) TM 3.1: Hessian Fly-Free Dates for Missouri
3. Activity Sheet
   a) AS 3.1: Making Planting Decisions

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

Our last lesson discussed the different classes of wheat, barley, and oats and gave information on how to make a variety selection. Information was also presented on the major diseases of these small grains in Missouri.

B. ***Motivation***

Ask students to list different methods of preparing the seedbed for planting wheat or other small grains. Have them also list advantages and/or disadvantages of each method.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. The methods of preparing seedbeds for planting small grains have changed in the last decade or so from deep, moldboard plowing to methods employing conservation tillage. Review these methods and their advantages and disadvantages.

   What are tillage methods?

   a) Tillage methods
      1) Conventional - practiced on limited basis
      2) Minimum
      3) No-till
   b) Advantages of minimum tillage and no-till practices
      1) Reduced fuel costs
      2) Reduced equipment costs
      3) Less soil compaction
      4) Decreased operator time
      5) Less soil erosion
      6) Improved soil moisture retention
      7) Maintenance of soil organic matter.

2. Discuss with the students the factors to be considered when choosing a tillage method.

   What are factors to consider when choosing a tillage method?

   a) Firm seedbed
      1) Good seed-to-soil contact is important for rapid germination and stand establishment.
      2) Wet soil leads to soil compaction and development of tillage pans that cause problems later in the growing season.
   b) Residue management
      1) Residues may be incorporated with one or two passes with the chisel or disk.
      2) More residue leads to increases of foliar diseases.
      3) Resistant varieties are important in this cropping system.
      4) Residues may be left untouched until just before fall planting.

5) No-till drills are effective for planting wheat or small grains in corn or sorghum residue.
6) No-till drills save time and soil moisture.
7) Residue advantages
   (a) Reduces soil moisture evaporation
   (b) Reduces soil erosion
   (c) Reduces water and soil runoff
   (d) Increases water infiltration and snow catch during the winter

c) Wheat disease concerns
   1) Moldboard plowing buries residue harboring Hessian fly and other destructive insects.
   2) Plowing also controls diseases such as *Rhizoctonia* root rot where rainfall is high.

3. Students should develop an understanding of the primary methods of planting wheat and other small grains. Discuss the various planting methods.

What are planting methods?

a) Wheat should be drilled in a well-prepared seedbed for optimum placement of seeds and number of seeds per acre.
   1) Uniform stands will optimize yields.
      (a) Decrease lodging potential
      (b) More uniformly extract soil moisture and nutrients
      (c) More efficiently intercept incoming light energy
   2) Planting in rows as narrow as possible will control weeds and accomplishes the above goals.

b) Seeds that are broadcast and incorporated result in about 20% stand loss due to being planted too deep or too shallow.
   1) Too shallow - plant dries up from roots not reaching moisture
   2) Too deep - plants will leaf out under the soil and die

c) Planting equipment should be calibrated to place the appropriate number of seeds per linear foot of row to maximize yield.
   1) Planting too few seeds will result in excessive tillering, delaying plant maturity, and may allow weed infestation to increase.
   2) Planting too many seeds per acre is an unnecessary expense and may result in increased lodging and decreased yields.

d) Semi-dwarf varieties planted in Missouri should not be planted more than 2 inches in depth.

4. Seeding rates will vary in different parts of the state due to different environmental conditions and different planting methods. Refer to the Wheat Seeding Chart in the Student Reference (Table 3.1)

What are the recommended seeding rates for each tillage and planting method?

a) Seeding rates for wheat are as follows.
   1) Broadcasting - 120 to 180 lb. per acre (equals 2 to 3 bu./acre with 60 lb. test weight wheat)
   2) Drilling - plant seeds per acre, not bushels per acre (refer to Table 3.1 in Student Reference)

b) Seeding rates for barley are as follows.
   1) Broadcast - 96 to 120 lb./acre
   2) Drilling - 72 to 96 lb./acre

c) Seeding rates recommended for oats is as follows.
   1) Broadcast 96 to 120 lb./acre
   2) Drilled - 48 to 96 lb./acre

5. The Hessian fly-free dates for Missouri are demonstrated in TM 3.1. Planting wheat and barley is recommended to take place after those dates.

How is a wheat or small grain planting calendar used?

a) Winter wheat and barley should be planted within a week after the fly-free date.
   1) Early planting will allow plants to establish crown roots and three to five tillers before winter dormancy, reducing chance of winterkill.
   2) Planting too early increases chances of insect hazards and diseases such as leaf rust and wheat streak mosaic virus.

b) Barley planting should follow the wheat planting schedule because barley is subject to the same insects and diseases as wheat.

c) Spring oats should be planted as early in the spring as soil conditions will allow.
   1) The planting range is from March 1 to April 15.
   2) After April 15, the yields decrease.

F. ***Other Activity***

Invite a wheat producer from your area to visit the class and discuss crop management procedures: what guidelines are used to determine how fields are prepared for planting, how to determine when to plant, and what seeding rates to use.

G. ***Conclusion***

Students should understand the advantages of reduced tillage practices. These include less equipment costs, less operator time, less fuel costs, less soil compaction, less soil erosion, improved soil moisture conditions, and better maintenance of soil organic matter. A firm seedbed is necessary for seed-to-soil contact and increasing seed germination and stand establishment. Residue management is important to benefit soil conservation as well as manage disease and insect problems. Most wheat and small grains will be drilled because broadcasting results in decreased stands. Planting recommendations (seeding rates) and times of planting will vary with different parts of the state and should be followed to optimize wheat and small grain yields.

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

1. Students should locate their county on the Hessian fly-free date calendar and select the recommended planting date within a week after the fly-free date in their area.

2. Answers may vary. If the student selected a seeding rate of 120 pounds/acre, the answer would be 80 bushels of seed wheat to be purchased. If 180 pounds was selected, the answer would be 120 bushels.

3. Answers may vary, but for example, if a no-till system was selected, the student could justify his/her reasoning by explaining some of the advantages listed in this lesson for the selection.

I. ***Answers to Evaluation***

1. b
2. c
3. b
4. a
5. Excessive tillering that may delay plant maturity and allow weed competition to increase.
6. Unnecessary expense, increased lodging, and decreased yields due to lack of nutrient and moisture support

7. Increases hazards of insects and disease

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 3: Selecting a Tillage and Planting Method Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is <u>not</u> an advantage of using minimum tillage when planting wheat?

   a. Less soil erosion
   b. Increased loss of soil moisture
   c. Less fuel and equipment costs
   d. Improvement of soil organic matter

2. Which of the following statements would be a benefit of leaving crop residue on the planting field?

   a. Allows the soil to crust
   b. Increases water runoff velocities
   c. Maximizes soil moisture retention
   d. Increases chance of crop insects and diseases

3. Broadcasting wheat or small grain seeds may lead to _____ % seed loss.

   a. 10
   b. 20
   c. 30
   d. 40

4. When drilling _____, recommended seeding rates are determined by plant seeds per acre, not bushels per acre.

   a. Wheat
   b. Oats
   c. Barley
   d. Small grains

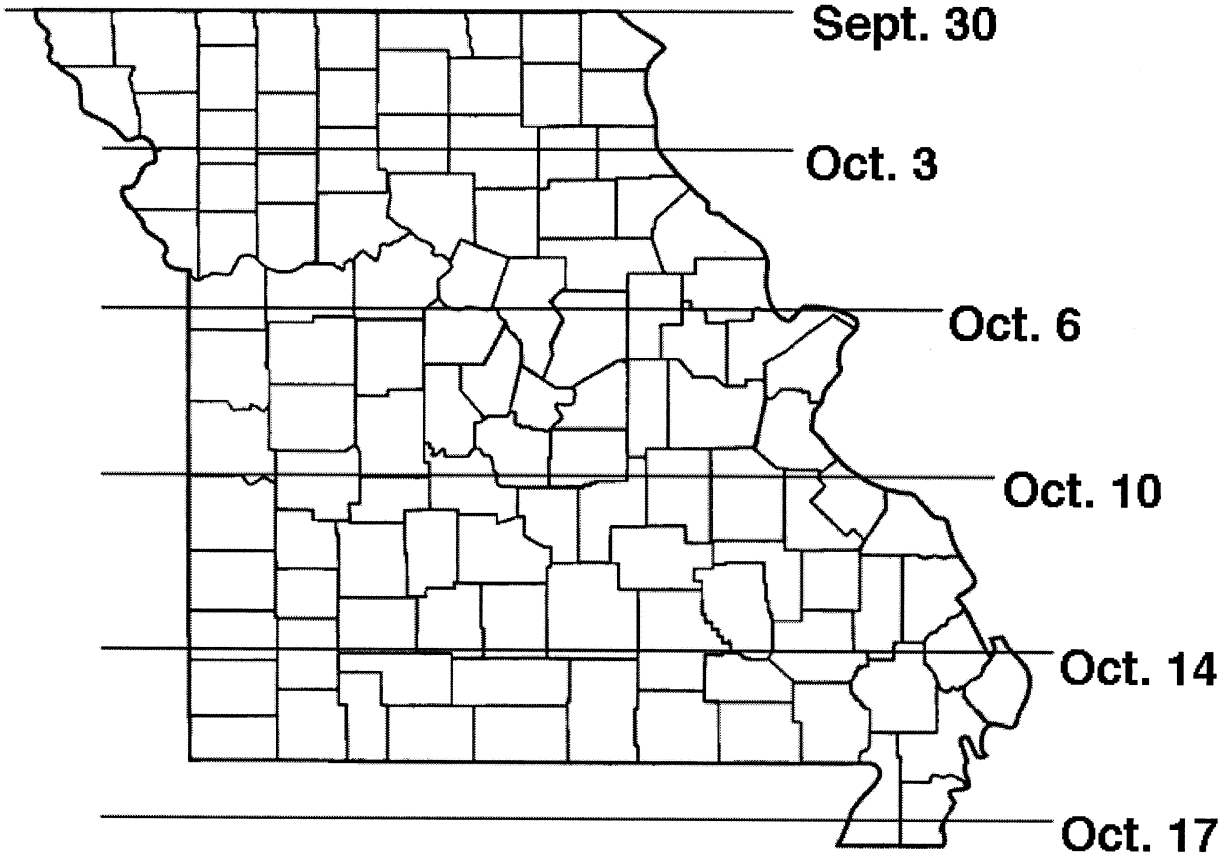
Complete the following short answer questions.

5. What problems may occur if too few seeds are planted per acre?

6. What problems may occur if too many seeds are planted per acre?

7. What problem may occur if planting is done too early?

Hessian Fly-Free Dates for Missouri



Lesson 3: Selecting a Tillage and Planting Method Name_____

Making Planting Decisions

Objective: Students will make decisions regarding the planting of wheat or other small grains.

Directions: Using the information provided in the Student Reference, answer the questions below.

1. What would be the earliest date you may decide to plant wheat in your county? _____

   Justify (explain) your decision.

2. You have decided to plant 40 acres of wheat. How many bushels of seed wheat would you purchase? _____ bushels

   Explain how you arrived at this number.

3. What method would you use to prepare the seedbed and plant the wheat in the above example?

   Explain why you selected these methods.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 4: Selecting a Pest Control Program

Competency/Objective: Select a pest control program.

Study Questions

1. **What are the factors that determine a pest control program?**
2. **What pests are specific to wheat and small grains?**
3. **What pest control options are available?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000.
2. Activity Sheet
   a) AS 4.1: Hessian Fly Report

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 4: Selecting a Pest Control Program

TEACHING PROCEDURES

A. ***Review***

Lesson 2 discussed the diseases that affect wheat and other small grains. Lesson 3 discussed the importance of considering the factors that may influence the selection of the tillage and planting methods employed by the wheat and other small grain producer. As we learned, more producers are using conservation or no-till methods to conserve soil and soil moisture. The importance of planting after the "fly-free" date and approximate seeding rates were also presented.

B. ***Motivation***

Ask students to name as many pests associated with small grain production as they can. List these on the board. Should other pests such as rodents that may be noticed around storage facilities be classified as a pest control problem? If any students have an incident of a small grain pest problem, have them share this with the class.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. The following considerations must be addressed when deciding what type of pest control program may be used for wheat, barley, or oat crops. The major objective of a pest control program is to reduce insect populations to acceptable levels.

   What are the factors that determine a pest control program?

   a) Previous experience or what other producers are using
      1) These options may not be the best rationale.
      2) Conditions change as do pest control methods.
      3) An option that works for a producer may not work for another.
   b) Cost - first factor to consider
      1) Rising costs of chemicals have some producers looking for alternative methods of control.
      2) Amount and kind of chemical used will be based on pest problems found when scouting the field.
   c) Consideration of the environment
      1) More producers are becoming aware of harmful effects of chemical overuse.
      2) Educational efforts of groups and agencies responsible for land and water quality impact producer's decisions.
   d) Nonchemical methods (physical and biological mechanisms)
      1) Plowing under crop residues
      2) Introducing predators and parasites that feed on harmful pests
      3) Planting pest-resistant varieties
      4) Releasing sterilized male insects into the populations that cause females to bear infertile eggs
   e) Employing integrated pest management (IPM) techniques
      1) Combinations of chemical, biological, and physical control measures
      2) Reduce use of pesticides - pest control improved
      3) Reduces environmental problems

f) Specific pest problem and soil types and conditions
   1) Crop advisors and agronomy extension agents can help recognize specific pest problems.
   2) They can also identify soil types and conditions that may affect chemical control success.

2. The following is a list and description of the major insects and pests that are specific to cereal grains. These may be problems with wheat, barley, or oat production.

What pests are specific to wheat and small grains?

a) Aphids
   1) Widespread pests of cereal grains
   2) May cause significant feeding damage if in large numbers
   3) May also act as "vectors" or carriers of BYDM
   4) Cause yellowing and premature death of leaves
   5) Symptoms of infestation
      (a) Deposits of sugary liquid, known as honeydew, leave scorch marks on the leaves.
      (b) Sooty molds develop.
      (c) Necrotic (dead) areas may develop.
      (d) Purpling and rolling of the infested leaves may occur.
   6) Species
      (a) Bird cherry-oat aphid
      (b) Greenbug
      (c) Corn leaf aphid
      (d) Rose grass aphid
      (e) English grain aphid
      (f) Russian wheat aphid

b) Stink bugs
   1) Losses due to stink bugs are variable due to weather, density of insects, and length of the growing season.
   2) Mild winters and low rainfall favor outbreaks of the insect.
   3) They will feed on grasses and weeds as well as cereal grains.
   4) Losses result primarily in reduced baking quality of the grain.
   5) Saliva of the insect is toxic to the plant and a puncture can kill the stem.
   6) They feed on the kernels of the grain during the milk dough stage and badly shrivel the grain.
   7) Bugs have a shield-shaped body and foul smell when crushed.
   8) They lay eggs on various parts of the plant.
   9) Hatched nymphs feed on the plant.

c) Armyworms, cutworms, and stalk borers
   1) Pests may cause severe damage and devastate large areas.
   2) Primary symptom is the defoliation of leaves.
   3) Larvae chew from the edges of the leaf to the midrib.
   4) Some species may feed on the soil surface, others underground on the roots, and others on the stems.
   5) Eggs are laid on the leaf and leaf sheaths near the ground.
   6) Larvae hatch within a few days and feed at night or early in the morning.
   7) In damp weather, larvae may feed all day.

d) Cereal leaf beetle
   1) Beetles cause significant losses to winter wheat and fall-sown spring wheat.
   2) Yield losses may be 15% to more than 25%.
   3) Adult beetles are 4-5 mm long, have a black head, light brown thorax, and shiny blue-green wings with parallel lines of small dots.
   4) Most prominent symptom is the distinct longitudinal stripes on the leaves.
   5) The insect produces one generation per year.

6) Adult feeding begins in the spring.
7) They lay yellow eggs, either singly or in small chains, covered with a sticky film.
8) Adults overwinter in plant debris on the soil surface, in leaf sheaths, on ears of corn, or under the bark of trees.
9) Wheats with hairy leaves are less affected.

e) Thrips
1) Pest are small (1 mm), brown or black insects with a tapering, segmented abdomen.
2) They have piercing and sucking mouthparts and usually two pairs of narrow wings.
3) They are usually found feeding on the stem, behind the sheath on the flag leaf.
4) Both adults and nymphs can cause damage.
5) If present in large enough numbers, they may cause the tissue to take on a silver coloration.
6) Generations are short, with 10 or more per year.
7) Heavy rains can destroy high populations of this insect.
8) They rarely cause serious damage and it is uncommon to find infestations large enough to warrant control measures.

f) Hessian fly
1) Insect is the most destructive on cereals.
2) Widespread outbreaks have occurred and may recur annually.
3) It is mainly a pest of wheat but can attack barley, rye, or grasses.
4) Infestations cause stunting of the plants, thin stands, lodging, and reduced yields.
5) Injury is caused entirely by the larvae sucking juices from plant tissue.
6) Adult flies are 3-4 mm long, with a black head and thorax, and pinkish or yellow-brown abdomen.
7) Pupae overwinter in straw and stubble and emerge in the spring.
8) Eggs hatch within 1 week and are minute, oblong, reddish, and laid in rows on the upper sides of leaves.
9) Legless larvae settle behind the leaf sheaths and suck the plant sap.
10) Larvae develop into a translucent, pale-green, slug-like maggot.

g) Wheat stem maggot
1) Insect may infect 10-15% of the plants.
2) Heavy infestations can kill a significant portion of the tillers.
3) Maggots attack young tillers in the fall or early spring.
4) Infected plants usually show the "white head" condition typically produced by stem-boring insects cause the tillers to die.
5) Adults are pale green to yellow with dark stripes.
6) Females lay small white eggs, one per stem, near the sheath of the flag leaf.
7) Larvae burrow into stem, killing upper part of the plant.
8) Three generations occur per year, one in the spring, one in the summer, and the third in the fall that overwinters as larvae.

h) Sawfly
1) Infestations are usually not continuous but can cause significant damage in some years.
2) Nearly all cultivated cereals and native grasses may act as a host to this insect.
3) Fall-sown cereals are more commonly attacked.
4) Wheat with solid or partially solid stems are less susceptible.
5) Damage includes premature yellowing of the head and shriveling of the grain.
6) Larvae girdle the stem and cause lodging.
7) Adults are small, fly-like wasps and appear in late spring to midsummer.
8) Females deposit small, white eggs on the stem, just below the head.
9) Larvae tunnel and feed downward on the pith of the stem.

i) White grubs
1) Many species of white grubs attack wheat and other plant species.
2) Significant damage can occur to cereals that are seeded in heavily infested areas, usually when grain follows grassland.
3) White grubs are the larvae of May or June beetles.
4) Eggs are deposited in the soil and larvae feed on the roots.

5) Patches of wilting and dying plants are symptoms similar to root rots.
6) Examine the soil for larvae when stunted patches are observed.
7) Larvae may be several centimeters long and 1 cm thick when fully grown.

j) Wireworms
1) Insects are among the most damaging of the soil-infesting pests.
2) Damage is most severe when wheat follows many years of grass.
3) Wireworm species are found worldwide and all attack wheat.
4) Damage is similar to other soil-inhabiting chewing insects.
5) Only sure way to identify wireworm is to find them with damaged seedlings.
6) Wireworms are a tough, wire-like larvae, 20-30 mm long, with a smooth, hard, and highly polished appearance.
7) Insects may attack grain as soon as the seed is planted, feeding on the endosperm and leaving only the seedcoat.
8) A common symptom of wireworm is the wilting and/or dying of a number of adjacent plants either in a row or patch.
9) Stems of seedlings are chewed just above the seed.
10) Eggs are laid in the soil, usually in the spring, and the larvae take several years to develop.
11) Several generations may exist at one time, overlapping so all stages and sizes may be found in the soil.

k) Grasshoppers
1) Severe damage can be caused to full-seeded small grains, especially following a dry growing season.
2) If populations are high, treat fence rows and other areas before the grain germinates.
3) After the grain emerges, treating the margins of the fields will give adequate control.
4) If one or more grasshoppers per square yard appear throughout the field, apply chemical controls.

3. Control measures will be determined by the specific pest problem and the time of the year the problem is noticed. Discuss these control measures with the students.

What pest control options are available?

a) Before planting
1) Plow under residues to destroy "hosts" for insects to overwinter.
2) Spray for grasshopper problems before planting.
3) Treat seed for wireworm before planting.

b) During the growing season
1) Use foliar sprays at the first sign of infestations.
2) Repeat most sprays 14 days later if necessary.
3) Follow directions on the sprays.
4) Some sprays must not be used 7 to 45 days before harvest.

c) During storage
1) Thoroughly clean bins before harvest.
2) Some control sprays must be used before (24-36 hours) placing the grain in the bin.
3) Some control sprays are applied to the grain as it is entering the bin.
4) Poisons may be used for rodent control.

F. ***Other Activities***

1. Have a custom applicator specialist speak to the class about the pest control process and programs.

2. Have sample insects mounted for the students to observe or obtain photos of insects for them to identify. *A Field Guide to Insects* is available for free loan from MRCCTE, University of Missouri-Columbia.

G. ***Conclusion***

Producers of wheat and small grains, such as barley and oats, must understand the factors to be considered when selecting pest control measures. These factors include examining the cost of the control measure, past experiences of the producer and fellow producers, consideration for the environment, potential nonchemical controls, and understanding the specific pest problem. There are several insect pests that may affect production, with the Hessian fly causing the most damage to small grains in Missouri. Control measures include residue management before planting, seed treatments to control pests in the soil, and foliar sprays to use at different times during the growing season. Directions must be adhered to when applying foliar sprays. Pest problems during storage must also be addressed.

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

Answers will vary

I. ***Answers to Evaluation***

1. b
2. d
3. a
4. Using a combination of chemical, biological, and physical controls to manage pests.

5. Any three of the following: residue management, seed treatment, foliar spraying, storage facility treatment (spraying), poisons for rodents.

6. Any three of the following: plowing under residues, using predator or parasitic insects, using pest resistant varieties, or using sterilized male insects that cause females to produce infertile eggs.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 4: Selecting a Pest Control Program Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following pests exudes a sugary liquid that causes scorch marks on the foliage of small grains?

   a. Stink bugs
   b. Aphids
   c. Hessian fly
   d. Thrips

2. Which of the following pests is considered the most widespread destructive pest in small grains?

   a. Aphids
   b. Cereal leaf beetle
   c. Sawfly
   d. Hessian fly

3. These pests are the larvae of May or June beetles and feed on the roots of small grains.

   a. White grubs
   b. Wireworms
   c. Grasshoppers
   d. Thrips

Complete the following short answer questions.

4. What is meant by "integrated pest management"?

5. List three pest control options that would be available for small grain producers.

   a.

   b.

   c.

6. What are three examples of "nonchemical" pest control methods?

   a.

   b.

   c.

Lesson 4: Selecting a Pest Control Program Name_____

Hessian Fly Report

Objective: Students will obtain information and prepare a report on the Hessian fly.

Directions: Information may be obtained about this insect by contacting any University Extension web site, typing in the insect name on an Internet search engine, or securing the information from an encyclopedia (print or electronic version). Information presented in the report should address the items listed below. The instructor will give report format details.

1. When did the Hessian fly appear in the United States?
2. How did it get its name?
3. Include a description of the insect.
4. Describe its life cycle.
5. How and where does it damage the plant?
6. What are the measures that may be used to control this pest?

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

Competency/Objective: Evaluate the growing crop and determine appropriate solutions.

Study Questions

1. **What plant condition factors are considered when evaluating the growing crop?**
2. **How does one determine when replanting is necessary?**
3. **What amount of weed pressure justifies a herbicide application or mechanical removal?**
4. **What amount of insect pressure justifies an insecticide application?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000.
2. Transparency Master
   a) TM 5.1: Aphid Threshold In Wheat
3. Activity Sheet
   a) AS 5.1: Determining the Corrective Action

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

Lesson 4 gave us an understanding of the factors that need to be considered when selecting a pest control measure. We examined the cost of the control measure, past experiences of producers, considerations that must be given for the environment, and the importance of knowing the specific pest problem. Details were given as to major pest problems and how they may be controlled.

B. ***Motivation***

Ask students if any of them have accompanied their parents when scouting, or evaluating, a growing crop. What did they observe? Were any problems encountered and if so, what solutions were presented?

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Successful producers scout, or evaluate, their growing crop on a regular basis, looking for possible problems and analyzing cultural and mechanical practices they have used to establish that crop. Discuss the factors to consider when evaluating the growing crop.

   What plant condition factors are considered when evaluating the growing crop?

   a) Fertility program
      1) Recognize nutrient deficiency problems.
      2) Use corrective measures, such as nitrogen top-dressing, when necessary in the spring.
   b) Tillage and planting methods used
      1) Seedbed condition plays a large role in stand establishment in the fall.
      2) Evaluate previous crop's residue to determine if a problem has developed (disease or insect overwintering, etc.).
      3) Evaluate expected yields produced from conservation or no-till methods.
   c) Soil moisture levels
      1) Dig into the soil to determine moisture and its depth.
      2) Provide irrigation, if possible, as needed.
   d) Kind and amount of weeds
      1) Evaluate in the fall and in the spring.
      2) Producers must know when and what corrective action must be taken.
   e) Disease and insect damage
      1) Recognize the problem
      2) Know what kind of corrective action must be taken

2. If the wheat or small grain stand does not reach the expected stand density or establishment, a decision must be made concerning replanting. Discuss the conditions that should be considered before replanting.

   How does one determine when replanting is necessary?

a) Decisions are complicated by not knowing what future growing conditions will occur.
b) Decisions should be based on historic trends and current environmental and economic conditions.
c) Decision to replant same crop or replant different crop should be based on the following factors.
    1) Cause and severity of the plant injury
    2) Soil moisture
    3) Replanting costs
    4) Previous herbicide use
    5) Replanting date
d) Replanted crops generally yield less than the original planting.
e) Replanting results in moisture loss.
f) Acceptable yields may result with lower plant populations (12-18 plants per square foot) if the stand is uniform.
g) Generally, stands that are below 30% of the original plant densities or with 4-6 foot gaps in rows should be considered for replanting.

3. One of the major decisions that may need to be made is whether or not a weed control measure is justified for the wheat or other small grain field. The producer's decision must be based on economics. How large is the problem? What kind of corrective measure must be used?

What amount of weed pressure justifies a herbicide application or mechanical removal?

a) Winter and summer annual broadleaf weeds have an important economic impact on wheat and small grains.
b) Weeds compete with the grain for the following factors.
    1) Light
    2) Water
    3) Space
    4) Nutrients
c) Effective weed control can reduce yield losses due to weeds and increase net returns.
d) Weed-free winter wheat stubble will increase the success of reduced and no-till programs.
e) Effective weed control programs consider three control methods.
    1) Prevention
        (a) Plant crop seed that is weed free.
        (b) Clean tractors, implements, and combines before moving them from infested fields to clean fields.
        (c) Keep uncropped areas weed free (fence rows, field borders).
        (d) Do not allow livestock to move directly from infested to clean fields (seeds passed through manure).
        (e) Spray or mow to prevent weed seed production.
    2) Cultural weed control
        (a) Provide a favorable environment for crops but an unfavorable environment for weeds.
        (b) Use crop competition to establish a vigorous stand that competes with weeds for light, space, moisture, and nutrients.
            (1) Proper seedbed preparation
            (2) Adequate fertilization
            (3) High-quality crop seed
            (4) Careful variety selection
            (5) Proper date, rate, and depth of seeding
        (c) Use crop rotations.
            (1) Use spring-seeded crops to break the life cycle of problem weeds.
            (2) Use herbicides not feasible with small grain crops.
    3) Herbicide use
        (a) Some varieties of small grains are more sensitive to herbicides than others.
        (b) Consider the following factors when selecting a herbicide.

(1) Identify the weed problem.
(2) Spray when weeds are small and actively growing.
(3) Use spray equipment in good condition and not contaminated with herbicide previously used.
(4) Calibrate the sprayer to ensure application accuracy.
(5) Read and follow directions on the herbicide label.
(6) Know the rotational plans to avoid herbicide carryover to sensitive crops.

f) Research shows that weeds emerging at the same time as the crop plants may reduce yields up to 35%, while weeds that do not emerge until the 3rd or 4th week after the crop show yield reductions of only 8-12%.

4. As with weed pressure, the producer must inspect for insects and decide a course of action or corrective measures depending on the amount of insect or pest presence. TM 5.1 should be used when discussing aphid levels or thresholds.

What amount of insect pressure justifies an insecticide application?

a) Accurate insect identification is important because some closely resemble others.
b) Identify insects with the following criteria in mind.
   1) Visual appearance
   2) Location in the field
   3) Seasonal occurrence (time of the year)
c) After identification, the population numbers must be determined to see if a point of economic damage is achieved. This is known as the "economic threshold."
d) Fields should be checked in the fall during the first 20-50 days after planting.
   1) Foliar sprays will provide greatest economic returns at this time.
   2) Check at least five spots in each field, examining at least 1 foot of a row.
   3) Check edges of field also.
   4) Pull plants and check roots because some insects are below ground level.
   5) For large plants, slap the plants to jar insects to the ground for counting.
   6) If insect population is light (50 or fewer per foot), determine an exact count.
   7) If insect population is heavy, an estimate is acceptable.
e) Aphids not only cause feeding damage, they may help transmit viruses that cause disease.
   1) There are four main aphids to check for.
      (a) Greenbug
         (1) Particularly prevalent in the fall
         (2) Sucks plants juices and injects toxin that can kill the plant
      (b) English aphid
         (1) More common in the spring
         (2) Can cause reduction in yield during heading
      (c) Oat bird cherry aphid
      (d) Corn leaf aphid
   2) Mild, dry winters and cool, dry springs favor aphid outbreaks.
   3) The following factors affect aphid threshold levels in small grains.
      (a) Size and vigor of the plants
      (b) Temperature
      (c) Time of the year
      (d) Moisture conditions
      (e) Stage of growth
      (f) Presence of parasites and predators of aphids
f) Fall armyworm
   1) Record number of armyworm caterpillars per linear foot of drill row.
   2) Sample the field margins also. Sometimes only the margin needs treatment.
   3) Armyworms attack in the fall during seedling stage, causing extensive damage.
   4) Threshold level is two to three larvae/linear row.
   5) Older plant's threshold is three to four larvae.

g) True armyworm
   1) Name separates them from fall armyworm and cutworm.
   2) They cause damage in the spring by feeding on leaves, beards, and then the kernel.
   3) They cut the stem just below the head of the wheat plant.
   4) They feed mainly at night.
   5) Three to four larvae per linear row-foot is acceptable.
   6) If there is no evidence of head clipping, control may be delayed.
   7) If larvae are mature, control is not advised because larvae will drop to the soil and pupate.

h) Cereal leaf beetles
   1) They may infest late-planted winter grains but mostly affect spring-planted oats.
   2) Adults mate and lay eggs on upper surfaces of the leaves in March and April.
   3) In wheat, one-half to one beetle per tiller when 30% of the eggs have hatched should receive control method.
   4) Threshold level in barley and oats is one and one-half adults or larvae per flag leaf.

i) Hessian fly
   1) This insect is the most important pest of wheat and barley. Oats are never infested with Hessian fly.
   2) Small white maggots feed on joints along the stem. Their toxic salivary secretion stunts plant growth.
   3) Avoid Hessian fly infestations by planting resistant varieties and after the fly-free date for the area.
   4) If 20% of the tillers of susceptible varieties are infected, significant yield losses will result.
   5) Nitrogen application may not produce the yield response to justify the additional costs.
   6) Control by rotating wheat fields, turning under wheat stubble, and destroying volunteer wheat before planting.

F. ***Other Activities***

G. ***Conclusion***

The students should understand the importance of what to look for when evaluating the growing stand of wheat or other small grains. They should examine the results of the nutrient program, how well the crop was established using the tillage and planting methods employed, how to identify weed and insect pressures, and know what corrective measures may be taken. Generally it is not economical to replant stands of wheat and small grains unless 30% or more of the intended populations have been affected by something that prevents growth.

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

1. Possible nitrogen deficiency. Have the field evaluated and a decison may be made to apply nitrogen top-dressing.

2. Nothing would be recommended. This level of winter-kill damage is below the recommended economic level of 30% to justify replanting.

3. This is more than the threshold level of aphids for the plant at this time and justifies the application of an insecticide.

4. Economic loss of yields are to be expected and the producer should consider not planting wheat in that field next year, as well as using a resistant variety in the future.

I. ***Answers to Evaluation***

1. c
2. d
3. a
4. Any three of the following: (1) fertility program, (2) tillage and planting methods, (3) soil moisture, (4) weed pressure, (5) disease and/or insect pressure

5. Any three of the following: (1) use weed-free crop seed; (2) clean tractors, implements, and combine before moving from infested to clean fields; (3) keep uncropped areas (fence lines, field borders, etc.) weed free; (4) do not move livestock directly from infested fields to clean fields; (5) spray or mow to prevent weed seed production

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 5: Scouting and Maintaining the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Stands of wheat and other small grains are generally not replanted unless the plant population is _____ % or less than intended.

   a. 10
   b. 20
   c. 30
   d. 40

2. About _____ % of small grains are treated with herbicides today.

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

3. The point at which corrective measures may be justified in controlling insects is known as the _____.

   a. Economic threshold
   b. Point of diminishing returns
   c. Equilibrium law
   d. Final control point

Complete the following short answer questions.

4. List three factors that should be considered or evaluated when scouting the growing crop.

   a.

   b.

   c.

5. What are three rules of "preventive" weed control?

   a.

   b.

   c.

Aphid Threshold in Wheat

Growth Stage	Treat If There Are More Than:
Seedling (0-30 days after planting)	3 aphids /row foot
Vegetative plants (30-60 days after planting)	6-8 aphids/row foot
Vegetative plants (60 days after planting to start of jointing)	10 aphids/row foot
Jointing	2 aphids/stem
Boot/flag leaf stage	5 aphids/stem
Head emergence to dough	10 aphids/head, including the flag leaf
Mid-dough to maturity	Do not treat

Lesson 5: Scouting and Maintaining the Crop Name_____

Determining the Corrective Action

Objective: Students will analyze possible problems with wheat or other small grain production and determine a corrective action.

Directions: Read the scenarios below and state if a corrective action should or should not be taken, and if so, what action you may recommend.

1. During the spring, no insects or diseases are found; however, the plants seem small and not as dark a green color as they should be. Possible corrective action:

2. About 20% of the wheat crop did not survive the winter. The rest of the crop looks fine. Possible corrective action:

3. When scouting the wheat field 25 days after planting, the producer noticed an average of five aphids per row-foot of drilled grain. Possible corrective action:

4. During the spring, the producer found about 30% of the tillers of the Hessian fly-susceptible wheat were infested with Hessian fly maggots. Possible corrective action:

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 6: Harvesting the Crop

Competency/Objective: Identify factors to determine harvesting and post-harvesting management.

Study Questions

1. **What factors determine harvest timing?**
2. **What factors affect seed damage at harvest?**
3. **What are the major sources of crop loss during harvest?**
4. **What are local storage options?**
5. **What are storage problems associated with wheat and other small grains?**
6. **How is crop quality maintained during storage?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VIII.
2. Transparency Masters
   a) TM 6.1: Beginning Dates for Winter Wheat Harvest in the United States
   b) TM 6.2: Harvest Time Indications
   c) TM 6.3: Combine Settings for Wheat Harvesting
   d) TM 6.4: Checking Wheat Harvest Losses
   e) TM 6.5: Correcting Wheat Harvest Losses
3. Activity Sheet
   a) AS 6.1: Determining Grain Loss and Moisture

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 6: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

Lesson 5 gave us an understanding of what to look for when scouting the growing wheat or other small grain crops for problems that may impede yields. We also looked at damage caused by weeds and insects and discussed when it may be appropriate to consider replanting.

B. ***Motivation***

Secure grain samples that have a high moisture content, insect and/or mechanical damage, and a sample that is clean with about a 12% moisture content. Ask the students to identity the problems and discuss why buyers would dock the undesirable samples.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Knowing when to harvest is a management practice that producers must know. This study question will discuss factors that must be considered when making that decision. TM 6.1 and TM 6.2 would be used during this discussion to show beginning dates for harvesting winter wheat in the United States and harvest time indicators.

   What factors determine harvest timing?

   a) Usual times for winter wheat harvest to begin in Missouri is between June 16 and June 30.
      1) Times may vary depending on the condition of the crop (usually the moisture content).
      2) Barley and oat harvesting takes place at approximately the same time.
   b) Optimum time to harvest is when grain contains about 12.5% moisture.
      1) Harvest can occur at higher moisture levels (20%) if the producer has the capabilities of quick crop drying.
      2) High moisture grain delivered immediately to commercial buyers will be devalued (docked) according to the moisture amount.
      3) Moisture meter or oven-drying method may be used to determine when to harvest.
      4) Harvesting early, at higher moisture levels (above 15%) may have an advantage of increasing profit potential of a second crop in a double-cropping system.
      5) Early harvesting can increase yields owing to higher test weight and less shatter loss at the header.

2. The combine must be adjusted to the proper settings and then fine-tuned when harvesting to reduce harvest losses or damage of grain. Use TM 6.3 to show combine settings for harvesting wheat.

   What factors affect seed damage at harvest?

   a) The major portion of damage occurs during the threshing operation at harvest.
   b) Threshing occurs at the cylinder or front portion of the rotor and is affected by the concave clearance and the cylinder/rotor speed.
   c) Symptoms of overthreshing are cracked grain and excessive amounts of return.

d) To avoid overthreshing, set the cylinder speed and concave clearance according to operator's manual.
   1) Some operators prefer to leave an occasional kernel in the head as a sign of the best balance in threshing action.
   2) Consult the operator's manual for oat and barley settings.

3. While harvesting or operating the combine, the producer must check for harvest losses and for how well the combine is adjusted. This discussion will indicate where and how these inspections may take place. Use TM 6.4 and TM 6.5 to show examples of how to check for wheat harvest losses and options for correcting losses.

What are the major sources of crop loss during harvest?

a) Minor adjustments of the combine may make the difference of 8-10 bushels of grain saved during harvest.
b) Engine speed is one of the most important settings. Speed too slow will also cause the separator speed to be to slow and performance will suffer.
c) Fine-tuning the combine involves considering the five basic functions or operations of the combine.
   1) Cutting and feeding
   2) Threshing
   3) Separating
   4) Cleaning
   5) Handling
d) Cutting and feeding adjustments include header and cutting height, reel speed and height, and reel position (moved forward or backward).
   1) Cutting height is controlled by the operator raising and lowering the table as conditions change.
   2) The goal is to harvest all of the grain with a minimum amount of chaff and straw.
   3) The reel should be adjusted slightly ahead of the cutter bar so as to move the grain gently into the cutter.
   4) The reel should also turn slightly faster than the ground speed to lay the heads on the platform.
e) Threshing occurs between the concave and the cylinder/rotor.
   1) Check setting with the operator's manual.
   2) Verify setting. Bars and concave may be worn so the distance may be greater than the pointer would indicate.
   3) Concave and cylinder must be parallel.
f) Separation takes place between the chaffer and the shoe openings.
   1) Airflow should be adjusted so the grain falls through the first 2/3 of the chaffer.
   2) Proper sieve opening should be large enough for grain to pass through without allowing foreign material into the grain bin.
   3) Ground speed should not overload the straw walkers.
   4) Reducing ground speed 25% on overloaded walkers could cut harvesting losses in half.
g) Three ground counts should be made to check harvest losses.
   1) A preharvest count in front of the combine
   2) A header count after backing up about 20 feet
   3) A separator count behind the combine
h) A usual (acceptable) loss is about 2% of the total yield. Acceptable loss is higher for downed or damaged preharvested grain.

4. What to do with the grain after it is harvested is a question that must be addressed and answered after each harvest season. Four options will be discussed.

What are local storage options?

a) On-farm storage
   1) Advantages
      (a) More efficient use of labor and equipment
      (b) Earlier harvest possible
      (c) Potential for grain drying returns
      (d) Additional marketing flexibility
      (e) Potential for higher net returns (if cash markets go up)
      (f) Provides tax management flexibility
   2) Disadvantages
      (a) On-farm storage of grain is costly.
      (b) Additional labor and management are required.
      (c) There is risk of grain quality loss.
      (d) There is a potential for lower net prices (if markets go down).
      (e) There are risks of selling overdry grain.

b) Commercial storage
   1) Space is rented at a grain elevator.
   2) Storage rent is usually 3 to 4¢ per bushel per month.
   3) Producers will not recover the exact grain but it will be the same quality.

c) Price-later contracts
   1) This is a deferred price agreement with the elevator that receives the grain.
   2) Producers retain the right to price at a later date, usually the same price offered on the particular day on the cash grain market.

d) Futures market positioning
   1) This means selling the grain on the cash market at harvest and purchasing a long (buy) position in the grain futures market.
   2) This option is considered a method of "storing on paper."
   3) Substantial risk is involved. The price of grain could go down and would be the same as a cash loss.

5. There are four major problems that would be associated with storage of grain on the farm. This question discusses these problems.

What are storage problems associated with wheat and other small grains?

a) Poor initial grain quality
   1) Kernels may be cracked during threshing (harvesting).
   2) This may occur due to unfavorable harvest conditions at the time.
   3) Damaged kernels lead to storage mold development and possible insect invasion.

b) Moisture migration
   1) Moisture may shift from place to place.
   2) Changes in temperature may lead to air currents carrying moisture from one part of the bin to another.
   3) Pockets of moisture may be created and can spoil the grain.
   4) Problems may be corrected with aeration.

c) Storage mold development
   1) Significant damage is caused to the grain.
   2) Fungi are always involved when spoilage occurs.
   3) High moisture and high temperature cause serious grain quality losses.

d) Insect and rodent invasion
   1) Insects and rodents are a major cause of loss in stored grain.
   2) They consume grain and contaminate it with insect fragments, feces, webbing, and bad smelling metabolic products.
   3) Several hundred insects are associated with stored grain, but only a few cause serious damage.
   4) Insect invasion is usually associated with dirty facilities and inadequate control of moisture and temperatures.

5) Insect identification and knowing insect control measures are important to preventing serious losses.

6. Producers should know what they can do to keep good quality grain from deteriorating during storage. This question will discuss this issue and provide some solutions to maintaining quality in stored grain.

How is crop quality maintained during storage?

a) Many physical factors affect the market quality of grain.
   1) Moisture content
   2) Test weight
   3) Shrunken and broken kernels

b) Deteriorated grain
   1) Molds discolor the germs of the grain, leading to increased damaged kernel counts.
   2) Discounts may range from 1¢ to 15¢ per bushel.
   3) Presence of insects may lead to 5-10¢ per bushel discounts.
   4) Uncontrolled molds lead to objectionable odors.
   5) Problems may lead to grain being designated as "sample grade" with discounts of 10¢ per bushel or complete rejection.

c) Preventing discounts
   1) Sanitation
   2) Monitoring
   3) Aeration
   4) Proper use of chemicals

d) Drying grain
   1) Grain must be dried to less than 12.5% moisture and cooled within 4 days to ensure against growth of molds and invasion of insects.
   2) The higher the moisture of stored grain, the faster heated air should be moved through the storage bin.

e) Insect damage
   1) Insects are the most difficult part of farm storage to control.
   2) Over 20 different insects survive in grain.
   3) Stored grain insects have a life cycle of 4-12 months.
   4) Insect reproduction is related to temperature during their life cycle.
   5) Optimal feeding temperatures are from 70 to 90°F.
   6) The lesser grain borer is the most damaging grain insect during storage.
   7) Temperatures below 50°F control insect reproduction.
   8) Discounts related to insect presence can be reduced with IPM (integrated pest management).
   9) There are minimum insect densities at which controls are cost-effective.
      (a) If more than two insects are found in samples, take a total of five samples/bin.
      (b) If lesser grain borers or weevils (internal feeders) are found in more than one sample, fumigation may be necessary unless entire grain mass can be cooled to below 50°F within 3 weeks.
      (c) If only external-feeding insects (flat or rusty grain beetles, flour beetles, meal moths, saw-tooth grain beetles, etc.) are found, an average of two per sample is usually acceptable if the grain can be cooled to below 50°F within 2 months.

f) Structures
   1) Should hold the grain without loss from leaks or spills
   2) Prevent rain, snow, or soil moisture from reaching the grain
   3) Protect grain from rodents, birds, objectionable odors, and theft
   4) Provide safety from fire and wind damage
   5) Permit effective treatment to prevent or control insect infestation
   6) Provide headroom over the binned grain for sampling, inspecting, and ventilating

g) Sanitation

1) Cleaning and sanitizing the storage area are critical in maintaining small grain quality while in storage.
2) Cleaning and sanitizing should be done immediately after emptying and again 4-6 weeks prior to filling.
3) Critical infestation areas to clean include floor area, unloading pits, augers, sump pits, bin walls, ladder rungs, opening with attached debris, handling equipment, and aeration ducts.
4) Crossover infestation can occur if adjacent grain bin is dirty.
5) New grain should not be placed on top of old grain.
6) Treat bins after cleaning with insecticides.
7) Insecticides may be placed on grain kernels entering storage (as bin is being loaded). This may be in a spray or dust form.
8) Fumigation requires special training and is usually done by a licensed commercial applicator.

h) Monitoring
1) Best management practice is monthly inspections throughout the storage period.
2) Frequent monitoring can reduce risk of major deterioration.
3) Grain probe, moisture meter, temperature measuring device, and screening pans are required.
4) Inspect more than just the surface of the grain - insects tend to concentrate in top layer and gives false impression of infestation levels.

F. *Other Activities*

1. Visit a local small grain producer and examine the grain storage and handling facilities.

2. Visit a local grain elevator and have the manager give a tour of the grain storage, drying, and handling facilities. Ask the manager to explain what happens to the grain received from producers.

G. *Conclusion*

It is important that small grain producers know harvest signals and times. The calendar and moisture levels signal when harvest should begin. Producers should also know how to adjust combines to reduce harvest losses and be able to inspect in front of and behind combines to check losses. Most grain is lost during the threshing operation. Grain is usually stored on the farm before marketing; however, there are some other options. These include storing at the local grain elevator, using a price-later contract, or purchasing a futures contract. Storage losses may be reduced by properly cleaning the facilities, monitoring grain quality during the storage period, knowing and using proper aeration methods, and properly using chemicals to treat grain problems.

H. *Answers to Activity Sheet*

1. Average of 35, 44, and 38 is 39. Average of 56, 52, and 63 is 57.

$$\text{Header loss} = \frac{57 - 39}{20} = \textbf{.9 bushel}$$

2. Average of 128, 140, and 134 is 134

$$\text{Separator loss} = \frac{134 - 57}{80} = \textbf{.96 bushel}$$

3. .9 plus .96 = **1.86 bushel**

4. $\frac{.5 - .4}{.5} \times 100 =$ **20% moisture**

I. ***Answers to Evaluation***

1. d
2. d
3. d
4. During the threshing operation. Make sure the concave/cylinder clearance is properly adjusted and the cylinder/rotor speed is correct.

5. Any three of the following: more efficient use of labor and equipment, earlier harvest is possible, potential for grain drying returns, additional marketing flexibility, potential for higher net returns, and/or provides tax management flexibility.

6. Any three of the following: poor initial grain quality leading to mold development or insect invasion, moisture migration, storage mold development, and/or insect and rodent invasion.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 6: Harvesting the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Small grain harvest time in Missouri usually begins _____.

   a. May 1 - May 15
   b. May 16 - May 30
   c. June 1 - June 15
   d. June 16 - June 30

2. Small grain that is harvested with over a _____ % moisture level should be dried when entering storage.

   a. 10
   b. 11.5
   c. 12
   d. 12.5

3. Grain bins should be cleaned and sanitized _____

   a. 1 month after emptying
   b. Immediately after emptying
   c. 4 to 6 weeks before filling
   d. Both b and c

Complete the following short answer questions.

4. During which function of the harvesting operation is most grain lost? Explain how this can be corrected.

5. List three advantages of storing grain in on-farm storage after harvesting and before marketing.

   a.

   b.

   c.

6. What are three possible problem areas that may develop in stored grain?

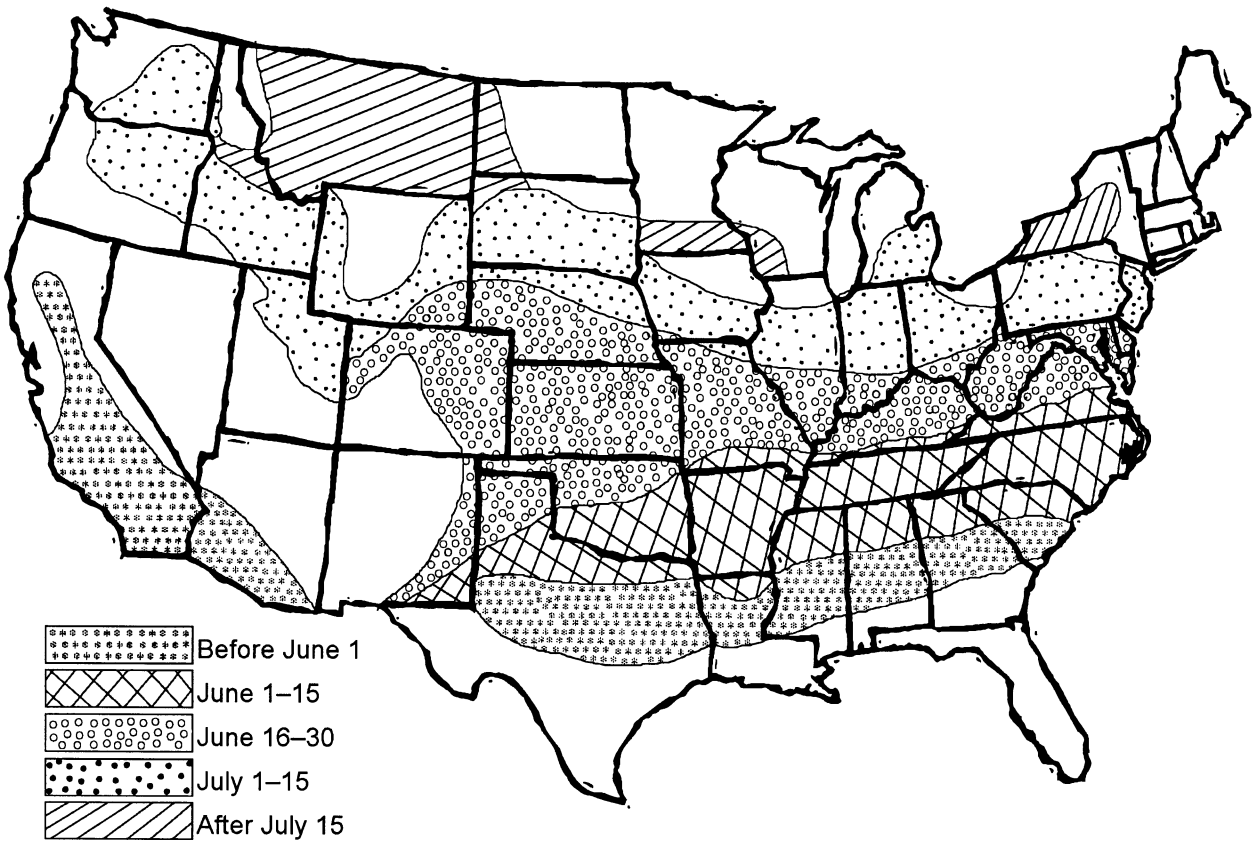
   a.

   b.

   c.

TM 6.1

Beginning Dates for Winter Wheat Harvest in the United States



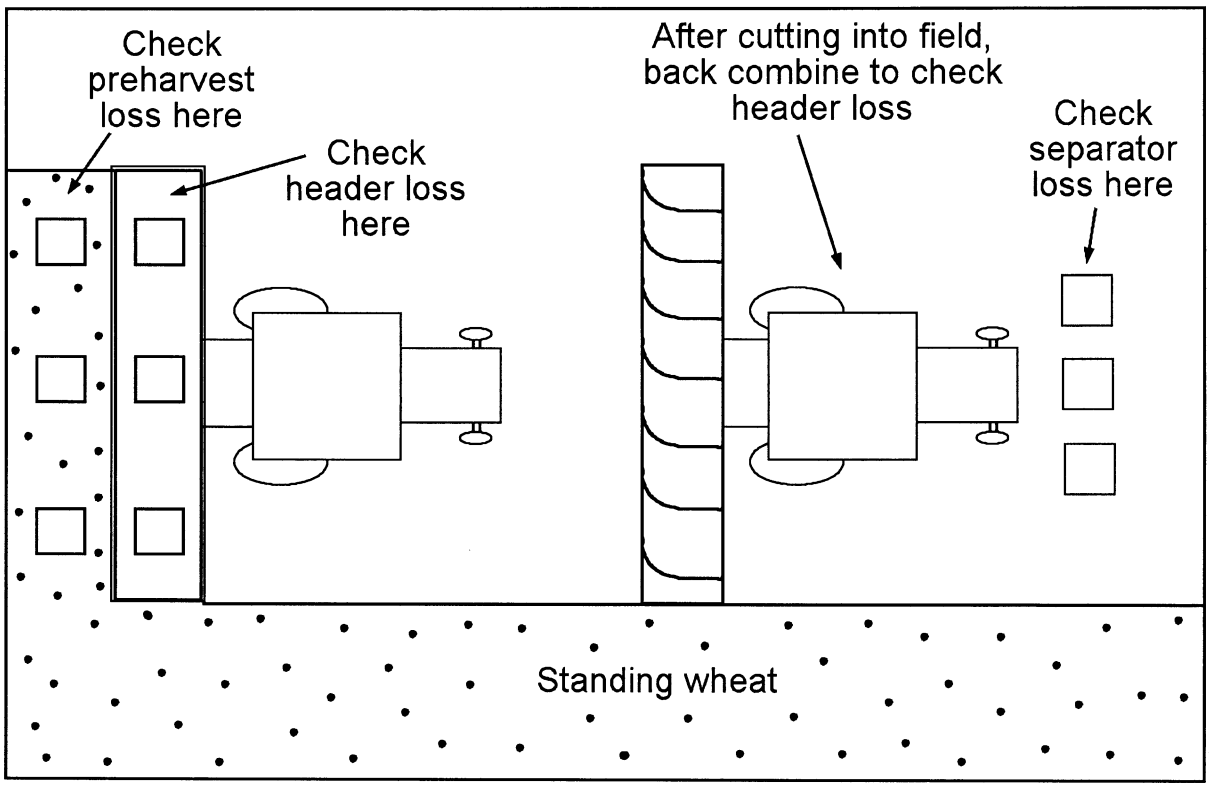
Harvest Time Indications

Crop	Percent Moisture	Plant Maturity Stage	Physical Plant Signs for Harvest	Method Used to Harvest
Wheat	below 14%	a little past hard dough stage	majority of kernels shell out when rubbed between hands	direct combine
Oats	no more than 13-14%	hard-dough or 2-3 days later	when the straw shows no greenness and the heads have turned a dull white	direct combine or windrow-pickup combine
Barley	below 14%	hard-dough stage	when heads have turned golden yellow but straw may be slightly green	direct combine or windrow pickup combine

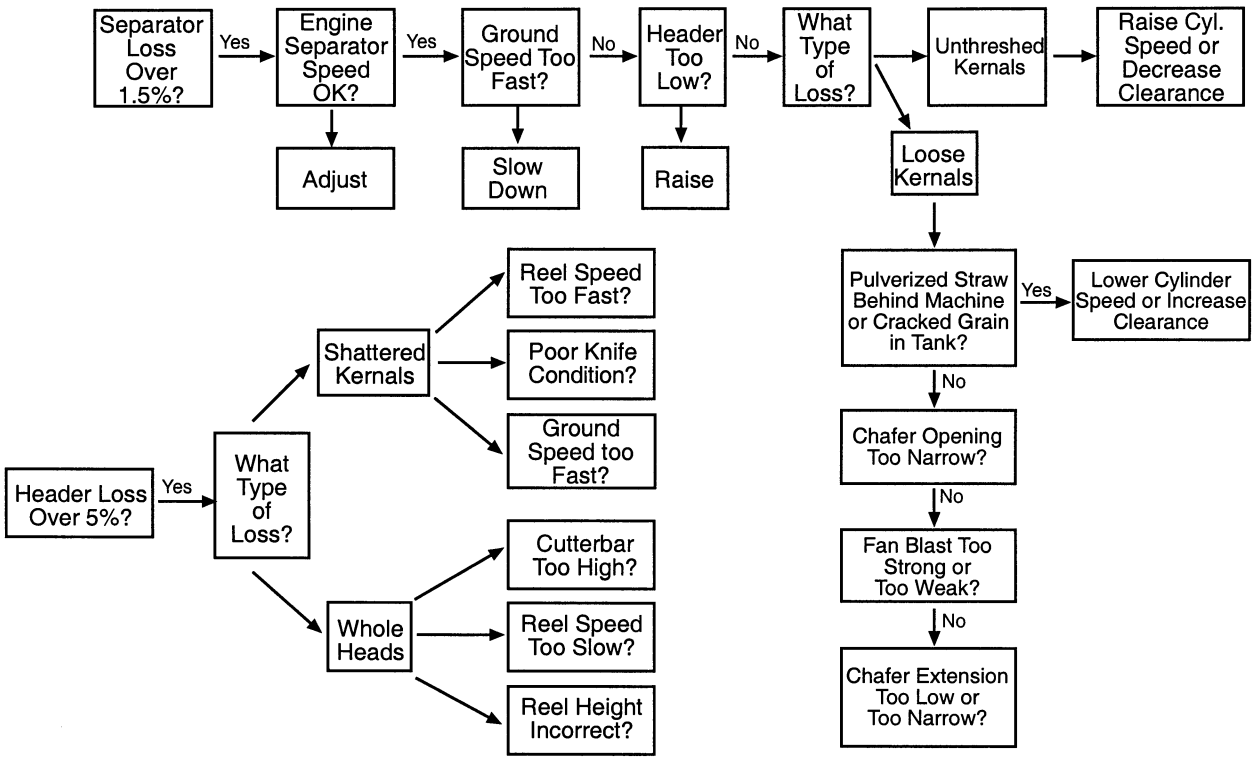
Combine Settings for Wheat Harvesting

	Range	Recommended
Chaffer opening (inches)	1/4 to 3/4	5/8
Sieve opening (inches)	1/8 to 3/8	1/4
Fan setting (speed or choke)	medium to high	near high end
Cylinder/rotor speed (rpm)	750 to 1350	1000
Cylinder/rotor & concave spacing (inches)	1/8 to 1/2	1/4

Checking Wheat Harvest Losses



Correcting Wheat Harvest Losses



Lesson 6: Harvesting the Crop Name_____

Determining Grain Loss and Moisture

Objective: Students will determine the amount of grain that may be lost from certain harvesting conditions.

Directions: Using the information supplied in the student reference, determine the answer to the following situations.

1. The producer laid a 1-foot square frame down three times in standing wheat and secured a count of 35, 44, and 38 grains of wheat. The same procedure was then done in front of the header after the combine was backed about 20 feet and counts of 56, 52, and 63 kernels of wheat were obtained. What was the "header" loss (bushels/acre) from the harvesting operation?

2. The producer then made a count behind the combine not equipped with any type of straw-spreading device and secured the following numbers: 128, 140, and 134. What did the producer figure as the "separator" loss (bushels/acre) from the harvesting operation?

3. What was the producer's total loss of grain (bushels/acre) from the harvesting process?

4. The producer was also interested in finding out the moisture content of the grain but did not have a moisture meter. He took a 1/2-pound sample of the harvested grain, dried it in an oven at 260°F overnight, and found that it weighed .4 of a pound the next morning. What was the moisture content of the grain sample?

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 7: Marketing the Crop

Competency/Objective: Describe marketing opportunities.

Study Questions

1. **What options are available for marketing wheat or other small grains?**
2. **How do producers determine when to sell, feed, or store wheat or other small grains?**
3. **How does grain quality of wheat and other small grains affect price?**
4. **How are wheat prices affected by international markets?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VIII.
2. Transparency Masters
   a) TM 7.1: The Marketing Greed Chart
   b) TM 7.2: Grades and Grade Requirements for Wheat
   c) TM 7.3: Grades and Grade Requirements for Barley
   d) TM 7.4: Grades and Grade Requirements for Oats
3. Activity Sheet
   a) AS 7.1: World Wheat Production and Projections

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 7: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

Our last lesson focused on factors that are important for the small grain producers when harvesting their crop. We learned that moisture content plays a large roll in harvest timing and harvest losses. We also learned how to measure harvest losses and make adjustments in the combine to reduce or eliminate those losses. Since most wheat in Missouri is stored after harvest, we also discussed storage options and storage problems that may affect the quality and marketing of small grains.

B. ***Motivation***

Ask students to identify different options for marketing small grains. List those on the board and see if the students could produce advantages and/or disadvantages of each. You may also ask them if they can identify the major countries that play a role in international marketing of small grains, especially wheat.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Producers of small grains should know there are three basic options for marketing their product. This study question will address these three options and factors to consider in determining which option they may choose.

   What options are available for marketing wheat or other small grains?

   a) Important facts about small grains to help understand marketing options of those grains
      1) Wheat
         (a) More than 50% of wheat grown in the United States is exported.
         (b) 33% is consumed domestically as a food product (flour, etc.).
         (c) 8% is used for livestock feed.
         (d) 4% is used for seed.
      2) Barley
         (a) 57% used as feed for livestock and poultry
         (b) 40% used for food, alcohol (including malting), and industrial uses
         (c) 3% used for seed
      3) Oats
         (a) 55% is harvested for grain.
            (1) 50% is fed to livestock.
            (2) 25% is used for food, seed, and industrial uses.
            (3) 2% is exported to foreign customers.
            (4) Remainder is stored for future use.
         (b) 45% of acreage is used for grazing cattle or sheep, as a cover crop protecting farmland from wind and water erosion, or oat hay for winter forage for livestock.
   b) Three basic options for the marketing of wheat or other small grains
      1) Harvest for grain only
         (a) Most grains in Missouri are marketed through this method.
         (b) After harvesting, producers have two choices.

(1) Sell on cash market.
(2) Hold (store) for later sales.

(c) Retaining ownership may be done on the farm or through the purchase of a futures contract.

(d) Both concepts involve risk and provide an opportunity to speculate on improved grain prices.

2) Use for grazing and then harvest for grain

(a) This option is used if traditional forages are low or depleted, or if planting date, growing conditions, moisture levels have produced expected growth.

(b) Research shows little or no effect on yields if managed properly.

(c) Remove livestock before jointing takes place in the fall.

(d) Fertilize in spring after removing spring-grazing animals.

3) Used in a forage system

(a) Crop is used for early spring pasture; animals are removed; then cut, bale, and store the forage for use the following winter.

(b) Determining the net returns through this type of marketing will be difficult.

(c) Genetic potential, feed conversion, setbacks due to disease/parasites, etc., will affect value received through the forage.

2. The timing of when to sell or when to use other options of marketing small grains involves experience, gathering information, making a marketing plan, and using discipline in following the plan. Use the "greed" transparency (TM 7.1) to demonstrate how waiting can lead to lower returns.

How do producers determine when to sell, feed, or store wheat or other small grains?

a) Good marketing requires getting a clear picture of pricing and delivery alternatives.

b) Marketing goal is to aim for higher than average net returns.

c) Some producers sell for reasons not related to maximizing returns.
1) Bin space is limited.
2) Fertilizer payments are due.
3) It is the end of the calendar year.
4) The weather is good, promising a bumper future crop.
5) Make room for next year's crop.

d) Experienced marketers have two things in common.
1) A market plan
2) Selling discipline

e) One of the first things producers must know before deciding to sell, feed, or store is their cost of production.
1) They should consider spreading sales over 12-24 months.
2) This allows an opportunity to price into three or four market rallies in an average crop year.

f) There are some typical price slumps producers should avoid.
1) During harvest
2) As 90-day storage expires
3) During cash flow selling periods such as spring

g) Another key component is for producers to stay informed of market data.
1) Gather sources of information.
2) The telephone is still a powerful tool and information source.
3) Contact buyers, dealers, millers, brokers, and analysts on a regular basis.
4) Use the Internet, printed market reports, television and radio market new services.

h) The most common selling strategy is the "wait and see" approach.

3. There is a direct relationship between the quality of the grain and the price that will be received. Use TMs 7.2, 7.3, and 7.4 to explain how the grades of wheat, barley, and oats are determined.

How does grain quality of wheat and other small grains affect price?

a) Grain quality characteristics are listed below.
   1) Protein content
   2) Strength of gluten
   3) Weight per bushel
   4) Amount of dockage
   5) Grades
   6) Milling data
   7) Physical dough analysis
b) These characteristics have an effect on price.
c) Information on wheat (grain) quality helps producers obtain better prices.
d) Grain buyers can also use this to determine areas of production (parts of the state) where they can find the grain to meet their requirements.
e) Quality grades are built into futures contracts. The following example demonstrates this.
   1) Wheat is priced on a U.S. No. 2 grade.
   2) If the grain is U.S. No. 1, a premium is paid.
   3) If the grain is U.S. No. 3, a dock, or discount, is assessed.

4. The grain markets today are affected more than ever before by what is taking place in other major grain producing and consuming nations. These factors along with U.S. governmental policies have a great impact on the price structure of grain producers in the United States.

How are wheat prices affected by international markets?

a) World markets are replacing domestic markets in determining grain prices and farm incomes.
   1) U.S. producers must compete to survive in a global economic environment.
   2) This also means markets exist where they did not exist before.
b) These markets must be identified and cultivated.
   1) Missouri has agricultural marketing offices in several foreign countries for this purpose.
   2) They seek out markets and promote agricultural products.
c) Wheat is the principal food grain in the United States and throughout the world.
d) Price determination is controlled by supply and demand factors as well as governmental policies.
   1) Supply factors
      (a) Beginning or carryover stocks from previous year's crops
      (b) Import amounts from other countries
      (c) Amount of grain produced by the United States and other countries
   2) Demand factors
      (a) Food, seed, and industrial uses of wheat
      (b) Feed usage for livestock
      (c) Amount of wheat exported to other countries
e) Government policies
   1) Food Security Wheat Reserve (FSWR) of 1980/81 provided for government-held reserves for emergency food needs of developing countries.
   2) FSWR was replaced by the 1996 Farm Act as the Food Security Commodity Reserve (FSCR) to include other grains.
   3) This amounted to 93 million bushels of wheat in 1996.
      (a) These carryover stocks have an impact on prices.
      (b) If stocks decline, farm prices tend to increase.
f) Major wheat competitors of the United States include the following countries.
   1) European Union (EU)
   2) Argentina
   3) Australia
   4) Canada
g) A crop shortfall in one of these countries can lead to increase prices and export opportunities for the United States.

h) Major importers of wheat is include the following countries.
   1) North African nations (Algeria, Morocco, and Egypt)
   2) Middle East (Iran)
   3) Asia (China, Indonesia, Philippines, Pakistan)
   4) Former Soviet Union countries (Kazakstan, Russia, Ukraine)

i) Global carryover of grain stocks also affects prices.
   1) As global stocks decrease, world prices tend to increase.
   2) Their effect on global wheat prices also follows an inverse relationship.

F. *Other Activities*

1. Have a grain buyer visit the class to discuss the grain buying process and what buyers look for when buying grain from producers.

2. Secure a video on International production of food grains. Visual Education Productions (VEP) (1-800-235-4146) has a video available for purchase, *World Agriculture and Population: Seeking a Balance for Survival*, which discusses population and food supply.

G. *Conclusion*

Marketing options for wheat and other small grains such as barley and oats include using the crop for forage purposes, using the crop for grazing and grain harvesting, and harvesting the crop for grain purposes only. If harvested for grain, producers may retain ownership of the grain through storage on the farm or buying a futures contract, or selling the grain on the cash market immediately after harvesting. Factors to consider when deciding whether to sell, store, or feed the crop could be determined by the producer's cost of production and the price of the grain on the cash market. One of the keys to making informed decisions is to stay informed. This can be done through several sources such as using the telephone to contact buyers and market analysts, and keeping informed through media methods (printed reports, Internet, radio, etc.). The quality of the grain produced will have a direct effect on the price received by the producer. International markets and production of grains play a large role in price determination for U.S. grain. The largest competitors with the United States in the production of wheat are Argentina, Australia, Canada, and the European Union (EU).

H. *Answers to Activity Sheet*

Answers will vary each year.

I. *Answers to Evaluation*

1. c
2. a
3. d
4. a. Harvest for grain only
   b. Use for grazing and then harvest for grain
   c. Use in a forage system exclusively

5. One of the following:
   a. Store on the farm and wait for appropriate time to sell on the cash market.
   b. Sell on the cash market and purchase a futures contract (storage on paper) and later sell (hedging process).

6. Carryover stocks usually have an inverse relationship to grain prices. As stocks increase, the price of the grain decreases.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 7: Marketing the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Approximately what percent of the wheat grown in the United States is exported to other countries?

   a. 30%
   b. 40%
   c. 50%
   d. 60%

2. Most of the oats grown in the United States is _____.

   a. Harvested for grain and fed to livestock
   b. Exported to foreign countries
   c. Stored for future use
   d. Used for food, seed, and industrial uses

3. A major importer of wheat grown in the United States is _____.

   a. Australia
   b. Canada
   c. Argentina
   d. Egypt

Complete the following short answer questions.

4. What are the three basic options small grain producers have for marketing their grain?

   a.

   b.

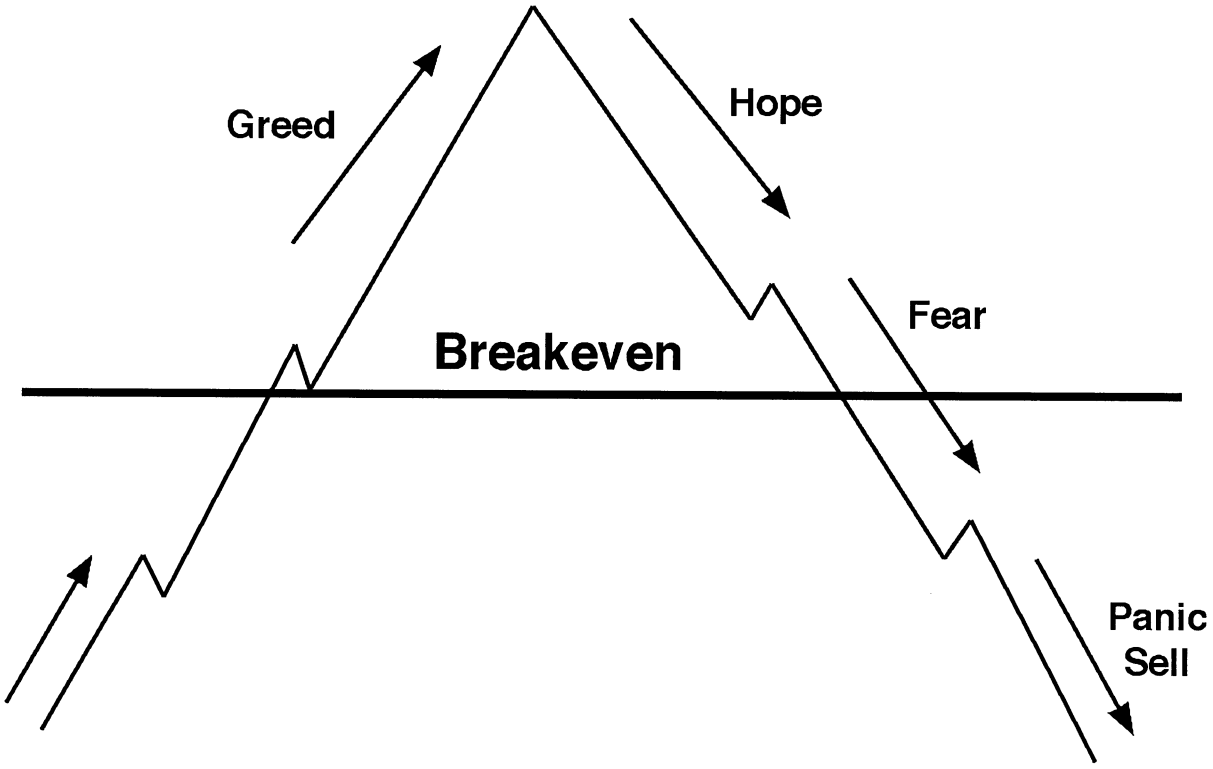
   c.

5. Explain one method a producer may use to retain ownership of the grain after harvest.

6. Explain the relationship that carryover stocks may have on grain prices.

TM 7.1

Marketing Greed Chart



Grades and Grade Requirements for Wheat

Grading Factors	Grades U.S. Nos.				
	1	2	3	4	5
Minimum pound limits of:					
Test weight per bushel					
Hard Red Spring or White Club wheat	58.0	57.0	55.0	53.0	50.0
All other classes and subclasses	60.0	58.0	56.0	54.0	51.0
Maximum % limits of:					
Defects:					
Damaged kernels					
Heat (part of total)	0.2	0.2	0.5	1.0	3.0
Total[1]	2.0	4.0	7.0	10.0	15.0
Foreign material	0.4	0.7	1.3	3.0	5.0
Shrunken and broken kernels	3.0	5.0	8.0	12.0	20.0
Total	3.0	5.0	8.0	12.0	20.0
Wheat of other classes[2]					
Contrasting classes	1.0	2.0	3.0	10.0	10.0
Total[3]	3.0	5.0	10.0	10.0	10.0
Stones	0.1	0.1	0.1	0.1	0.1
Maximum count limits of:					
Other material:					
Animal filth	1	1	1	1	1
Castor beans	1	1	1	1	1
Crotalaria seeds	2	2	2	2	2
Glass	0	0	0	0	0
Stones	3	3	3	3	3
Unknown foreign substances	3	3	3	3	3
Total[4]	4	4	4	4	4
Insect-damaged kernels in 100 grams	31	31	31	31	31
U.S. Sample grade is wheat that: (a) Does not meet the requirements for U.S. Nos. 1, 2, 3, 4, or 5; or (b) Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or (c) Is heating or of distinctly low quality					

[1]Includes damaged kernels (total), foreign material, and shrunken and broken kernels.
[2]Unclassed wheat of any grade may contain not more than 10.0 % of wheat of other classes.
[3]Includes contrasting classes.
[4]Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, or unknown foreign substance.

Grades and Grade Requirements for Barley

Grade	Minimum limits of		Maximum limits of				
	Test weight per bushel (pounds)	Sound barley (%)	Damaged kernels[5] (%)	Heat-damaged kernels (%)	Foreign material (%)	Broken kernels (%)	Thin barley (%)
U.S. No. 1	47.0	97.0	2.0	0.2	1.0	4.0	10.0
U.S. No. 2	45.0	94.0	4.0	0.3	2.0	8.0	15.0
U.S. No. 3	43.0	90.0	6.0	0.5	3.0	12.0	25.0
U.S. No. 4	40.0	85.0	8.0	1.0	4.0	18.0	35.0
U.S. No. 5	36.0	75.0	10.0	3.0	5.0	28.0	75.0

U.S. Sample grade is barley that:
(a) Does not meet the requirements for the grades U.S. Nos. 1, 2,3,4, or 5; or
(b) Contains 8 or more stones or any number of stones that have an aggregate weight in excess of 0.2% of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria* spp.), 2 or more castor beans (*Ricinus communis* L.) 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), 8 or more cocklebur (*Xanthium* spp.) or similar seeds singly or in combination, 10 or more rodent pellets, bird droppings, or equivalent quantity of other animal filth per 1 ⅛ to 1 ¼ quarts of barley; or
(c) Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or
(d) Is heating or otherwise of distinctly low quality.

[5]Includes heat-damaged kernels. Injured-by-frost kernels and injured-by-mold kernels are not considered damaged kernels.

Grades and Grade Requirements for Oats

Grade	Minimum limits		Maximum limits		
	Test weight per bushel (pounds)	Sound oats (%)	Heat-damaged kernels (%)	Foreign material (%)	Wild oats (%)
U.S. No. 1	36.0	97.0	0.1	2.0	2.0
U.S. No. 2	33.0	94.0	0.3	3.0	3.0
U.S. No. 3[6]	30.0	90.0	1.0	4.0	5.0
U.S. No. 4[7]	27.0	80.0	3.0	5.0	10.0
U.S. Sample grade are oats that: (a) Do not meet the requirements for the grades U.S. Nos. 1, 2, 3, or 4; or (b) Contain 8 or more stones that have an aggregate weight in excess of 0.2% of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria* spp.), 2 or more castor beans (*Ricinus communis* L.) , 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), 8 or more cocklebur (*Xanthium* spp.) or similar seeds singly or in combination, 10 or more rodent pellets, bird droppings, or equivalent quantity of other animal filth per 1 ⅛ to 1 ¼ quarts of oats; or (c) Have a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or (d) Are heating or otherwise of distinctly low quality.					

[6]Oats that are slightly weathered shall be graded not higher than U.S. No. 3.
[7]Oats that are badly stained or materially weathered shall be graded not higher than U.S. No. 4.

Lesson 7: Marketing the Crop Name_____

World Wheat Production and Projections

Objective: Students will determine the major wheat-producing and importing countries, their production rankings, and projected wheat production for the coming year.

Directions: Access the Foreign Agricultural Service on the Internet using the following web address: <www.fas.usda.gov>. Select "Grain commodities," then "world agricultural production" and answer the following questions.

1. List the 3 years that are covered by the World Wheat Yield and Production summary (two completed and one projected).

   a. _____

   b. _____

   c. _____

2. What are the four largest wheat exporters (producers) of wheat, in order of production?

   a. _____

   b. _____

   c. _____

   d. _____

3. What are five of the major importing countries for wheat?

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

4. Which country had the largest percent increase (change in production) from the previous year?

   a. _____

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 8: Figuring Crop Costs

Competency/Objective: Calculate cost per acre.

Study Questions

1. **What variable costs are associated with wheat and small grain production?**
2. **What fixed costs are associated with wheat and small grain production?**
3. **What factors are considered when determining an acceptable return on investment?**
4. **How is cost per acre calculated?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VIII.
2. Transparency Masters
   a) TM 8.1: Variable Costs Per Acre for Wheat
   b) TM 8.2: Fixed Costs Per Acre for Wheat
3. Activity Sheet
   a) AS 8.1: Determining Crop Costs and Returns

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 8: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

The previous lesson discussed opportunities for marketing wheat or small grain crop. These included cash and futures marketing. Students also learned about factors that affect prices, such as moisture docking and drying costs. These factors were used in deciding whether the crop should be stored or sold at harvest.

B. ***Motivation***

Ask students if they have an idea of how much it costs to produce a bushel of wheat. Then ask or give information about what wheat is bringing on the cash market today. Have them determine how many bushels of wheat would they have to produce to purchase a $25,000 farm truck.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Give the definition of variable costs. See if the students can give examples of these costs. They must understand what makes up these type of costs. Use TM 8.1 to explain variable costs.

   What variable costs are associated with wheat and small grain production?

   a) Must be determined to figure break-even prices of a crop
   b) Also known as operating costs
   c) Will vary with the level of production
      1) Increased plant populations will result in greater yields.
      2) Increased costs are incurred from purchasing additional seed.
   d) Other variable costs
      1) Fertilizer
      2) Chemicals
      3) Labor

2. Explain fixed costs to the students. Discuss the differences between fixed and variable costs and give examples. Use TM 8.2 to give examples of fixed costs.

   What fixed costs are associated with wheat and small grain production?

   a) Fixed costs are also known as ownership costs.
   b) Fixed costs will be the same no matter what the level of production.
   c) Fixed costs include the following items.
      1) Rent or mortgage payments
      2) Insurance
      3) Taxes

3. Students should understand that an acceptable return is in relation to the number of acres under production for that specific crop. The greater the number of acres, the greater the total returns.

   What factors are considered when determining an acceptable return on investment?

a) Cost and returns must be compared to other crop alternatives when deciding to produce wheat or small grains.
b) Costs and yields are affected by the type and amount of equipment, crop rotations, farm size, and tillage practices.
c) Use realistic yields and prices per bushel.
d) With total costs of $222.22 per acre (fixed and variable 1998 figures), $4.36 per bushel must be received to break even for an average yield of 51 bushel per acre.

4. Use some examples when discussing this study question. Students should have practice when solving for total costs per acre. AS 8.1 should be used to determine crops costs and returns.

How is cost per acre calculated?

a) Cost per acre is determined by the addition of all fixed and variable costs per acre.

F. ***Other Activity***

Have an Extension Agricultural Economist visit the class to explain how variable and fixed costs affect returns over a 5- to 10-year period. The point needs to be made that not all years are profitable and not all years have losses.

G. ***Conclusion***

Variable and fixed costs can be determined for a crop through accurate and complete record keeping. It is important for producers to understand what makes up fixed and variable costs and that these costs must be used when determining net returns.

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

Variable Costs	**Per Acre**	**Field Total**
Seed	$15.00	$2,250.00
Plant food	36.00	5,400.00
Crop chemicals & materials	1.70	255.00
Machinery costs (fuel, oil & repairs	18.00	2,700.00
Machinery hire & services	5.00	750.00
Labor costs	16.00	2,400.00
Taxes and insurance	2.00	300.00
Miscellaneous	10.00	1,500.00
Operating interest	6.00	900.00
Total Variable Costs	109.70	$16,455.00
Fixed Costs		
Machinery depreciation and interest	24.00	$3,600.00
Land costs	78.00	$11,700.00
Total Fixed Costs	102.00	$15,300.00
Total All Costs	$211.70	$31,755.00

1. $16,455
2. $15,300
3. $31,755
4. $3.85
5. $26,812.50
6. $4,942.50 (Loss)

I. ***Answers to Evaluation***

1. b
2. c
3. c
4. Any two of the following: seed, plant food, chemicals and materials, machinery costs, machinery hire and services, labor costs, taxes and insurance, operating interest, miscellaneous

5. Machinery (depreciation, taxes, and interest)
6. Land costs
7. By adding all variable and fixed costs

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name_____

Lesson 8: Figuring Crop Costs Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Total costs of the production of a crop includes all variable and _____ costs.

   a. Marginal
   b. Fixed
   c. Economic
   d. Related

2. What is the break-even price that must be received per bushel if the variable costs of production are $97/acre, the fixed costs are $101/acre, and the yield is 60 bushel/acre?

   a. $3.15
   b. $3.25
   c. $3.30
   d. $3.40

3. Net returns per acre are figured by _____.

   a. Multiplying per acre costs by the number of acres
   b. Subtracting variable costs from all fixed costs
   c. Subtracting total costs from total receipts
   d. Dividing costs per acre by price per bushel

Complete the following short answer questions.

4. What are two examples of variable costs?

   a.

   b.

5. What are two examples of fixed costs?

   a.

   b.

6. Explain how total costs per acre are calculated.

Variable Costs per Acre for Wheat

Number of Farms Reporting	54
Average Number of Acres	157
Average Yield/Acre (bushels)	51
Average Variable Costs/Acre	
Seed	$ 15.26
Plant Food (Fertilizer & Lime)	38.33
Crop Chemicals and Materials	1.70
Machinery Fuel, Oil & Repair	19.22
Machinery Hire & Services	5.36
Average Labor Cost/Acre	16.06
Taxes and Insurance	2.25
Miscellaneous	10.38
Operating Interest	6.13
Total Variable Costs/Acre	$114.69

Fixed Costs per Acre for Wheat

Average Fixed Costs/Acre	
Machinery depreciation and interest	$ 24.71
Land costs	82.82
Total Fixed Costs/Acre	$ 107.53

Lesson 8: Figuring Crop Costs Name _____

Determining Crop Costs and Returns

Objective: Students will determine the cost of production for a wheat or small grain crop.

Directions: With the inputs given in the scenario described below, complete the table and answer the questions.

A producer has 150 acres of wheat. The field yields an average of 55 bushels per acre valued at $3.25 per bushel on the cash market.

Variable Costs	**Per Acre**	**Field Total**
Seed	$15.00	
Plant food	36.00	
Crop chemicals & materials	1.70	
Machinery costs (fuel, oil, and repairs)	18.00	
Machinery hire & services	5.00	
Labor costs	16.00	
Taxes and Insurance	2.00	
Miscellaneous	10.00	
Operating interest	6.00	
Total Variable Costs		
Fixed Costs		
Machinery depreciation and interest	$24.00	
Land costs	$78.00	
Total Fixed Costs		
Total All Costs		

1. What were the total variable costs for the 150-acre field? $ _____
2. What were the total fixed costs for the 150-acre field? $ _____
3. What was the total of all costs for the 150-acre field? $ _____
4. What was the cost of production per bushel of wheat produced? $ _____
5. What was the gross returns for the 150 acres of wheat? $ _____
6. What was the net returns (profit or loss) for the 150 acres of wheat? $ _____