UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 1: Planning the Crop

**Competency/Objective**: Evaluate local growing conditions and determine fertilizer needs for corn and grain sorghum.

***Study Questions***

1. **What environmental conditions are necessary for corn and grain sorghum production?**

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

3. **What are the fertilizer requirements for corn and grain sorghum?**

***References***:

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

2. Transparency Master

   a) TM 1.1: Effect of Temperature on Corn Growth

3. Activity Sheet

   a) AS 1.1: Ingredients for a Successful Crop of Corn

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

Corn and sorghum production in Missouri and in the United States is very important to the agricultural economy, accounting for a large portion of grain produced. Certain factors concerning the environmental conditions of the production area, the history of the field, and the fertilizer needs of these crops must be examined and understood by the successful producer.

B. ***Motivation***

Ask students to describe the "ideal" corn-producing environment. What type of soil and environmental conditions would promote maximum production?

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. What are the ideal growing conditions for corn? Some of these conditions may be controlled by the producer wheras some cannot be controlled. Refer to TM 1.1 to show the effect of temperature on corn growth.

   **What environmental conditions are necessary for corn and grain sorghum production?**

   a) Corn and sorghum are warm-season annual plants.
      1) Best adapted to well-drained, loamy soils
      2) Soil pH of 5.5 (mildly acidic) to 8.0 (moderately basic)
      3) 130 to 150 days maturity in most commercial hybrids
   b) Ideal growing temperature is 75 to 86°F.
      1) Above normal temperatures are advantageous for planting until mid-June.
      2) Plant after the average date of the last spring freeze in Missouri.
   c) Cool temperatures restrict nutrient uptake and cause slow growth.
      1) Early planting dates and shallow planting take advantage of more favorable soil temperatures near the soil surface.
      2) At late planting dates, soil temperature is generally adequate throughout all planting depths and soil moisture content becomes the limiting factor.
   d) Slightly below normal temperatures are better for corn growth from mid-June to early September.
      1) Warm nights cause corn to burn too much energy in cell respiration.
      2) Cool nights, sunny days, and moderate temperatures are ideal.
   e) Adequate moisture must be maintained either through natural rainfall or irrigation.
   f) The "discomfort index" for corn and sorghum is opposite of that for humans.
      1) Humans enjoy a cooling benefit when they lose moisture.
      2) Plants suffer from moisture loss.
   g) Grains are produced best in regions that have 25 to 40 inches of annual precipitation or are under irrigation.
      1) Moisture is critical during the summer, especially during the preflowering stage (6 to 8 inches of rain).
      2) Large quantities of water are needed for high yields.
   h) Sorghum can tolerate dryer, hotter, and wetter conditions than corn.

2. Before planting corn or sorghum on a particular field, the producer should known certain things classified as "field history". These items may have an effect on the production of the grain.

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

a) Several factors need to be considered when evaluating field history.
   1) Previous crops grown
   2) Soil type
   3) Soil drainage
   4) Soil fertility
   5) Slope of the soil
   6) Previous weed and insect problems
   7) Previous herbicide and insecticide applications

b) If the previous crop was a legume, nitrogen needs may be less.

c) A crop rotation may break the cycle of insect, disease, and weed problems.

d) Crop rotation may increase yields over continuous corn or sorghum.

e) Soil tests are an important guide to nutrient levels.

f) Drainage is important because excess moisture may kill young corn plants.
   1) Well-drained soils are warmer, promoting plant growth.
   2) Poor drainage will interfere with timing and completion of planting, cultivating, spraying, and harvesting.

g) Consideration of soil erodibility is important since corn and sorghum are row crops and result in more soil exposure to wind and rain.
   1) Amount of rainfall
   2) Length and steepness of slope
   3) Texture and structure of soil
   4) Crops grown
   5) Erosion control practices - terracing, tiling, and contouring

h) Fewer problems exist with diseases and insects.
   1) Resistant hybrids
   2) Seed treatments
   3) Early harvesting

3. Higher fertilizer prices and low commodity prices affect the fertilization methods and amounts that producers must consider. Discuss the fertilization requirements for corn and grain sorghum. Upon completion of the discussion for this lesson, have students complete AS 1.1, in which they identify the necessary ingredients for a successful corn crop.

**What are the fertilizer requirements for corn and grain sorghum?**

a) Understand fertilizers and how they behave in the soil.
   1) Fertilizers come in many forms, brands, analyses, packages.
   2) Nutrient value is always guaranteed on the bag, tag, or invoice.
   3) Fertilizers may be applied as a solid, gas, slurry, liquid, or suspension form.

b) Understand the soils and how to use them for maximum output.
   1) Soils samples must be taken accurately, analyzed properly, and recommendations followed for maximum results.
   2) Estimate or determine kinds and amounts of nutrients the soil will supply.

c) Apply the proper amount of fertilizer, at the proper time, in the proper location.
   1) Nitrogen is the most limiting nutrient for corn production.
      (a) Base decisions on price, availability, ease of application, and potential for volatilization.
      (b) Split the application of nitrogen for efficiency.
      (c) Maximum use of nitrogen is just before pollination.
      (d) Apply 1/4 to 1/3 of total nitrogen recommended before corn emergence.

(e) In corn, delay bulk of application 25 to 35 days after emergence.
(f) For corn, side-dress early in the growing season to avoid root pruning.
(g) For grain sorghum, side-dress about 10 to 25 days after planting, but before the five-leaf stage.
(h) For each bushel of corn, 1.3 pounds of nitrogen are recommended up to 100 bushel per acre, and 1.7 pounds/bushel for each additional bushel above 100-bushel goal.
(i) Grain sorghum requires about 2 pounds of applied nitrogen to produce 100 pounds of grain.

2) Phosphorus and potassium should be applied according to soil test results.
(a) Phosphorus is important to crop maturity, root and stalk development, and energy transfer and storage.
(b) Purple leaf tips indicate phosphorus deficiencies and occur more often in young plants exposed to good growing conditions after cool, wet conditions.
(c) Many cultural and environmental factors limit root growth.
(d) Fall application of phosphorus and potassium is recommended.
(e) Phosphorus can also be injected preplant or side-dressed to increase availability to corn and sorghum roots.
(f) Fertilizer may be banded, placed to the side and below the seed.

3) Potassium is as important as nitrogen to produce good yields.
(a) Necessary to build strong stalks, fight diseases, and translocate water within the plant
(b) Fall application recommended
(c) Relatively immobile in most soils
(d) Recycled through plant residue
(e) Increased recommendations following forage or silage harvest
(f) Deficiency common in rotation with soybeans

4) Minor nutrients such as sulfur, magnesium, and zinc are also needed for corn and sorghum production.
(a) Sulfur and magnesium deficiencies occur most often in sandy soils with less than 1% organic matter.
(b) Zinc deficiencies commonly occur on sandy, low organic soils with high pH and phosphorus levels in cool, wet conditions.
(c) Zinc deficiencies are evident by interveinal light striping or whitish bands beginning at the base of the leaf.

## F. *Other Activity*

Secure some color pictures from the local agronomy supply dealer or local extension office that show corn plants with certain deficiencies such as nitrogen or phosphorus symptoms. Students may be tested on their recognition of corn plant problems.

## G. *Conclusion*

There are several important items to consider before planting a field of corn or sorghum. The climate of the producer's location plays a major role in the plant's development. Fortunately, Missouri is located in the Corn Belt where conditions for growth are almost ideal. If moisture is not adequate, irrigation may be used to supplement lack of rainfall. After considering the history of the anticipated planting field, the producer can more adequately plan for the crop. Field history may help decide the fertilization program. Nitrogen is the major nutrient concern for corn and sorghum. Phosphorus and potassium should be applied according to soil test results. There are also some minor nutrients such as sulfur, magnesium, and zinc to consider in the total nutrient program.

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

1. Answers may vary but should include the importance of warm days (75-86°F) and cool nights and adequate moisture (25-40 inches of annual rainfall) especially 6-8 inches during preflowering stage.
2. Examples of practices that may be used should include installing terraces, tiling the field for drainage, and farming the crop on a contour to avoid soil erosion.
3. (1.3 lb. N x 100 bu. = 130 lb.) + (1.7 lb. N x 50 bu. = 85 lb.) = 215 total lb. of nitrogen

I. ***Answers to Evaluation***

1. c
2. b
3. c
4. To the side and below the seed
5. Sulfur, magnesium, and zinc
6. In the fall
7. Any four of the following: previous crop grown, soil type, soil fertility, soil drainage, soil slope, previous weed or insect problems, previous herbicide application
8. Well-drained, loamy soils with pH of 5.5 to 8.0

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 1: Planning the Crop Date_____

EVALUATION

**Circle the letter that corresponds to the best answer.**

1. Corn and grain sorghum are _____.

   a. Cool-season crops
   b. Winter annuals
   c. Warm-season crops
   d. Summer perennial

2. The ideal weather conditions for growing corn are _____.

   a. Hot days and hot nights
   b. Sunny days and cool nights
   c. Cool days and cool nights
   d. Cool days and hot nights

3. How should nitrogen be applied to corn and sorghum?

   a. The complete amount in the spring before planting
   b. 1/2 of the amount in the fall and the other 1/2 in the spring
   c. 1/4 to 1/3 before corn emergence and the rest during certain growth stages
   d. All nitrogen should be applied in the fall after harvest

**Complete the following short answer questions.**

4. Explain where fertilizers are placed when "banding" is practiced.

5. List the three minor nutrients that should receive attention when planning a fertilization program for corn and grain sorghum.

   a.

   b.

   c.

6. When should most phosphorus and potassium be applied for corn and grain sorghum production?

7. What are four items relating to a field's history that should be evaluated before planting corn?

   a.

   b.

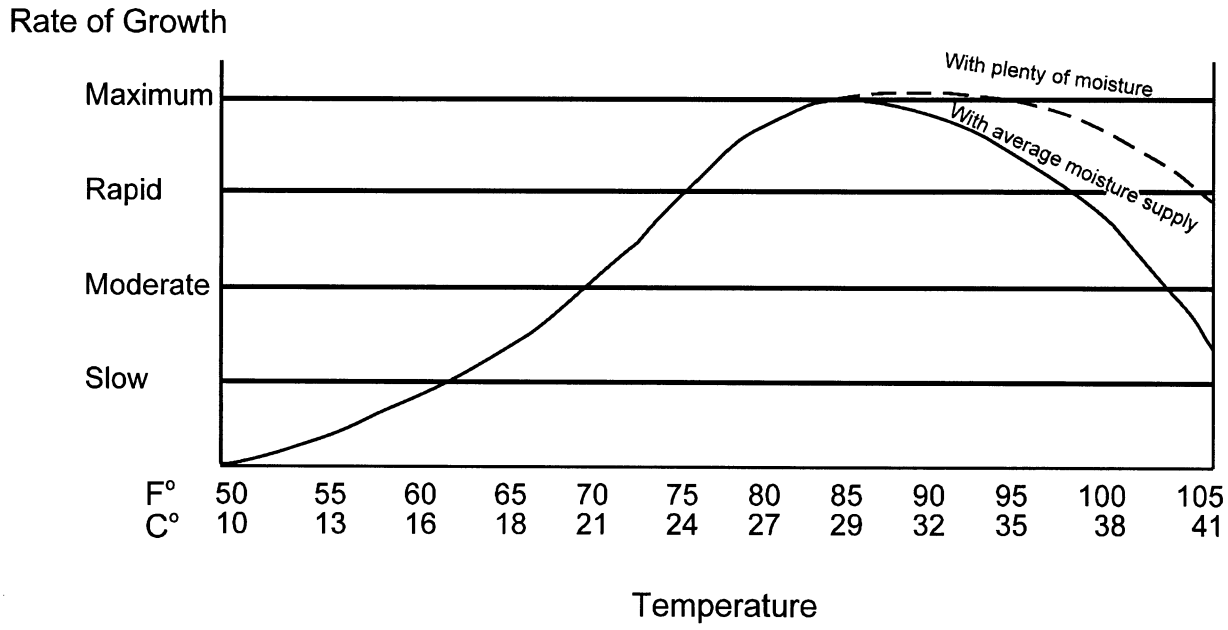
   c.

   d.

8. Describe the optimum type of soil for corn and sorghum growth.

TM 1.1

# Effect of Temperature on Corn Growth



Lesson 1: Planning the Crop Name_____

## Ingredients for a Successful Crop of Corn

**Objective**: Students will demonstrate knowledge of the ingredients necessary for a successful corn crop.

**Directions:** Respond to the items below.

1. Describe the ideal weather (climate) conditions during the complete growing season for the production of corn or sorghum.

2. Discuss what management practices you might incorporate in your plans for a crop of corn on a field that may be considered too steep for row crop production.

3. Using the information in the Student Reference, calculate how many pounds of nitrogen you would apply if your yield goal for a crop of corn was 150 bushel per acre. (Show your work below.)

Lesson 2: Selecting a Variety Name _____

## Identifying Corn and Sorghum Diseases

**Objective:** Students will demonstrate a knowledge of corn and sorghum diseases.

**Directions:** Match the statements or descriptions in the right column to the appropriate answer in the left column.

1. _____ Southern leaf blight
2. _____ Common rust
3. _____ Corn stunting virus disease
4. _____ Maize dwarf mosaic virus
5. _____ Stewart's bacterial wilt
6. _____ Fusarium kernel or ear rot
7. _____ Aspergillus ear rot

a. Most severe damage reported in bottom land fields along the Gasconade and Missouri rivers

b. Forms a powdery, cottony-pink mold on the ear of corn

c. Has two types, Race O and Race T

d. Overwinters in plants in southern states and spreads northward to windborne spores

e. Symptoms vary from plant to plant, within the same field, and may show up at different times of the season.

f. Dark brown cavities on the lower stalk, with premature, bleached tassels.

g. Black or greenish-yellow powdery mold on or between the kernels of grain on the ear

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

***Competency/Objective:*** Determine tillage or planting methods for corn and grain sorghum.

***Study Questions:***

1. **What are optional tillage methods?**
2. **What are optional planting methods?**
3. **What are the recommended seeding rates for corn and grain sorghum?**
4. **How is a corn and grain sorghum planting calendar used?**

***References:***

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. Transparency Masters
   a) TM 3.1: Corn Planting Calendar
   b) TM 3.2: Grain Sorghum Planting Calendar
3. Activity Sheet
   a) AS 3.1: Figuring Corn Populations and Costs

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

Lessons 1 and 2 provided information on planning the crop and choosing a seed variety. This lesson will review information regarding the tillage and planting methods used for corn and grain sorghum. Recommended seeding rates and use of a planting calendar will also be reviewed.

B. ***Motivation***

Have students guess what day soil temperatures will reach 55°F in the spring and when it will be 50°F in the fall. Take daily soil temperature readings at a 4-inch depth in a corn or grain sorghum field at the same time each day. Continue taking temperature readings for 7 to 10 days after first getting the desired reading to be sure the temperature is going to stay at the desired level. An additional activity could be to take temperature readings in a grass- or sod-covered field to see the effects of residue.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask the students how each of the tillage systems compare. List the systems across the top of the board and make two columns under each for advantages and disadvantages. Refer to Unit II for detailed information about each tillage method.

   **What are optional tillage methods?**

   a) Tillage methods
      1) Conventional tillage
      2) Minimum tillage
      3) No-till
   b) Considerations
      1) Achieve seedbed that will give satisfactory emergence
      2) Reduce costs by minimizing trips across field and tillage depth
      3) Added tillage - cause increased soil erosion
      4) Previous methods used for each field

2. Discuss the two options for planting corn and grain sorghum. Include information regarding research being done on row widths and the relation to plant population counts. Available equipment is also a key element in deciding row width.

   **What are optional planting methods?**

   a) Planting methods
      1) Row seeding
      2) Drill seeding
   b) Considerations
      1) Row width limited to equipment being used
      2) Corn commonly planted in 28- to 30-inch rows
      3) Grain sorghum planted in narrower rows, such as 18 inches
      4) Trend toward narrow rows at higher population counts with yield increases of 3-5%

3. Obtain information from a seed company to help explain the seeding rates required for various hybrids. Discuss how the soil fertility levels and water-holding capacity affect seeding rates. Complete AS 3.1 to determine corn populations and costs involved with purchasing seed corn.

**What are the recommended seeding rates for corn and grain sorghum?**

a) Corn seeding rates
   1) Plant populations at harvest range - 20,000 to 30,000+ plants per acre
   2) Dependent on hybrid and production environment
   3) Genetically altered hybrids - greater than 24,000 plants per acre to achieve potential yield
b) Grain sorghum seeding rates
   1) Plant populations at harvest as high as 100,000 or more plants per acre
   2) 5 to 7 pounds of seed per acre for desired plant population
   3) Drier areas without irrigation - 3 to 4 pounds of seed per acre
   4) Irrigated areas - 12 to 15 pounds of seed per acre

4. Refer to TM 3.1, Corn Planting Calendar, and TM 3.2, Grain Sorghum Planting Calendar, to help explain the variations in planting time that occur by regions of the state and country.

**How is a corn and grain sorghum planting calendar used?**

a) Determines normal planting dates by local area and/or region
b) Soil temperatures for planting
   1) Corn 50° to 55°F
   2) Grain sorghum 60° to 65°F
   3) 2-inch depth from 8 a.m. to 9 a.m.
   4) Constant temperature for 5 to 7 days before planting
   5) Heavy residue fields - check temperature at 4-inch depth
c) Planting dates
   1) Corn - April 5 to June 10
   2) Grain sorghum - April 25 to July 1

## F. *Conclusion*

Local temperature and moisture levels have an effect on tillage and planting methods, and seeding rates for corn and grain sorghum. Planting calendars are useful to producers to determine the optimal time for planting in their area.

## G. *Answers to Activity Sheet*

1. 24,000 divided by (.95 x .90) = 28,070 plants
2. 80,000 divided by 28,070 = 2.85 bags/acre. 100 acres divided by 2.85 bags/acre = 35 bags
3. 35 bags x $95/bag = $3325

## H. *Answers to Evaluation*

1. Conventional tillage, minimum tillage, no-till
2. c
3. b
4. c
5. a
6. c
7. d
8. c

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 3: Selecting a Tillage and Planting Method Date_____

EVALUATION

**Complete the following short answer questions.**

1. What are the three tillage methods used in corn and grain sorghum production?

   a.

   b.

   c.

**Circle the letter that corresponds to the best answer.**

2. The soil temperature for corn should be _____ °F at a 2-inch depth from 8 a.m. to 9 a.m. constantly for 5 to 7 days before planting.

   a. 45 to 55
   b. 60 to 65
   c. 50 to 55
   d. 40 to 50

3. The soil temperature for grain sorghum should be _____ °F at a 2-inch depth from 8 a.m. to 9 a.m. constantly for 5 to 7 days before planting.

   a. 45 to 55
   b. 60 to 65
   c. 50 to 55
   d. 40 to 50

4. In Missouri, grain sorghum is planted _____.

   a. April 1 to June 1
   b. April 15 to June 15
   c. April 25 to July 1
   d. May 1 to July 15

5. Corn is planted using the _____ method.

   a. Row or drill
   b. Row or broadcast
   c. Drill or broadcast
   d. Broadcast or aerial

6. Recommended plant populations for corn at harvest range from _____ plants per acre.

   a. 8,000 to 10,000
   b. 10,000 to 15,000
   c. 20,000 to 30,000
   d. 30,000 to 40,000

7. Grain sorghum may have plant populations at harvest as high as _____ or more plants per acre.

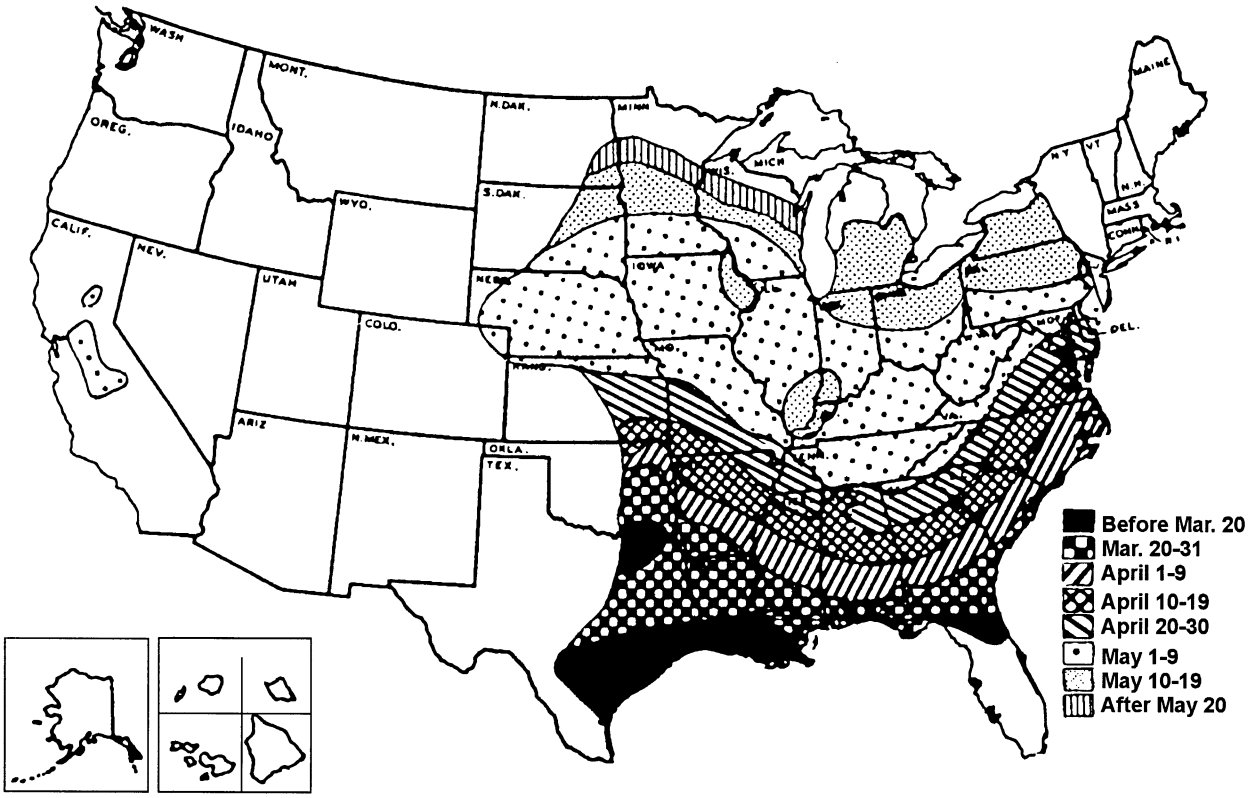
   a. 30,000
   b. 50,000
   c. 75,000
   d. 100,000

8. Before planting grain sorghum, soil temperatures on fields with heavy residues should be checked at a _____ -inch depth.

   a. 2
   b. 3
   c. 4
   d. 5

TM 3.1

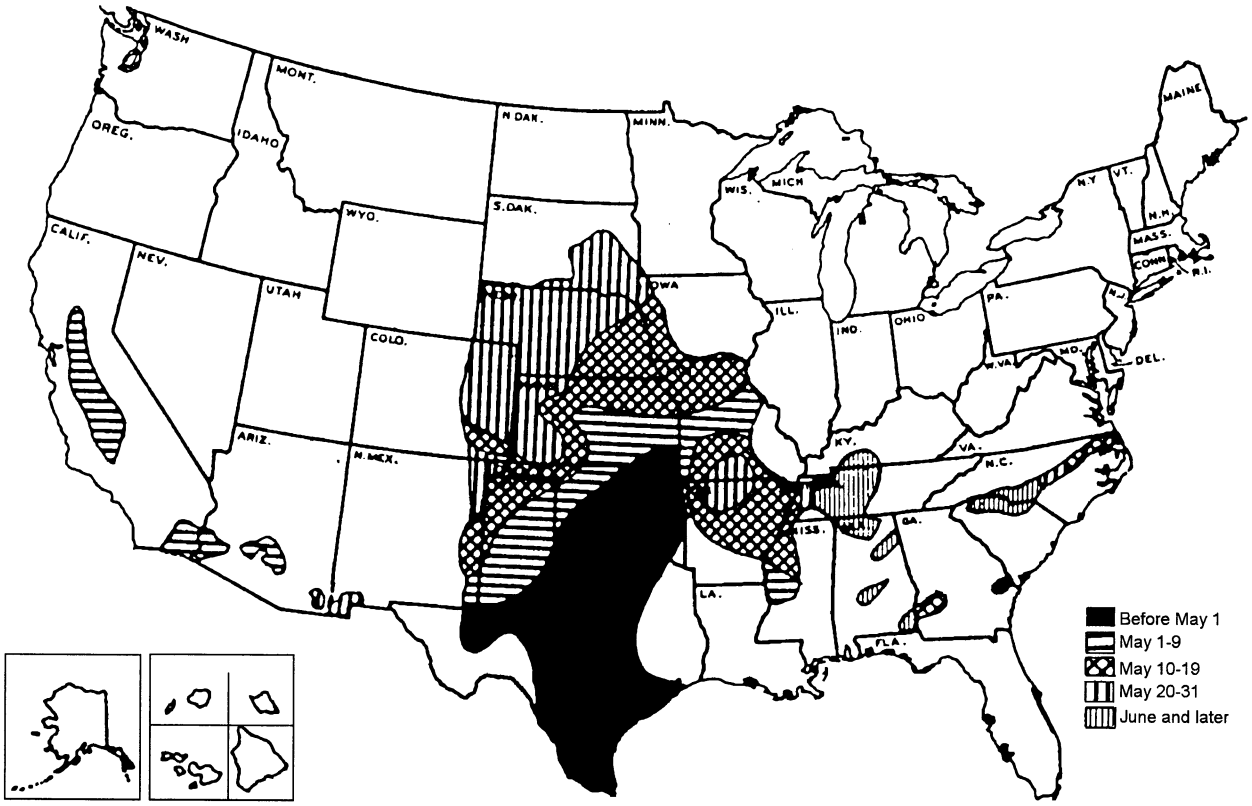
# Corn Planting Calendar




Source: U.S. Department of Agriculture, Statistical Reporting Service

TM 3.2

# Grain Sorghum Planting Calendar




Source: U.S. Department of Agriculture, Statistical Reporting Service

Lesson 3: Selecting a Tillage and Planting Method Name _____

## Figuring Corn Populations and Costs

**Objective:** Students will determine corn populations and costs of planting.

**Directions:** Use the following information to answer the questions below.

$$\text{*Planting Rate} = \frac{\text{Desired Population/Acre}}{\text{Germination X Expected Survival}}$$

*Bag of seed corn = 80,000 kernels

*Seed Corn Cost: $95/bag

As a producer, you are planning to plant 100 acres of corn and want a plant population of 24,000 plants/acre.

1. Using the formula above, how many kernels per acre should be planted if the seed corn has a 95% germination rate and you expect 90% of the seed to survive? Show your work below.

2. How many bags of seed corn should be purchased to plant the above 100 acres? Show your work below.

3. What would be the total cost of the seed to plant the 100 acres? Show your work below.

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 4: Selecting a Pest Control Program

***Competency/Objective***: Select a pest control program.

***Study Questions***

1. **What factors determine the type of pest control program?**
2. **What pests are specific to corn and grain sorghum?**
3. **What effect do pests have on corn and grain sorghum yields?**
4. **What pest control options are available?**

***References***:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. *Corn Insect Pests: A Diagnostic Guide*, Manual 166, University of Missouri Extension, 1998. Available through Extension Publications, University of Missouri-Columbia, 1-800-292-0969.
3. Transparency Master
   a) TM 4.1: Time Line for Corn Insects in Missouri
4. Activity Sheet
   a) AS 4.1: Corn and Sorghum Pests

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 4: Selecting a Pest Control Program

TEACHING PROCEDURES

A. ***Review***

A previous lesson discussed the impact of diseases on corn and sorghum. Of equal importance to corn yield is the effect of pests. This lesson will give information on factors to consider when selecting a pest control program, the major pests of corn and sorghum, and control methods used.

B. ***Motivation***

Obtain pictures of common corn pests in your area. Ask students to identify as many as they can. List their answers on the board and check them for accuracy. You may have them rank the pests in what they see as the order of importance in their community.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask the students what considerations they think should be given when determining the type of pest control program used on farms.

   **What factors determine the type of pest control program?**

   a) Objective of pest control programs
      1) Reduce acceptable levels of insect pest populations
      2) Specific control techniques - chemical, physical, biological
   b) Chemical agents (pesticides) - insecticides and fungicides
      1) About 9% of agricultural land is treated with insecticides and 1% with fungicides.
      2) About 67% of all insecticides are used on cotton and corn.
      3) For every $1 invested in pesticides, the producer will get about $4 in return.
   c) Nonchemical controls - physical and biological
      1) Plowing under crop residues
      2) Introducing predators and parasites to feed on harmful pests
      3) Selecting plants that are pest resistant
      4) Releasing sterilized males to cause females to bear infertile eggs
      5) Using crop rotations
   d) Integrated pest management (IPM) - combination of methods
   e) Factors to consider
      1) Cost
      2) Previous experience or observing other producers
      3) Considerations for the environment
      4) Specific insect or pest
      5) Soil conditions
      6) Refuge requirements

2. Discuss the fact there are 10,000 species of pests that cause problems with food and fiber production. Relate that to the number of pests (about 20) involved with corn and sorghum production. Ask students to name ones that they know. Refer to University of Missouri Manual 166, *Corn Insect Pests, A Diagnostic Guide*. Use TM 4.1 and complete AS 4.1.

**What pests are specific to corn and grain sorghum?**

a) Corn
   1) Birds
   2) Rodents
   3) Seedcorn maggot
   4) Seedcorn beetles
   5) Wireworms
   6) White grubs
   7) Grape colaspis larva
   8) Chinch bug
   9) Black cutworm
   10) Stalk borer
   11) Billbugs
   12) Stink bugs
   13) Thrips
   14) Corn flea beetle
   15) Sod webworm
   16) Southern corn leaf beetle
   17) Army worm
   18) Southern corn rootworm
   19) Grasshoppers
   20) European corn borer
   21) Corn leaf aphid
   22) Corn earworm

b) Sorghum insects (all of the above with the following additions)
   1) Greenbug
   2) Sorghum midge
   3) Sorghum webworm

3. Very little data is available to demonstrate losses to corn and sorghum production due to pests. Corn and sorghum losses have decreased tremendously in the last 20 to 25 years due to resistant hybrids and other standard control methods.

**What effect do pests have on corn and grain sorghum yields?**

a) About 35% of all crops worldwide are destroyed annually by pests.
b) Insects, rodents, and birds inflict additional 10 to 20% loss after harvest.
c) The major problem in the Corn Belt is the European corn borer.
   1) Approximately $350 million is lost annually to corn and sorghum producers.
   2) Losses vary from region to region in Missouri.
d) There would be an estimated increase of $1.00 to $6.25 in costs of crop production if soil and foliar insecticides were not applied.

4. Most pest control measures in corn and sorghum production are initiated at planting time. Invite a certified chemical applicator or dealer to discuss or demonstrate insecticide application methods.

**What pest control options are available?**

a) There are five basic options for pest management.
   1) Application of a grandular or liquid soil insecticide at planting
   2) Application of insecticide in a herbicide tank mix preplant or postemergence
   3) Application of a seed treatment prior to planting
   4) Use of no treatment at all
   5) Use of pest-resistant hybrids

b) Use of soil insecticides at planting is the most used method of pest control in Missouri; however, most acreage is planted without treatment due to lack of pest pressure or presence.
c) Insecticide treatment at planting reduces stand loss from the following pests.
    1) Seedcorn maggots
    2) Cutworms
    3) Grubs
    4) Wireworms - Reducing weed problems reduce wireworm problems.
d) Pest problems decline after stands are established.
e) Corn rootworms may show up at mid-growth stage.
    1) Little can be done at this time.
    2) Lodged plants will be evident.
f) Few problems occur as plants enter the tasseling and silk stages.
    1) Corn leaf aphid
    2) Beetles
g) As the ears mature, a second brood of European corn borers may become a problem.
    1) Rescue treatments (spraying) may be necessary.
    2) Infested fields should be harvested early.
h) Plant pest-resistant hybrids.
    1) Bt corn
    2) Genetically improved hybrids
i) Greenbugs should be treated with a control treatment when 20% of the plants show yellowing leaves and insects are found on young plants.
j) Cultural practices are recommended for the sorghum midge and the sorghum webworm.

F. ***Other Activity***

This would be an excellent time for a field trip for demonstrations of chemical application equipment. Local agricultural supply companies may be used to supply containers or bags of insecticides that may be used to discuss application methods, precautions, etc.

G. ***Conclusion***

Although pests may be a major problem at times, overall it is not a concern for corn and sorghum producers in Missouri. Loss prevention can be minimized by recognizing pest problems and knowing when and where to observe for infestations. Most pest control methods are used when corn and sorghum is planted through use of insecticides and seed treatments.

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

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

I. ***Answers to Evaluation***

1. c
2. d
3. b

4. Any four of the following: cost, previous experience and observing other producers, environmental considerations, specific pest problems, stage of plant growth, soil conditions, and refuge requirements.

5. Greenbug, sorghum midge, and sorghum webworm

6. Any three of the following: (1) application of grandular or liquid soil insecticide at planting, (2) application of insecticide with herbicide tank mix as a preplant or postemergence treatment, (3) application of a seed treatment, (4) use of no treatment at all, and (5) use of pest-resistant hybrids.

7. The use of physical or biological controls such as plowing under crop residues, introducing predators or parasites that feed on harmful pests, breeding plants that are pest resistant (Bt corn), using sterilized male insects that cause females to lay infertile eggs, or crop rotations

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 4: Selecting a Pest Control Program Date_____

EVALUATION

**Circle the letter that corresponds to the best answer.**

1. What percent of all insecticides are used on cotton and corn/sorghum production?

   a. 9
   b. 35
   c. 67
   d. 83

2. What are the approximate returns for each dollar invested in insecticide use?

   a. $1
   b. $2
   c. $3
   d. $4

3. Approximately how many species of pests affect corn and sorghum production?

   a. 10
   b. 20
   c. 100
   d. 10,000

**Complete the following short answer questions.**

4. List four of the major factors to consider when determining a pest control method.

   a.

   b.

   c.

   d.

5. What are three major pests discussed in this lesson that are specific to sorghum production?

   a.

   b.

   c.

6. What are three pest control management options for corn and sorghum production in Missouri?

   a.

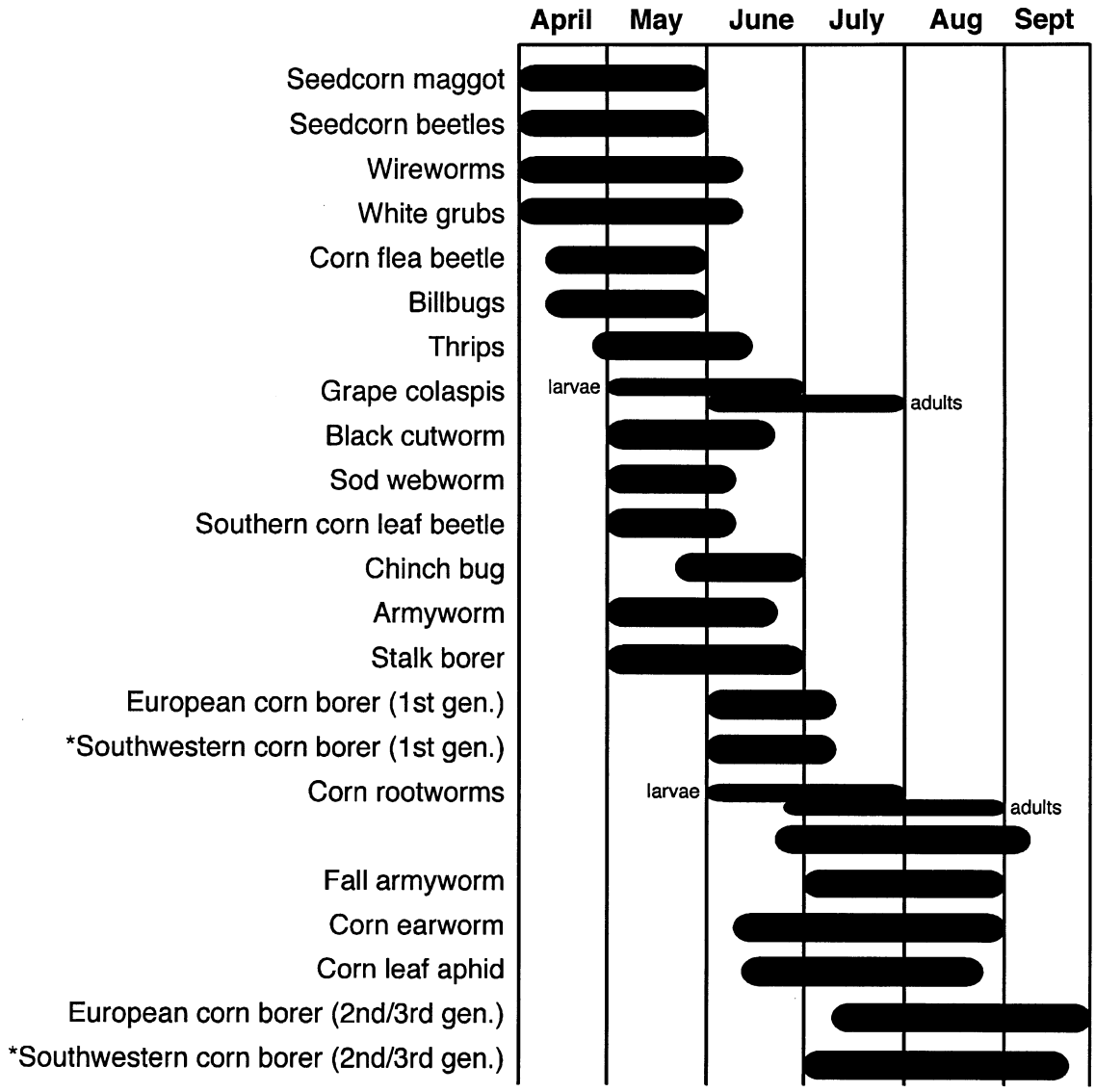
   b.

   c.

7. Explain what is meant by "nonchemical" methods of pest control measures.

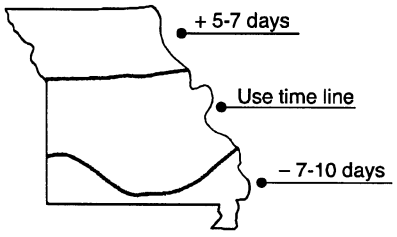
TM 4.1

# Time Line for Corn Insects in Missouri




*Southwestern corn borer is an economic pest primarily in southeastern Missouri and the southern quarter of Illinois.

This time line is estimated for central Missouri. Adjust time line as shown for other regions.



Lesson 4: Selecting a Pest Control Program Name _____

## Corn and Grain Sorghum Pests

**Objective:** Students will identify causes of damage from corn and grain sorghum pests.

**Directions:** Match the statement in the left column to the appropriate corn or grain sorghum pest in the right column. Write the correct letter in the space provided.

1. _____ Stalks malformed, growing upward in a gooseneck shape, also lodging
2. _____ Seeds bored into or hollowed out
3. _____ Plant cut off near base
4. _____ Orange fly, larvae eats the grain, found in areas where Johnsongrass is prevalent
5. _____ Causes small, circular holes in leaves, tassels to be broken, and tunneling or chewing damage
6. _____ Lacy, skeletonized leaves
7. _____ Silks clipped
8. _____ Chunks of plant tissue eaten from leaf margins, ragged holes in leaves
9. _____ Large chunks of kernels removed, often at blister and milk stages
10. _____ Small whitish moth, develops a caterpillar that eats grain kernels, leaving a hollow hull

a. Sorhum midge
b. European corn borer
c. Corn rootworm
d. Sorghum webworm
e. Seedcorn maggot
f. Armyworm
g. Grasshoppers
h. Black cutworms
i. Japanese beetle
j. Southern corn rootworm beetle

UNIT VI - CORN AND GRAIN SORGHUM 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 appropriate?**
3. **What amount of weed pressure justifies a herbicide application or mechanical removal?**
4. **What amount of insect pressure justifies an insecticide application?**
5. **How do environmental conditions during pollinations affect yields?**

***References***

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. Transparency Masters
   a) TM 5.1: Effect of Planting Dates on Corn
   b) TM 5.2: Yield Losses with Weeds
   c) TM 5.3: Effect of Weeds on Corn Yields
   d) TM 5.4: Moisture Requirements for Corn
3. Activity Sheet
   a) AS 5.1: Determining Replanting Costs and Returns

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

Lesson 4 discussed factors that determine a pest control program for the corn and grain sorghum crop. This lesson will focus on evaluating the growing crop and what actions may be taken to replant if conditions are warranted.

B. ***Motivation***

Describe a scenario of two fields of corn, similar in size, same variety, etc., with one field yielding 140 bushels per acre and the other 90 bushels per acre. Ask students why this difference may have occurred. List those factors.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Corn and sorghum producers need to know what to look for when beginning the crop scouting program or practice before planning a corrective course of action.

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

   a) Evaluation should begin and continue until harvest.
   b) Different possible problems may be related to stages of growth and development.
      1) Germination problems
         (a) Disease
         (b) Insects
         (c) Soil moisture
         (d) Soil temperature
         (e) Soil crusting
         (f) Herbicide injury
         (g) Nutrient inefficiency
      2) Early growth stages
         (a) Insect or disease problems
         (b) Moisture requirements
            (1) Increase until after pollination
            (2) Decline as grain matures and dries
         (c) Insecticide or herbicide damage
         (d) Fertilization programs success
      3) Early and middle growth stages
         (a) Evaluate effectiveness of fertilization program.
         (b) Adjustments should be made for next year's crop.

2. Producers may be faced with deciding whether a field of corn or grain sorghum may need to be replanted. What factors do they consider when making that decision? University Extension has a web site <http://muextension.missouri.edu/scripts/xplor/G04091.asp> to help producers analyze their situations. Students will need this to complete AS 5.1. Provide the students with optional replanting dates for several scenarios. Also review TM 5.1 to show the effect planting dates have on corn.

**How does one determine when replanting is appropriate?**

a) It is common for 10 to 15% of planted seeds to fail.
b) Other losses may cause replanting.
    1) Insect damage
    2) Late frost
    3) Hail
    4) Flooding
    5) Poor seedbed preparation
c) First rule is to not make a hasty decision. Corn and grain sorghum plants can outgrow some leaf damage.
d) Gather information before deciding to replant.
    1) Original planting date and plant stand
    2) Earliest replanting date and plant stand
    3) Input costs
        (a) Seed and pest control for replanting
        (b) Replant policy on the seed that was purchased
e) Use MU Extension worksheet to determine if replanting would be appropriate.

3. Weeds will always be present to some extent in a corn or grain sorghum field. Information in this question may help determine how many weeds it would take to justify applying a herbicide and implementing a mechanical practice for their control. Refer to TMs 5.2 and 5.3.

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

a) The objective is to control weeds that emerge at or about the same time as the corn.
b) Early planning must be followed by early action.
c) Early action starts with good cultural practices.
    1) Proper seedbed preparation
    2) Adequate fertilization
    3) Crop rotation
    4) Optimum row width
    5) Optimum plant population
d) First 3 to 5 weeks are critical in corn and sorghum weed control.
e) If weeds become 6 to 8 inches tall, yield is already cut.
f) Application of preemergence herbicide will prevent many weed problems.
g) Mechanical practices for weed control include cultivation and use of rotary hoes.
h) Cultural practices for weed control include optimum planting rates to provide a canopy to prevent weed growth. Thin stands often result in weeds in the row.

4. It is much more difficult to gauge damage to yields from insect pressure than weed pressure. The following factors should be considered to determine if the problem can be corrected with the application of an insecticide and/or if replanting is necessary.

**What amount of insect pressure justifies an insecticide application?**

a) The following factors need to be evaluated.
    1) The type and species of pest or insect
    2) Stage of growth of the corn and/or grain sorghum plant when problem occurs
    3) Severity of damage to the seed or plant
    4) Size of damaged area in number of acres
b) Frequent scouting from germination until harvest will be important to recognize and initiate controls of the problem.
c) Seek advice from the following people in determining corrective measures.
    1) Pesticide dealer
    2) Extension agronomy agent

3) Other crop experts in area

5. List and explain what environmental factors may play a role in affecting crop yields for corn and grain sorghum during the critical stage of pollination. Refer to TM 5.4 for moisture requirements for corn.

**How do environmental conditions during pollination affect yields?**

a) Four environmental factors play major roles in limiting the plant's success for optimum yields.
   1) Moisture
      (a) Water stress is most critical from 2 weeks before silking to 2 weeks after silking.
      (b) Yields will not reach their full potential if moisture is not adequate during silking.
   2) Adequate nutrition - planned and supplied at planting time according to soil tests
   3) Extremely high temperatures
      (a) High temperatures accompanied by hot winds during the day and night is stressful to plants during pollination.
      (b) In corn, delays in silking will result in unfertilized ears.
   4) Hail or weather damage
      (a) Tassel and leaves are exposed during this time.
      (b) Loss of leaves will result in loss of yield.

b) Factors such as fertilization and irrigation may be controlled by the producer.

c) The economic effects of some environmental factors may be reduced (hail insurance).

F. ***Other Activity***

Invite an insurance crop adjuster to speak to the class on the process of insuring a corn or grain sorghum crop for hail damage. Have the adjuster explain how damage is determined.

G. ***Conclusion***

Producers should know and understand the factors that must be considered when scouting corn or grain sorghum to assess its condition during the growing season. They should know when and what to look for to determine the plant's progress. Recognizing insect damage, effects of soil moisture, herbicide damage, etc., are important skills producers should acquire. Making decisions to replant should be based on sound judgments after accumulating and analyzing crop facts. Experts such as chemical dealers and agronomy specialists are available to help with these decisions.

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

(Note: These answers are for the central/north region.)

1. $234.26
2. $120.00
3. $114.26
4. ($74.12)
5. $154.26
6. ($34.12)

I. ***Answers to Evaluation***

1. c
2. d
3. b
4. From 2 weeks before to 2 weeks after silking
5. Hail insurance

6. Any three of the following: germination percentage, insect damage, herbicide damage, fertilizer effectiveness

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 5: Scouting and Maintaining the Crop Date_____

EVALUATION

**Circle the letter that corresponds to the best answer.**

1. What percentage of seeds will normally not produce a viable corn or grain sorghum plant?

   a. 2 to 4%
   b. 5 to 8%
   c. 10 to 15%
   d. 20 to 25%

2. What effect will delays in planting dates have on corn yields?

   a. Yields will increase about 2 bushels per acre.
   b. Yields will increase about 10 bushels per acre.
   c. There is no increase or decrease in yield.
   d. Yields will be decreased more as the planting dates become later.

3. Allowing weeds to grow for 2 weeks during the early growth of corn will decrease yields by _____ bushel per acre.

   a. 5
   b. 10
   c. 15
   d. 20

**Complete the following short answer questions.**

4. When would the lack of moisture cause the most stress in a corn plant?

5. How can a producer offset the loss of yield that may result from hail damage?

6. List three plant conditions a producer should evaluate when scouting the growing crop.

   a.

   b.

   c.

# Effect of Planting Dates on Corn

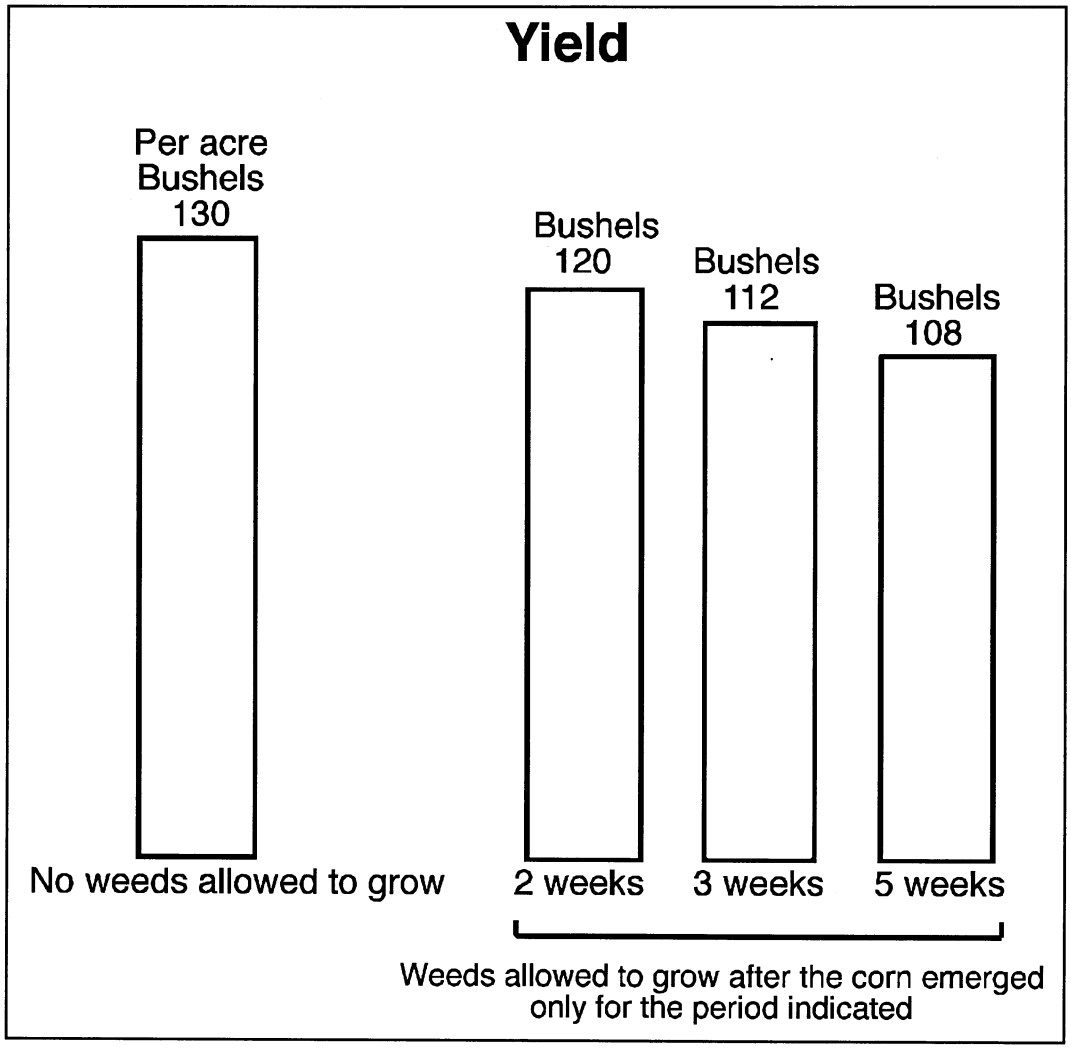
## Central and North Missouri

| Corn Planting Date | Yield as % of Normal |
|---|---|
| May 11 | 100 |
| May 16 | 99 |
| May 21 | 97 |
| May 26 | 94 |
| May 31 | 90 |
| June 5 | 85 |
| June 10 | 80 |
| June 15 | 75 |

## Southeast and Southwest Missouri

| Corn Planting Date | Yield as % of Normal |
|---|---|
| April 1 | 100 |
| April 10 | 99 |
| April 30 | 92 |
| May 10 | 87 |
| May 20 | 83 |
| May 30 | 79 |
| June 10 | 72 |
| June 20 | 59 |

# Yield Losses with Weeds



# Effect of Weeds on Corn Yields

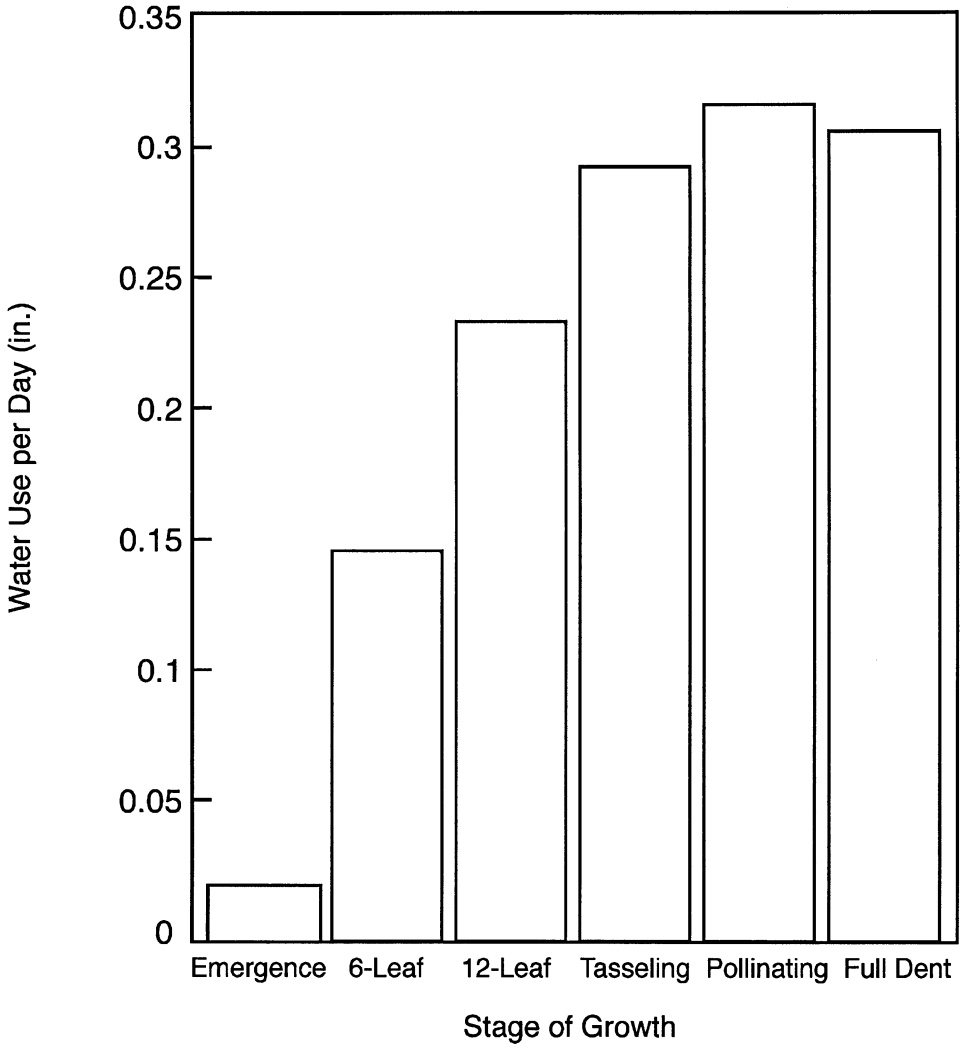
## Effect of Pigweed Stand on Corn

| Pigweed Stand in the Corn Row | Yield Per Acre (bushels) | Yield Loss (bushes/acre) |
|---|---|---|
| None | 108 | 0 |
| 1 per 40 inches | 101 | 7 |
| 1 per 20 inches | 92 | 16 |
| 1 per 10 inches | 91 | 17 |
| 1 per 5 inches | 78 | 30 |
| 1 per inch | 67 | 41 |
| Band of weeds | 64 | 44 |

## Effect of Giant Foxtail on Corn Yield

| Time Foxtail Emerged After Corn Planted | Average Bushels/Acre |
|---|---|
| Same day | 115 |
| 3 weeks later | 131 |
| 6 weeks later | 132 |
| 12 weeks later | 132 |
| Weed Free | 132 |

# Moisture Requirement for Corn



Lesson 5: Scouting and Maintaining the Crop Name_____

## Determining Replanting Costs and Returns

**Objective:** Students will make decisions concerning replanting a corn crop after figuring the net returns from replanting.

**Directions:** Access the University of Missouri Extension interactive Corn/Soybean Replant Worksheet (G4091) at <http://muextension.missouri.edu/scripts/xplor/G04091.asp>. The spreadsheet will figure the costs and returns when replanting corn. Input the figures from the scenario below and answer the questions.

Estimated planting income:

| | |
|---|---|
| New planting date | May 20 |
| Estimated stand density of sparse stand | 11,000 |
| Normal yield | 115 bushels |
| Estimated market value of crop | $2.10 |

Estimated planting costs:

| | |
|---|---|
| Seed | $40 |
| Fuel, machinery, labor | 35 |
| Pesticides | 30 |
| Other costs | 15 |

1. What is the estimated total income/acre from replanting? $ _____
2. What is the estimated total expenses/acre for replanting? $ _____
3. What is the estimated net income/acre from replanting? $ _____
4. What is the estimated profit or loss from replanting? $ _____

Some seed companies may have a replant policy with no cost to replant. Recalculate the scenario eliminating the seed costs.

5. What is the estimated net income/acre from replanting (with no seed costs)? $_____
6. What is the estimated profit or loss from replanting (with no seed costs)? $ _____

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 6: Harvesting the Crop

***Competency/Objective:*** Identify factors to determine harvesting and postharvesting management.

***Study Questions***

1. **What factors determine harvest timing?**
2. **What are the different harvesting methods?**
3. **What are the major sources of crop loss during harvest?**
4. **What factors affect grain damage at harvest?**
5. **What are local storage options?**
6. **What are the storage problems associated with corn and grain sorghum?**
7. **What are the factors that determine whether to dry corn?**
8. **What are the methods of drying corn and grain sorghum?**
9. **How is crop quality maintained during storage?**
10. **What are the storage problems associated with corn or grain sorghum silage?**

***References***

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. University Extension agricultural publication
   a) G01290: *Measuring and Reducing Corn Harvesting Losses*
3. Transparency Master
   a) TM 6.1: Moisture Migration in a Grain Bin
4. Activity Sheet
   a) AS 6.1: Measuring Harvest Losses

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 6: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons discussed the planning of the crop, selecting a variety, tillage and planting method, and pest control program. This is followed by scouting and maintaining the crop. Harvesting the crop is the next step in the production process.

B. ***Motivation***

Collect several samples of corn and grain sorghum. Display them in small glass jars. Add additional moisture to some of the samples to simulate heat and mold damage. (This should be done before this lesson to produce mold.) Use this for discussion.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the factors that determine when to harvest. It is important to harvest a crop at the optimum time to ensure the greatest yield and highest quality. Refer to Table 6.1 in the Student Reference for characteristics of proper harvest time.

   **What factors determine harvest timing?**

   a) Plant characteristics - stage of maturity, tendency to lodge, tendency to shatter
      1) Results of not harvesting at appropriate maturity stage
         (a) Cause decrease in yield
         (b) Increase loss due to lodging and shattering
         (c) Nutrient loss for feed
      2) Corn harvested for grain
         (a) Corn harvested for grain is considered mature when moisture content is 20 to 28%.
         (b) Moisture content more than 15.5% will need artificial drying if it is stored.
         (c) High moisture corn can be used for feed if it is stored in an airtight container.
      3) Corn harvested for silage
         (a) Ears well dented - between 32 to 35% moisture stage
         (b) Leaves not yet turned brown and dry
      4) Grain sorghum for grain
         (a) Moisture content is not more than 20%.
         (b) Grain is harvested after heads matured.
         (c) Stalks begin to dry.
   b) Weather conditions
      1) Crop moisture content affected by
         (a) Rainfall
         (b) Humidity
         (c) Wind
         (d) Temperature
      2) Results
         (a) Increased mold
         (b) Cause overheating during storage

3) Crop damage from heavy rains, hail, strong winds
4) Wet fields - harvesting equipment not useable

c) Harvesting methods - moisture level much higher for chopping silage than for corn or grain sorghum combined for grain

2. Discuss the primary harvesting methods used to harvest corn and grain sorghum for grain and for silage. If the students are not familiar with the equipment, obtain photos of the various types of harvesting equipment from a local implement dealer or from the Internet.

**What are the different harvesting methods?**

a) Corn
   1) Combine
      (a) Equipped with a corn head
      (b) Ear removed from plant, husks removed from ear, kernels removed from cob by sheller
   2) Silage chopper
      (a) Chopper cuts stalk into small particles about 1/2 inch long, with 15 to 20% of the particles 1 inch in length.
      (b) Particle size has effect on ability to pack silage tightly to reduce air.
      (c) Particle size can be manipulated through machine adjustments.

b) Grain sorghum
   1) Combine
      (a) Regular grain head
      (b) Cut high as possible
      (c) Threshing action - enough to detach seed from heads
   2) Silage chopper
      (a) Coarse-chops standing crop
      (b) Particle size important for desirable fermentation

c) Estimated yield - may affect harvesting method used
   1) High yield - combine for grain
   2) Low yield - chopped for silage
   3) Estimating yield
      (a) Count number of ears per acre and number of kernels per ear.
      (b) Multiple these numbers to get estimate of number of kernels per acre.
      (c) Divide by average number of kernels in a normal bushel to get yield in bushels per acre.

3. Identify the causes of harvest losses and then discuss how crop losses can be identified and measured. Perform AS 6.1, Measuring Harvest Losses. Refer to *Measuring and Reducing Corn Harvesting Losses* (G01290), University of Missouri Extension agricultural publication. <http://muextension.missouri.edu/xplor/agguides/agengin/g01290.htm>.

**What are the major sources of crop loss during harvest?**

a) Preharvest loss
   1) Occur from plant lodging
   2) Appear as whole ear losses
   3) Should be less than 1% of total crop yield
   4) Higher in adverse crop years or delayed harvest

b) Header ear loss
   1) Occurs when harvest equipment driven too fast or too slow
   2) Occurs by driving off the row
   3) Occurs by operating header too high

c) Header kernel loss
   1) Occurs when kernels are shelled out and lost by header at gathering snouts or snapping bars and rolls

2) Losses average about 0.6%
3) Can be reduced to 0.4%
   (a) Proper adjustments and machine operation
   (b) Good field conditions

d) Combine cylinder loss
1) Unsatisfactory shelling action causes kernels to remain on cob or stalk as they pass through the machine.
2) Loss should not exceed 0.3%.
   (a) Correct cylinder or rotor speed
   (b) Correct concave clearance adjustment
3) Excessive kernel breakage occurs when shelling action is too vigorous.

e) Combine separation loss
1) Separation loss occurs when kernels pass over sieves and out the combine.
2) Losses can be corrected with the correct sieve and wind adjustment.
3) Loss should not exceed 0.1% of total crop yield.

4. Explain the importance of reducing grain damage to maintain high-quality grain. Then discuss the factors that affect grain damage at harvest.

**What factors affect grain damage at harvest?**

a) Improper equipment settings
1) Harvest speed
2) Cylinder speed
3) Concave clearance adjustments
4) Sieve adjustments

b) Improper moisture at harvest
c) Weather conditions
d) Plant maturity
e) Excessive handling

5. Discuss the possible storage options available to producers. Point out local grain elevators and processing plants in the area.

**What are local storage options?**

a) On-farm storage bins or silos
b) Local grain elevator
c) Processing facilities
1) Ethanol plants
2) Feed mills
3) Feedlots

d) Regional transport facilities
1) River terminal
2) Railway cars

6. Discuss the economic losses that can occur from problems with storage of corn and grain sorghum. Refer to TM 6.1 and explain how moisture migrates in a grain bin.

**What are the storage problems associated with corn and grain sorghum?**

a) High moisture
1) Mold - problem if grains are harvested and stored when moisture content is too high
2) Will cause rotting and spoilage to occur

b) Improper drying
1) Overdrying
2) Underdrying

c) Foreign material - encourages grain spoilage
d) Insect and rodent infestations - reduce quality by contamination

7. Explain to the students that harvest loss can be reduced by drying corn. There are certain factors that a producer must consider when deciding whether drying the crop is the best option.

**What are the factors that determine whether to dry corn?**

a) Weather conditions during harvest
b) Market price
c) Grain quality
d) Storage availability
e) Dryer cost
f) Operational costs

8. Discuss the methods for drying corn and grain sorghum. Table 6.2 in the Student Reference explains how to determine the right moisture levels for the current humidity and temperature. Include in the discussion the differences in moisture levels of corn and grain sorghum.

**What are the methods of drying corn and grain sorghum?**

a) Unheated air
   1) Unheated air is used to dry harvested grain that contains no more than 15% moisture.
   2) To decrease moisture content, unheated air must have a relative humidity of 70 to 75% or less.
   3) During final drying stages, unheated air must contain less than 50 to 60% humidity to reduce grain moisture to 13%.
   4) What are the advantages?
      (a) Lower expense for energy
      (b) Less fire hazards
      (c) Lower initial equipment costs
      (d) Little management and supervision
      (e) Less chance of overdrying
      (f) High-quality dried grain
   5) What are the advantages?
      (a) Uses outside air affected by natural weather conditions
      (b) Not effective in cold, damp conditions
      (c) Slower drying rates
      (d) More drying time required
      (e) Bin fill limitations
      (f) Greater possibility of damage from mold due to prolonged drying times
b) Heated air
   1) Air heated with natural gas or petroleum fuels
   2) Heated air forced throughout storage bin
   3) Direct heat - evaporates 50 to 85 pounds of water from grain
   4) Indirect heat - 35 to 60 pounds of water removed
   5) Advantages
      (a) Increased ability to dry the wettest grain
      (b) No dependency on weather conditions
      (c) Shorter, faster drying times
      (d) High drying capacity
   6) Disadvantages
      (a) Initial cost higher
      (b) Fuel expense higher
      (c) Some fire hazard
      (d) Potential to overdry grain - reducing quality

(e) More careful management and supervision

c) Field drying
   1) Crop allowed to dry to appropriate moisture content while standing
   2) Harvest with appropriate combine head attachments - prevent kernel damage and lodging

9. Explain the factors that affect grain quality of stored grain. Grain quality includes the purity of the crop and variety, percentage of weeds and other mixtures, and percentage of diseased and damaged kernels. Discuss how these qualities are maintained during storage.

**How is crop quality maintained during storage?**

a) Corn
   1) Store at moisture content of 14% or less.
   2) Level the top surface.
   3) Aerate in fall to cool grain to 40°F.
   4) Do not allow to freeze.
   5) Check and record grain temperature every 21 days.
   6) Aerate if temperature increase is evident.
   7) Warm grain in the spring to 65°F with an aeration fan.
   8) Maintain less than 20-degree difference between outdoor temperature and grain temperature.

b) Grain sorghum
   1) Cooling - first consideration
   2) Humidity and moisture control - secondary consideration
   3) Run fan
      (a) Whenever grain is heating or over 22% moisture content
      (b) When grain is below 22% moisture and not heating
      (c) Whenever the outside air is 10 degrees cooler than the grain mass until the grain is cooled down to 40°F to 50°F

10. Explain the ensiling process and then discuss what problems could occur during storage. Silage crops should be harvested at a stage of maturity that produces silage with 30 to 40% dry matter.

Ensiling Process: The ensiling process occurs as chopped forages and grains are compressed as they are placed in the silo. The cells of the plants are still alive and breathing. Breathing plant cells and microorganisms form carbon dioxide and heat using the trapped air. As carbon dioxide increases, an anaerobic condition is formed in the silo. Aerobic bacteria do not require oxygen for metabolism and start the fermentation process when plant respiration stops.

**What are the storage problems associated with corn or grain sorghum silage?**

a) Air exposure
   1) Limit air exposure during ensiling.
      (a) Maintain carbon dioxide for fermentation process.
      (b) Avoid mold growth and nutrient loss.
   2) Cover trench or bunker silos with plastic.

b) Improper moisture
   1) High moisture levels
      (a) Moisture seeps or water leaks to bottom of silo or bunker.
      (b) Vital nutrients are lost.
   2) Low moisture levels
      (a) Hard to pack or store
      (b) Extra air present
      (c) Fermentation and mold growth
      (d) 50% dry matter - add water

c) Temperature

1) Recommended temperature for desirable bacterial decomposition - between 80°F and 100°F
2) Too hot
   (a) Black or brown color
   (b) Caramel odor
3) Freezing
   (a) Occurs in bunk or trench silos
   (b) Can cause digestive disturbances in livestock

d) Improper distribution and packing
1) Seepage
2) Poor fermentation
3) Loss in storage capacity

e) Maintain freshness
1) Daily removal amounts
   (a) Upright silos
      (1) Summer - 3 inches
      (2) Winter- 2 inches
   (b) Trench or bunker silos
      (1) Summer- 4 inches
      (2) Winter- 3 inches
2) Light, pleasant smell
   (a) Slight vinegar odor
   (b) Color slightly brown to dark green

F. ***Conclusion***

Producers face many challenges during harvest. Even the best crop can be lost if the proper harvesting and postharvesting methods are not implemented.

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

Answers will vary depending on the results of the experiment.

H. ***Answers to Evaluation***

1. Plant characteristics, weather conditions, harvesting methods
2. Combining and silage chopping
3. Preharvest loss, header ear loss, header kernel loss, combine cylinder loss, combine separation loss
4. Any three of the following: improper combine settings, improper moisture, weather conditions, plant maturity, excessive handling
5. Any three of the following: on farm storage bins or silos, local county elevators, local processing facilities, regional transport facilities
6. High moisture content, improper drying, foreign material, insect and rodent infestations
7. Any three of the following: weather, market price, grain quality, storage availability, drying equipment, cost of drying
8. a
9. b
10. b
11. a
12. b
13. 14
14. 21
15. 20
16. 10
17. Any three of the following: air exposure, moisture, temperature, distribution and packing

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 6: Harvesting the Crop Date_____

EVALUATION

**Complete the following short answer questions.**

1. What factors determine harvest time?

   a.

   b.

   c.

2. What methods are used to harvest corn and grain sorghum?

   a.

   b.

3. What are the major sources of crop loss during harvest?

   a.

   b.

   c.

   d.

   e.

4. What are three factors that affect grain damage at harvest?

   a.

   b.

   c.

5. What are three storage options for producers?

   a.

   b.

   c.

6. What are the four main storage problems associated with corn and grain sorghum?

   a.

   b.

   c.

   d.

7. What are three factors that determine whether to dry corn?

   a.

   b.

   c.

**Match the definition on the left to the term on the right.**

8. _____Lower energy cost, decrease fire hazards, little management and supervision

9. _____Increased ability to dry very wet grain

10. _____Increased initial cost and operational expenses

11. _____Not effective in cold, damp conditions

12. _____No dependency on weather conditions

a. Drying with unheated air

b. Drying with heated air

**Complete the following short answer questions.**

13. In order to maintain crop quality, corn should be stored at a moisture content of _____% or less.

14. Stored grains should be checked and a temperature recorded every _____ days.

15. Producers should maintain less than a _____ -degree difference between outdoor and indoor grain temperatures for corn.

16. If grain sorghum is below 22% moisture when drying, run the fan whenever the outside air is _____ degrees cooler than the grain mass.

17. What are three factors that can cause spoilage in corn or grain sorghum silage?

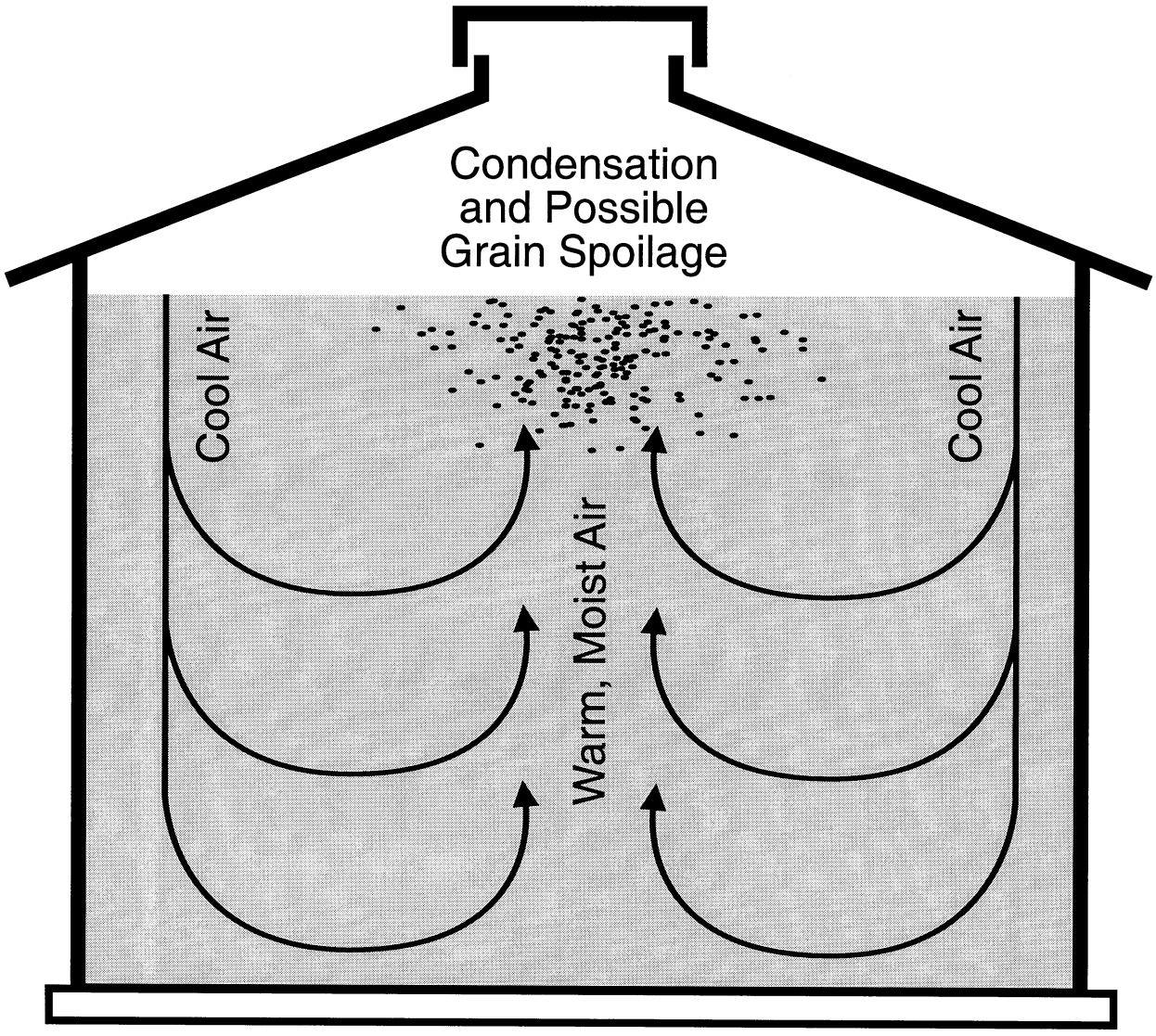
   a.

   b.

   c.

TM 6.1

# Moisture Migration in a Grain Bin



Lesson 6: Harvesting the Crop Name _____

## Measuring Harvest Losses

**Objective**: Students will be able to identify the process of measuring and reducing corn harvesting losses.

**Directions:** Determine losses by counting the number of full-size ears (approximately 3/4 pound) or the equivalent weight in smaller ears found in 1/100 acre. Each full-size ear represents about 1 bushel per acre loss. Count the kernels per 10 square feet to determine kernel losses. Two kernels per square foot equals a 1-bushel-per-acre loss. Enter ear and kernel counts in Table 2 and Table 4, respectively.

After you complete these tables, they will show the total harvest loss as well as the loss at each section of the machine. The results will identify the areas where combine adjustments should be made. First, disconnect the straw spreader or chopper. Stop the combine where the crop is representative of the entire field. Shut off the header. Back up a distance equal to the length of the combine and shut off the combine.

Determine the total ear loss (step 1) and the total kernel loss (steps 4, 5, and 6) for the combine. If the total loss for the machine is 3% to 5% of the total crop yield, keep on harvesting. If the loss is greater, find the source of loss to determine where adjustments are needed.

**Procedure:**

**Total Ear Loss (preharvest and header)**

**Step 1.** Step off the required distance behind the combine. The length of corn rows for this 1/100 acre varies with row width and number of rows covered by the corn head. (See Table 1.) Gather and count all the whole and broken ears in these rows. Record this number in Table 2. Each 3/4-pound ear or the equivalent weight in smaller ears represents 1-bushel-per-acre loss. Three ½-pound ears represent 2 bushels per acre.

*Table 1 - Row Length in Feet per 1/100 Acre*

| Row width (inches) | One row | Two rows | Three rows | Four rows | Six rows | Eight rows | Twelve rows |
|---|---|---|---|---|---|---|---|
| 20 | 262 | 131 | 87.3 | 65.5 | 43.6 | 32.7 | --- |
| 28 | 187 | 93.5 | 61.3 | 46.7 | 31.1 | 23.3 | --- |
| 30 | 174 | 87 | 58 | 43.6 | 29 | 21.8 | 14.5 |
| 36 | 145 | 72.5 | 48.3 | 36.2 | --- | --- | --- |
| 38 | 138 | 69 | 46 | 34.5 | --- | --- | --- |
| 40 | 131 | 65.5 | 43.6 | 32.7 | --- | --- | --- |
| 42 | 124 | 62 | 41.3 | 31 | --- | --- | --- |

*Table 2 - Ear Loss Data Table*

| | Number of ears[1] | Bushels/acre |
|---|---|---|
| Total ear loss (Step 1) | | |
| Preharvest ear loss (Step 2) | | |
| Header ear loss (Step 3) | | |
| [1]One 3/4-pound ear = 1 bushel/acre | | |

**Step 2.** Step off the required distance in the standing corn. (See Table 1.) The combine header width times the distance stepped off represents 1/100 acre. Gather and count all the loose and lodged ears in these rows. Record this number in Table 2.

**Header Ear Loss**

**Step 3.** Subtract the preharvest ear loss from the total ear loss to determine header ear loss. Record this number in Table 2.

**Total Kernel Loss (header and separation loss)**

Count the loose kernels on the ground and those still attached to threshed cobs in a 10-square-foot area for each row behind the combine to determine total kernel loss. The procedure is outlined in steps 4, 5, and 6. To obtain the 10-square-foot area, make a rectangle with a plastic clothesline and four wire pegs. The area's width should be equal to the planted row's width. Use Table 3 to determine length.

*Table 3 - Row Length for 10-Square-Foot Frame*

| Row width (inches) | Row length (inches) |
|---|---|
| 20 | see footnote[1] |
| 28 | 51.5 |
| 30 | 48 |
| 36 | 40 |
| 38 | 38 |
| 40 | 36 |
| 42 | 34 |
| [1]Use same frame as for 40-inch rows, but place frame over two rows at a time. | |

**Step 4.** Place the frame over each row behind the machine. Count the number of loose kernels on the ground within the frame. Record this number in Table 4, column 3. This figure represents the total loose kernel loss (header loss plus separating loss).

**Step 5.** Before moving the frame to the next row behind the machine, also count the number of kernels still attached to the threshed cobs. Ignore small kernels at the butt or tip end of cob. Record this figure in Table 4, column 2. It represents the cylinder loss.

**Step 6.** For each row, add columns 2 and 3 of Table 4. Divide by 20 to convert the kernel loss to bushels per acre. Record the result in Table 4, column 1. The average of the values in column 1 gives the combine's total kernel loss in bushels per acre.

**Header Kernel Loss**

**Step 7.** Place the frame over each harvested row in front of the machine where the separator has not yet passed. Count the loose kernels within the frame and record the number in Table 4, column 4. It represents the header kernel loss.

**Separation Kernel Loss**

**Step 8**. For each row, subtract column 4 from column 3 and record the number in column 5. The result represents the separation kernel loss.

*Table 4 - Kernel Loss Data Table*

| Column | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Row number** | **(Step 6) Total kernel loss per acre[1]** | **(Step 5) Cylinder loss[2]** | **(Step 4) Header and separation loss[3]** | **(Step 7) Header loss[3]** | **(Step 8) Separation loss[3]** |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| Average loss | | | | | |

[1]Divide by 20 = bushels per acre
[2]Kernels on cob per 10 square feet
[3]Kernels per 10 square feet

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 7: Marketing the Crop

***Competency/Objective:*** Describe marketing opportunities and how grade requirements affect grain prices.

***Study Questions***

1. **What options are available for marketing corn and grain sorghum?**
2. **How do producers determine when to sell, feed, or store corn and grain sorghum?**
3. **How does grain quality (grade requirements) affect price?**
4. **How does moisture docking compare to drying costs?**
5. **What are corn checkoff dollars?**

***References***

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. Transparency Masters
   a) TM 7.1: Grade Requirements for Corn
   b) TM 7.2: Grade Requirements for Grain Sorghum
3. Activity Sheet
   a) AS 7.1: Determining Storage Break-even Costs

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 7: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

The final step in producing corn and grain sorghum is marketing the crop. This lesson will discuss what marketing options are available for corn and grain sorghum; when producers should sell, feed, or store their crop; and how USDA grading influences profit. The effect of corn checkoff dollars will also be explained.

B. ***Motivation***

1. Ask students where they or their parents obtain marketing information. List these sources on the board and have students bring in examples (reports) that you do not have. Also, as a group view market information sources such as AgEBB and the USDA on the Internet, showing students how information at these sites relates to topics of this lesson.

2. Visit a local grain elevator or feedmill and have a grain inspector demonstrate how to test and grade corn and/or grain sorghum.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the five marketing options and how these are influenced by government trade policies and programs, global weather patterns, and world economics. Also, discuss with students how certain factors such as the U.S. and world total crop production and the livestock industry might affect the price of corn and grain sorghum. (For supplemental information, review market economics in Unit II of the IML guide, *Agribusiness Sales, Marketing & Management.*)

   **What options are available for marketing corn and grain sorghum?**

   a) Five basic marketing choices
      1) Sell the crop when it is harvested.
      2) Store the crop and sell it later.
      3) Feed the crop to producer's livestock.
      4) Forward price the crop through cash contracts, futures contracts, or options.
      5) Use a combination of these methods.
      6) Participate in commodity price support programs from the government.
   b) Choice is dependent on the current cash price, the price of futures, and producers' speculation on the futures market

2. Point out to the class that the cost of farm storage and producers' predictions on price trends in grain and livestock after harvest are the main factors that determine whether to sell, feed, or store corn and grain sorghum. Also, discuss general price trends and how they are influenced by U.S. crop production and other noncrop factors. Refer to the current version of *Missouri Farm Facts* for specific information. Complete AS 7.1 by using the AgEBB spreadsheet available on the Internet at <http://agebb.missouri.edu/download/university>. This is a file-sharing web site and the file "cropstor.exe" will need to be downloaded to your hard drive.

   **How do producers determine when to sell, feed, or store corn and grain sorghum?**

a) Factors affecting this decision
   1) Cost of farm storage
   2) Producers' price trend predictions on grain and livestock prices
   3) Interest rates
b) General assumptions
   1) If the price of corn is high and may potentially drop in the future—sell.
   2) If the price of corn is low and may potentially fall in the future—store.
   3) If the price of corn is low and livestock prices are up for the future—feed.
c) Global markets - affecting changes in futures market
   1) Size of crops in other parts of the world influences U.S. prices.
   2) Corn is an important item in the balance of trade with other countries.
   3) United States sends corn overseas in return for fuel oil.
   4) Prices of corn will have higher peaks and valleys.
   5) Federal government is less involved with price supports and does not provide grain storage bins.
   6) More corn is being moved from the field directly to the elevators.
      (a) This puts a heavy strain on storage facilities and transportation.
      (b) The number of railroad cars is inadequate during harvest rush.
      (c) This is complicated when weather is ideal and harvest is rapid.
d) Based on U.S. crops
   1) Odds favor regularly storing corn and grain sorghum for a short time after harvest.
   2) Storing until the next fall is risky.
   3) Success with corn and grain sorghum storage over a period of years depends upon selecting the right time to sell in individual years.
   4) Feeding corn or grain sorghum is a good option when cash price is low and livestock futures are trending steady to high.
   5) Average rise in price is little more than the cost of storing except right after harvest.
   6) Having on-farm storage increases producers' flexibility in deciding when to sell.
e) Storage costs
   1) Costs must be figured, including loss of interest on money received if the corn was sold at harvest.
   2) Normal storage is 12¢ per bushel per month with a first 3-month minimum.
   3) Additional months' cost is 3¢ per bushel per month.
   4) To calculate the monthly storage cost, use the following formula: [(Interest x current price) ÷ 12] x # of months + storage cost for that month.

3. Using the tables in the Student Reference obtained from the *U.S. Grain Grading Handbook*, discuss the factors used in grading corn and grain sorghum. Bring samples of corn and grain sorghum for the class to examine. Have students divide into two groups and grade the corn and sorghum. Using the discounts provided or ones obtained from a local elevator, determine the price.

**How does grain quality (grade requirements) affect price?**

a) Limited seed damage to preserve grain quality
b) Factors used in grading
   1) Test weight
   2) Moisture content
   3) Seed damage (cracked kernels)
   4) Foreign material present
   5) Special discounts such as musty, sour, heating, foreign odor, and weathered (sorghum)
c) USDA standards
   1) Corn graded on a scale of 1 - 5, with 1 being the highest grade, or best quality
   2) Grain sorghum graded on a scale of 1 - 4
   3) Sample grade - low quality

(a) Sample grade for corn has one or more of the following characteristics: contains stones, musty, sour, heating, and/or has a foreign odor.
(b) Sample grade for grain sorghum has one or more of the following characteristics: contains stones, musty, sour, heating, foreign odor, and/or is badly weathered.

4. Using estimated figures or actual moisture test results on corn and grain sorghum, explain to students how to determine if it is profitable to dry grain or sell it wet.

**How does moisture docking compare to drying costs?**

a) Test weight determines the weight of a bushel value of grain.
   1) Test weights indicate whether the grain reached full maturity.
   2) If grain moistures are greater than 15.5%, the test weights will be biased downward.
b) Producers need to decide whether to sell the crop wet and take the moisture dock or spend the time and money to dry the grain.
   1) If cash prices are high and producers have little or no available storage, sell and take the dock.
   2) If grain prices are high and steady or close to breakeven, consider drying.
c) High-moisture corn sells for less.
   1) Less dry weight
   2) Costs more to dry
   3) Discourages producers from selling it
d) Dock on high-moisture corn and grain sorghum
   1) Dock is often 3¢ per bushel for every 1/2% above 15% moisture.
   2) Cost is normally figured at 3¢ per bushel per 1% of moisture removed.
e) Shelled grain weights can be adjusted using a grain shrink table.
   1) Shrink represents both the moisture loss and 0.5% dry matter loss encountered during drying and grain handling.
   2) Multiply the wet weight by the shrink factor from the shrink table.

5. Explain corn checkoff dollars and the benefits obtained from these funds by the Missouri Corn Growers Association and the National Corn Growers Association.

**What are corn checkoff dollars?**

a) Specified rate is invested by the seller at the first point of sale for every bushel of corn sold.
   1) Missouri started in 1984.
   2) Missouri rate is ½¢ per bushel of corn sold.
b) Monies are sent to the Missouri Corn Growers Association.
   1) Corn promotion board is run by farmer-directors.
   2) These dollars fund state programs of research, market development, and education to increase the demand for corn.
   3) A portion of the funds is sent to the National Corn Growers Association.
      (a) Invested in same areas as on the state level
      (b) Other funds from NCGA members and state associations
   4) Individual producers play an important role through checkoff dollars.

F. ***Other Activities***

1. Have students go through an exercise using the futures market. Give each student a specified quantity of corn and grain sorghum and have them create a futures contract, keeping track of actual market information. You might want to make this a contest between teams of students to see who can get the top price for their crops.

2. As an alternative to the first exercise, student teams could set up imaginary farming situations where some teams have on-farm storage, some do not, and some have livestock enterprises.

Each team can be given a set amount of time to decide whether to sell, store, or feed its harvested grain. Using futures prices, teams would design a plan for how they would handle their harvested crop and their projected profit.

G. ***Conclusion***

This lesson should emphasize what marketing options are available for corn and grain sorghum and when producers should sell, feed, or store their crop. Students should also gain a working knowledge of USDA testing and grading and how grain quality influences profit.

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

AS 7.1

| Month in the Future | Interest Charge to Date | Storage Charge to Date | Price Required to Break Even |
|---|---|---|---|
| Oct. 99 | 0.01 | 0.12 | $ 2.18 |
| Nov. 99 | 0.03 | 0.12 | 2.20 |
| Dec. 99 | 0.04 | 0.12 | 2.22 |
| Jan. 00 | 0.06 | 0.12 | 2.23 |
| Feb. 00 | 0.07 | 0.15 | 2.28 |
| March 00 | 0.09 | 0.18 | 2.33 |
| April 00 | 0.11 | 0.21 | 2.38 |
| May 00 | 0.13 | 0.24 | 2.43 |
| June 00 | 0.14 | 0.27 | 2.48 |
| July 00 | 0.16 | 0.30 | 2.53 |

1. $2.53 per bushel
2. 16¢ per bushel
3. 30¢ per bushel

* Students may also figure the above information using the formula given in the Student Reference.

I. ***Answers to Evaluation***

1. a. Sell the crop when it is harvested.
   b. Store the crop and sell it later.
   c. Feed the crop to their own livestock.
   d. Forward price the crop through cash contracts, future contracts, or options.
   e. Use a combination of these methods.
   f. Participate in commodity price support programs from the Government.
2. Corn checkoff dollars go to the Missouri Corn Growers Association. The farmer-directors of the board use the monies generated by the checkoff to fund state programs of research, market development, and education to increase the demand for corn. (Answers will vary.)
3. Feed
4. Sell
5. Store
6. b
7. c

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION Name_____

Lesson 7: Marketing the Crop Date_____

EVALUATION

**Complete the following short answer question.**

1. What are the five basic options producers have when marketing their crops?

   a.

   b.

   c.

   d.

   e.

2. Briefly explain the purpose of corn checkoff dollars.

**Fill in the blank to complete the following sentences.**

3. If the price of corn is low and livestock prices are looking up _____.

4. If the price of corn is high and may drop in the future _____.

5. If the price of corn is low and may rise in the future _____.

**Circle the letter that corresponds to the best answer.**

6. Corn that falls below Grade 5 is called _____ grade.

   a. Producer
   b. Sample
   c. Livestock
   d. Test

7. A dock on grain refers to _____.

   a. The taxes imposed by the government
   b. The storage of grain by the producer until prices go higher
   c. The reduced price that a producer sells grain at to make up for moisture content
   d. The method by which producers and buyers bargain with each other over the sale of grain

# Grade Requirements for Corn

| Grade | Minimum test weight per bushel (pounds) | Maximum limits of: | | |
|---|---|---|---|---|
| | | Damaged kernels | | Broken corn and foreign material (%) |
| | | Heat-damaged kernels (%) | Total (%) | |
| U.S. No.1 | 56.0 | 0.1 | 3.0 | 2.0 |
| U.S. No.2 | 54.0 | 0.2 | 5.0 | 3.0 |
| U.S. No.3 | 52.0 | 0.5 | 7.0 | 4.0 |
| U.S. No.4 | 49.0 | 1.0 | 10.0 | 5.0 |
| U.S. No. 5 | 46.0 | 3.0 | 15.0 | 7.0 |

U.S. Sample grade is corn that:

(a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4, or 5; or

(b) Contains stones that have an aggregate weight in excess of 0.1% 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 cockleburs (*Xanthium* spp.) or similar seeds singly or in combination, or animal filth in excess of 0.20% in 1,000 grams; or

(c) Has a musty, sour, or commercially objectionable foreign odor; or

(d) Is heating or otherwise of distinctly low quality.

# Grade Requirements for Grain Sorghum

| Grade | Minimum test weight per bushel (pounds) | Maximum limits of: | | |
|---|---|---|---|---|
| | | Damaged kernels | | Broken kernels, foreign material, and other grains (%) |
| | | Heat damaged (%) | Total (%) | |
| U.S. No. 1 | 57.0 | 0.2 | 2.0 | 4.0 |
| U.S. No. 2 | 55.0 | 0.5 | 5.0 | 7.0 |
| U.S. No. 3* | 53.0 | 1.0 | 10.0 | 10.0 |
| U.S. No. 4 | 51.0 | 3.0 | 15.0 | 13.0 |

U.S. Sample grade is sorghum that:

(a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, or 4; or

(b) Contains stones that have an aggregate weight in excess of 0.2% of the sample weight, 1 or more pieces of glass, 2 or more crotalaria seeds (*Crotalaria* spp.), 1 or more castor beans (*Ricinus communis* L.), 3 or more particles of an unknown foreign substance(s), 7 or more cockleburs (*Xanthium* spp.) or similar seeds singly or in combination, 9 or more particles of animal filth per 1,000 grams of sorghum, or

(c) Has a musty, sour, or commercially objectionable foreign odor (except smut odor); or

(d) Is badly weathered, heating, or distinctly low quality

* Sorghum that is distinctly discolored shall not be graded higher than U.S. No. 3.

Lesson 7: Marketing the Crop Name_____

## Determining Storage Break-even Costs

**Objective:** Students will determine the break-even price that must be received for a bushel of corn when storing for a given number of months.

**Directions:** Access the University of Missouri's Agricultural Electronics Bulletin Board at <http://agebb.missouri.edu/download/university> and download the grain spreadsheet titled "cropstor.exe" to figure the break-even cost of storing grain. Input the following information and determine what the producer would have to receive per bushel of corn if the grain was stored until July of the following year. Complete the chart and answer the questions below.

| | |
|---|---|
| Interest rate | 8% |
| Commercial storage costs ($/bu./month) | 3¢ |
| Month beginning storage (month-year) | Oct. 99 |
| Current cash market | $2.05 |
| Minimum charge for storage | 12¢ |

| Month in the Future | Interest Charge to Date | Storage Charge to Date | Price Required to Break Even |
|---|---|---|---|
| Oct. 99 | | | |
| Nov. 99 | | | |
| Dec. 99 | | | |
| Jan. 00 | | | |
| Feb. 00 | | | |
| March 00 | | | |
| April 00 | | | |
| May 00 | | | |
| June 00 | | | |
| July 00 | | | |

1. What would the cash price of corn have to be in July for the producer to break even? $ _____

2. What was the total amount of interest (per bushel) in July? $ _____

3. What was the total storage charge (per bushel) in July? $ _____

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 8: Figuring Crop Costs

***Competency/Objective:*** Calculate cost per acre.

***Study Questions***

1. **What variable costs are associated with corn and grain sorghum production?**

2. **What fixed costs are associated with corn and grain sorghum production?**

3. **What factors should be 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 VI.

2. Transparency Masters

   a) TM 8.1: Variable Costs/Acre for Corn and Grain Sorghum
   b) TM 8.2: Fixed Costs/Acre for Corn and Grain Sorghum

3. Activity Sheet

   a) AS 8.1: Determining Crop Costs and Returns

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 8: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

The previous lesson discussed opportunities for marketing the corn or grain sorghum crop. This 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. This lesson will discuss crop costs and figuring cost per acre.

B. ***Motivation***

Ask students if they have an idea how much it costs to produce a bushel of corn. Then ask or give them information about what corn is bringing on the cash market today. Have them determine how many bushels of corn they would 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. To help them understand what makes up these types of costs, use TM 8.1, which provides several examples.

   **What variable costs are associated with corn and grain sorghum production?**

   a) Variable costs must be determined to figure break-even prices of a crop.
   b) Variable costs are also known as operating costs.
   c) Variable costs will vary with the level of production.
      1) Greater yields will increase plant populations, thereby increasing seed costs.
      2) Decreasing planting rates requires less seed but the crop yield will be less.
   d) In addition to seed costs, other variable costs will include the following items.
      1) Fertilizer
      2) Chemicals
      3) Labor
   e) Detailed records necessary to appropriate costs to proper enterprise.
   f) Variable costs for grain sorghum is lower than for corn.

2. Help the students define fixed costs. Be able to explain the difference between fixed and variable costs and give examples. Use TM 8.2 during this discussion.

   **What fixed costs are associated with corn and grain sorghum production?**

   a) Fixed costs are also known as ownership costs and are unavoidable.
   b) Fixed costs must always be paid no matter what the level of production.
      1) Land costs
      2) Mortgage payments (include interest and principal due in coming year)
      3) Insurance
      4) Taxes
   c) Fixed costs are more per acre with corn than with grain sorghum.

3. Students must realize that the one factor that determines an acceptable return is the number of acres under production for that specific crop. The greater the number of acres, the greater the total returns.

   **What factors should be considered when determining an acceptable return on investment?**

   a) Net returns are determined by subtracting the total costs from the total returns.
   b) Yearly cycles exist where profits are affected by supply and price stability.
   c) Acceptable returns are affected by the total number of acres of a specific crop.

4. Use some examples when discussing this study question. Students should have practice when solving for total costs per acre. Have students complete AS 8.1.

   **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***

Through accurate and complete record keeping, variable and fixed costs can be determined for a crop of corn or grain sorghum. It is important for producers to understand what makes up fixed and variable costs and that these costs must be figured when determining net returns.

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

| Variable Costs | Per Acre | Field Total |
|---|---|---|
| Seed | $ 28.00 | $14,000 |
| Plant food | 54.00 | 27,000 |
| Crop chemicals & materials | 35.00 | 17,500 |
| Machinery costs (fuel, oil & repairs.) | 29.00 | 14,500 |
| Machinery hire & services | 7.00 | 3,500 |
| Labor costs | 26.00 | 13,000 |
| Taxes and insurance | 4.00 | 2,000 |
| Miscellaneous | 14.00 | 7,000 |
| Operating interest | 14.00 | 7,000 |
| **Total Variable Costs** | $ 211.00 | $ 105,500 |

| Fixed Costs | Per Acre | Field Total |
|---|---|---|
| Machinery depreciation and interest | $ 38.00 | $ 19,000 |
| Land costs, taxes, and interest. | $110.00 | $ 55,000 |
| **Total Fixed Costs** | $148.00 | $ 74,000 |
| **Total All Costs** | $359.00 | $179,500 |

1. $105,500
2. 474,000
3. $179,500
4. $2.87
5. 140,625
6. - 38,875 (loss)

I. ***Answers to Evaluation***

1. b
2. b
3. c
4. Any two of the following: fertilizer; chemicals; labor; miscellaneous; machinery fuel, oil, and repair; machinery hire and services; operating interest
5. Machinery (depreciation, taxes, and interest)
   Land (taxes and interest)
6. Add all variable and fixed costs

UNIT VI - CORN AND GRAIN SORGHUM 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. Grain sorghum production is usually _____ in relation to corn production costs.

   a. Higher
   b. Lower
   c. The same
   d. None of the above

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. List two examples of costs that would be classified as variable costs.

   a.

   b.

5. List two examples of costs that would be classified as fixed costs.

   a.

   b.

6. Explain how total costs per acre are calculated.

TM 8.1

# Variable Costs Per Acre for Corn and Grain Sorghum

| | Corn | Grain Sorghum |
|---|---|---|
| Number of Farms Reporting | 89 | 13 |
| Average Number of Acres | 332 | 119 |
| Average Yield/Acre (bushels) | 121 | 99.3 |
| **Average Variable Costs/Acre** | | |
| Seed | $27.89 | $9.86 |
| Plant Food (Fertilizer & Lime) | 50.50 | 45.33 |
| Crop Chemicals and Materials | 31.34 | 21.85 |
| Machinery Fuel, Oil & Repair | 26.04 | 20.90 |
| Machinery Hire & Services | 6.30 | 4.18 |
| Average Labor Cost/Acre | 26.56 | 4.16 |
| Taxes and Insurance | 3.75 | 1.08 |
| Miscellaneous | 13.70 | 12.16 |
| Operating Interest | 14.55 | 12.83 |
| **Total Variable Costs/Acre** | $200.63 | $152.35 |

# Fixed Costs Per Acre for Corn and Grain Sorghum

| | Corn | Grain Sorghum |
|---|---|---|
| **Average Fixed Costs/Acre** | | |
| Machinery depreciation and interest | $ 36.10 | $24.87 |
| Land costs, taxes, and interest | $ 93.45 | $66.65 |
| **Total Fixed Costs/Acre** | $129.55 | $91.52 |

Lesson 8: Figuring Crop Costs Name_____

## Determining Crop Costs and Returns

**Objective:** Students will determine the cost of production for a corn crop.

**Directions:** With the information provided, complete the table and answer the questions.

A producer has 500 acres of corn. The field yields an average of 125 bushels per acre, valued at $2.25 per bushel on the cash market.

| Variable Costs | Per Acre | Field Total |
|---|---|---|
| Seed | $28.00 | |
| Plant food | 54.00 | |
| Crop chemicals and materials | 35.00 | |
| Machinery costs (fuel, oil, and repairs) | 29.00 | |
| Machinery hire & services | 7.00 | |
| Labor costs | 26.00 | |
| Taxes and insurance | 4.00 | |
| Miscellaneous | 14.00 | |
| Operating interest | 14.00 | |
| **Total Variable Costs** | | |
| **Fixed Costs** | | |
| Machinery depreciation and interest | $ 38.00 | |
| Land costs, taxes, and interest | $110.00 | |
| **Total Fixed Costs** | | |
| **Total All Costs** | | |

1. What are the total variable costs for the 500-acre field? $_____
2. What are the total fixed costs for the 500-acre field? $_____
3. What is the total of all costs for the 500-acre field? $_____
4. What is the cost of production per bushel of corn produced? $_____
5. What are the gross returns for the 500 acres of corn? $_____
6. What are the net returns (profit or loss) for the 500 acres of corn? $_____