UNIT XI - RICE PRODUCTION

Lesson 1: Planning the Crop

Competency/Objective: Evaluate local growing conditions and determine fertilizer needs for rice production.

Study Questions

1. **What environmental conditions are necessary for rice production?**

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

3. **What are the fertilizer requirements for rice?**

References:

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

2. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.

3. Activity Sheet

    a) AS 1.1: Nitrogen Fertilizer Rates

UNIT XI - RICE PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

Although rice is not a predominant crop in Missouri, this state ranks 6th in U.S. rice production, representing 4% of the country's total yield. According to the U.S. Department of Agriculture's Economic Research Service, in 1999 Missouri produced 160,000 acres of rice, which is a record. Learning how to plan the crop, evaluate field history, and determine fertilizer requirements is essential to successful rice production.

B. ***Motivation***

Ask students to name countries that are known for producing rice and to locate these areas on a world map. Encourage students to use their knowledge from geography and history classes to characterize the climate in these places. Ask why rice would flourish there. This will focus the discussion on specific growing conditions. Then ask them to identify the climate and temperature in Missouri's Bootheel. Ask students if they detect any similarities in growing conditions between Missouri and the countries they identified.

C. ***Assignment***

To prepare for subsequent lessons, have students send for Rice Information Sheets from the Missouri University Outreach and Extension. These sheets provide planting dates, seeding rates, fertilization information, and disease control for specific rice varieties. For the Butler County office, contact 222 N. Broadway, Poplar Bluff, MO 63901 (573) 686-8064. For Stoddard County, contact P.O. Box 169, Bloomfield, MO 63825 (573) 568-3344. Although students have not yet learned about seed varieties, have them request information about Bengal, Cocodrie, Cypress, Drew, Jefferson, LaGrue, Lemont, and Wells.

D. ***Supervised Study***

E. ***Discussion***

1. Explain to students that in Missouri, the principal rice-producing areas are Butler and Stoddard counties, which are located in the Bootheel. Half or more of the rice grown comes from Butler and almost 1/3 is produced in Stoddard. Use information and insights obtained from the discussion in the Motivation to identify environmental conditions required for growing rice.

   What environmental conditions are necessary for rice production?

   a) Frost-free dates
      1) Usual planting dates - April 15 to June 10
      2) Usual harvesting dates
         (a) Beginning - September 10
         (b) Most active - September 25 to October 25
         (c) End - November 1
   b) Soil temperature - above 50°F; temperature at germination - 50-104°F
   c) Soil moisture
      1) For successful rice production, the soil must be moist, not muddy. Avoid planting on dry soil.

2) For a given field, a water supply is adequate, assuming the producer can do the following.
   (a) Flush in 2-4 days.
   (b) Flood in 3-5 days.
   (c) Maintain flood for the season.
3) Use the following recommended pumping rates for different soil texture groups, as measured in gallons per minute per acre (gpm/A).
   (a) Silt loam with pan - 10 gpm/A (same rate for minimum and desired)
   (b) Sandy loam - 15 gpm/A minimum, 25 gpm/A desired
   (c) Silt loam, no pan - 10 gpm/A minimum, 15 gpm/A
   (d) Clay and silty clay - 15 gpm/A minimum, 20 gpm/A desired

d) Rainfall/irrigation - water added to flood to maintain depth

e) Water-seeded rice - two water management methods
1) Pinpoint flooding
   (a) Water is drained so seedlings anchor in the soil.
   (b) Soil should not dry.
   (c) Field is flooded within 5 days, then drained and reflooded within 3-5 days.
   (d) Field is reflooded with shallow flood; flood is increased as seedlings develop.
2) Continuous flooding - Water is maintained at constant level and is never drained.

2. Ask students to identify information they would need to have about a field before planting rice.

What factors are considered when evaluating field history?

a) Previous crop
1) Rice is usually rotated with soybeans.
   (a) Red rice (disease) is controlled.
   (b) Soybeans need more potassium and phosphorus than rice.
   (c) Enough residual nitrogen might be left in the soil for rice until tillering.
2) Other rotated crops (e.g., grain sorghum, wheat) affect which fertilizer(s) rice will require.
3) If previous crop on silt and sandy loam soils was precision graded, topsoil has been removed, reducing productivity.

b) Soil test - conducted by Extension office or other professional soil expert
1) Assesses fertility of field
2) Establishes whether potassium or phosphorous should be applied, based upon crop rotation
   (a) If soybeans are rotated every other year with rice, potassium or phosphorous may be required.
   (b) If rice is in a rotation of 2 years soybeans and 1 year rice, potassium or phosphorous may not be required.
3) Determines if liming is required
   (a) Preferred time to apply lime is several months before planting rice, which allows time to raise pH in soil.
   (b) Do not apply before planting rice; this could induce zinc deficiency.
4) Determines if zinc is required - with rice dying soon after flooding
5) Helps diagnose why seedling rice is dying

c) Previous tillage
1) Drill seeding - most common tillage method in Missouri
   (a) Offers options for crop rotations
   (b) Has numerous herbicide options
   (c) Is prone to sheath blight
   (d) Delays tilling and planting during wet spring weather
2) Water seeding
   (a) Suppresses red rice after field becomes infested
   (b) Allows continuous cultivation of red rice-free rice crop in same field

(c) Is prone to insect pests (e.g., rice weevil) and weed problems (sheath blight); has limited disease control options

3. After students have identified growing conditions for rice production and field history, focus their attention to fertilizer requirements for growing rice.

What are the fertilizer requirements for rice?

a) Nitrogen
   1) Amount and management of nitrogen depend on rice variety, cultural practices, crop rotations, soil conditions, soil moisture, and other factors.
   2) Apply nitrogen early if the following conditions have not been met.
      (a) Rice grown in rotation after soybeans
      (b) Soil with a pH less than 6.5
      (c) Optimum stand density
      (d) Land in cultivation for more than 5 years
   3) Excessive application of nitrogen can significantly reduce yield through lodging and disease.

b) Lime
   1) Used to benefit other crops in rotation
   2) Timing for lime application if soil test determines that it is required
      (a) Preferred time - several months before planting rice to allow time to raise pH in soil; not before planting rice - could induce zinc deficiency
      (b) Immediately after rice crop is harvested and before other rotated crop is planted

c) Zinc
   1) Application of zinc sulfate or zinc oxide preplant
   2) Deficiency in silt and sandy loam but not clay soils
   3) Deficiency seen in seedling rice
   4) Deficiency caused when rice soils are flooded - increase of soil pH to more than 6.5

d) Phosphorous
   1) Apply in limited amounts only as recommended; overapplication harms seedlings.
   2) Southeast Missouri Delta soils have high levels of phosphorous.

e) Potassium
   1) Potassium chloride, the fertilizer source, is a salt. A few southeast Missouri soils already have excessive sodium salt.
   2) Apply in limited amounts only as recommended; overapplication harms seedlings.

F. ***Other Activities***

1. Invite a soil scientist from the Delta Research Center, Missouri University Extension, or USDA Natural Resource Conservation Service (NRCS) to discuss the unique qualities of soils in southeast Missouri and the challenges they pose for rice producers.

2. Invite a research scientist from the USDA NRCS to discuss and demonstrate use of electromagnetic induction and electrical resistance to create geo-referenced maps that measure variations in soil at different depths.

3. Have students investigate major rice-producing countries and describe the field conditions, climate, soil, etc. Students could focus on one country by working in teams. Have them display their findings in a chart or collage or make a brief oral report. As a bonus, ask them to determine how rice came to the United States.

G. ***Conclusion***

Planning a successful rice crop involves knowing suitable growing conditions, assessing field history, and identifying fertilizer requirement. Producers rely on soil test recommendations to determine fertilizer and nutrient needs.

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

1. 40 lb/A, 9,600 lb
2. 60 lb/A, 9,000 lb
3. 20 lb/A, 10,000 lb
4. 50 lb/A, 30,000 lb
5. 80 lb/A, 9,600 lb
6, 60 lb/A, 21,000 lb

I. ***Answers to Evaluation***

1. b
2. c
3. a

4. If the following conditions are <u>not</u> met:
   (1) Rice grown in rotation with soybeans
   (2) Soil with pH less than 6.5
   (3) Optimum stand density
   (4) Land in cultivation for more than 5 years

5. Pinpoint flooding: Water is drained so seeds anchor but soil is not dry. Field is flooded in 5 days, drained, and reflooded within 3-5 days. Continuous flooding: Water is maintained at constant level and is never drained.

6. Drill seeding is most common. Advantages - many crop and herbicide options; Disadvantage - prone to sheath blight, delays tillage and planting during wet spring weather.

   Water seeding - Advantages - suppresses red rice, continuous cultivation of crop in same field; Disadvantage - requires smaller field, limited disease control options, prone to insect pests and sheath blight

UNIT XI - RICE PRODUCTION Name_____

Lesson 1: Planning the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What information does a soil test provide?

   a. The degree of red rice infestation
   b. How much and what kind of fertilizer should be applied
   c. Whether herbicide application is an option
   d. How many types of crop rotations are available

2. When is the average time for planting rice?

   a. September 10-September 25
   b. July 15-July 30
   c. April 15-June 10
   d. May 15-May 30

3. What information about the previous crop is useful to the producer?

   a. Which crop was in rotation
   b. How much water was needed
   c. Timing of harvest
   d. Amount of gallons per minute per acre required

Complete the following short answer questions.

4. Describe four situations that would require applying nitrogen to rice.

   a.

   b.

   c.

   d.

5. Compare pinpoint flood and continuous flooding.

6. Identify two tillage methods used in Missouri. Which is used most frequently? Describe advantages and disadvantages of each.

   a.

   b.

Lesson 1: Planning the Crop Name_____

Nitrogen Fertilizer Rates

Objective: Students will calculate nitrogen fertilizer rates based on adjustments required for various situations.

Directions: Assume that 30 pounds of nitrogen fertilizer are applied per acre. Adjust this rate according to the four conditions listed below. For each question, first identify the adjusted nitrogen rate per acre. Then calculate the total fertilizer application for the acreage described in each situation, as calculated by the Cooperative Extension Service, University of Arkansas. Show all of your work.

a. Increase early nitrogen rates by 20 pounds per acre (lb/A) if (a) rice follows rice or soybeans in rotation and/or (b) the stand density is less than six to eight plants per square foot.

b. Increase early nitrogen rate by 10 lb/A if (a) rice follows wheat, grain sorghum, or corn in rotation and/or (b) the soil pH is greater than 6.5.

c. Decrease early nitrogen rate by 10 lb/A if rice follows set aside or fallow that is not continuously tilled in rotation.

d. Increase early nitrogen rate by 30 lb/A if rice is grown on clay soils.

Key Questions:

1. You own 240 acres of rice that has a stand density of 10 plants per square foot. The soil pH is 7.0. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

2. Your soil is mostly clay but you want to grow 150 acres of rice. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

3. Your 500-acre field previously grew soybeans but no crops have been grown for several years. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

4. For 2 years in a row, your 600-acre field grew rice. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

5. Your 120 acres of clay soil previously had a plant density of four plants per square foot. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

6. Your last crop was cotton and you now want to plant rice on 350 acres of soil whose pH is 6.6. Adjusted nitrogen rate_____lb/A Total fertilizer application for acreage_____lb

UNIT XI - RICE PRODUCTION

Lesson 2: Selecting a Variety

Competency/Objective: Select rice variety and grade to be planted with a local rice consultant.

Study Questions

1. **Why and how are consultants used in rice production?**
2. **What factors should be considered when selecting a seed variety?**
3. **What factors should be considered when selecting a grade?**
4. **What diseases are prevalent to rice locally?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit XI.
2. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.
3. Activity Sheet
    a) AS 2.1: Creating Your Own Rice Crop

UNIT XI - RICE PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

After students investigate how rice crops are planned, discuss how producers select a rice variety. To make this lesson relevant, focus on specific conditions of your own area: soil texture, diseases, temperature, rainfall, etc.

B. ***Motivation***

By now, the Rice Information Sheets should have arrived that describe various seed types and maturity groups. Divide the class into small groups and provide one or two Rice Information Sheets for each group. Allow time for students to scan the data and then engage in a general discussion of why rice specialists have bred so many varieties of rice seed.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask students why producers typically ask University Extension or other experts to conduct soil tests. Extend their responses to a discussion about why producers would rely on consultants for other aspects of rice production. Mention that there are several rice consultants in Missouri.

   Why and how are consultants used in rice production?

   a) Why consultants are used
      1) They are professionals who are usually located in the same area as the rice producer.
      2) Consultants have specialities that the rice producer needs.
         (a) Technological and scientific expertise
         (b) Research capabilities
         (c) Source of up-to-date information, publications, web sites, etc.
   b) How consultants help rice producers
      1) Make accurate management decisions to assist local producer
         (a) Variety selection
         (b) Pest control
         (c) Soil test to determine fertility requirements
         (d) Tillage and seeding management
         (e) Herbicide selection and application
      2) Assess rice crop during growing season
         (a) Insect/disease infestation
         (b) Nutrients/fertilizer deficiencies
         (c) Weed identification and treatment thresholds

2. Discuss the key factors that the rice producer should consider when selecting a seed variety. Emphasize how each factor affects profitability.

   What factors should be considered when selecting a seed variety?

   a) Grain and milling yields - more total income from more bushels per acre

1) Newer varieties will yield much more than older varieties.
2) High yield is only economical if rice variety is relatively high quality and risk free.

b) Tolerance - resistance to disease
1) Certain diseases are disastrous for some varieties.
2) Other diseases can reduce yield and quality but not be disastrous for rice variety.
3) Costs for preventing diseases can be excessive.
4) Resistant varieties are often not the highest-yielding varieties, but they have less risk, reduced production costs, and higher-milling quality.

c) Maturity - when rice crop is produced
1) Early short season
2) Very short season
3) Short season
4) Mid-season

d) Cost
1) Seeds - New seeds are expensive.
2) Irrigation - Amount and duration of water required can be costly.

e) Expected milling quality and special traits of the rice

3. After students identify factors for selecting a seed variety, extend the discussion to how a producer selects a grade for milling.

What factors should be considered when selecting a grade?

a) Maximum economic returns
1) High economic returns can be obtained from a lower-yielding variety if variety has high-milling yield and quality.
2) High returns can result from a very high-yielding variety with somewhat lower-milling yield.

b) Value - greater income from each bushel sold
1) Comes from high-milling yield (head rice)
2) Comes from high quality (milled rice)

c) Six grades of rice designated by the U.S. Department of Agriculture
1) Based on maximum limits of number of seeds, heat-damaged kernels, and chalky kernels
2) States color requirements
3) U.S. Sample Grade - fails to meet standards for grades 1-6

4. Ask student to identify various diseases that harm crops in their area. Ask if they know which diseases affect rice crops in particular. Use photographs or diagrams to illustrate the effect of these diseases upon rice crops. The *Rice Production Handbook* (MP 192) has colored photographs depicting the development of sheath blight and blast. Discuss symptoms, causes, progression of disease, and control methods for these major diseases.

What diseases are prevalent to rice locally?

a) Producer needs to know field history of soil to determine what diseases have infested crops in the past. Identifying neighboring acreage with infestations of diseases is essential; drift could occur.

b) Sheath blight is the most destructive disease for rice; its severity has increased in recent years.
1) Symptoms
(a) Oblong, water-soaked lesion on leaf sheaths at or near water line
(b) In 2-3 days, a grayish-white center surrounded by dark purplish- or reddish-brown margin, up to 1 inch long
2) Cause - fungus *Rhizoctonia solani*
(a) Increased use of highly susceptible varieties
(b) Short intervals between crop rotations

(c) Thicker stands
(d) Use of higher nitrogen rates
(e) Short maturity groups and early seeding dates

3) Progression of disease
(a) Sheath blight develops after jointing begins.
(b) Fungus survives in soil year after year as a hard, weather-resistant structure called sclerotium.
(c) Sclerotium floats to surface of rice flood water.
(d) After contacting rice plant, fungus grown out from sclerotium and moves to leaf sheath.
(e) New sclerotia, developed on infected stem surfaces, fall from rice plant and remain in soil for several years.
(f) Temperature is above 95°F; canopy humidity is 96-97%.

4) Control methods
(a) Plant high-yielding varieties that are the least susceptible to the disease.
(b) Seed to a stand of 15-20 plants per square foot.
(c) Plant when it is optimal for a specific variety. Avoid extremely early planting.
(d) Nitrogen applications should be timed so that 30 pounds or less are applied at internode elongation.
(e) From internode elongation to a few days before heading, scout field for symptoms.
(f) Use a labeled fungicide when sheath blight reaches threshold level.

c) Blast - also called rotten neck
(a) Losses
(1) Increasing since 1984
(2) Does not develop yearly; destructive when it occurs
(3) 1986 - estimated losses in Missouri at $2.4 million

(b) Symptoms
(1) Occur on leaves, leaf sheaths, nodes, panicles
(2) Leaf spots - oval-shaped with gray-white centers and brown to red-brown margins
(3) Fully developed leaf lesions - 0.4-0.7 inch long and 0.1-0.2 inch wide.
(4) Color and shape dependent on environment, age of lesion, rice variety
(5) Lesions on leaf sheaths (rarely develop) same as those on leaves

(c) Cause - fungus - *Pyricularia oryzae*
(1) Airborne spores
(2) Long periods of wetness
(3) Rainy, cloudy weather

(d) Progression of disease
(1) Spores spread from rice seeds and infected rice stubble (where fungus overwinters) to new rice plants.
(2) Several races (strains) of *Pyricularia oryzae* exist; it is not known which races are prevalent in Missouri.
(3) When spore contacts plant tissue, a sticky substance is produced, which adheres spore to plant, initiating infection.

(e) Control measures
(1) Seed to a stand of 15-20 plants per square foot.
(2) Plant varieties that are least susceptible to the fungus.
(3) Use broad-spectrum seed treatment.
(4) Reduce areas where fungus might overwinter.
(5) Incorporate or roll rice stubble soon after harvest to promote early decomposition.
(6) Keep soil flooded from time plants are 6-8 inches tall to draining for harvest.
(7) Apply no more than 30 pounds of nitrogen per application at mid-season. In fields with history of blast, always split applications.

(8) Apply fungicides about 5-7 days before heading and again about 2 days after 50% heading.
(9) Scout for leaf symptoms of blast beginning at seedling stage and continue until early heading.

F. ***Other Activities***

1. Visit a local rice field during different stages of development. If possible, ask the local consultant to point out how he/she advised the producer in managing and assessing the crop.

2. Working in small groups, students "design" an ideal rice variety for their area. They should determine its maturity group, grain type, irrigation needs, etc. The Internet, Agriculture Extension Bulletin Board, University of Missouri Extension publications, and the Rice Information Sheets are useful references. Each group should name the new rice variety and display its attributes in an appealing manner (poster, collage, PowerPoint demonstration, etc.). Engage the class in a general discussion about why new rice varieties are continually developed.

G. ***Conclusion***

Consultants are vital to rice producers' success in selecting the appropriate seed varieties for their area. This involves several factors that also impact which grade is selected for milling. Rice producers need to assess which diseases are prevalent locally.

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

1. To maximize yield.
2.-5. Answers will vary.

I. ***Answers to Evaluation***

1. b
2. c
3. a

4. Any two of the following:
(a) Plant high-yielding varieties that are least susceptible to the disease.
(b) Seed to a stand of 15-20 plants per square foot.
(c) Plant when it is optimal for a specific variety and avoid extremely early planting.
(d) Time nitrogen applications so that 30 pounds or less are applied at internode elongation.
(e) Scout field for symptoms from internode elongation to a few days before heading.
(f) Use a labeled fungicide when sheath blight reaches threshold level.

5. Any three of the following:
(a) Seed to a stand of 15-20 plants per square foot.
(b) Plant varieties that are least susceptible to the fungus.
(c) Use broad-spectrum seed treatment.
(d) Reduce areas where fungus might overwinter.
(e) Incorporate or roll rice stubble soon after harvest to promote early decomposition.
(f) Keep soil flooded from time plants are 6-8 inches tall until draining for harvest.
(g) Apply no more than 30 pounds of nitrogen per application at midseason. In fields with history of blast, always split applications.
(h) Apply fungicides about 5-7 days before heading and again about 2 days after 50% heading
(I) Scout for leaf symptoms of blast beginning at seedling stage and continuing until early heading.

6. Learn about the field history of soil to determine which diseases infested crops in the past; identify neighboring acreage that had infestations of disease.

UNIT XI - RICE PRODUCTION Name_____

Lesson 2: Selecting a Variety Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. One of the purposes of consultants is to ____:

   a. Thresh mature rice at harvest
   b. Help manage and assess crop
   c. Determine economic yield of crop
   d. Identify standards of rice graded

2. A major factor in selecting a seed variety is ____:

   a. Tillage and planting
   b. Equipment needs
   c. Resistance to disease
   d. Research capabilities

3. What criteria are used to grade rice?

   a. Color and condition of kernels
   b. Soil type
   c. Field history
   d. Water requirements

Complete the following short answer questions.

4. Identify two control measures for sheath blight.

   a.

   b.

5. Identify three control measures for sheath blast.

   a.

   b.

   c.

6. How do producers determine what diseases are widespread on their own fields?

Lesson 2: Selecting a Variety Name_____

Creating Your Own Rice Crop

Objective: Students will select two rice varieties from different maturity groups for a hypothetical rice field and then answer questions.

Directions: Using the Rice Information Sheets you requested in Lesson 1, select two rice varieties from different maturity groups. Assume that you are planting a 220-acre field. Work in small groups or with a partner. Answer the questions in the space provided.

Identify each rice variety, its respective maturity group, and grain type. The numbers listed on the left are used for identification in the following questions.

#1 Rice variety: _____Maturity group _____Grain type_____

#2 Rice variety: _____Maturity group _____Grain type_____

Key Questions:

1. Why is it advisable for a rice producer to plant several varieties and maturity groups of rice on the same acreage?

2. What disease(s) and pest(s) is #1 susceptible to? How can these problems be managed?

3. When should #2 have nitrogen fertilizer applied? How much nitrogen should be applied?

4. Create a chart that compares days to 50% heading, height, and yield for both varieties. Which variety yields more per bushel/acre? Calculate the yield to pounds/acre by multiplying bushels/acre by 45.

5. Based upon what you've learned about each variety, how much of each would you plant on your field? Explain your reasoning. Consider fertilizer needs, water management, and disease control.

UNIT XI - RICE PRODUCTION

Lesson 3: Tilling and Planting the Crop

Competency/Objective: Describe the seedbed preparation.

Study Questions

1. **What is proper seedbed preparation for rice?**
2. **What are the seeding options?**
3. **What are the seeding rates for each option?**
4. **How is a rice planting calendar used?**
5. **How is a levee constructed?**
6. **Why are levees important in rice production?**
7. **What is the importance of water in a rice production system?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit XI.
2. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.
3. Transparency Master
   a) TM 3.1: Rice Planting Calendar
4. Activity Sheet
   a) AS 3.1: Missouri Rice Degree Day 50

UNIT XI - RICE PRODUCTION

Lesson 3: Tilling and Planting the Crop

TEACHING PROCEDURES

A. ***Review***

After the producer plans the crop and selects the seed variety, tilling and planting occur. In this lesson students are introduced to how the seedbed is prepared.

B. ***Motivation***

Ask students to describe what they usually do to prepare a garden or acres of a certain crop. On the board, list the various tilling and planting methods used per crop. Establish the idea that tilling and planting may vary per crop, for example, corn is planted differently than wheat. With rice, different options are available.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Ask students why preparing soil for a crop is important. Compare variables in seedbeds: soil texture, moisture, etc. List their responses on the board. Explain that there are two options for planting rice; each has different requirements for preparing the seedbed.

   What is proper seedbed preparation for rice?

   a) Preparation for drill-seeded (dry seeding) seedbed
      1) Disk in early spring and only if soil moisture will <u>not</u> create clods.
      2) To increase straw decomposition, disk the stubble or roll in the fall and flood the field.
      3) "Landplane" (float) field once or twice by going in opposite or diagonal directions of disked area.
      4) Prepare a shallow, firm seedbed with field cultivar implement.
         (a) Limit trips across field.
         (b) Destroy existing vegetation to avoid drift from previous season's seedlings.
   b) Preparation for water-seeded seedbed
      1) Field grade to zero grade (up to .02 grade) to permit some field drainage, planned crop rotation, or substitution of other crop if rice fails.
      2) Fill potholes and wheel tracks.
      3) Create ridged, rough seedbed to minimize seedling drift.
      4) For final seedbed preparation before flooding, use a groover (similar to a flat roller).
         (a) Forms small furrows on the seedbed and packs the soil
         (b) Prevents wavelike movement of water, which smooths the soil surface
      5) On clay soils, disk field and leave large clods that will provide a place for seeds to settle without threat of drift.

2. Based on the previous discussion, identify advantages and disadvantages of each seeding option. Organize information into a chart or "mind map." (A mind map is a free-form outline. Each major point is written within a circle. Related ideas, also enclosed in circles, radiate from the main idea. As students find more connections or relationships, additional circled ideas are drawn and connected to the main point.)

What are the seeding options?

a) Drill seeding - most prevalent seeding technique in Missouri
   1) Crop rotation options available; necessary in controlling red rice
   2) Herbicides (numerous options) and fertilizer applied by ground equipment (less expensive than by airplanes)
   3) Control rice water weevil through field drainage
   4) Larger field size
   5) Tilling and planting delayed by wet spring weather
   6) Sheath blight risk especially serious
   7) Significant labor required for levee construction and removal
   8) Season-long attention needed to maintain levee and water level
   9) Levee weeds a problem

b) Water seeding
   1) Does not require construction, maintenance, or removal of levees
   2) Allows continuous cultivation of rice without red rice infestation
   3) Suppresses red rice after field is infested; simplifies weed control
   4) Precise water management and facilitates uniform crop emergence
   5) Smaller field size in order to pinpoint flood and maintain season-long flood
   6) Risk of sheath blight, midges, rice water weevil, aquatic weeds, algae; limited control options
   7) Higher seeding rates and pregermination costs
   8) Higher pumping costs
   9) Aerial seeding in established flood; aerial application of nitrogen fertilizer at first tillering growth stage

3. Ask students to discuss various crops they have grown and to compare how much seed they had to plant for a successful yield. Ask if the planting method for these crops affects the seeding rate. Write their responses on the board. Tell them that each option for planting rice has its own seeding rate.

What are the seeding rates for each option?

a) Seeding rate, measured in pounds per acre (lb/A), varies according to the number and weight of seeds per variety.

b) The recommended seeding rate is based on soil texture, seeding date, seedbed, as well as the seeding option.

c) The following seeding rate is used for drill-seeded crops.
   1) Calibrate grain drill to deliver 40 seeds per square foot when seeding under ideal conditions.
   2) Alter seeding rate according to various factors.
      (a) If early seeding, increase rate by 10%.
      (b) If seeding in clay soil or in a poorly prepared seedbed, increase rate by 20%.

d) The following seeding rate is used for water seeding. This option uses pregerminated seeds (soaked 24-36 hours and drained 24-36 hours before planting).
   1) Increase seeding rate by 30% over drill-seeded option.
   2) This increased seeding rate percentage compensates for poorer germination, insect injury, and reduced tillering.

4. On the board, list various activities required for planting a vegetable garden and the dates/time of year in which to perform them. Ask students why they schedule certain tasks at these times. Explain that in rice production, following a specific calendar helps ensure a successful crop. Refer to TM 3.1, which is also included as Table 1 in the Student Reference, as a general time line for rice production in Missouri. Conduct AS. 3.1 to illustrate what a rice producer should do and when, according to specific seed variety and locale. This activity is based on a computer program developed and maintained by Commercial Agriculture Program Agronomists at the University Extension, University of Missouri-Columbia.

How is a rice planting calendar used?

a) Identify when to prepare the field and seedbed
b) Identify when to plant desired seed variety
c) Plan for irrigation
d) Apply fertilizer
e) Monitor for disease
f) Drain for harvest
g) Deliver grain to elevator

5. Bring in pictures of levees from the local area or from agricultural publications. Focus the students' attention to the structural features of a levee.

How is a levee constructed?

a) The field is surveyed.
    1) Most levees should be surveyed on 0.2-foot vertical intervals.
    2) For flat fields with more than 10 acres per levee, survey on 0.1-foot vertical intervals.
    3) Increase vertical intervals 0.3 to 0.4 foot for fields with steep slopes and stacked levees.
b) A plow, consisting of two sets of disks, is pulled across a field.
    1) Height of levee obtained by making two to eight passes with levee disk.
    2) To minimize formation of clods in clay soils, allow several hours of drying.
c) Disks dig out two parallel ditches.
d) The soil thrown up from the center forms the levee.
e) If field was already graded, the levee runs at right angles to the edge of the field; otherwise, the levees run along the contour of the existing slope and wind across the field.
f) Install levee gates in each levee where they can be checked daily and ensure that the bottom of each levee gate is directly on the soil line.
g) Gates in the levee are set to cascade the water across the depressions in the soil and leave no more than 2 inches in drop from levee to levee.

6. After students learn how levees are built and what they do, ask them to evaluate the benefits of levees in rice production. Write their responses on the board.

Why are levees important in rice production?

a) The amount of water in a levee can be controlled.
b) If rainfall is inadequate, additional water can be supplied.

7. Drawing from the previous study questions, ask students to summarize what they have learned about the relationship between rice production and water.

What is the importance of water in a rice production system?

a) Rice grows well in shallow water (4-6 inches of water).
b) Water in the plant dissolves and carries nutrients through the cell wall and roots.
c) Water is required to compensate for hot, dry, windy days.

F. ***Other Activities***

1. Have students investigate the environmental benefits of rice production. Direct their attention to the web sites for USA Rice Federation web site at <http://www.usarice.com> and *The Rice Conservationist* and to the following conservation groups (search the Internet for respective web sites): The Nature Conservancy, Ducks Unlimited, National Fish and Wildlife Foundation, North American Waterfowl Foundation, and the U.S. Fish and Wildlife Service. Issues to consider are

water use, water conservation, and threats to aquatic habitats. Students may work alone or in small groups. Have them report what they have learned to the rest of the class.

2. Ask students to identify components of water quality and to identify how water quality is measured and protected. Have them conduct research via the Internet and contact the Missouri Department of Natural Resources and the U.S. Environmental Protection Agency. Compile findings in a collage, diorama, or poster.

3. Go to a rice field and determine the population and condition of the plants.

G. ***Conclusion***

Proper seedbed preparation depends upon the seeding option selected, soil textures, moisture, etc. The main seeding options for rice productions are drill-seeding, which is most prevalent in Missouri, and water-seeding. The seeding rates are based upon pounds of seed per acre and vary according to seed variety, soil texture, and other factors. Producers rely on a rice planting calendar to ensure that the crop is planted, fertilized, scouted, and harvested on time. Levees provide needed water. Water in the levees controls weeds and nourishes the rice plant.

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

Answers will vary.

I. ***Answers to Evaluation***

1. c
2. d
3. b
4. Limited control options for sheath blight, aquatic weeds, algae, and insects (rice water weevil and midges)

5. (A) Pounds per acre; (B) varies by number and weight of seeds per variety

6. Any four of the following: identify when to prepare field and seedbed, identify when to plant seed variety, plan for irrigation, apply fertilizer, monitor for disease, drain for harvest, deliver grain to elevator

7. (A) Placed in each levee; bottom of levee is flush with the ground. (B) Cascades water across depressions in field and leave no more than 2 inches of water

8. Regulates amount of water on field

9. Any two of the following: controls weeds; rice grows well in shallow water; water in plant supplies nutrients; water compensates for hot, dry, windy days

UNIT XI - RICE PRODUCTION Name_____

Lesson 3: Tilling and Planting the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. To prepare a drill-seeded seedbed, the rice producer should ____.

   a. Leave large clods on clay soils
   b. Dig canal for drainage
   c. Disk early in spring only if clods will not form
   d. Create ridged, rough seedbeds

2. To prepare a water-seeded seedbed, the rice producer should____.

   a. Prepare a shallow, firm seedbed
   b. Landplane (float) field once or twice
   c. Increase decomposition of straw
   d. Field grade to zero grade

3. Which of the following is a disadvantage of the drill-seeded option?

   a. No levee construction, maintenance, or removal
   b. Serious risk of sheath blight
   c. Higher pumping costs
   d. Higher seeding rates

Complete the following short answer questions.

4. Describe the disadvantage of the water-seeded option.

5. (A) How is a seeding rate calculated? (B) Name <u>two</u> variables that affect the seeding rate.

6. Name four items of information that a rice planting calendar provides.

   a.

   b.

   c.

   d.

7. (A) Where are levee gates placed? (B) How are they used in a levee?

8. What benefit does a levee provide in rice production?

9. Identify two reasons why water is important to rice plants.

   a.

   b.

Rice Planting Calendar

Date	Activity
March	Start preparing field: plane land & disk
Mid-April - early June	Prepare final seedbed & planting
1-2 weeks after planting (May & June)	Flush irrigate field if necessary for emergence
4-6 weeks after planting (May & June)	Apply herbicide(s) to control very young weeds
Immediately after weed control (late May to July)	Top dress bulk of nitrogen fertilizer
Immediately after fertilizing (late May to July)	Flood field & maintain even water depth
10-14 days after flooding (late May to June)	Scout for rice water weevil & treat if necessary
20-30 days after flooding (June & July)	Measure plant growth for nitrogen sufficiency
30-40 days after flooding (late June to July)	Apply mid-season nitrogen according to variety & growth
After mid-season nitrogen (late June to mid-August)	Monitor crop for sheath blight and blast
July & August	Treat for disease control as necessary
10 days before harvest	Drain for harvest

Lesson 3: Tilling and Planting the Crop Name_____

Missouri Rice Degree Day 50

Objective: Students will use a computer-generated report that identifies key dates and activities in rice production to answer crop-related questions.

Directions: Locate the Missouri DD-50 Rice Model on the Internet at <http://agebb.missouri.edu/rice/ricemodel.htm>. Read the web site before entering the necessary information. Based on the selected seed variety and weather station, answer the following questions.

Key Questions:

1. Identify seed variety and weather station.

2. Between emergence and first tiller, what are the producer's main concerns?

3. a) When is the first application of nitrogen?

   b) Where is it applied?

   c) In what form is nitrogen applied?

4. When is the second application of nitrogen?

5. At what point should the producer check for sheath blight and blast?

6. When does the producer stop scouting for sheath blight and blast?

7. What does the rice plant look like when field is drained on clay soils? On silt/sandy soils?

8. Run the DD-50 report again with a second seed variety in two different weather stations. Answer questions 1-7.

UNIT XI - RICE PRODUCTION

Lesson 4: 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?**

References:

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

2. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.

3. Activity Sheet

    a) AS 4.1: Evaluating Times for Planting Rice Crops

UNIT XI - RICE PRODUCTION

Lesson 4: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

As a follow-up to the previous lesson about tilling and planting the crop, this lesson focuses on how a producer monitors and maintains the rice crop. Review the growing stages of rice as depicted in TM 2.7 in Unit II, Lesson 2, to reinforce how the rice plant develops. Point out that the producer has to carefully scout the rice plant from the vegetative and reproductive stages to maturity.

B. ***Motivation***

Ask students to identify activities that produce both a successful and an unsuccessful garden. Have them organize their responses according to the plants' life cycles. This can be done as a class or within small groups. Then select three to five activities from the list that students attributed to an unsuccessful garden. Ask them to "turn back the clock." What should the "gardener" have looked for? When would have been the best time to do so? What could be done right now?

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Based on previous lessons, ask students to predict what a rice crop needs in order to grow successfully. Ask them what a producer should look for while the crop develops. The producer begins scouting, or evaluating, the crop as soon as the first rice plant emerges.

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

   a) Damage from disease, weeds, or insects
      1) Control by flooding and preventive treatment.
      2) Time treatment application for key points in growth cycle: 1/2-inch internode, early boot, and 10% heading.
   b) Moisture levels - irrigation requirements
      1) Maintain 2-4 inches of water throughout growing season.
      2) If drought stress threatens crop, flush over quickly, close gates, and raise flood level to appropriate depth.
   c) Timing of nitrogen application
      1) Early application of preflood nitrogen determines potential grain yield.
      2) Nitrogen applied mid-season (beginning at 1/2 - or 3/4-inch internode elongation) is 65-80% efficient, depending on preflood rate, soil fertility, and seed variety.
   d) Quality of seedbed
      1) Past history of red rice, insect infestation, sheath blight, or blast adversely affects crop yield.
      2) Tillage method must rid the field of past vegetative growth to avoid seedling drift.

2. A producer may decide to replant sections or all of a rice crop under certain circumstances.

   How does one determine when replanting is appropriate?

   a) Evaluate extent of plant stand.

1) Except for Katy and Millie varieties, 15-20 plants per square foot is optimal stand density.
2) If stand is less than 15-20 plants/sq ft, larger panicles (with more grains per panicle) are produced that require more insecticides, herbicides, and nitrogen.
3) Thick stands are more susceptible to lodging, have greater severity of diseases, and require extra seed, which increases cost.

b) Assess degree of damage from disease, weeds, insects.
1) Producers can manage pest damage through integrated pest management (IPM).
2) IPM combines biological control, host-plant resistance, and various cultural practices to maintain low pest populations.
3) By using natural enemies of insect pests and diseases, pest populations can be kept below damaging levels.
4) Natural biological controls, particular field management practices, and diverse rice varieties provide alternative to managing insect pests without chemical.

c) Manage maturity groups.
1) Grow very short season variety to compensate for lost crop.
2) Combine types of maturity groups on same field.

F. ***Other Activities***

1. To demonstrate how pest control can be accomplished while reducing the use of pesticides, show video AGV110, *Integrated Pest (IPM) Management*, available from the Missouri Resource Center for Career & Technical Education, University of Missouri-Columbia.

2. Introduce the term biodiversity. Explain that in any natural environment, such as a rice field, various life-forms contain different genetic traits and interact with each other. Encourage students to investigate rice-producing countries (e.g., the Philippines, Thailand, and China) whose ecosystems contain diverse species that inhabit rice fields. Ask students to explore how these plants and animals actually help to control pests that threaten rice crops. Students may choose to work in small groups or alone. Results of their inquiries can be presented visually (e.g., diagrammed as a flowchart or displayed as a poster) or presented orally.

3. Students engage in a debate about whether applying principles of biodiversity can eliminate (or lessen) the need for pesticides and herbicides in rice production.

G. ***Conclusion***

Throughout the rice crop's life cycle, the producer has to scout for damage from disease, weeds, and insects; evaluate plant density; appraise temperature; and determine adequacy of fertilization. The decision to replant part or all of the crop depends upon the extent and severity of loss incurred.

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

Answers will vary.

I. ***Answers to Evaluation***

1. d
2. a
3. To increase probability of crop yield.

4. Thin stands: larger panicle with more grains per panicle; require additional insecticide, herbicide, and nitrogen application. Thick stands: two of the following: - more lodging, greater severity of disease, requires more seeds.

UNIT XI - RICE PRODUCTION Name_____

Lesson 4: Scouting and Maintaining the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What planting condition should the producer evaluate during the growing season?

   a. Seed variety
   b. Date planted
   c. Brand of fungicide
   d. Seedbed

2. The optimum plant stand density for most varieties is ____plants per square foot.

   a. 15-18
   b. 16-17
   c. 15-20
   d. 19-25

Complete the following short answer questions.

3. What is the purpose of planting different maturity groups?

4. Compare two consequences that result from thin plant density stands and thick plant density stands.

   Thin plant density:

   a.

   b.

   Thick plant density

   a.

   b.

Lesson 4: Scouting and Maintaining the Crop Name_____

Evaluating Times for Planting Rice Crops

Objective: Students will appraise advantages and disadvantages of planting rice at various times.

Directions: Use Internet resources, Extension publications, Rice Information sheets, or any other references to answer the following questions.

Key Questions:

1. How does the time of planting affect maturity?

2. What are some of the concerns of planting early?

3. What is the relationship between the time of planting and the likelihood of disease infestation?

4. What are the consequences of planting late in the growing season?

5. Which maturity groups and seed varieties would help produce a season-long, disease-free crop?

UNIT XI - RICE PRODUCTION

Lesson 5: Harvesting the Crop

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

Study Questions

1. **What factors determine harvest timing?**
2. **What factors influence levee breakage during harvest?**
3. **What factors affect seed damage at harvest?**
4. **What is the major source of crop loss during harvest?**
5. **How is rice stored?**
6. **What are storage problems associated with rice production?**
7. **How is crop quality maintained during storage?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit XI.
2. Benz, Raymond C. *Rice Drying on the Farm* (MP 283). Cooperative Extension Service, University of Arkansas. 1991.
3. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.
4. Transparency Masters
    a) TM 5.1: Continuous Flow Commercial Dryer
    b) TM 5.2: On-the-Farm Storage with Stirring Devices
    c) TM 5.3: Aeration
5. Activity Sheets
    a) AS 5.1: The Harvested Crop
    b) AS 5.2 Features of a Harvested Rice Variety

UNIT XI - RICE PRODUCTION

Lesson 5: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

After planning the rice crop and selecting the seed and grade varieties, the crop is tilled and planted. Then after scouting and maintenance, the rice crop is ready for harvesting. This lesson covers various aspects of harvesting and postharvesting management.

B. ***Motivation***

Invite a local rice producer to class to share his/her experiences during harvesting. Before the speaker comes to class, have students prepare questions that focus on issues covered in this lesson. They may work alone or in small groups.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Review the growing requirements of various rice seed varieties and maturity groups. Relate these needs to harvest time.

   What factors determine harvest timing?

   a) Maturity - ripening ("grain filling") stage
      1) Time of maturation varies among rice varieties.
      2) Size and weight of rice grain increase.
      3) Color of plants changes from green to straw or gold.
      4) Light intensity is critical because 60% or more of the carbohydrates used are now photosynthesized.
      5) Temperature affects ripening stage.
   b) Grain moisture content
      1) To avoid reduced quality or yield, harvest at 17-21% moisture.
      2) Plan combine's capacity so harvesting is completed when rice reaches 16% moisture.
   c) Timing of seeding - avoiding extremely early- or late-season seeding is advised

2. Briefly refer to the discussion of levees and the importance of water in Lesson 3. Have students brainstorm about the conflicting priorities a producer might have when deciding when to break the levee during harvest. A possible response may be the realization that because water is vital for the crop, the producer wants to keep water on the field as long as possible. Another response might be that the soil has to dry out so that the combine can run over the crop.

   What factors influence levee breakage during harvest?

   a) Water management
      1) Maintain flooded field until 2 weeks before harvest unless draining is required to control straighthead.
      2) Drain field to prepare for harvest 10 -14 days after heading if enough flood is on the field to prevent drought stress.
      3) If it is exceedingly hot, continue pumping for 5-7 days.

b) Plant maturity - drain when plants have ripened

3. A primary concern of producers is maintaining the quality of the rice seed throughout harvest. Cracked or broken kernels will adversely affect milling yield and therefore reduce profit. Preserving the seed intact is a major priority.

What factors affect seed damage at harvest?

a) Harvesting at either high or low moisture content
   1) Rice kernels are wet; ends grind off and become dust.
   2) If dried below 15% moisture, rice could crack.
b) Environmental stress on kernels - differs among varieties of rice
   1) Drought
   2) Inadequate or excessive nitrogen
   3) Low intensity of sunlight
   4) Disease/insect infestation
      (a) Kernel smut
      (b) Blast
      (c) Sheath blight
      (d) Rice water weevil
   5) Draining water early in hot weather

4. Identify the sources of crop loss during harvest and have students relate these causes to profitability. During this discussion, highlight how the stripper header and platform header operate. If possible, obtain pictures of each machine. Point out that the stripper head is faster and makes a cleaner cut with no leaves, stems, or trash left behind. The platform header is slower and causes leaves and trash to be left behind on the field.

What is the major source of crop loss during harvest?

a) Poor harvesting techniques
   1) Optimal operating speed differs among rice varieties.
   2) Lower speeds will not separate rice very well.
   3) Moisture content, amount of material entering combine, and weeds affect speed and efficiency.
   4) Adjust level of stripper according to height of rice heads and ease of grain detachment.
   5) Obtain and calibrate a separation loss monitor based on local conditions. Separation losses increase when stripper overspeeds.
b) Foreign matter - stems, weed seed, and other trash with more moisture than rice, which lowers milling yield
c) Rapid field rewetting (rainfall)
   1) Major cause for lowered head rice yield once rice reaches 15% or less moisture
   2) Susceptibility depends on rice variety

5. Explain that "green rice" must be dried. Commercial elevators are available in some areas, but not all rice producers have access to them and must therefore dry and store rice on their own. To illustrate how rice is dried commercially, display TM 5.1. Use TM 5.2 to illustrate on-farm storage facilities. Because airflow plays such an important role in proper rice storage, use TM 5.3 to display the entire process of aeration in reducing the hazard of moisture migration.

How is rice stored?

a) Commercial elevators
   1) Drying process
      (a) Continuous flow dryers move large volumes of heated air through layers of rice (12 inches or less) for a short period of time.

(b) With each pass through the dryer, 2-3% moisture is removed.
(c) Rice is moved into tempering bins after each pass.
(d) Rice is passed again through continuous flow dryer for additional moisture removal.
(e) Air temperature is higher than on-farm facilities because rice is exposed to heated air for shorter period of time.

2) Storage
(a) Moisture at center of kernel slowly moves to outer layers In tempering bins (within 4-12 hours), depending on grain's temperature and moisture.
(b) Rice is transferred after last pass to storage bins and aerated until grain kernels' temperature reaches about 50°F.
(c) Rice is moved to different bins and aerated as needed to prevent top layers from spoiling or hot spots from developing within the bin.

b) On-farm facilities
1) Layer drying
(a) Dry 4-ft depth of rice to a moisture level of 15% or less then add 2- to 3-foot layers and dry until bin is full.
(b) Overdrying bottom layer before top layer reaches proper moisture content causes problems.
(1) Maintain moisture equilibrium between drying air and desired moisture content of the rice.
(2) Stirring devices help maintain equilibrium by mixing rice within bin and leveling the rice.
(c) Do not rewet or keep the fan on.
(d) Do not overdry because kernels will crack when milled.

2) Continuous flow, in-bin drying
(a) Tapered auger rides on top of perforated floor and removes 5- to 6-inch layers of rice in a circular sweep.
(b) Rice is kept at a 3- to 4-foot depth.
(c) Spreader at top of bin maintains equal distribution and depth across drying bed.
(d) Airflow rate is 25-35 cubic feet per minute (cfm) per square foot of floor surface.
(e) Drying air temperature is 110°F. If rice kernel temperature does not exceed 100°F before removal from sweep auger, drying air temperature can vary above or below 10 degrees.

3) Storage
(a) Bins are circular with perforated floors or ducts at the bottom to promote air circulation.
(b) After rice is dried in batches 6-12 feet deep, it is transferred into storage where it is cooled through aeration.

6. Point out difficulties that can occur while the rice is being stored.

What are storage problems associated with rice production?

a) Insect infestation - Severity depends on the following factors.
1) Amount and type of insect in storage area
2) Condition of new rice
3) Grain moisture
4) Temperature

b) Unclean storage areas
1) Insect populations can survive year after year in feed that is stored in bins.
2) Floors and walls contain lodged grain, sweepings, and old rice that harbor insects.
3) Insects migrate to the new rice.

c) Fungi
1) Fungi grow when moisture content is below 13.5%.

2) Growth of fungi depends on temperature.
   (a) At 40-50°F storage fungi grow slowly.
   (b) At 80-90°F storage fungi grow rapidly.

7. Discuss how the producer ensures that the rice crop maintains quality throughout storage in order to realize maximum yield.

   How is crop quality maintained during storage?

   a) Sanitize storage area by removing all waste grain, dust, and any other trash.
   b) Remove or bury waste away from the storage area.
   c) Clean all equipment that handles rice.
   d) Spray storage bins with an approved protective treatment after they are cleaned.
   e) Spray rice as it enters the storage area with protective insecticide treatment.

F. ***Other Activity***

Visit a grain elevator and rice mill to observe the entire milling process. Examine testing procedures for moisture and means of assessing rice quality.

G. ***Conclusion***

Harvesting is the culmination of the producer's efforts. The timing for harvest is critical and includes the following factors: maturity stage, grain/moisture content, and when rice variety was seeded. Draining the levee requires deciding how long to maintain the flooded field. The producer has to balance priorities: whether to grow the crop for its maximum length or prepare the field for threshing. Seeds can be damaged during harvest, which reduces overall yield and profit. The crop itself could be lost if improper threshing techniques are used. Storing rice is a delicate process: it must be dried slowly and over low heat; overdrying cracks kernels. Storage bins should be kept clean and dry to maintain the quality of the rice crop.

H. ***Answers to Activity Sheets***

AS 5.1

1. Poultry litter, brewing beer, rice flour

2. Regular-milled white rice has outer husk removed and bran layers are milled away until grain is white. Brown rice has the outer hull removed also, but retains the bran layers.

3. a) Rice that lost nutrients during milling; nutrients (iron, niacin, thiamin) replaced through a topical coating

   b) Rough rice soaked in warm water under pressure, steam and dried before milling
   c) Rice as it comes from the field
   d) Inedible outer husks or straw of rice grain; removed during processing
   e) Type of starch in long grain rice

4. (A) Arkansas, Mississippi, Texas, California, Missouri, Louisiana, Florida; (B) Arkansas

AS 5.2

Answers will vary.

I. ***Answers to Evaluation***

1. c

2. a
3. d

4. (A) Problems: Any two of the following: different operating speeds; lower speeds will not separate rice very well; speed and efficiency affected by moisture content, amount of material and weeds entering combine; overspeeding stripper increases separation losses. (B) Solutions: obtain and calibrate monitor based on local conditions; adjust level of stripper.

5. (A) Insect infestation and unclean storage areas. (B) For insect infestation any three of the following: amount and type of insect in storage area, condition of new rice, grain moisture, temperature. For unclean storage areas: insects survive in feed in bins year after year; floor and walls contain lodged grain that harbors insects; insects migrate to new rice.

6. Any four of the following: sanitize storage area by removing all waste; remove or bury waste away from storage area; clean rice-handling equipment; spray bins with protective treatment; spray rice when it enters bins with protective treatment.

UNIT XI - RICE PRODUCTION Name_____

Lesson 5: Harvesting the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the optimal grain moisture content for harvesting rice?

   a. 13-18%
   b. 10-15%
   c. 17-21%
   d. 8-12%

2. When should the field be drained during harvest?

   a. 10-14 days after heading
   b. 2 weeks before 50% heading
   c. Not until threat of sheath blight disappears entirely
   d. 2 weeks during a drought

3. What is the consequence of harvesting at either high or low moisture content?

   a. Kernels resprout and drift
   b. Disease increases and threatens crop
   c. Excessive light prevents full growth
   d. Kernels crack and turn to dust

Complete the following short answer questions.

4. (A) Name two problems that can occur during threshing and (B) two measures that a producer can take to remedy these problems.

5. (A) Describe two major problems that can occur during storage. (B) Then select one of those problems and explain three factors that contribute to it.

6. Identify four measures that can be taken to ensure quality during storage.

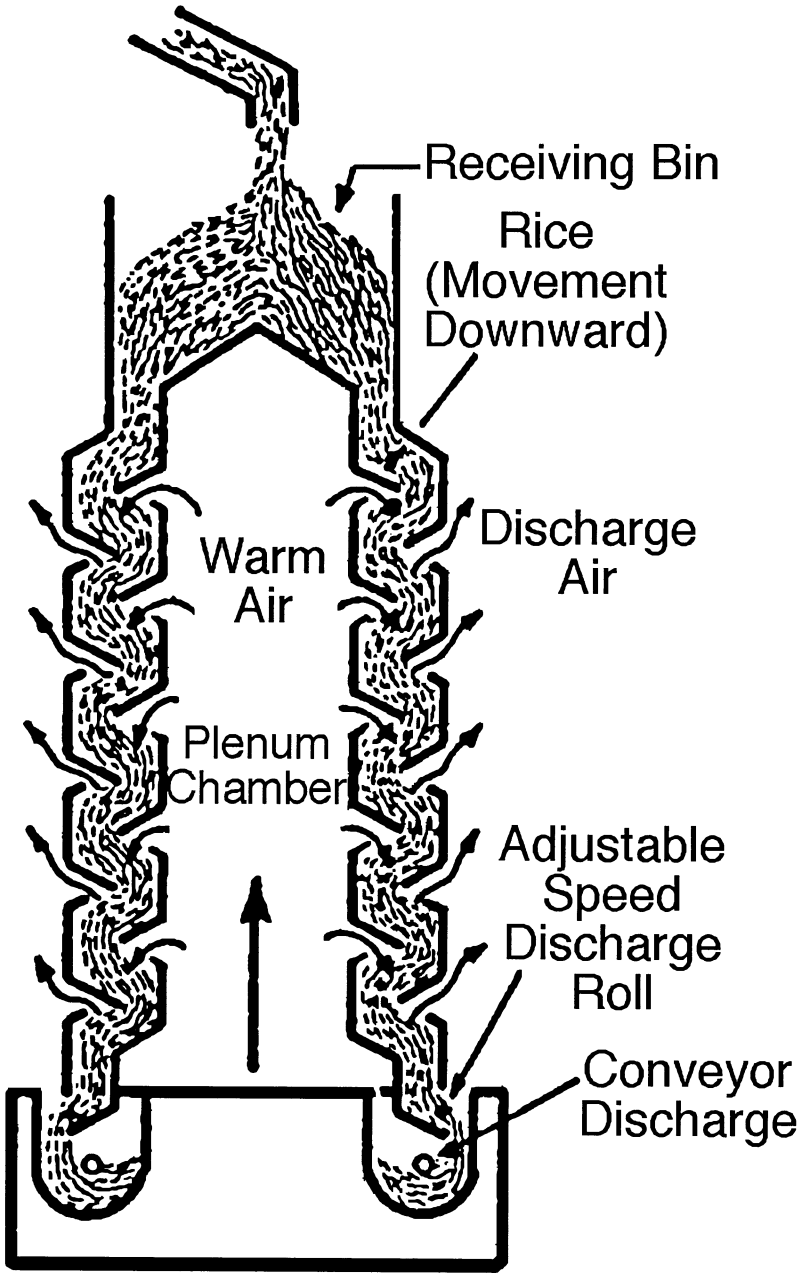
   a.

   b.

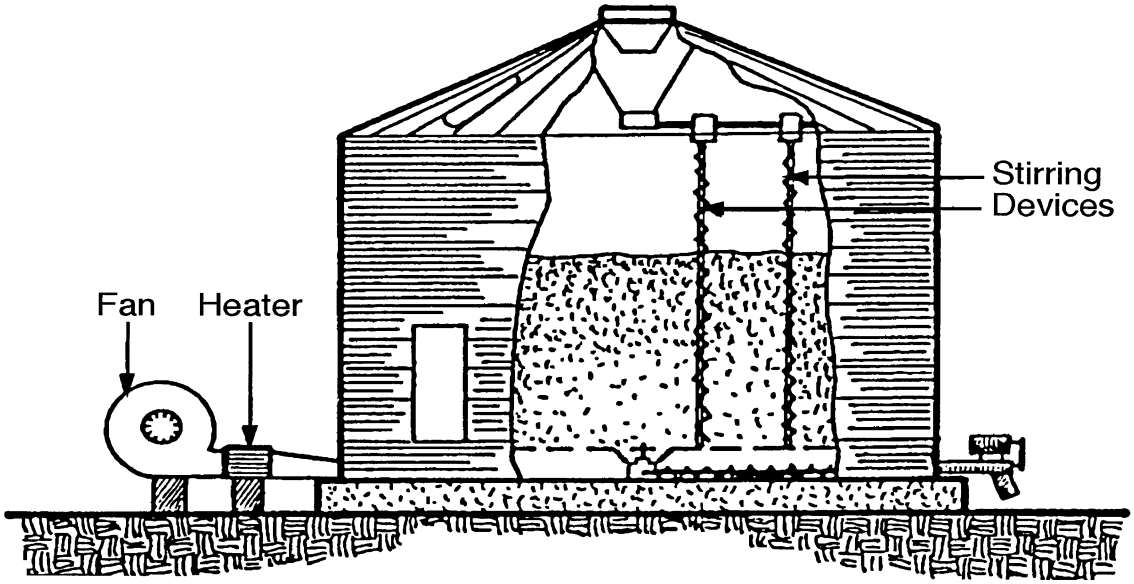
   c.

   d.

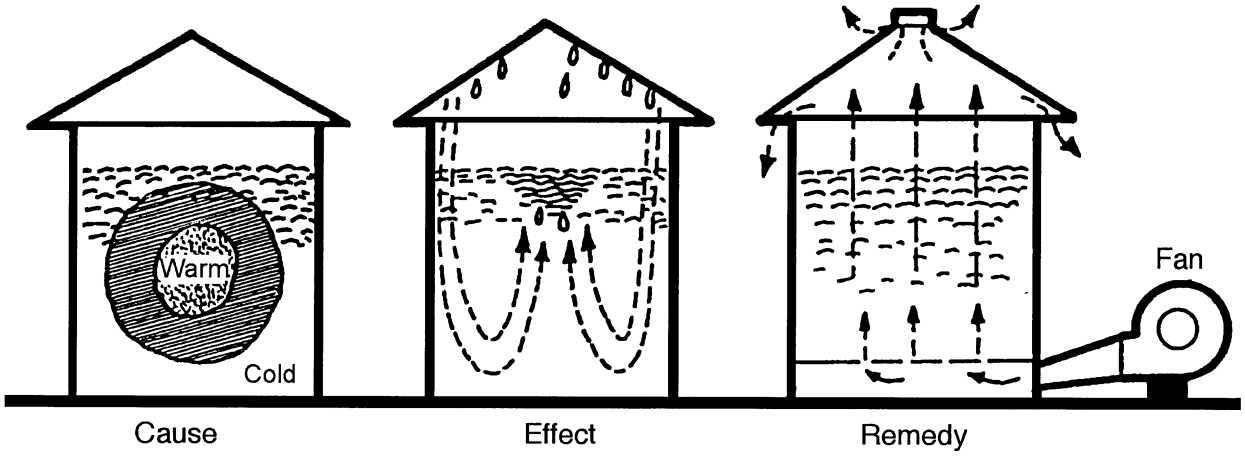
Continuous Flow Commercial Dryer



On-the-Farm Storage with Stirring Devices



Aeration



Lesson 5: Harvesting the Crop Name_____

The Harvested Crop

Objective: Students will explain and identify key aspects concerning the harvested rice crop.

Directions: Use various resources to answer the following questions (Internet, University Extension publications, textbooks, etc.). Write your answers in the space provided.

Questions:

1. Name three uses of broken kernels.

   a.

   b.

   c.

2. Differentiate between how regular-milled white rice and brown rice are processed.

3. Define the following terms:

   a. Enriched rice

   b. Parboiled rice

   c. Rough rice

   d. Rice hulls

   e. Amylose

   f. Rice bran

4. (A) Identify the seven rice-producing states in the United States and (B) indicate which state produces the most rice annually.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

Lesson 5: Harvesting the Crop Name_____

Features of a Harvested Rice Variety

Objective: Students will select a specific rice variety and identify various features it offers to the harvested rice crop.

Directions: Select one of the rice varieties described in the Rice Information Sheets that you have not used previously in other assignment sheets. Answer the following questions in the space provided.

Questions:

1. Identify the rice variety _____. Identify the maturity group _____.

2. How does this variety compare with other varieties in terms of head rice yield?

3. After harvest and milling, what is this variety best suited for?

4. What is the effect of harvest grain moisture content on yield?

UNIT XI - RICE PRODUCTION

Lesson 6: Marketing the Crop

Competency/Objective: Describe marketing opportunities.

Study Questions

1. **What options are available for marketing rice?**
2. **How do producers determine when to sell or store rice?**
3. **How does rice quality affect price?**
4. **What are rice checkoff dollars and how are these funds used?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit XI.
2. *Rice Production Handbook* (MP 192). Cooperative Extension Service, University of Arkansas. 2201 Brookwood Drive, P.O. Box 391, Little Rock, AR 72203. 1996.
3. Transparency Master
    a) TM 6.1: Grades and Grade Requirements for Rough Rice
4. Activity Sheet
    a) AS 6.1: Rice Crops on the Market

UNIT XI - RICE PRODUCTION

Lesson 6: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

All of the rice producer's efforts are concentrated on marketing the crop for a profit, from the moment the field is planned to harvest. In this lesson students will identify available options for selling rice, determine when to store or sell rice, assess how the quality of rice affects potential price, and define checkoff dollars and identify how they are used.

B. ***Motivation***

1. Visit the Louis Dreyfus Corporation rice mill in New Madrid and tour the facilities. Follow the milling process.

2. Invite a member of the US Rice Producers Association (USRPA) to class. Before the representative arrives, have the class prepare interview questions concerning how USRPA (1) promotes and markets rough rice, (2) represents the interests of rice producers to legislators and governments, (3) promotes domestic and overseas sales of rice, and (4) proposes rice-related legislation and policy concerning the environment and waterfowl.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Describe how rice producers contract with commercial mills or access producer-operated cooperatives to market their rice.

What options are available for marketing rice?

a) Through producer-owned cooperatives and mills
   1) Riceland Foods Cooperative, Stuttgart, Arkansas - world's largest miller and marketer for rice growers
   2) Anheuser-Busch mill - in Jonesboro, Arkansas
   3) Louis Dreyfus Corporation rice mill in New Madrid, Missouri - new market and options for pricing

b) Professional marketing consultants, satellite, and Internet marketing services

c) Forward contracting
   1) Rice is contracted before actual processing and delivery.
   2) The sale price is already established and does not reflect any changes in the cash market at harvest time.
      (a) If market moves upward to higher prices, the rice producers receives only the negotiated price.
      (b) If the crops fail, the producer must purchase rice to meet the contract.

2. Based on what they've learned about harvesting and storing procedures, ask students to predict how a producer decides whether to sell or store rice. Remind the class that rice is an international crop that feeds 2/3 of the world's population.

How do producers determine when to sell or store rice?

a) Storage costs
b) Interest rates
c) Price trend predictions and fluctuations
    1) Supply and demand of rice crop
    2) Governmental programs promoting export or import of rice crop
    3) Global market

3. Ask students to identify characteristics of rice that would be profitable. Show TM 5.1 to illustrate the grades and grade requirements of rough rice and discuss how these qualities affect price.

How does rice quality affect price?

a) Based on mill acceptance
    1) Grain and length must meet milling standards.
    2) Kernels must be whole.
b) No diseases, weeds, or foreign material
c) Red disease
    1) Major problem at harvest
    2) Reduces yield

4. Explain the checkoff program sponsored by the Missouri Department of Agriculture and describe how the funds are used.

What are rice checkoff dollars and how are these funds used?

a) The Missouri Department of Agriculture collects 2¢ per bushel checkoff funds from Missouri rice sold at the elevator or mill.
b) Checkoff monies are used to promote and market rice in the United States and overseas.
c) Checkoff monies are used for rice production research, which compares newly released varieties from breeding programs; disease observation tests; and rice performance trials.

F. ***Other Activities***

1. Brainstorm about the characteristics of the ideal rice seed needed to yield maximum harvest. Then ask the class to investigate research that agronomists are conducting to develop a higher-yielding rice variety.

2. Compare and contrast the nutritional values of white rice and brown rice. Prepare a menu of different rice dishes. Investigate various international cuisines that rely on rices and plan a "rice buffet." The Family and Consumer Science instructor may be of assistance.

G. ***Conclusion***

Producers market rice through cooperatives and mills, professional marketing consultants, satellite, and Internet marketing services. Riceland, the world's largest miller and marketer has several marketing options for the rice producer. Determining to sell or store rice depends on farm-related expenses, price trends, predictions, fluctuations, and global markets. The quality of rice affects the price the producer can receive. Checkoff dollars contribute to marketing efforts and research activities.

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

1. (A) Beneficial properties added to crop; (B) Answers will vary.

2.-3. Answers will vary.

I. ***Answers to Evaluation***

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

5. Any two of the following: promote and market rice in the United States and overseas; conduct research, compare new varieties, perform disease observation tests, perform rice performance trials

6. Any three of the following: grains and length do not meet mill standards; broken kernels; diseases, weeds, foreign matter in rice; presence of red rice

UNIT XI - RICE PRODUCTION Name_____

Lesson 6: Marketing the Crop Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Rice producers often rely on _____ to market their crops.

   a. Major corporations
   b. Producer-owned cooperatives
   c. Global commodity brokers
   d. Government-sponsored programs

2. What influences a producer in deciding whether to store or sell rice?

   a. Availability of grain elevator and mill
   b. Amount of checkoff dollars taken per bushel
   c. Amount of cracked or damaged kernels
   d. Cost of storage

3. The quality of rice must _____ in order to be profitable.

   a. Meet the supply and demand of the market
   b. Meet standards of the mill
   c. Be used for promoting sales
   d. Have the recommendation of the Riceland board of directors

4. Rice checkoff dollars come from_____.

   a. Riceland Foods Cooperative's marketing programs
   b. Contracts from producer-owned cooperatives
   c. 2¢ per bushel collected at mill or elevator
   d. Interest rates from storage fees

Complete the following short answer questions.

5. Describe two uses of rice checkoff dollars.

   a.

   b.

6. Describe three qualities of rice that would reduce price.

   a.

   b.

   c.

Grades and Grade Requirements for Rough Rice

Grade	Maximum limits of							Color requirements
	Seeds and heat-damaged kernels			Red rice and damaged kernels (singly or combined) (%)	Chalky kernels		Other types (%)	
	Total (singly or combined) (number in 500 grams)	Heat-damaged kernels and objectionable seeds (singly or combined) (number in 500 grams)	Heat-damaged kernels (number in 500 grams)		In long grain rice (%)	In medium or short grain rice (%)		
U.S. No. 1	4	3	1	0.5	1.0	2.0	1.0	Shall be white or creamy
U.S. No. 2	7	5	2	1.5	2.0	4.0	2.0	May be slightly gray
U.S. No. 3	10	8	5	2.5	4.0	6.0	3.0	May be light gray
U.S. No. 4	27	22	15	4.0	6.0	8.0	5.0	May be gray or slightly rosy
U.S. No. 5	37	32	25	6.0	10.0	10.0	10.0	May be dark gray or rosy
U.S. No. 6	75	75	75	15.0	15.0	15.0	10.0	May be dark gray or rosy

U.S. Sample grade shall be rough rice that:
(a) Does not meet the requirements for any of the grades from U.S. No. 1 to U.S. No.6, inclusive;
(b) Contains more than 14% of moisture;
(c) Is musty, sour, or heating;
(d) Has any commercially objectionable foreign odor; or
(e) Is otherwise of distinctly low quality.

Lesson 6: Marketing the Crop Name_____

Rice Crops on the Market

Objective: Students will discover various rice-related markets, issues, and uses.

Directions: Use the Internet, University Extension resources, or any other reference materials to answer the following questions. Some recommended web sites are the University of Arkansas Extension at <http://www.uark.edu>, *Rice Journal* at <http://www.ricejournal.com>, Rice Web at <http://www.riceweb.org>, USA Rice Federation at <http://www.usarice.com>, and USDA Foreign Agricultural Service at <http://www.fas.usda.gov/>. Answer the questions in the space provided.

Key Questions:

1. (A) Define "value-added crops" and (B) relate this definition to rice.

2. Investigate political issues related to exporting rice to developing countries. Describe U.S. rice producers' concerns and summarize actions they have taken.

3. Access the web site of an organization dedicated to rice production and compile a list of the various issues that concern marketing. Select one of these issues and conduct further research into that topic. Present your findings in written or oral format. If preferred, work in small groups or with a partner. Be sure to divide the work evenly.

UNIT XI - RICE PRODUCTION

Lesson 7: Figuring Crop Costs

Competency/Objective: Calculate cost per acre.

Study Questions

1. **What variable costs are associated with rice production?**
2. **What fixed costs are associated with rice production?**
3. **What factors are considered when determining an acceptable return on investment?**
4. **How is cost per acre calculated?**
5. **How does red rice affect price?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit XI.
2. Activity Sheet
   a) AS 7.1: Rice Budget

UNIT XI - RICE PRODUCTION

Lesson 7: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

The previous lessons tracked how the rice crop is planned and managed. This lesson identifies expenses the rice producer incurs throughout the growing season and focuses on how these costs affect the producer's ability to gain a return on his or her investments.

B. ***Motivation***

Present the students with the following scenario: They are the chief financial officers of a major agribusiness. After they select the type of agribusiness, ask them to categorize all the expenses this company must pay. Organize these costs as variable (subject to change) and fixed (not subject to change). Finally, ask students how they can determine if their company is earning a profit.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Refine the definition of variable costs established in the Motivation and relate it to rice production. Refer to previous lessons that discussed specific items needed for growing rice and identify which would represent variable costs.

   What variable costs are associated with rice production?

   a) Also called operating, or direct, expenses
   b) Depends on extent of rice production
      1) If yield is high, more plants are produced, which increases costs of seed and maintenance, equipment, and water.
      2) With lower planting rate, less seed is required, but yield is low.
   c) Examples of variable (operating) costs
      1) Seeds
      2) Fertilizer and lime
      3) Fungicides, herbicides, pesticides
      4) Labor
      5) Fuel, repair, and maintenance of equipment

2. Discuss which expenses are not subject to change in rice production.

   What fixed costs are associated with rice production?

   a) Known as ownerships costs and are unavoidable despite production levels
   b) Equipment
      1) Tractors, threshers, combines
      2) Stripper heads
      3) Seed drillers
      4) Land planes to level land
      5) Airplane to cast seeds over dry or flooded fields
      6) Depreciation and interest on machinery
   c) Implements

1) Grain separator monitor
2) Chlorophyll meter

d) Irrigation system
1) Levees
2) Gates
3) Laser guidance systems to determine where levees are placed

e) Mortgage payments and interest, taxes on land, land rent, and insurance

3. Ask students to define the phrase "return on investment" as related to the agribusiness they created in the Motivation. How would they know if they made a profit? Ask them how a rice producer would know if he/she earned a profit. Guide them to the recognition that an acceptable return on investment is determined by the amount of acreage successfully harvested and milled.

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

a) Costs of producing the rice crop (both variable and fixed)
b) Should be less than the net return of the rice crop price
c) Will vary depending on supply and prices

4. Have students complete AS 7.1 to demonstrate how a rice producer calculates cost per acre. Remind them that rice production comprises two types of expenses: variable (operating costs that can change) and fixed (ownerships costs that do not change, despite the production level).

How is cost per acre calculated?

a) Add the variable costs and the fixed costs per acre.
b) Keep all expenses listed and categorized.

5. Remind students that red rice is a weed. Focus on its effect on overall profitability of the rice crop.

How does red rice affect price?

a) Too much red rice can lead to rejection at the mill, decreasing profit.
b) Red rice can kill off hybrid cultivars and decrease plant density.

F. ***Other Activity***

Invite an Extension Economist to discuss variable and fixed costs and to detail the specific expenses that a rice producer would have.

G. ***Conclusion***

Rice production involves variable (operating) and fixed (ownership) costs. To determine what would be an acceptable return on investments, rice producers examine the total amount of acreage of whole kernel rice that meets milling standards. The net return is calculated by adding the variable and fixed costs. Red rice, a weed, can adversely affect price if it is not adequately controlled.

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

Expense	Unit	Total $/Unit	Total $/Acre	Your $/Acre
Cypress Seed	115	0.20	23.00	2760.00
Nitrogen	140	0.23	32.20	3864.00
Zinc	3	0.750	2.25	270.00
Fungicide	12	2.17	26.04	3124.80
Postemergence	2	14.24	28.48	3417.60
Machinery Fuel & Repair	1	32.00	32.00	3840.00
Irrigation - Fuel	1	28.00	28.00	3360.00
Irrigation Repair & Maintenance	1	3.50	3.50	3.50
Irrigation Labor	1	12.00	12.00	12.00
Labor	1	21.00	21.00	21.00
Custom Hire	3	4.50	13.50	13.50
Subtotal			221.97	20,686.40
Fixed Machine Cost	1	50.00	50.00	50.00
Fixed Irrigation Cost	1	47.00	47.00	47.00
TOTAL COSTS			318.97	20,783.00

I. ***Answers to Evaluation***

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

5. Any four of the following: tractor, threshers, combine, stripper head, seed driller, land plane, airplane

6. Red rice is a weed that can lead to rejection at the mill if there is too much.

UNIT XI - RICE PRODUCTION Name_____

Lesson 7: Figuring the Crop Costs Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. An example of a variable cost in rice production is _____.

   a. Fertilizer
   b. Interest rates
   c. Tractors
   d. Mortgage payment

2. An example of a fixed cost in rice production is _____.

   a. Labor
   b. Seeds
   c. Fungicides
   d. Seed driller

3. An acceptable return on investment depends on _____.

   a. Levees
   b. Acreage
   c. Depreciation
   d. Labor

4. Cost per acre is calculated by _____.

   a. Adding variable costs to interest rates
   b. Subtracting fixed costs from variable costs
   c. Adding variable and fixed costs
   d. Subtracting depreciation value from mortgage

Complete the following short answer questions.

5. Name four types of equipment used in rice production

   a.

   b.

   c.

   d.

6. Explain how red rice affects price.

Lesson 7: Figuring Crop Costs Name_____

Rice Budget

Objective: Students will calculate expenses for rice acreage.

Directions: Assume that you own 120 acres of rice. Based upon each cost listed below, calculate the total per acre. In the last column, calculate each expense for your acreage. Be sure to figure the subtotal, total, and total costs.

Expense	Unit	Total $/Unit	Total $/Acre	Your $/Acre
Cypress Seed	115	0.20		
Nitrogen	140	0.23		
Zinc	3	0.750		
Fungicide	12	2.17		
Postemergence	2	14.24		
Machinery Fuel & Repair	1	32.00		
Irrigation - Fuel	1	28.00		
Irrigation Repair & Maintenance	1	3.50		
Irrigation Labor	1	12.00		
Labor	1	21.00		
Custom Hire	3	4.50		
Subtotal				
Fixed Machine Cost	1	50.00		
Fixed Irrigation Cost	1	47.00		
TOTAL COSTS				