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ADVANCED CROP SCIENCE

INSTRUCTOR GUIDE

MISSOURI AGRICULTURAL EDUCATION

In cooperation with Agricultural Education Department • College of Agriculture, Food and Natural Resources
University of Missouri-Columbia

In cooperation with Agricultural Education Section • Division of Vocational and Adult Education
Elementary and Secondary Education • Jefferson City, Missouri

Instructor Guide

Advanced Crop Science

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Foreword

The development of the *Advanced Crop Science* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The *Advanced Crop Science* advisory committee suggested the topics to be included and reviewed the materials.

This curriculum contains 11 units. The instructor guide includes objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment. Topics include an overview of crop production, plant biology, soil fertility and management, identifying and selecting crops and seeds, safety environment, and legal issues, corn and grain sorghum production, soybean production, wheat and small grain production, forage production, cotton production, and rice production. One copy of the student reference is packaged with the instructor guide. Additional copies of the student reference can be purchased separately.

This guide incorporates the needed components to aid agriculture teachers in the implementation of VIMS. For ease of use, objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping. A table is included to show how the competencies in *Advanced Crop Science* relate to the Show-Me Standards and Missouri's Frameworks for Curriculum Development. A suggested teaching calendar is also included. *Advanced Crop Science* is primarily oriented toward students in the Natural Resources career path; however, several concepts would be valuable for students interested in other career pathways.

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Advanced Crop Science

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UNIT X – COTTON PRODUCTION

COMPETENCIES/OBJECTIVES

UNIT I – OVERVIEW
1. Identify the major Missouri crops and their uses.
2. Explain the economic importance of crop production.
3. Identify career opportunities in crop science or crop-related agribusiness.
4. Explain government influence and identify current trends in crop production.

UNIT II – PLANT BIOLOGY
1. Compare and contrast the parts and functions of monocot and dicot seeds and plants.
2. Describe how growth stages affect crop management practices.

UNIT III – SOIL FERTILITY AND MANAGEMENT
1. Identify how the composition of the soil affects fertility.
2. Identify how soil morphology affects cropping options.
3. Use soil test results to improve soil fertility and crop production.
4. Identify fertilizers and the applications needed to obtain optimal crop performance.
5. Identify how tillage and planting methods affect soil fertility.
6. Identify the conservation practices that affect crop production.

UNIT IV – IDENTIFYING AND SELECTING CROPS AND SEEDS
1. Identify crop and weed seeds and plants.
2. Identify factors that determine crop selection.
3. Utilize seed tag information to select quality seed.

UNIT V – SAFETY, ENVIRONMENT AND LEGAL ISSUES
1. Identify potential crop production hazards to operators/producers.
2. Identify the environmental and governmental issues that affect crop production.
3. Identify the legal issues involved with crop production.

UNIT VI – CORN AND GRAIN SORGHUM PRODUCTION
1. Evaluate local growing conditions and determine fertilizer needs for corn and grain sorghum production.
2. Select a corn and/or grain sorghum variety.
3. Determine tillage or planting methods for corn and grain sorghum.
4. Select a pest control program.
5. Evaluate the growing crop and determine appropriate solutions.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities and how grade requirements affect grain prices.
8. Calculate cost per acre.

UNIT VII – SOYBEAN PRODUCTION
1. Evaluate local growing conditions and determine fertilizer needs for soybean production.
2. Select a soybean variety suitable for your area.
3. Determine tillage and/or planting method.
4. Select a weed control program.
5. Evaluate the growing crop and determine appropriate solutions.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities.
8. Calculate cost per acre.

UNIT VIII – WHEAT AND SMALL GRAIN PRODUCTION
1. Evaluate local growing conditions and determine fertilizer needs for wheat and small grain production.
2. Select wheat and other small grain varieties.
3. Determine tillage or planting methods.
4. Select a pest control program.
5. Evaluate the growing crop and determine appropriate solutions.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities.
8. Calculate cost per acre.

UNIT IX – FORAGE PRODUCTION
1. Evaluate local growing conditions for forage production.
2. Identify the different types of forages and select forages appropriate for intended use.
3. Identify the principles for establishing forages.
4. Identify the principles for managing and maintaining forages.
5. Identify various forage grazing methods.
6. Identify the principles for producing forage seed.
7. Identify the principles for harvesting and storing forages for feed.
8. Describe marketing opportunities and calculate cost per acre.

UNIT X – COTTON PRODUCTION
1. Evaluate local growing conditions.
2. Select cotton variety with a local cotton consultant.
3. Describe the tillage and planting method for cotton.
4. Select a weed control program.
5. Evaluate the growing crop and determine appropriate solutions.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities.
8. Calculate cost per acre.

UNIT XI – RICE PRODUCTION
1. Evaluate local growing conditions and determine fertilizer needs for rice production.
2. Select rice variety and grade to be planted with a local rice consultant.
3. Describe the seedbed preparation.
4. Evaluate the growing crop and determine appropriate solutions.

5. Identify factors to determine harvesting and postharvesting management.
6. Describe marketing opportunities.
7. Calculate cost per acre.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the unit.

2. Observe the changes in behavior as evidence of the improved ability of students to deal with problems in this unit using background information acquired from earlier units.

3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

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Advanced Crop Science - Competency Crosswalk

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS *For Grades 9-12, For All Disciplines*					
	Knowledge (Content)	Performance (Goals)	Communication Arts	Health/ Physical Education	Fine Arts	Math	Science	Social Studies
A-1	CA 3, SC 4, SS 2, SS 4, SS 5	1.8, 1.10	I/2a				VIII.A/3a, b	III.D/1c, g, j; III.E/4h; IV.E/3j; IV.E/4g
A-2	CA 3, CA 4, MA 1, SC 5, SS 4, SS 5, SS 6	1.1, 1.2, 1.6, 1.8, 1.10, 2.1, 2.2, 3.1, 3.7, 3.8, 4.3	I/2a, II/6a			V/2a, V/3a	VI.A/2a; VIII.A/3a, b	I.D/2a-c; II.D/3f, II.D/9f, II.D/8k; III.D/7g; IV.D/3g
A-3	CA 1, CA 2, CA 3, HP 2, SS6	1.4, 1.10, 2.1, 2.3, 2.6, 4.8	I/2e, II/3c, IV/3a					
A-4	CA 3, SS 3, SS 4	1.6, 1.10, 3.1, 3.6, 3.8	I/3f					III.D/6g; IV.D/3e,k
B-1	SC 3	1.3, 1.4, 1.8					VII.A/4a	
B-2	SC 3	1.3, 1.4, 1.8					VII.B/1a, VII.B/2a; VIII.B/a	
C-1	SC 6	1.1, 1.2, 1.3, 1.6					VI.A/1a, VI.A/3a	
C-2	MA 3, SC 2, SC 3, SC 5	1.2, 1.3, 1.4, 1.6, 1.8				I/4b, III/2c, III/5d, IV/1c		
C-3	MA 1, SC 3, SC 5	1.2, 1.3, 1.4, 1.5, 1.6, 1.8					III.A/3a	
C-4	MA 1, SC 5	1.1, 1.3, 1.8				I/4d, V/1a	VIII.B/2a, b, c	
C-5	SC 5	1.2, 1.4, 1.6					VIII.B/1a	
C-6	SC 2, SC 4, SC 8, SS 2, SS 4, SS 6, SS 7	1.4, 1.6, 3.1, 3.2, 3.5, 3.7					VI.A/1a; VI.A/3a; VI.B/4a; VIII.A/2a, b; VIII.A/3a, b; VIII.B/1a	
D-1	SC 3, SC 4, SS 5	1.2, 1.3, 1.6, 1.7, 1.8, 4.1					VII.A/4a	III.E/3b, III.E/5a
D-2	CA 3, CA 4, MA 1, MA 3, SC 3, SC 4, SS 4, SS 5; SS 6, SS7	1.2, 1.4, 3.3, 3.5, 3.8, 4.1, 4.5	I/2c, I/3f, I/6c				VII.D/2a	II.D/3f
D-3	CA 3, CA 4, SC 3, SS 5	3.1, 4.1	I/2c, I/3f, I/6c				VII.D/2a	II.D/3f

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS *For Grades 9-12, For All Disciplines*					
	Knowledge (Content)	**Performance (Goals)**	**Communication Arts**	**Health/ Physical Education**	**Fine Arts**	**Math**	**Science**	**Social Studies**
D-4	MA 1, SC 3	1.1, 1.6				V/4a	VII.D/2a, VII.D/5a	
E-1	HP 2, HP 3, SC 4, SC 8, SS 3, SS 4, SS 5, SS 6,	1.2, 1.4, 2.3, 3.1, 3.2, 3.8, 4.3, 4.6, 4.7		III.D/1a; III.D/2a			II.A/1a; VIII.A/2a; VIII.A/3a, b; VIII.B/1a	I.E/3h, k, m, o; I.E/5c, m; IV.A/6k, j; IV.B/3a, b
E-2	SC 3, SC 4, SC 8, SS 3, SS 4, SS 5, SS 6	1.2, 1.4, 2.3, 3.1, 3.2, 3.8, 4.3, 4.6, 4.7					II.A/1a; VIII.A/2a; VIII.A/3a; VIII.B/1a	I.E/3h, k, m, o; I.E/5c, m; IV.A/6k, j; IV.B/3a, b
E-3	CA 3, CA 4, SC 8, SS 1, SS 3, SS 6	3.2, 3.4, 3.6, 4.2, 4.6, 4.7	I/2a, c, d; I/3a, d, f; II/1d; II/2a; II/3b, c; III/1a	III.D/1a; III.D/2a			VIII.A/2a; VIII.B/1a	I.E/3g; I.E/4h; I.E/5g, l, o; I.E/6g, l, o; II.E/5d, j, k; III.E/4g, i, n; IV.E/1d, g, i, l, m; IV.E/2d, g, i, l, m; IV.E/3d, g, i, l, m; IV.E/4d, g, i, l, m; IV.E/5d, g, i, l, m
F-1	SC 3, SC 4, SC 8, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a; II.A/2a; VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a, b, c	III.E/4f, l; III.E/5c
F-2	SC 3, SC 4, SS 5	1.2, 1.4, 1.5, 1.6, 1.10, 3.3					VII.D/2a	III.E/4f, l; III.E/5c
F-3	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.2, 1.3, 1.6, 1.8, 4.1	I/3b			V/4a	VI.A/1a; VI.A/3a; VI.B/1a	
F-4	CA 3, CA 4, SC 3, SC 4, SS 4	1.1, 1.2, 3.5, 3.8, 4.7	I/2e				VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k
F-5	CA 3, CA 4, SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 3.1, 3.6, 3.7, 3.8	I/2a				VII.A/1a; VII.A/2a	IV.D/2b, c, k, l; IV.E/5b, j
F-6	SC 8, SS 4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f; II.D/4k
F-7	MA 3, SS 4, SS 5, SS 6	1.1, 1.8, 4.6				VII/4a		II.D/2c; II.D/9b, j; III.D/6j, g; III.D/7k

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS *For Grades 9-12, For All Disciplines*					
	Knowledge (Content)	Performance (Goals)	Communication Arts	Health/ Physical Education	Fine Arts	Math	Science	Social Studies
F-8	MA 1, MA 3, SS 4	1.4, 1.6, 1.8, 3.2, 3.5, 4.1				I/4d, e; II/4h; V/4a; VII/4b		II.D/3c; II.D/4g
G-1	SC 3, SC 4, SC 8, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a; II.A/2a; VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a, b, c	III.E/4f, l; III.E/5c, f
G-2	SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					VII.D/2a	III.E/4f, l; III.E/5c, f
G-3	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.2, 1.3, 1.6, 1.8, 4.1	I/3b			V/4a	VI.A/1a; VI.A/3a; VIII.B/1a	
G-4	CA 3, CA 4, SC 3, SC 4, SS 4	1.1, 1.2, 3.5, 3.8, 4.7	I/2e				VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k
G-5	CA 3, CA 4, SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 3.1, 3.6, 3.7, 3.8	I/2a				VII.A/1a, VII.A/2a	IV.D/2b, c, k, l; IV.E/5b, j
G-6	SC 8, SS4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k
G-7	MA 3, SS 4, SS 5, SS 6	1.1, 1.8					VIII/4a	II.D/2c, j; II.D/9b, j, l; III.D/6g, j, l; III.D/7k
G-8	MA 1, MA 3, SS 4	1.4, 1.6,1.8, 3.2, 3.5, 4.1				1/4d, e; II/4h; V/4a; VII/4b		II.D/3c, II.D/4g
H-1	SC 3, SC 4, SC 8, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a; II.A/2a; VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a, b, c	III.E/4f,l; III.E/5c, f
H-2	SC 3, SC 4, SS 5	1.2, 1.4, 1.5, 1.6, 1.10, 3.3					VII.D/2a	III.E/4f,l; III.E/5c, f
H-3	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.2, 1.3, 1.6. 1.8, 4.1	I/3b			V/4a	VI.A/1a, VI.A/3a, VIII.B/1a	
H-4	CA 3, CA 4, SC 3, SC 4, SS 4	1.1, 1.2, 3.5, 3.8, 4.7	I/2e				VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k
H-5	CA 3, CA 4, SC 3, SC 4, SS 5	1.1, 1.2, 3.1, 3.6, 3.7, 3.81.3	I/2a				VII.A/1a, VII.A/2a	IV.D/2b, c, k, l; IV.E/5b, j
H-6	SC 8, SS4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS *For Grades 9-12, For All Disciplines*					
	Knowledge (Content)	**Performance (Goals)**	**Communication Arts**	**Health/ Physical Education**	**Fine Arts**	**Math**	**Science**	**Social Studies**
H-7	MA 3, SS 4, SS 5, SS 6	1.1, 1.8, 4.6				VII/4a		II.D/2c; II.D/9b, j; III.D/6g, j; III.D/7k
H-8	MA 1, MA 3, SS 4	1.4, 1.6, 1.8, 3.2, 3.5, 4.1				I/4d, e; II/4h; V/4a; VII/4b		II.D/3c, II.D/4g
I-1	SC 3, SC 4, SC 8	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a; II.A/2a; VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a, b, c	III.E/4f, I; III.E/5c, f
I-2	SC 3, SC 4, SS 5	1.2, 1.4, 1.5, 1.6, 1.10, 3.3					VII.D/2a	III.E/4f, I; III.E/5c, f
I-3	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.2, 1.3, 1.6, 1.8, 4.1	I/3b			V/4a	VI.A/1a, VI.A/3a, VIII.B/1a	
I-4	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.1, 1.2, 3.5, 3.8, 4.7	I/2e			V/4a	VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k
I-5	CA 3, CA 4, SC 3, SC 4, SC 8	1.1, 1.2, 1.3; 1.6, 1.7, 3.1, 4.1	I/2a, I/3a				II.A/2a; VI.A/1a; VI.A/3a; VIII.A/2a; VIII.B/1a; VIII.B/2a, b, c	
I-6	SC 8, SS 4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k
I-7	SC 8, SS 4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k
I-8	MA 3, SS 4, SS 5, SS 6	1.1, 1.8, 4.6				VII/4a		II.D/2c; II.D/9b, j
J-1	SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a, II.A/2a, VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a. B, c	III.E/4f, I; III.E/5c, f
J-2	SC 3, SC 4, SS 5	1.2, 1.4, 1.5, 1.6, 1.10, 3.3					VII.D/2a	III.E/4f, I; III.E/5c, f
J-3	CA 3, MA 1, SC 3, SC 4, SC 5, SC 8	1.2, 1.3, 1.6, 1.8, 4.1	I/3b				VI.A/1a, VI.A/3a, VIII.B/1a	II.D/3a, b, c, f; II.E/5j, k
J-4	CA 3, CA 4, SC 3, SC 4, SS 4	1.1, 1.2, 3.5, 3.8, 4.7	I/2e				VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS *For Grades 9-12, For All Disciplines*					
	Knowledge (Content)	Performance (Goals)	Communication Arts	Health/ Physical Education	Fine Arts	Math	Science	Social Studies
J-5	CA 3, CA 4, SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 3.1, 3.6, 3.7, 3.8					VIII.A/1a, VII.A/2a	III.D/6g, j; III.D/7k; IV.E/5j
J-6	SC 8, SS 4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k
J-7	MA 3, SS 4, SS 5, SS 6	1.1, 1.8				VII/4a		II.D/2c; II.D/9b, j; III.D/6g, j; III.D/7k
J-8	MA 1, MA 3, SS 4	1.4, 1.6, 1.8, 3.2, 3.5, 4.1				I/4d, e; II/4h; V/4a; VII/4b		II.D/3c, II.D/4g
K-1	SC 3, SC 4, SC 8, SS 5	1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3.3					I.A/3a; II.A/2a; VI.A/1a; VI.A/3a; VIII.B/1a; VIII.B/2a, b, c	III.E/4f, l; III.E/5c, f
K-2	SC 3, SC 4, SS 5	1.2, 1.4, 1.5, 1.6, 1.10, 3.3					VII.D/2a	III.E/4f, l; III.E/5c, f
K-3	CA 3, MA 1, SC 3, Sc 4, SC 5, SC 8	1.2, 1.3,1.6, 1.8, 4.1	I/3b			V/4a	VI.A/1a, VI.A/3a, VIII.B/1a	
K-4	CA 3, CA 4, SC 3, SC 4, SS 4	1.1, 1.2, 3.5, 3.8, 4.7	I2e				VIII.B/1a; VIII.B/2a, b, c	II.D/3a, b, c, f; II.E/5j, k
K-5	CA 3, CA 4, SC 3, SC 4, SS 5	1.1, 1.2, 1.3, 3.1, 3.6, 3.7, 3.8	I/2a				VII.A/1a, VII.A/2a	IV.E/5b, j
K-6	SC 8, SS 4	1.1, 1.2, 1.6, 1.7, 4.1					II.A/2a	II.D/3f, II.D/4k
K-7	MA 3, SS 4, SS 5, SS 6	1.1, 1.8, 4.6				VII/4a		II.D/2c; II.D/9b, j; III.D/6g, j; III.D/7k

Advanced Crop Science

Teaching Calendar

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit I, Lesson 1	2-3 days	AS 1.1 1 class period
		AS 1.2 1 class period
Unit I, Lesson 2	2-3 days	AS 2.1 1 class period
Unit I, Lesson 3	1-2 days	AS 3.1 1 class period
Unit I, Lesson 4	1-2 days	AS 4.1 1 class period
Unit II, Lesson 1	2-3 days	
Unit II, Lesson 2	2-3 days	AS 2.1 1 class period
Unit III, Lesson 1	2-3 days	AS 1.1 1 class period
Unit III, Lesson 2	2-3 days	AS 2.1 1 class period
Unit III, Lesson 3	3-4 days	AS 3.1 1 class period
		AS 3.2 1 class period
Unit III, Lesson 4	2-3 days	AS 4.1 1 class period
Unit III, Lesson 5	3-4 days	AS 5.1 1 class period
		AS 5.2 1 class period
		AS 5.3 1 class period
Unit III, Lesson 6	3-4 days	AS 6.1 1 class period
		AS 6.2 1 class period
		AS 6.2A 1 class period
Unit IV, Lesson 1	3-4 days	AS 1.1 1 class period
Unit IV, Lesson 2	2-3 days	AS 2.1 1 class period
Unit IV, Lesson 3	3-4 days	AS 3.1 1 class period
		AS 3.2 1 class period
Unit V, Lesson 1	3-4 days	AS 1.1 1 class period
Unit V, Lesson 2	2-3 days	AS 2.1 1 class period
Unit V, Lesson 3	3-4 days	AS 3.1 1 class period
Unit VI, Lesson 1	2-3 days	AS 1.1 1 class period
Unit VI, Lesson 2	3-4 days	AS 2.1 1 class period
Unit VI, Lesson 3	3-4 days	AS 3.1 1 class period
Unit VI, Lesson 4	3-4 days	AS 4.1 1 class period

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit VI, Lesson 5	3-4 days	AS 5.1 1 class period
Unit VI, Lesson 6	4-5 days	AS 6.1 1 class period
Unit VI, Lesson 7	3-4 days	AS 7.1 1 class period
Unit VI, Lesson 8	2-3 days	AS 8.1 1 class period
Unit VII, Lesson 1	2-3 days	
Unit VII, Lesson 2	3-4 days	AS 2.1 1 class period
		AS 2.2 1 class period
Unit VII, Lesson 3	2-3 days	AS 3.1 1 class period
Unit VII, Lesson 4	3-4 days	AS 4.1 1 class period
Unit VII, Lesson 5	3-4 days	AS 5.1 1 class period
Unit VII, Lesson 6	3-4 days	AS 6.1 1 class period
Unit VII, Lesson 7	2-3 days	AS 7.1 1 class period
Unit VII, Lesson 8	2-3 days	AS 8.1 1 class period
Unit VIII, Lesson 1	2-3 days	
Unit VIII, Lesson 2	4-5 days	AS 2.1 1 class period
		AS 2.2 1 class period
		AS 2.3 1 class period
Unit VIII, Lesson 3	3-4 days	AS 3.1 1 class period
Unit VIII, Lesson 4	2-3 days	AS 4.1 1 class period
Unit VIII, Lesson 5	3-4 days	AS 5.1 1 class period
Unit VIII, Lesson 6	3-4 days	AS 6.1 1 class period
Unit VIII, Lesson 7	2-3 days	AS 7.1 1 class period
Unit VIII, Lesson 8	2-3 days	AS 8.1 1 class period
Unit IX, Lesson 1	2-3 days	AS 1.1 1 class period
Unit IX, Lesson 2	3-4 days	AS 2.1 1 class period
Unit IX, Lesson 3	2-3 days	AS 3.1 1 class period
Unit IX, Lesson 4	2-3 days	
Unit IX, Lesson 5	3-4 days	AS 5.1 1 class period
Unit IX, Lesson 6	2-3 days	AS 6.1 1 class period
Unit IX, Lesson 7	3-4 days	AS 7.1 1 class period
Unit IX, Lesson 8	2-3 days	AS 8.1 1 class period
Unit X, Lesson 1	2-3 days	AS 1.1 1 class period
Unit X, Lesson 2	2-3 days	AS 2.1 1 class period

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit X, Lesson 3	2-3 days	AS 3.1 1 class period
Unit X, Lesson 4	2-3 days	
Unit X, Lesson 5	2-3 days	AS 5.1 1 class period
Unit X, Lesson 6	3-4 days	AS 6.1 1 class period
Unit X, Lesson 7	2-3 days	AS 7.1 1 class period
Unit X, Lesson 8	3-4 days	AS 8.1 1 class period
Unit XI, Lesson 1	2-3 days	AS 1.1 1 class period
Unit XI, Lesson 2	3-4 days	AS 2.1 1 class period
Unit XI, Lesson 3	3-4 days	AS 3.1 1 class period
Unit XI, Lesson 4	2-3 days	AS 4.1 1 class period
Unit XI, Lesson 5	3-4 days	AS 5.1 1 class period
		AS 5.2 1 class period
Unit XI, Lesson 6	2-3 days	AS 6.1 1 class period
Unit XI, Lesson 7	3-4 days	AS 7.1 1 class period

Advanced Crop Science
Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale: **3 Mastered** - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

3	2	1	N	**A. Overview**
				1. Identify the major Missouri crops and their uses.
				2. Explain the economic importance of crop production.
				3. Identify career opportunities in crop science or crop-related agribusiness.
				4. Explain government influence and identify current trends in crop production.
				Other ______________________

3	2	1	N	**B. Plant Biology**
				1. Compare and contrast the parts and functions of monocot and dicot seeds and plants.
				2. Describe how growth stages affect crop management practices.
				Other ______________________

3	2	1	N	**C. Soil Fertility and Management**
				1. Identify how the composition of the soil affects fertility.
				2. Identify how soil morphology affects cropping options.
				3. Use soil test results to improve soil fertility and crop production.
				4. Identify fertilizers and the applications needed to obtain optimal crop performance.

3	2	1	N	**C. Soil Fertility and Management (continued)**
				5. Identify how tillage and planting methods affect soil fertility.
				6. Identify the conservation practices that affect crop production.
				Other ______________________

3	2	1	N	**D. Identifying and Selecting Crops and Seeds**
				1. Identify crop and weed seeds and plants.
				2. Identify factors that determine crop selection.
				3. Utilize seed tag information to select quality seed.
				Other ______________________

3	2	1	N	**E. Safety, Environment, and Legal Issues**
				1. Identify potential crop production hazards to operators/producers.
				2. Identify the environmental and governmental issues that affect crop production.
				3. Identify the legal issues involved with crop production.
				Other ______________________

3	2	1	N	**F. Corn & Grain Sorghum Production**
				1. Evaluate local growing conditions and determine fertilizer needs for corn and grain sorghum production.
				2. Select a corn and/or grain sorghum variety.
				3. Determine tillage or planting methods for corn and grain sorghum.
				4. Select a pest control program.
				5. Evaluate the growing crop and determine appropriate solutions.
				6. Identify factors to determine harvesting and postharvesting management.
				7. Describe marketing opportunities and how grade requirements affect grain prices.
				8. Calculate cost per acre.
				Other ______________________

3	2	1	N	**G. Soybean Production**
				1. Evaluate local growing conditions and determine fertilizer needs for soybean production.
				2. Select a soybean variety suitable for your area.
				3. Determine tillage and/or planting method.
				4. Select a weed control program.
				5. Evaluate the growing crop and determine appropriate solutions.

3	2	1	N	G. Soybean Production (continued)
				6. Identify factors to determine harvesting and postharvesting management.
				7. Describe marketing opportunities.
				8. Calculate cost per acre.
				Other ____________________

3	2	1	N	H. Wheat and Small Grain Production
				1. Evaluate local growing conditions and determine fertilizer needs for wheat and small grain production.
				2. Select wheat and other small grain varieties.
				3. Determine tillage or planting methods.
				4. Select a pest control program.
				5. Evaluate the growing crop and determine appropriate solutions.
				6. Identify factors to determine harvesting and postharvesting management.
				7. Describe marketing opportunities.
				8. Calculate cost per acre.
				Other ____________________

3	2	1	N	I. Forage Production
				1. Evaluate local growing conditions for forage production.
				2. Identify the different types of forages and select forages appropriate for intended use.
				3. Identify the principles for establishing forages.
				4. Identify the principles for managing and maintaining forages.
				5. Identify various forage grazing methods.
				6. Identify the principles for producing forage seed.
				7. Identify the principles for harvesting and storing forages for feed.
				8. Describe marketing opportunities and calculate cost per acre.
				Other ____________________

3	2	1	N	J. Cotton Production
				1. Evaluate local growing conditions.
				2. Select cotton vareity with a local cotton consultant.
				3. Describe the tillage and planting method for cotton.
				4. Select a weed control program.

3	2	1	N	J. Cotton Production (continued)
				5. Evaluate the growing crop and determine appropriate solutions.
				6. Identify factors to determine harvesting and postharvesting management.
				7. Describe marketing opportunities.
				8. Calculate cost per acre.
				Other ____________________

3	2	1	N	K. Rice Production
				1. Evaluate local growing conditions and determine fertilizer needs for rice production.
				2. Select rice variety and grade to be planted with a local rice consultant.
				3. Describe the seedbed preparation.
				4. Evaluate the growing crop and determine appropriate solution.
				5. Identify factors to determine harvesting and postharvesting management.
				6. Describe marketing opportunities.
				7. Calculate cost per acre.
				Other ____________________

ADVANCED CROP SCIENCE

Student Names

UNIT I – OVERVIEW

1. Identify crops and their major uses.
2. Explain the economic importance of crop production.
3. Identify career opportunities in crop science and crop-related agribusiness.
4. Explain government influence and identify current trends in crop production.

UNIT II – PLANT BIOLOGY

1. Compare and contrast the parts and functions of monocot and dicot seeds and plants.
2. Describe how growth stages affect crop management practices.

UNIT III – SOIL FERTILITY AND MANAGEMENT

1. Identify how the composition of the soil affects fertility.
2. Identify how soil morphology affects cropping options.
3. Use soil test results to improve soil fertility and crop production.
4. Identify fertilizers and the applications needed to obtain optimal crop performance.
5. Identify how tillage and planting methods affect soil fertility.
6. Identify the conservation practices that affect crop production.

UNIT IV – IDENTIFYING AND SELECTING CROPS AND SEEDS

1. Identify crop and weed plants.
2. Identify factors that determine crop selection.
3. Utilize seed tag information to select quality seed.

Student Names

UNIT V – SAFETY, ENVIRONMENT, AND LEGAL ISSUES

1. Identify potential crop production hazards to operators/producers.
2. Identify the environmental and governmental issues that affect crop production.
3. Identify potential crop production hazards to operators/producers.

UNIT VI – CORN AND GRAIN SORGHUM PRODUCTION

1. Evaluate local growing conditions and determine fertilizer needs for corn and grain sorghum production.
2. Select a corn and grain sorghum variety.
3. Determine tillage and/or planting method used with corn and grain sorghum.
4. Select a pest control program.
5. Evaluate the growing crop and determine appropriate solutions.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities and how grade requirements affect grain prices.
8. Calculate cost per acre.

UNIT VII – SOYBEAN PRODUCTION

1. Evaluate local growing conditions and determine fertilizer needs for soybean production.
2. Select a soybean variety suitable for your area.
3. Determine tillage and/or planting method.
4. Select a weed control program.
5. Evaluate the growing crop and determine appropriate solutions.

Student Names

UNIT VII – SOYBEAN PRODUCTION (continued)

6. Identify factors that determine harvesting and postharvesting management techniques.
7. Describe marketing opportunities.
8. Calculate cost per acre.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

1. Evaluate local growing conditions for forage production.
2. Select wheat and other small grain varieties.
3. Determine tillage or planting methods.
4. Select a pest control program.
5. Evaluate the growing crop and determine appropriate solution.
6. Identify factors to determine harvesting and postharvesting management.
7. Describe marketing opportunities.
8. Calculate cost per acre.

UNIT IX - FORAGE PRODUCTION

1. Evaluate local growing conditions.
2. Identify the different kinds of forages and select species appropriate for intended use.
3. Identify the principles for establishing forages.
4. Identify the principles for maintaining and managing forages.
5. Identify various forage grazing methods.
6. Identify the principles for producing forage seed.
7. Identify the principles for harvesting and storing forages for feed.
8. Describe marketing opportunities and calculate cost per acre.

Student Names															
UNIT X – COTTON PRODUCTION															
1. Evaluate local growing conditions.															
2. Select cotton variety with a local cotton consultant.															
3. Describe the tillage and planting method for cotton.															
4. Select a weed control program.															
5. Evaluate the growing crop and determine appropriate solutions.															
6. Identify factors to determine harvesting and postharvesting management.															
7. Describe marketing opportunities.															
8. Calculate cost per acre.															
UNIT XI – RICE PRODUCTION															
1. Evaluate local growing conditions and determine fertilizer needs for rice production.															
2. Select rice variety and grade to be planted with a local rice consultant.															
3. Describe the seedbed preparation.															
4. Evaluate the growing crop and determine appropriate solution.															
5. Identify factors to determine harvesting and postharvesting management.															
6. Describe marketing opportunities.															
7. Calculate cost per acre.															

UNIT I - OVERVIEW

Lesson 1: Missouri Crops and Their Uses

Competency/Objective: Identify the major Missouri crops and their uses.

Study Questions

1. **What are the major agricultural crops in Missouri?**

2. **What are the main uses of the major Missouri crops?**

3. **What are the main uses of components from the major crops?**

4. **What are the alternative uses of the major crops?**

5. **What other important crops are grown in Missouri?**

6. **Which companies use the major crops or crop components?**

References

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

2. *AgriMissouri Buyers Guide*. Missouri Department of Agriculture, Market Development Division, AgriMissouri Program. Jefferson City, MO. Current copies are available by telephone (573-751-9266) or can be accessed on the Internet at <http://www.mda.state.mo.us/bguide.htm>.

3. Activity Sheets

   a) AS 1.1: Processed Food
   b) AS 1.2: Everyday Products from Soybeans

UNIT I - OVERVIEW

Lesson 1: Missouri Crops and Their Uses

TEACHING PROCEDURES

A. ***Introduction***

Agriculture is Missouri's number one industry and therefore crop production plays an important role in the state. The variation in topography and climate throughout the state allows for the great variation in crops being produced. This also leads to the numerous individuals, companies, and corporations across the state that use crops to manufacture many everyday products. Because of this diversity, Missouri is among the country's leaders in agricultural production, growing, and processing of many high-quality food, feed, and industrial products.

B. ***Motivation***

1. Ask students individually or in groups to make a list of what crops they think are grown in the state. Next have students select one crop and make another list of how this crop is used and who uses it. Keep these lists for students to review at the completion of the lesson to compare with what they have studied. Initiate a competition among students or student teams for a week or throughout the crop science course by collecting labels or brochures from different types of products that are made from a selected crop. Winners could be determined by the student or team finding the most unusual crop product and the most uses of a crop.

2. Visit a nearby processing plant that produces consumer or industrial products from crops. (Examples might be a local elevator or feed mill, a flour mill, an ethanol plant, or a soybean processing plant.) Observe how harvested crops enter the plant and what steps they go through to make the manufactured product(s). Students should be able to discuss how some crops take little or no processing (livestock feed), wheras others take extensive processing to be used in everyday products (flour, fuel products, or cooking oil). Use *AgriMissouri Buyer's Guide* to locate plants or companies to visit.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the variety of crops produced in the state of Missouri and where they are grown. Explain how variances in topography and climate play a role in the diversity of crops grown. Highlight the top 10 crops (by value) grown in the state. Let students know that only seven crops will be covered in detail. Refer to Table 1.1, 1998 Top 10 Missouri Crops, found in the Student Reference. For current values, refer to the most recent *Missouri Farm Facts.*

   What are the major agricultural crops in Missouri?

   a) Soybeans - grown everywhere in Missouri except south central region
   b) Corn and grain sorghum - grown throughout state
   c) Wheat - grown throughout state
   d) Hay - grown throughout state
   e) Rice - grown in the southeast, or "Bootheel"
   f) Cotton - grown in the southeast (Bootheel) and the southwest
   g) Tobacco - grown in the uplands (elevated plains) along the Missouri River
   h) Vegetables and fruits - grown in the river bottoms along Missouri and Mississippi rivers

2. Discuss the major uses of the crops produced in Missouri. Explain how these crops are mainly used for either livestock feed or human food.

What are the main uses of the major Missouri crops?

a) Soybeans
   1) Whole beans - processed into protein-rich meal and used for livestock feed
   2) Oil - cooking oils (food); diesel fuel, inks, paints, and plastics (industrial)
   3) Meal - livestock and poultry feed
b) Corn - 61% used for livestock feed
c) Grain sorghum - livestock feed
d) Hay - livestock roughage feed source
e) Wheat - flour (food)
f) Cotton - cotton fiber used for clothing
g) Rice - food for human consumption

3. Discuss which components of the major crops are used. Refer to Figures 1.1 and 1.2 in the Student Reference, which give a detailed listing of uses for soybeans and corn. Also explain the processing of soybeans used to remove oil and meal from grains for food, feed, and industrial uses. (If possible, incorporate Motivation 2 into the lesson at this point.)

What are the main uses of components from the major crops?

a) Soybeans (seed or bean used in three ways)
   1) Whole beans
      (a) Hulled and rolled into full fat flakes
      (b) Can be ground for feed or flour
   2) Oil
      (a) Fat flakes bathed in solvent (degumming) to remove lecithin then crushed to remove crude oil
      (b) Refined to produce cooking oil, margarine, and shortening
   3) Meal or protein
      (a) Defatted flakes are ground into a meal for animal feed or soy flour (50% protein); flour processed into higher protein concentrates used in protein drinks, soup bases, or gravies.
      (b) Defatted flakes are chemically processed to create soy isolates (90% protein) used in dairylike products.
b) Corn
   1) Whole seed/kernel - used as a livestock energy feed source; fed in a cracked, rolled, or ground form
   2) Seed parts - refined into two groups
      (a) Primary products - starches, syrups, and dextrose, generated from the endosperm (starch) of the seed; used in foods, industrial products, and drugs
      (b) Co-products - solubles (dissolved carbohydrates in water processing solution), gluten (protein) and hulls, and seed germ (oil); used in drugs, livestock feed and food
   3) Immature or green plant - harvested as silage, used as livestock forage feed
   4) Stalks - used as a winter feed supplement for cattle
c) Grain sorghum
   1) Kernel - very hard, requires additional processing for feed
   2) Green plant - cut as silage for livestock feed
d) Wheat
   1) Seed
      (a) Endosperm - source for all flour manufacturing
      (b) Bran (outer coat) and germ - by-products from white flour milling, used separately or included in whole wheat flour

(c) Middlings and shorts - discarded waste products from flour manufacturing; includes germ, fine bran, and some flour; processed into livestock feed
2) Stem - (stubble left after harvest) cut, dried, and baled into straw; used for livestock bedding, ground cover, mulch, and crop residue
3) Immature or green plant - harvested as silage, used as livestock forage feed

e) Grass or legume hay
1) Stems, leaves, and seed heads of grasses and legumes - cut, dried, and baled; used for livestock roughage feed
2) Roots - legumes that replace nitrogen in soil

f) Cotton
1) Fiber - processed into thread and woven into fabric and textiles for clothing and home furnishings
2) Seed
(a) Oil and meal - used for food products, livestock feed, and flour
(b) Foots (wastes from oil refining) - processed into fatty acids for industrial products
(c) Hulls - used with or without the meal for livestock, poultry, and fish feed or as fertilizer

g) Rice
1) Seed
(a) Brown rice - hulled, leaving bran layer surrounding kernel; used as food
(b) White rice - milled further; cooked and eaten whole, or processed into cereals, rice cakes, or starch that is used in other food products
(c) Bran (including hull and germ) - processed further to make rice oil, a cholesterol-free cooking oil
2) Hulls - ground for use in poultry bedding
3) Stem - cut, dried, and baled as straw for livestock feed and bedding

4. Discuss how crops and processing wastes can be further processed into edible and industrial products. Refer to Figures 1.1 and 1.2 in the Student Reference.

What are the alternative uses of the major crops?

a) Soybeans - more alternative uses than most other crops (refer to Figure 1.1 Soybeans' Many Uses)
b) Corn - refer to Figure 1.2 Primary Products and Co-Products of Corn
c) Grain sorghum - ethanol, produced from the endosperm
d) Wheat
1) Livestock roughage feed source; injected with ammonia
2) Foods/beverages - breakfast foods, beer, whiskey, alcohol, and coffee substitutes
3) Building materials
e) Hay - livestock bedding; ethanol research
f) Cotton
1) Fiber
(a) Processed into lint (fiber after the seeds have been removed at the gin); used for padding in furniture, mattresses, and car seats
(b) Other cellulose products, cardboard, plastic, and U.S. paper currency
2) Waste - recycled into new products
g) Rice
1) Meal, bran, and rice polish - used as livestock feed
2) Broken kernels (less than 3/4 of whole kernel) - used to brew beer and make flour
3) Stems - ethanol research

5. Discuss other crops grown in Missouri and their impact on the state's economy.

What other important crops are grown in Missouri?

a) Tobacco
b) Vegetables - potatoes and watermelons
c) Fruits - apples, peaches, and grapes

6. Discuss the importance of agricultural processing in the United States. Without additional processing, many products produced from raw grains would not be available on a daily basis. The companies listed are only a sampling of the many grain merchandisers and processors in Missouri and in the United States. Have students complete AS 1.1.

Which companies use the major crops or crop components?

a) Grain merchandisers - connection between producers and consumers.
b) M.F.A. Incorporated - production of feed, grain sales, sales of seeds, fertilizer, and crop protection chemicals.
c) Cargill, Inc. - international marketing, processing, and distribution of agricultural food.
d) Archer Daniels Midland Company - processing cereal grains and oilseeds.
e) Farmland - crop production and crop protection products; livestock feed; petroleum; grain processing and marketing; and processing and marketing of pork and beef products.
f) Koch Industries - large livestock producer; specializes in using crops or crop components to feed cattle at their company-owned ranches and feedlots.
g) Nestle USA - food processing plant
h) Ralston/Purina - grain processing facility
i) ConAgra, Inc. - diversified international food company
j) Other large food processors
    1) RJ Reynolds
    2) Nabisco
    3) Sara Lee
    4) General Mills
    5) Quaker Oats
    6) Pillsbury
    7) Colonial Baking Company
    8) Kraft Foods
    9) Ralcorp Holdings, Inc.
    10) Frito-Lay, Inc.

F. ***Other Activities***

1. After completing Activity Sheet 1.2, make posters listing products derived from soybeans. Each day challenge the students to think of additional products to add to the posters.

2. Have students use their creativity and imagination to invent a new food product. Explain what plant it comes from and how it is harvested and processed. Design packaging for the product and explain who will probably purchase and use it.

3. Have the students research various grain merchandisers or food processors. Information is available on the Internet to develop a company profile. Have the students write a report and share the information with the class.

G. ***Conclusion***

Missouri is a major contributor of crops and crop products both nationally and internationally. Not only are Missouri crops used to produce food for human consumption, but also for livestock feed and alternative uses such as plastics, clothing, cleaning agents, and building materials. Missouri is home to major corporations that process raw grains into products used throughout the world.

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

Answers will vary for both activity sheets.

I. ***Answers to Evaluation***

1. d
2. b
3. d
4. e
5. a
6. f
7. b
8. d
9. c

10. Answers will vary but should include two of the following for each crop:
    a) Corn
        1) Kernel - used as a livestock energy feed source
        2) Seed (primary products) - endosperm of the seed; used in foods, industrial products, and drugs
        3) Seed (co-products) - solubles, gluten and hulls, and seed germ; used in drugs, livestock feed and food
        4) Green plant - harvested as silage, used as livestock forage feed
        5) Stalks - used as a winter feed supplement for cattle
    b) Wheat
        1) Seed (endosperm) - used for flour
        2) Seed (bran and germ) - used separately or in whole wheat flour
        3) Seed (middlings and shorts) - processed into livestock feed
        4) Stem - baled into straw; used for livestock bedding, ground cover, mulch, and crop residue
    c) Rice
        1) Seed (brown rice) - used as food
        2) Seed (white rice) - used as food or processed into cereals, rice cakes, or starch for food products
        3) Seed (bran) - cholesterol-free cooking oil
        4) Hulls - used as poultry bedding
        5) Stem - baled as straw for livestock feed and bedding

11. Answers will vary but should include one of the following for each crop:
    a) Soybeans - refer to Figure 1.1 in the Student Reference
    b) Grain sorghum - ethanol
    c) Cotton
        1) Lint used for padding in furniture, mattresses, and car seats
        2) Other cellulose products, cardboard, plastic, and U.S. paper currency

12. Tobacco, Vegetables, Fruit

13. Answers will vary, but should include three of the following companies.
    MFA Incorporated; Cargill, Inc.; Archer Daniels Midland Company; Farmland; Koch Industries; Nestle USA; Ralston/Purina; ConAgra, Inc.; RJ Reynolds; Nabisco; Sara Lee; General Mills; Quaker Oats; Pillsbury; Colonial Baking Company; Kraft Foods; Ralcorp Holdings, Inc.; Frito-Lay, Inc.

UNIT I - OVERVIEW | Name______________________________

Lesson 1: Missouri Crops and Their Uses | Date_______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Most of our food supply comes directly or indirectly from _______________ .

   a. Food processors
   b. Supermarkets
   c. Producers
   d. Crops

2. _______________ is Missouri's largest cash crop.

   a. Grain sorghum
   b. Soybean
   c. Corn
   d. Hay

3. Missouri ranks second in the United States in ___________ production.

   a. Grain sorghum
   b. Soybeans
   c. Corn
   d. Hay

Match the crop on the right with its main use on the left. All of the answers should be used once.

4.	_____ Livestock feed	a.	Soybeans
5.	_____ Industrial products	b.	Rice
6.	_____ Flour	c.	Hay
7.	_____ Human consumption	d.	Cotton
8.	_____ Clothing	e.	Corn and grain sorghum
9.	_____ Livestock roughage feed	f.	Wheat

Complete the following short answer questions.

10. List two components from each of the following crops and describe how each component is used.

    a. Corn
       (1)

       (2)

    b. Wheat
       (1)

       (2)

c. Rice

(1)

(2)

11. List an alternative use for each of the following crops.

    a. Soybeans

    b. Grain sorghum

    c. Cotton

12. List three alternative crops that make an important contribution to the Missouri economy.

    a.

    b.

    c.

13. Name three companies that use crops or crop components.

    a.

    b.

    c.

Lesson 1: Missouri Crops and Their Uses Name______________________________

Processed Food

Objective: Students will identify crops that produced the processed food items they eat.

Directions: Select a favorite processed breakfast cereal and answer the questions listed below. If research is necessary, use reference books, Internet sources, local and state crop associations, companies, etc., to help locate where the cereal was grown and processed. Finally, write a report and share with the class what you have learned.

1. Name the processed breakfast cereal you have selected.

2. List the top three ingredients shown on the package.

   a.

   b.

   c.

3. What crop was this food item derived from?

4. Where is this crop grown?

5. What company processed the item? (Some packages may list the distributor and this may be different than who processed the item, so you may need to do some research.)

6. Where is the company located?

7. What other processed food products does this company make?

Bonus points:

8. Determine how the food was processed to get it from the farm to the table.

Lesson 1: Missouri Crops and Their Uses Name____________________________

Everyday Products from Soybeans

Objective: Students will be able to identify products derived from soybeans.

Directions: Using the columns below, list all activities that you were involved in for a whole day. Also, list all the foods you ate that day, collecting their product labels if possible. Using the table on the back, list all the products you used or ate that were produced from soybeans.

ACTIVITIES	FOODS
Examples: *Checked cattle on tractor, bottle fed calf*	*Examples:* *Pancakes, butter, syrup, sausage, milk*
Drove diesel truck to town for new paint job	*Snickers bar, Coke, and Doritos*

SOYBEAN PRODUCTS

Soybean Oil Products				Soybean Protein Products			Whole Soybean Products	Soybean Hulls
Soy Oil		Soybean Lecithin		Soy Flour Concentrates & Isolates		Soybean Meal		
Edible Uses	Technical Uses	Edible Uses	Technical Uses	Edible Uses	Technical Uses	Feed Uses	Edible Uses	
Doritos	*Diesel fuel*	*Snickers bar*	*Calf milk replacer*	*Sausage casings*		*Calf milk replacer*	*Pancake flour*	

UNIT I - OVERVIEW

Lesson 2: The Importance of Crops

Competency/Objective: Explain the economic importance of crop production.

Study Questions

1. **What is the economic importance of crops in Missouri?**

2. **What is the economic importance of crops in the United States?**

3. **What is the economic importance of crops in the world?**

4. **What are the major grain-exporting countries in the world?**

5. **What are the major importing countries of U.S. crops?**

6. **How do marketing principles affect crop economics?**

References

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

2. Transparency Masters

   a) TM 2.1: 1998 Missouri Cash Receipts
   b) TM 2.2: 1998 U.S. Crop Values

3. Activity Sheet

   a) AS 2.1: Missouri Cropland

UNIT I - OVERVIEW

Lesson 2: The Importance of Crops

TEACHING PROCEDURES

A. ***Review***

Lesson 1 discussed the major crops and crop components grown in Missouri. This lesson will discuss the economic impact those crops and crop components have, not only in Missouri, but in the United States and the world. Also included will be major importers and exporters of crops and the impact marketing has on crop economics.

B. ***Motivation***

Ask the students if they know how many crops are produced in the state, nation, and/or world. Using a bale of hay (60 lb.) or a bushel of corn (56 lb.), have students guess how many of each were produced in the state during the past year. For example, in 1998 the total bushels of corn produced for grain was 285 million, 2.9% of the total produced in the United States. Use various crops to stress the importance of how much grain is actually produced. The most current *Missouri Farm Facts* guide will provide this information. Using the most current *Missouri Farm Facts* and the *USDA Agriculture Fact Book* allows students to research specific crop production facts for their county, state, and the United States.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the diversity of agriculture in Missouri. Consider the economic importance of crop production by illustrating how the value of crops sold in the state has a direct impact on the state's economy. Have students complete AS 2.1.

What is the economic importance of crops in Missouri?

a) In 1998, 49.8% of Missouri farm income was from crop production (Figure 2.1).
    1) Soybeans accounted for 21.2% of crops sold in Missouri.
    2) Feed crops (corn, hay, oats, and grain sorghum) comprised 17.6%.
    3) Food grains (rice and wheat), cotton, and miscellaneous crops consisted of 11%.
b) Missouri ranks in the top 10 crop-producing states in the United States for hay, sorghum, soybeans, rice, corn; 11th in winter wheat production, and 12th in the nation in cotton.
c) Missouri grew 6% of all U.S. soybeans and grain sorghum.
d) Missouri agriculture employs 15% of the state's labor force (400,000 workers).

2. Discuss the economic impact crop production has on the U.S. economy. Explain that humans would not be able to enjoy the abundant food supply of the United States without efficient and productive farmers. The United States is the largest food supplier worldwide, and grains are the leading U.S. export.

What is the economic importance of crops in the United States?

a) In 1998, the value of crops sold in the United States totaled $98 billion.
b) Crops were 48% of the $196.8 billion total farm receipts in 1998.
c) Crop distribution in the United States is substantial.
    1) Corn (America's largest crop) added $24.4 billion to the economy in 1998.

    2) Soybeans added $17.7 billion to the economy.
    3) Wheat contributed $8.7 billion to the economy.
    4) Cotton contributed 5.9 billion to the economy.
    5) Hay contributed 13.3 billion economy.

3. Explain the importance of grain production in feeding the population of the world. Countries trade their products for grains to feed their people and livestock. The topography and climate of a country determine what crops it produces.

   What is the economic importance of crops in the world?

   a) Food and feed crop production must increase to meet the demand of increasing populations.
      1) 5.6 billion people in the world in 1997
      2) Increasing at 1.7% per year
   b) Underdeveloped countries have difficulties meeting grain needs of their populations.
      1) Limited knowledge of grain production
      2) Lack of equipment and seeds
      3) Climate
      4) Lack of infrastructure (transportation, processing, storage)
   c) U.S. production accounts for largest percentage of crops produced.
      1) U.S. produced 46% of the 500 million metric tons of corn grown worldwide.
      2) U.S. produced 50% of the world's soybeans in 1997 - 2.73 billion bushels.
      3) Only 1/5 of U.S. land is used in crop production.
      4) The American farmer produces enough food to feed nearly 150 people at the end of the 20th century.
   d) Brazil, China, Argentina, Canada, and Australia are also large crop-producing nations.

4. Discuss how the United States competes against other countries in crop production. Students need to understand how crop-producing countries compete to sell their grain to the major grain importers. Producers need to know whom they are competing against, so they can be better players in the worldwide market. This competition affects the prices paid to American producers for their crops.

   What are the major grain-exporting countries in the world?

   a) The United States is the largest exporter with yearly exports of agriculture products exceeding $69.7 billion dollars in 1998.
   b) The largest feed grain (corn and wheat) exporters in the world are the United States, China, Canada, and Australia.
   c) The largest oil crop (soybeans) exporters in the world are the United States, Brazil, and Argentina.
   d) Improved technologies and competition from other countries are reducing the amount of exports from the United States.

5. Discuss the importance of knowing which countries purchase the most crops. This could be explained by comparing the producer to a small business owner who must know the customer base to provide the most needed or desired products (crops) or services. It is important to know what prices those customers can or are willing to pay for those products and services. The United States tries to maintain good trading relationships with large world grain importers by offering them a high-quality product at an affordable price. The more grain imported by these countries, the better prices American producers will receive for their crop.

   What are the major importing countries of U.S. crops?

   a) Major importers of U.S. grains include Japan, Mexico, Taiwan, and Middle East countries.
   b) The United States imports crops it is unable to grow or cannot grow in sufficient quantities.

1) Bananas
2) Coffee beans
3) Cocoa beans

6. Producers of grain should understand the basic marketing principles that play a role in the economics of production. These principles are basically the same as with other agricultural commodities. Research into the marketing of a specific commodity and careful planning are keys to success. The University of Missouri's *Missouri Farm Financial Outlook* guide can be used as a reference.

How do marketing principles affect crop economics?

a) The basic economic law of supply and demand plays a major role in grain marketing.
b) Surplus grains lead to lower prices and smaller profit margins.
c) The Chicago Board of Trade (CBOT) plays a major role in grain price discovery and determination.
    1) CBOT was established in 1848 to bring order to a chaotic marketing situation.
    2) It brings buyers and sellers together through brokers to negotiate prices.
    3) Daily world news of government grain-buying orders, weather changes, etc. help establish prices.
d) Successful grain marketing is a three-step process.
    1) Determine the cost of production and break-even price per unit.
    2) Develop a marketing plan with different pricing alternatives (cash sales, forward contracting, futures and options).
    3) Develop a follow-through plan as the last step. Track the markets daily.
e) Stick to your marketing plan.

F. ***Other Activity***

Have the students select one of the important grains marketed in Missouri and follow the prices of that grain on a daily basis during this unit. Students could report the finding by chart or bar graph format to determine when might be a best time to sell their commodity.

G. ***Conclusion***

The production of grains in Missouri and the United States is important to our economy. Grain sales and the exporting of grains play a major role in reducing the balance of trade between American and its trading partners. Missouri is a leader in the United States in hay production as well as being in the top 10 among all other states in corn and soybean production. Missouri agriculture employs over 15% of our state's workforce and is the home of about 2,000 agribusinesses.

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

Answers will vary with the census year.

I. ***Answers to Evaluation***

1. d
2. a
3. Corn
4. Answers should include four of the following: United States, China, Canada, Australia, Brazil, and Argentina.
5. Answers should include three of the following: Japan, Mexico, Taiwan, Korea, Middle East.
6. Answers will vary.

UNIT I - OVERVIEW

Name ______________________________

Lesson 2: The Importance of Crops

Date ______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What was the total value of crops sold in Missouri in 1998?

   a. $1-2 million
   b. Under $10 million
   c. $1-2 billion
   d. Over $4 billion

2. What is the total value of crops sold annually in the United States?

   a. Over $90 billion
   b. $25-50 billion
   c. $100 million
   d. Under $100 million

Complete the following short answer questions.

3. What is the largest grain crop produced in the United States?

4. List four countries that are large exporters of crops in the world.

   a.

   b.

   c.

   d.

5. List three countries that import the most crops from the United States.

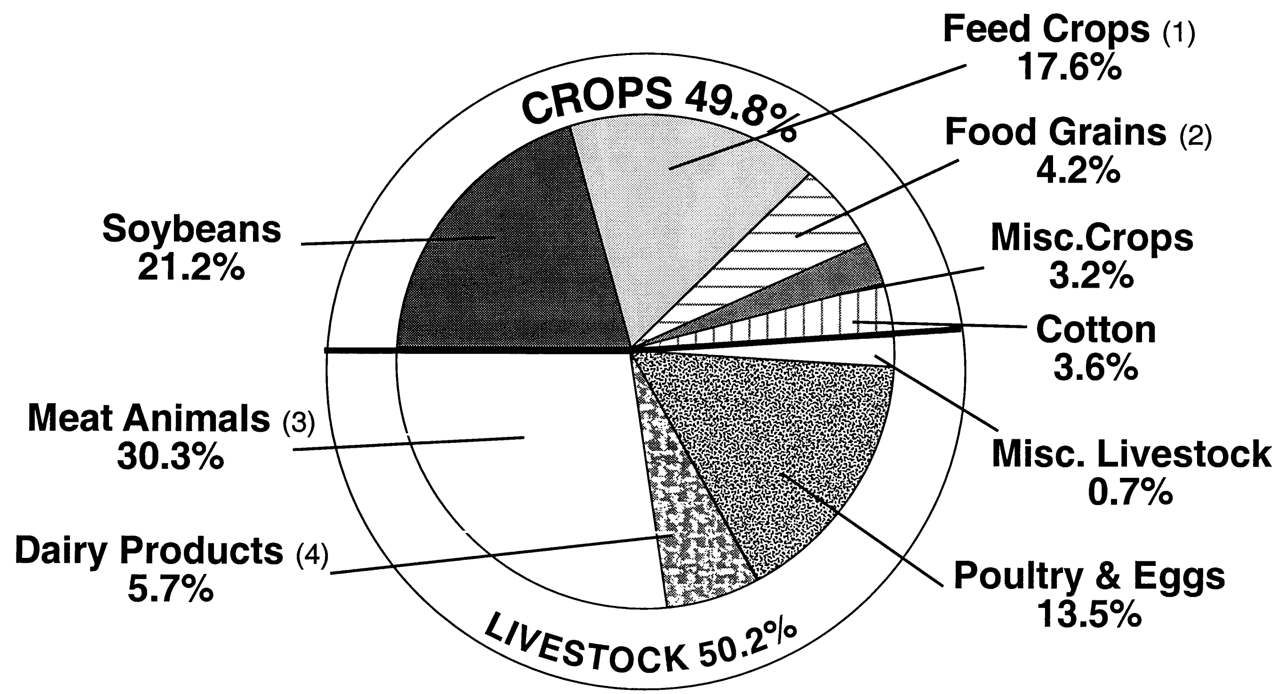
   a.

   b.

   c.

6. Explain how marketing principles affect crop economics.

1998* Missouri Cash Receipts

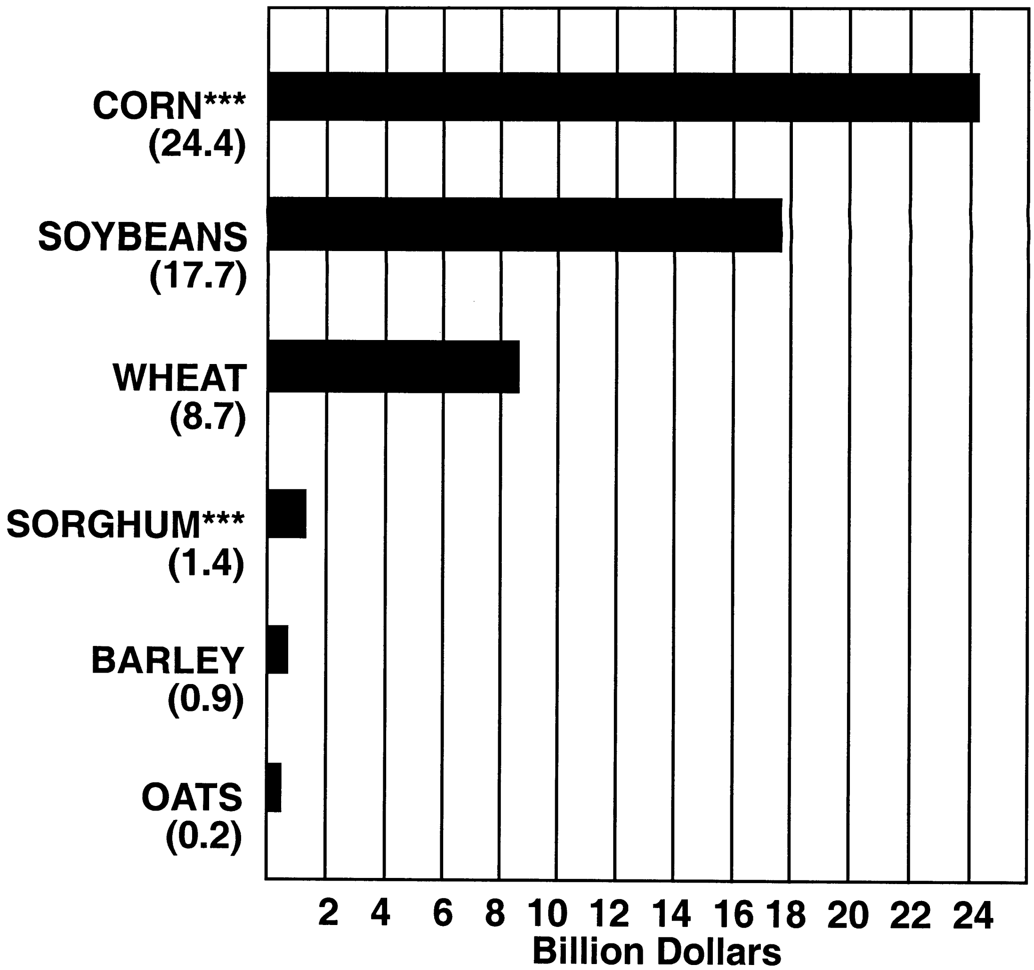


1 - Corn, Hay, Grain Sorghum, and Oats
2 - Wheat and Rice
3 - Cattle, Hogs, and Sheep
4 - Wholesale Milk

*Source: Economic Research, U.S.D.A. preliminary data for 1998

TM 2.2

1998 U.S. Crop Values
(Billion Dollars**)



*Estimate for marketing year ending August 31, 1998.

**All figures calculated by multiplying year-end production by projected average farm price.

***Includes grain production only.

Source: USDA/National Agricultural Statistics Service

Lesson 2: The Importance of Crops Name ___________________________

Missouri Cropland

Objective: Students will determine impact of crop farming in the state of Missouri and in their local county.

Directions: Using the Internet, access the Missouri Agricultural Statistics Service web site at <http://agebb.missouri.edu/mass/moagri.htm>. For the current year listed, complete the following table.

Year: _____________

Commodity	Acres Harvested	Yield	Production
Corn			
Soybeans			
Winter wheat			
Grain sorghum			
Oats			
Rice			
Tobacco			
All potatoes			
Cotton			
All hay			
Potatoes			

From the Missouri Agricultural Statistics Service site <http://agebb.missouri.edu/mass/agrifact/index.htm>, locate your local county on the map. Use the link to “Rank Within Misouri’s 114 Counties” and complete the following table.

Commodity	Rank Within Missouri’s 114 Counties
Corn	
Wheat	
Soybeans	
Sorghum	
Hay	
Tobacco	
Rice	
Cotton	

UNIT I - OVERVIEW

Lesson 3: Careers in Crop Science

Competency/Objective: Identify career opportunities in crop science or crop-related agribusiness.

Study Questions

1. **What career opportunities are there in crop science and crop-related agribusiness?**

2. **What are the educational requirements for careers in crop science and crop-related agribusiness?**

References

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

2. *Think About It* (Brochure) National FFA Organization. Available by phone at 888-332-2668 or on the Internet at <www.ffa.org>.

3. Transparency Master

   a) TM 3.1: Employment Categories

4. Activity Sheet

   a) AS 3.1: Selecting a Crop Science Career

UNIT I - OVERVIEW

Lesson 3: Careers in Crop Science

TEACHING PROCEDURES

A. ***Review***

A career in crop production or any agribusiness-related field is available to students willing to learn and work hard. To be competitive, a producer needs to understand basic math, read detailed manuals, and keep current on computer-based technology. A high school education is a necessity with some jobs requiring college degrees ranging from a bachelor's to a doctorate.

B. ***Motivation***

1. Arrange for a person employed in crop production or a crop-related agribusiness to visit the class. Hold a discussion on the educational qualifications, technical experience, duties, benefits, etc., required for his or her job. Allow time for student questions.

2. Arrange a visit to a college campus to tour the agriculture facilities. Talk to faculty members and students about the programs offered. Collect brochures and other information about the school and programs. The high school guidance counselor can be a good source of information and help with these arrangements.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss possible career opportunities available in crop science and crop-related agribusiness. This lesson breaks career opportunities into six categories with examples in each category. Refer to TM 3.1 to illustrate the various employment categories and the percentage of available jobs. The student reference lists jobs in each category. Also, refer to National FFA publications such as the *Think About It* brochure.

What career opportunities are there in crop science and crop-related agribusiness?

a) Marketing, merchandising, and sales
   1) Work with producers and consumers to provide agricultural products
   2) Employ 32.4%
b) Scientists, engineers, and related professionals
   1) Leading edge of agricultural technology
   2) Employ 28.8%
c) Managers and financial specialists
   1) Business skills, extensive knowledge and understanding of agriculture
   2) Employ 14%
d) Social service professionals
   1) Safeguard the public, assist with individual, community, world needs
   2) Employ 9.7%
e) Education and communications
   1) Sharing news and information about agriculture
   2) Employ 7.6%
f) Production
   1) Require knowledge and development of multiple skills
      (a) Machinery and equipment operation
      (b) Chemical safety

(c) Marketing strategies
2) Employ 7.5%

2. Discuss the importance of education to increase career opportunities in crop science and crop-related agribusiness. Ask the students how the educational levels required now are different from those required in previous generations. Also explain the various levels of postsecondary education (refer to Table 3.1 in Student Reference).

What are the educational requirements for careers in crop science and crop-related agribusiness?

a) Types of education
    1) Informal - learning by observing
        (a) Growing up on a farm
        (b) Working in production agriculture
        (c) Working in an agribusiness environment
    2) Formal - structured learning in a school setting
        (a) High school agriculture courses
        (b) Vocational or technical training
        (c) Course of study to obtain a specific degree at a college or university
b) Levels of education
    1) High school - agriculture courses/diploma
    2) Postsecondary
        (a) Technical school - certificate with course work in specific subject area
        (b) College - associate's, bachelor's, master's, or doctorate degree
            (1) Longer than a certificate program
            (2) General education classes along with specific subject area

F. ***Other Activities***

1. Arrange for students to spend a day with someone in a crop science or crop-related agribusiness occupation. Have students give an oral or written report on the machines used, people they talked to, and the general nature of the work.

2. Have students take the *AgriScience Interest Inventory* to help assess their individual interests. This is not a test but a way to have students think about what they like and jobs they might not have considered before. This is a computer-based questionnaire that is available from Interstate Publishers, Inc., Danville, Illinois.

G. ***Conclusion***

Careers in crop science or crop-related agribusiness are continually increasing in variety and importance. Individuals with on-the-job experience or a college degree in crop science can find a variety of jobs available. If students are interested in working with crops they should also consider what their outside interests and abilities are to find a career both challenging and rewarding.

H. ***Answers to Evaluation***

1. f
2. d
3. e
4. c
5. a
6. f
7. d
8. a
9. b

10. f
11. e
12. b
13. c
14. e
15. An informal education is learning by observing and can be obtained from knowledge acquired growing up on a farm, working in production agriculture, or in an agribusiness environment.
16. A formal education is structured learning in a school setting and includes taking high school agriculture courses, vocational or technical training, or a required course of study to obtain a specific degree at a college or university.

UNIT I - OVERVIEW

Lesson 3: Careers in Crop Science

Name ____________________________

Date ____________________________

EVALUATION

Match the employment category on the right with the job title on the left. Answers will be used more than once.

1. _____ Food Inspector
2. _____ Agricultural Educator
3. _____ Agricultural Credit Analyst
4. _____ Agricultural Chemical Dealer
5. _____ Custom Harvester
6. _____ Cotton Grader
7. _____ Cooperative Extension Agent
8. _____ Greenhouse Manager
9. _____ Water Quality Specialist
10. _____ Federal Grain Inspector
11. _____ Fertilizer Plant Supervisor
12. _____ Entomologist
13. _____ Fruit Distributor
14. _____ Commodity Broker

a. Crop production

b. Scientists, engineers, and related professionals

c. Marketing, merchandising, and sales

d. Education and communication

e. Managers and financial specialists

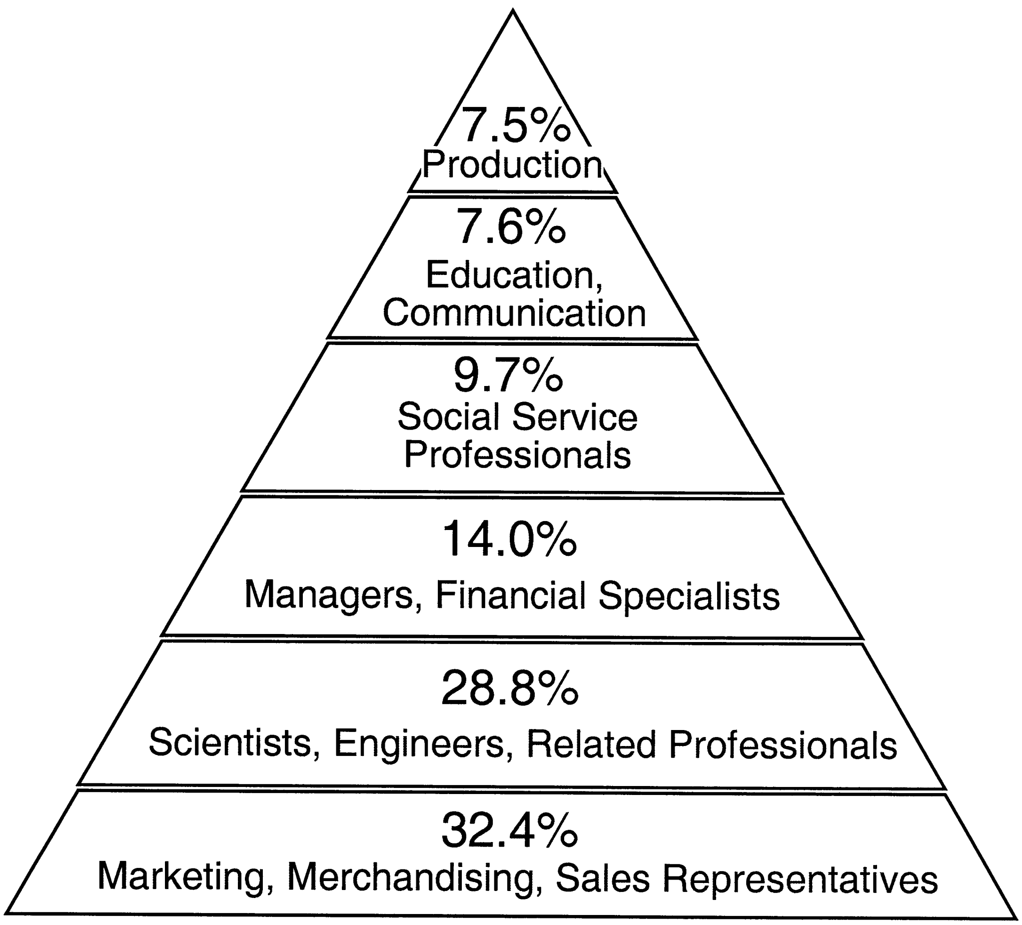
f. Social service professionals

Complete the following short answer questions.

15. What is an informal education?

16. What is a formal education?

Employment Categories



Employment Categories

Source: Higher Education Programs, USDA (1995)

Lesson 3: Careers in Crop Science Name ____________________________

Selecting a Crop Science Career

Objective: Students will be able to learn facts concerning the educational and job skill requirements as well as other employment-related information of the selected career.

Directions: Using the Internet, find the FFA Agriculture Career Center at the web address <www.ffa.org>. Select the path to the interactive quiz under Ag Jobs. Follow the instructions to find out which jobs are best suited to your interests. Write a short report on why you selected this career.

UNIT I - OVERVIEW

Lesson 4: Government Influence and Current Trends

Competency/Objective: Explain government influence and identify current trends in crop production.

Study Questions

1. **How do government programs and trade agreements influence crop production?**

2. **What are current trends in crop production?**

References

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

2. Food and Agricultural Policy Research Institute (FAPRI) <http://www.fapri.iastate/edu/default.htm>

3. Activity Sheet

   a) AS 4.1 The World Trade Organization (WTO)

UNIT I - OVERVIEW

Lesson 4: Government Influence and Current Trends

TEACHING PROCEDURES

A. ***Review***

In previous lessons, we have examined Missouri crops, their economic importance, and careers associated with crop production. This lesson will finalize the overview unit and discuss how government programs influence crop production as well as some of current new technologies that affect producers.

B. ***Motivation***

Make a list of the following acronyms on the board; NAFTA, IPM, GMO, GATT, and CRP and ask students if they can tell you what the letters mean. You might also ask them to describe what impact government farming programs have on crop production.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. The effect of government programs and trade agreements on agricultural production can be very complicated. Students should have a basic understanding of these activities and how they function. Have students complete AS 1.1.

How do government programs and trade agreements influence crop production?

a) GATT (General Agreement on Tariffs and Trade)
    1) Existed from 1948 to 1995
    2) Purpose - minimize tariffs, quotas, and other barriers to international trade
    3) Sponsored eight rounds of trade negotiations
    4) Formation of the WTO (World Trade Organization) that took over GATT's functions
        (a) Stronger powers to enforce agreements
        (b) Authority to issue trade sanctions
        (c) Disciplines imposed on trade barriers and trade-distorting domestic farm policies
b) NAFTA (North American Free Trade Agreement)
    1) Took effect on January 1, 1994
    2) Agreement between Canada, Mexico, and the United States to foster trade and investment
    3) Purpose - eliminate tariffs and nontariff barriers between these three countries
    4) Most goals reached by January 1, 1998
    5) Some tariffs on sugar, dairy, peanuts, and cotton from the United States
    6) Substantial increase in trade and investment between these three countries
c) U.S. farm policy
    1) First organized policy began in 1933 with the Agricultural Adjustment Act.
    2) It was designed to address the farm problems of low prices, surpluses, and low incomes.
    3) It changed over the years but new legislation was introduced in 1996 with the Federal Agricultural Improvement and Reform Act (FAIR).
        (a) This was a major step toward eliminating commodity programs and taking the United States toward an almost fully market-oriented farm policy.

(b) This change has led to farm income being more variable from year to year in response to supply and demand spikes.

d) CRP (Conservation Reserve Program)

1) CRP is a long-term, land retirement program to offset agriculture's adverse effects on the environment.
2) It was established in 1985 to conserve and improve soil, water, and wildlife resources on highly erodible and environmentally sensitive land through 10- and 15-year leases.
3) Renewal of FAIR program gives the authority to sign up 36.4 million acres through 2002.
4) One benefit is to increase market sales of farm commodities by increasing farm prices caused by idling formerly cultivated farmland.
5) It also benefits the private sector through improved water quality and improved wildlife for hunting and fishing.

2. New technologies are greatly changing the face of agriculture. Their impact could be significant. Students and agricultural producers must stay current on these new developments and what they mean to the production of agricultural products.

What are current trends in crop production?

a) Organic foods

1) They were developed to promote healthier foods for humans and to protect the environment.
2) Agricultural producers are encouraged to use methods that neither deplete the soil nor hurt environmental systems or workers.
3) Organic farming helps to promote biological diversity and recycling resources.
   (a) Crop rotation
   (b) Rotational grazing
   (c) Planting of cover crops
   (d) Intercropping
   (e) Animal and plant waste recycling
   (f) Reduced tillage methods
   (g) Adding minerals to crops
4) National Organic Standards Board defined "certified organic" in 1995.
   (a) Labeling term denoting products produced under authority of the Organic Foods Production Act
   (b) Controversy over trying to define organic standards
5) USDA first proposed national standards in 1997.
6) USDA released new standards in March 2000.
   (a) Bar the use of genetic engineering or irradiation of foods
   (b) Prohibit antibiotics in livestock production
   (c) Require use of organic feed
   (d) Carry "USDA Certified Organic" label

b) GMO (genetically modified organisms)

1) GMO has been done for many years with strains of wheat, corn, etc.
2) Today's technology now allows for splitting and inserting genes to make drastic changes in plants.
3) Genetic engineering will help meet the challenges of a growing, hungry population.
4) Genetically engineered plants were germinated on 65 million acres of prime farmland in 1998.
5) Bt corn and herbicide-resistant soybeans have initiated a worldwide debate as to the ethics of this biotechnology.
6) Bt corn develops a toxin that kills worms when they attack the plant.
7) Herbicide-resistant soybeans allow for better weed control.
8) GMOs have the potential to improve proteins, fat, and vitamins in crops and increase resistance to drought, frost, and bacteria in plants.

9) Critics contend the GMOs create the following problems.
   (a) GMO is a vast uncontrolled experiment.
   (b) New seeds will benefit large corporations.
   (c) Organic farmers, the environment, and the consumer will suffer long-term damage.
   (d) Bt corn kills the monarch butterfly.
   (e) Long-term consequences of these technologies for human health and the environment are unknown.

c) Alternative or sustainable agriculture
   1) Producers are looking for different methods of increasing their farm income.
   2) Other sources of agriculture income include the following items.
      (a) Elk
      (b) Bison
      (c) Berries
      (d) Shiitake mushrooms

d) Precision farming
   1) Carefully tailored soil and crop management fit different conditions found in each field.
   2) This is also known as "prescription farming," "site-specific farming," and "variable rate farming."
   3) It makes use of new technologies such as remote sensing, geographic information systems, and global positioning systems
   4) Producers can adjust seeding rates, plan crop protection programs, perform more timely tillage, and determine yield variation within a field.

e) IPM (Integrated Pest Management)
   1) Pests are managed with biological, cultural, physical, and chemical tools to minimize economic, health, and environmental risks.
   2) Pests may include insects, disease, weeds, nematodes, arthropods, and vertebrates.
   3) IPM uses beneficial organisms such as predators, parasites, etc., to suppress pest organisms.
   4) Cultural controls include crop rotation, cultivation, and sanitation to reduce pests.
   5) Physical controls involve barriers, traps, and adjustment of planting location or timing to evade or diminish pest pressure.
   6) To use IPM wisely, producers must spend more time observing and interpreting the impact of pest populations.

F. ***Other Activity***

This would be an excellent time to take a field trip or have a guest speaker (with slides, etc.) to demonstrate alternative farming programs.

G. ***Summary***

With the changes in agricultural production occurring so rapidly, producers must spend more time investigating and studying the new technologies that are being developed if they are going to remain in the business of agricultural production. They must also keep informed of the current agricultural policies of the government to take advantage of those programs that will assist them in maximizing their income.

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

1. Geneva, Switzerland
2. To ensure that trade flows as smoothly, predictably, and freely as possible
3. By negotiating and signing WTO agreements with the world's trading nations. These contracts guarantee important trading rights and bind governments to keep trading policies within agreed limits to everybody's benefits.

4. a. Promotes peace
   b. Handles disputes constructively
   c. Rules make life easier for all
   d. Free trade cuts the cost of living
   e. Provides more choice of products and qualities
   f. Raises incomes
   g. Stimulates economic growth
   h. Makes life more efficient
   i. Shields governments from lobbying
   j. Encourages good government

I. ***Answers to the Evaluation***

1. b
2. b
3. c
4. a. Federal Agricultural Improvement and Reform Act
   b. North America Free Trade Agreement
   c. General Agreement on Tariffs and Trade
   d. Conservation Reserve Program
   e. Genetically Modified Organisms
   f. Integrated Pest Management
   g. World Trade Organization
5. Organic foods, alternative or sustainable agriculture, precision farming, IPM (Integrated Pest Management)
6. Any one of the following: precision farming, prescription farming, or site-specific farming

UNIT I - OVERVIEW Name ________________________

Lesson 4: Government Influence and Current Trends Date ________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. The GATT organization was organized in _____________.

   a. 1933
   b. 1948
   c. 1994
   d. 1996

2. NAFTA is a trade agreement between the United States, _________________, and ______________.

   a. Mexico and Brazil
   b. Mexico and Canada
   c. Canada and Brazil
   d. Argentina and Brazil

3. The FAIR Act was adopted in ________________.

   a. 1994
   b. 1995
   c. 1996
   d. 1998

Complete the following short answer questions.

4. What do the following letters represent?

   a. FAIR -

   b. NAFTA -

   c. GATT -

   d. CRP -

   e. GMO -

   f. IPM -

   g. WTO -

5. List the four current trends in crop production discussed in this lesson.

   a.

   b.

   c.

   d.

6. What is another name for “variable rate farming”?

Lesson 4: Government Influence and Current Trends Name______________________________

The World Trade Organization

Objective: Students will develop an understanding of the WTO and its purpose.

Directions: Using the Internet, research the World Trade Organization (WTO) using the following web site: <http://www.wto.org> and answer the questions below.

1. Where is the headquarters of the WTO?

2. What is the main function of the WTO?

3. How does it accomplish this function?

4. What are the "10 benefits" of the WTO?

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

UNIT II - PLANT BIOLOGY

Lesson 1: Plant Physiology

Competency/Objective: Compare and contrast the parts and functions of monocot and dicot seeds and plants.

Study Questions:

1. **Which of the major crops are monocots and dicots?**
2. **What are the parts and functions of a monocot seed?**
3. **What are the parts and functions of a dicot seed?**
4. **What are the parts and functions of a monocot plant?**
5. **What are the parts and functions of a dicot plant?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit II.
2. *Plant Science* (Instructor Guide). University of Missouri-Columbia: Instructional Materials Laboratory, 1991, Lesson 5.
3. Transparency Masters

    a) TM 1.1: Parts of a Monocot Seed (Corn)
    b) TM 1.2: Parts of a Dicot Seed (Soybean)
    c) TM 1.3: Parts of a Monocot Plant (Grain)
    d) TM 1.4: Parts of a Dicot Plant (Legume)

UNIT II - PLANT BIOLOGY

Lesson 1: Plant Physiology

TEACHING PROCEDURES

A. ***Introduction***

Producers need to know the differences between monocots and dicots to accurately identify the plants and know how to care for them. Differences are easier to learn by comparing the functions of the seed and plant parts of different crops.

B. ***Motivation***

After discussing the first study question, make two lists (one labeled monocots and the other labeled dicots) on the board, a bulletin board, or on a large piece of poster paper. Under each list have students write crops that fall into these two classifications starting with the seven major crops produced in Missouri. Continue to add to the list while working on this unit.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Monocots (monocotyledonous) are plants with one cotyledon, or seed leaf, in each seed. Dicots (dicotyledonous) have two cotyledons per seed and are more complex in structure.

   Which of the major crops are monocots and dicots?

   a) Monocots
      1) Corn
      2) Grain sorghum
      3) Wheat and other small grains
      4) Grass hays
      5) Rice
   b) Dicots
      1) Soybeans
      2) Cotton
      3) Alfalfa
      4) Clover

2. Discuss the major parts and functions of a monocot seed using corn as an example. (Use TM 1.1.)

   What are the parts and functions of a monocot seed?

   a) Parts of a monocot seed
      1) Seed coat
      2) Embryo
         (a) Single cotyledon
         (b) Epicotyl
         (c) Hypocotyl
         (d) Radicle
      3) Endosperm
      4) Seed scar

(a) In corn called tip cap; seed attached to cob
(b) In grain sorghum, wheat, grass hays, and rice the seed located in or attached to inflorescence

b) Functions of monocot seed parts
1) Seed coat - outer covering; serves as protector
(a) Resists water and insects
(b) Maintains seed's viability
(c) In corn called pericarp; in wheat called bran
2) Embryo - miniature plant that sprouts within the seed
(a) Contains all genetics, enzymes, vitamins, and minerals for new plant
(b) Four parts
(1) Cotyledon (scutellum in corn) breaks down starch from endosperm, absorbs it, and moves it to the embryo.
(2) Epicotyl will develop into the first shoot with leaves that emerge from the seed upon germination. It is located above the cotyledon.
(3) Hypocotyl is found below the cotyledon and connected to the radicle. It is the first true stem of the plant.
(4) Radicle develops into the primary root, absorbing water and nutrients for the seed and dying later when permanent roots are formed.
(c) Called germ in wheat plants
3) Endosperm - energy source for germinating seed
(a) Found only in the monocot seedlings
(b) Comprises 75% of seed; 82% in corn seeds
(c) Used as feed for livestock; food for humans
(d) Provide carbohydrates, protein, iron, B-complex vitamins, and other nutrients

3. Discuss the major parts and functions of a dicot seed using the soybean as an example. (Use TM 1.2.)

What are the parts and functions of a dicot seed?

a) Parts of a dicot seed
1) Seed coat
2) Embryo
(a) Epicotyl
(b) Hypocotyl
(c) Radicle
(d) Two cotyledons
3) Seed scar called hilum

b) Functions of dicot seed parts
1) Seed coat is the outer covering (same as in monocots).
2) Embryo serves as new growing seedling.
(a) Epicotyl
(1) The growing end of main plant stem
(2) Attached to hypocotyl on one end and two embryonic leaves at the other
(b) Hypocotyl
(1) Becomes the main plant stem
(2) Lifts cotyledons out of soil for new seed leaves to emerge
(c) Radicle becomes the new primary root below the surface.
(d) Cotyledons
(1) Protect the epicotyle
(2) Provide food for sprouting plant
(3) Fleshy in form
(4) High in protein and oil

4. All plant parts are essential because each has a specific function to aid in the growth, maintenance, or reproduction of the plant. Discuss the major parts and functions of a monocot plant using a grain as an example. (Use TM 1.3.)

What are the parts and functions of a monocot plant?

a) Parts of a monocot plant
    1) Inflorescence, or head
    2) Leaf blade
    3) Node
    4) Internode
    5) Leaf sheath
    6) Tiller
    7) Roots
b) Functions of monocot plant parts
    1) Inflorescence (floral portion) - reproduction
    2) Leaf blade
        (a) Manufactures food by photosynthesis
        (b) Conducts respiration, transpiration, and food storage
    3) Node - attachment point of leaf to stem
    4) Internode - stem section between nodes
        (a) Supports plant
        (b) Transports and stores nutrients
    5) Leaf sheath - base of leaf that wraps around the stem
        (a) Supports and stabilizes stem
        (b) Protects leaf axil (stem attachment at base)
    6) Tiller - secondary stem
        (a) New shoot from primary plant
        (b) Grows and reproduces by itself
        (c) Example of how monocots multiply, specifically in rice and wheat
    7) Roots
        (a) Supports plant
        (b) Stores food
        (c) Absorbs nutrients

5. Discuss the major parts and functions of a dicot plant using a legume as an example. (Use TM 1.4.) Note: Point out the nodules on the legume plant as shown on the transparency. The importance and function of this plant part will be discussed in the next lesson under the topic of essential plant nutrients.

What are the parts and functions of a dicot plant?

a) Parts of a dicot plant
    1) Terminal bud
    2) Leaf
    3) Petiole
    4) Node
    5) Internode
    6) Axillary bud
    7) Hypocotyl
    8) Branch, or lateral roots
    9) Primary, or taproot
    10) Root hairs
b) Functions of a dicot plant parts
    1) Terminal bud
        (a) Growth point in the plant
        (b) Apical meristem tissues - increase length of plant

2) Leaf
   (a) Manufactures food by photosynthesis
   (b) Conducts respiration and transpiration
   (c) Stores food (sometimes)
3) Petiole - stalk of the leaf
   (a) Attaches leaves to plant stems at nodes
   (b) Provides support to leaves
   (c) Transports nutrients
4) Node - attachment point of petiole stem; supports petiole
5) Internode - stem sections between nodes
   (a) Supports aboveground plant
   (b) Transports and stores nutrients
6) Axillary bud
   (a) New developing leaf sections
   (b) Site of new node
7) Hypocotyl (stem between roots and first node)
   (a) Lifts plant out of soil
   (b) Base of the stem
8) Branch, or lateral roots - roots branching from taproot
   (a) Provides support
   (b) Absorbs nutrients
9) Taproot (primary root)
   (a) Main anchor for plant
   (b) Food storage
10) Root hairs
   (a) Common on branch and taproots
   (b) Increases plant absorption area

F. ***Other Activities***

1. Teachers may want to review the germination process of a monocot and dicot seed with students. To do this, use TMs 5.3 and 5.4 from the Instructor Guide of the IML *Plant Science* curriculum.

2. Have seeds and plants available for the students to identify and label the parts.

G. ***Conclusion***

Seeds and plants have different parts needed for different functions. Monocot and dicot seeds have similar parts, but functions are more complex in dicots. Every part of a plant has a use whether for reproduction, support, or absorbing nutrients. Although monocot and dicot plants are different, they share basic characteristics such as leaves, stems, and roots.

H. ***Answers to Evaluation***

1. Seed coat
2. Endosperm
3. Cotyledon
4. Embryo
5. Epicotyl
6. Hypocotyl
7. Radicle
8. Seed scar
9. Seed coat
10. Epicotyl
11. Hypocotyl
12. Radicle
13. Embryo
14. Cotyledons
15. Seed scar
16. Leaf blades
17. Leaf Sheath
18. Tiller
19. Roots
20. Internode
21. Node
22. Inflorescence
23. Internode
24. Petiole
25. Taproot
26. Branch roots
27. Hypocotyl
28. Node
29. Leaves
30. Terminal bud
31. Axillary bud
32. Nodules (bonus)

UNIT II - PLANT BIOLOGY

Name ______________________________

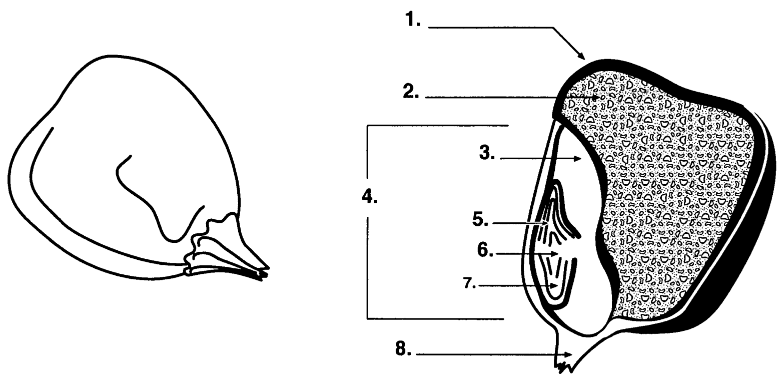
Lesson 1: Plant Physiology

Date ______________________________

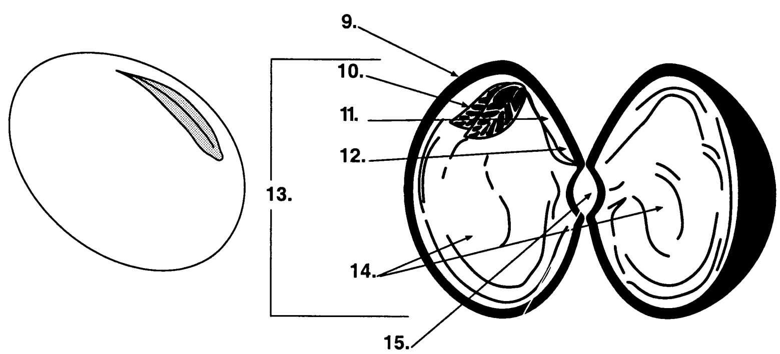
EVALUATION

Write the name of the seed or plant part in the blank with the corresponding number.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________



9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________



15. ____________________

16. ____________________

17. ____________________

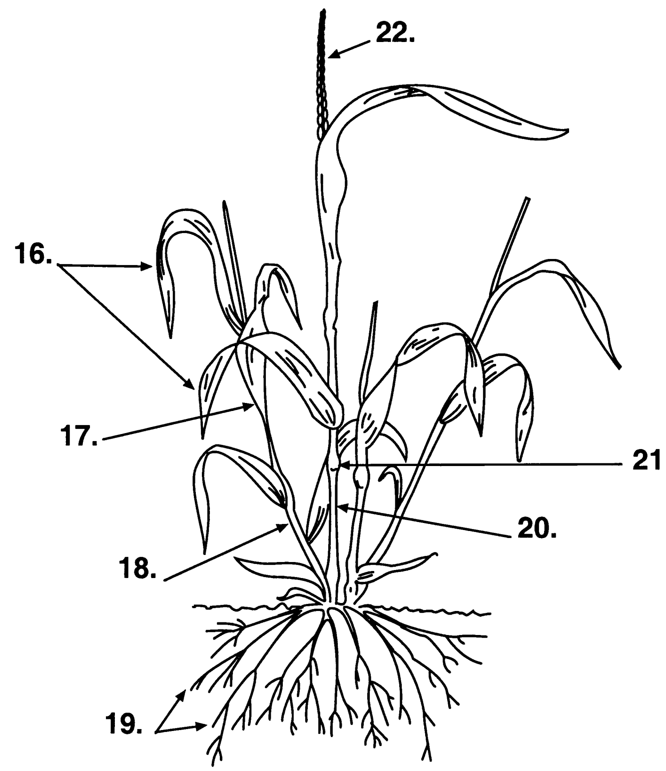
18. ____________________

19. ____________________

20. ____________________

21. ____________________

22. ____________________



23. ____________________

24. ____________________

25. ____________________

26. ____________________

27. ____________________

28. ____________________

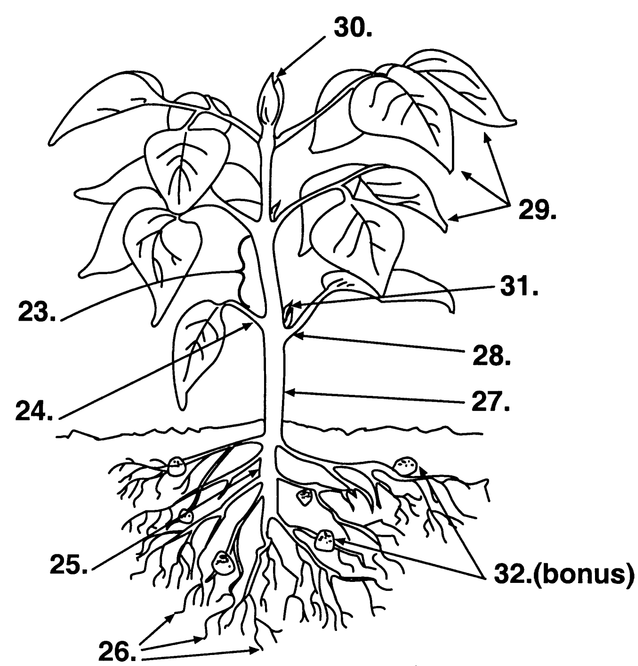
29. ____________________

30. ____________________

31. ____________________

(Bonus)

32. ____________________



Word Bank for Questions 1-8

Cotyledon
Embryo
Endosperm
Epicotyl
Hypocotyl
Radicle
Seed coat
Seed scar

Word Bank for Questions 9-14

Cotyledons
Embryo
Epicotyl
Hypocotyl
Radicle
Seed coat

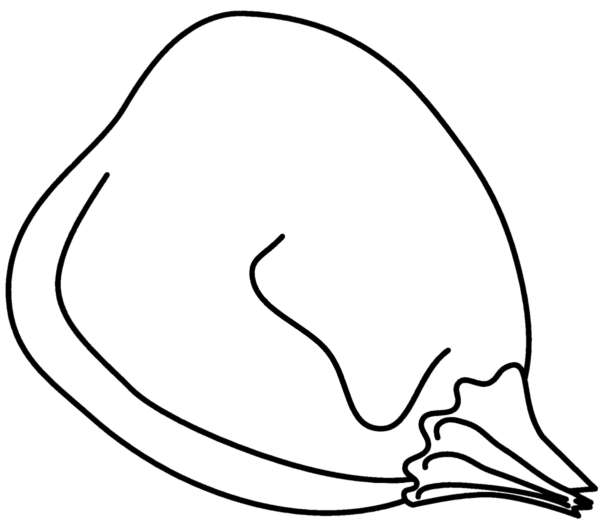
Word Bank for Questions 15-22

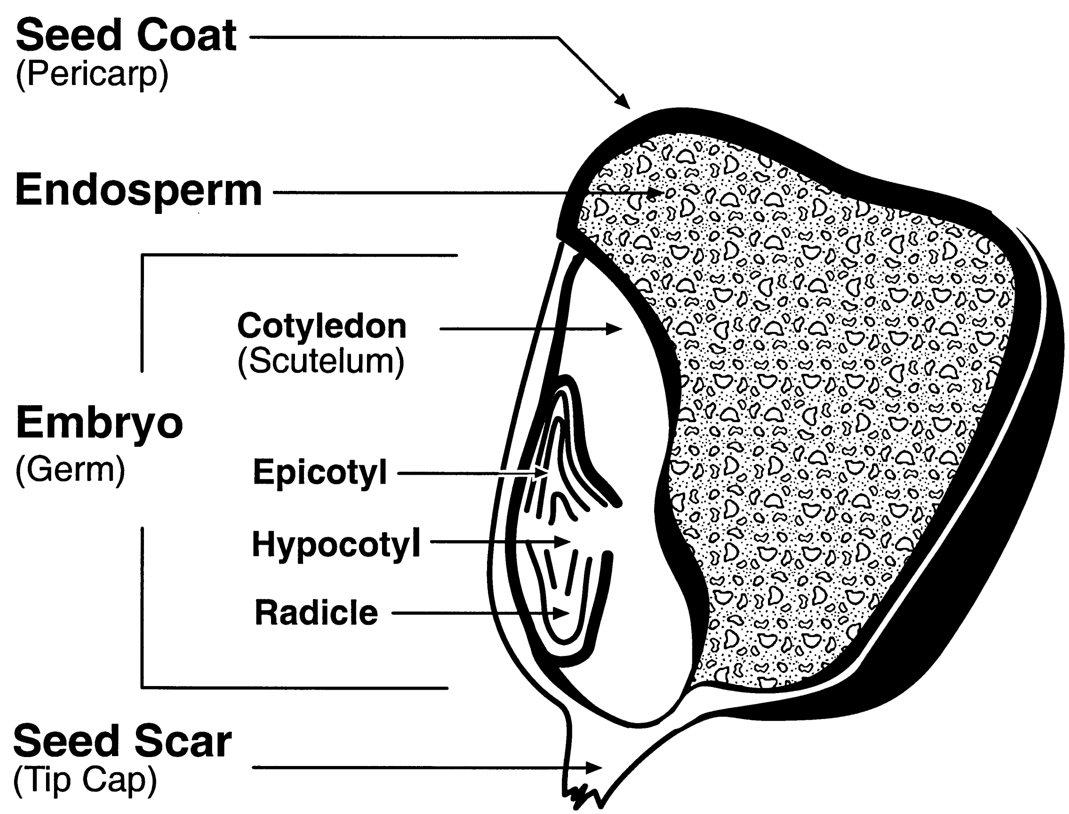
Inflorescence
Internode
Leaf blades
Leaf sheath
Node
Roots
Seed scar
Tiller

Word Bank for Questions 23-32

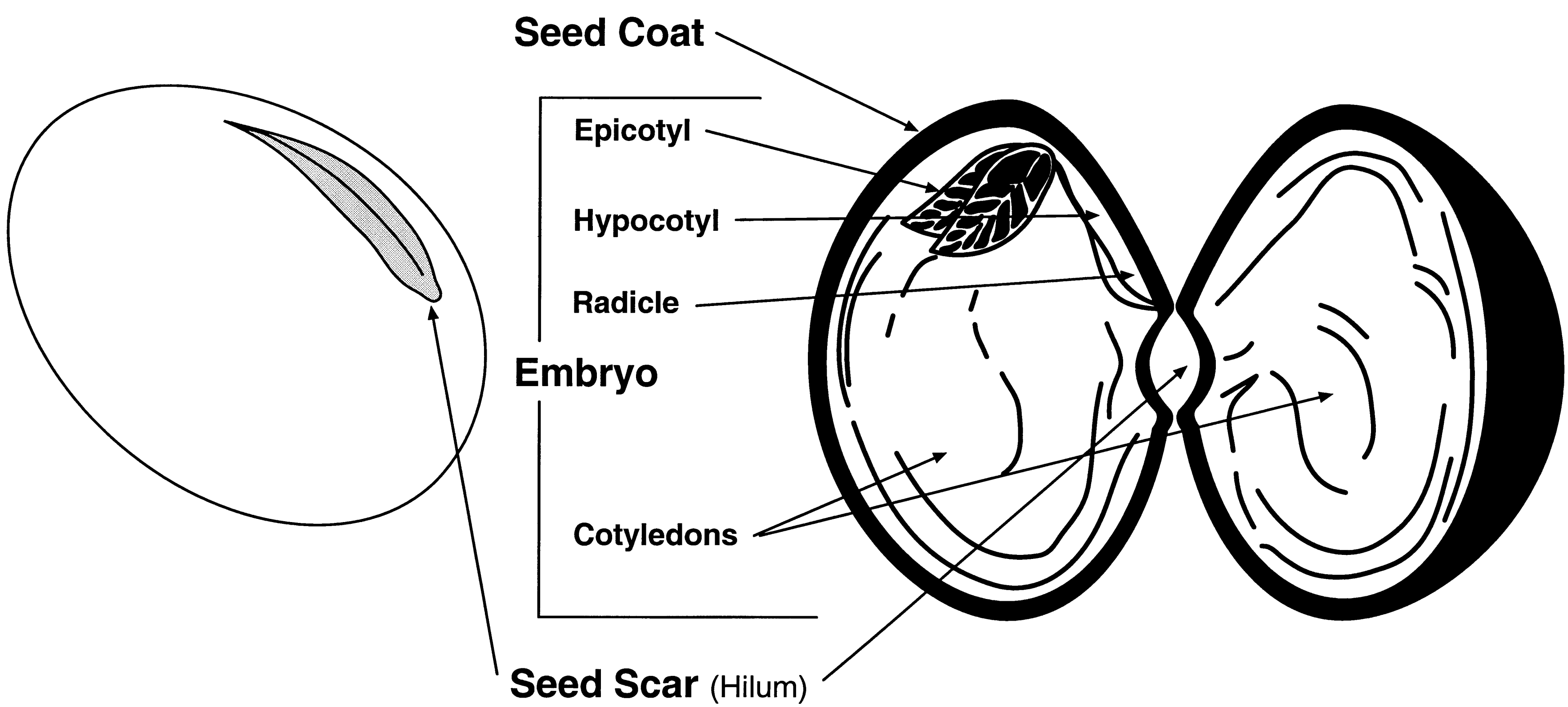
Axillary bud
Branch roots
Hypocotyl
Internode
Leaves
Node
Nodules
Petiole
Taproot
Terminal bud

Parts of a Monocot Seed (Corn)

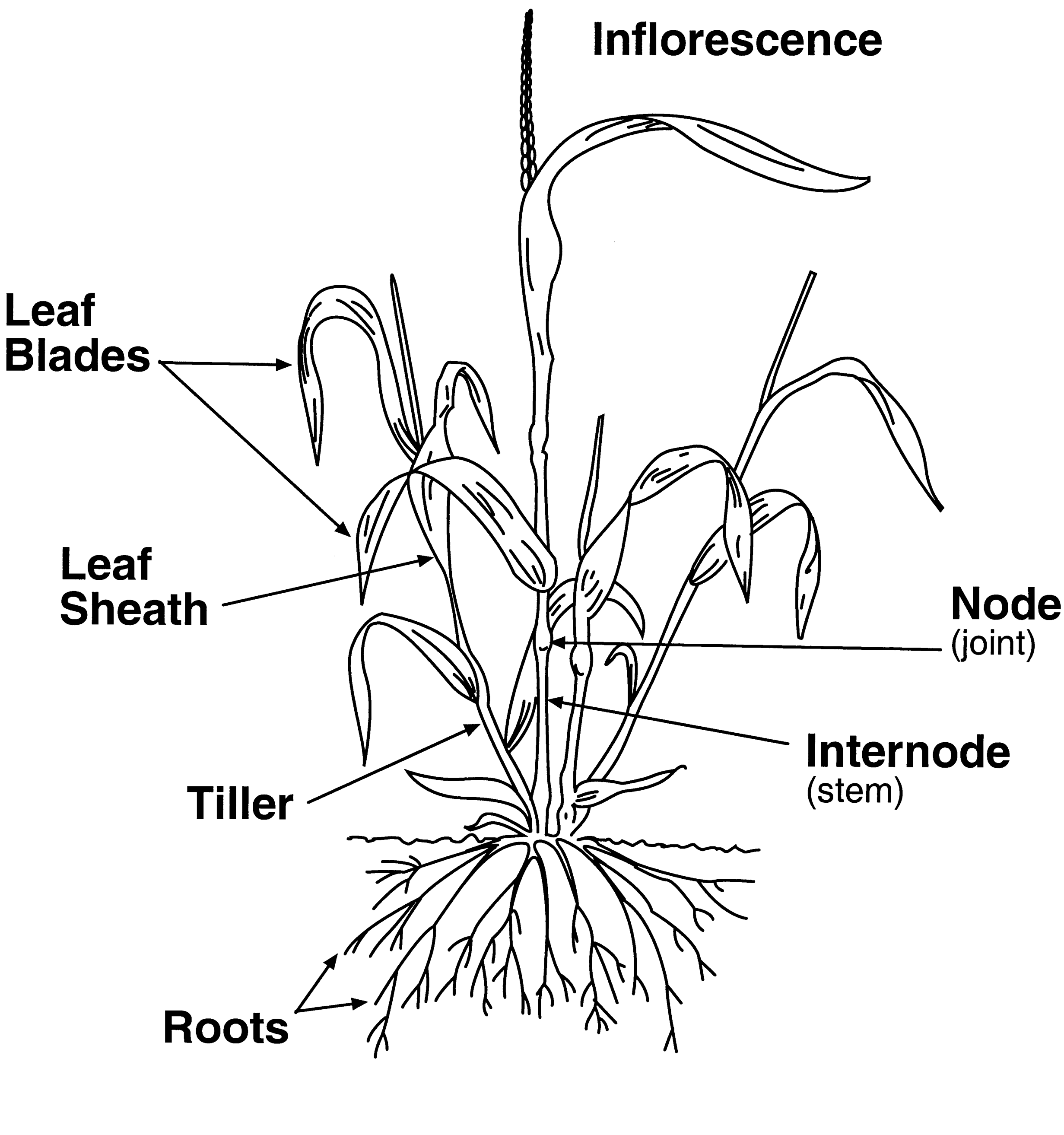




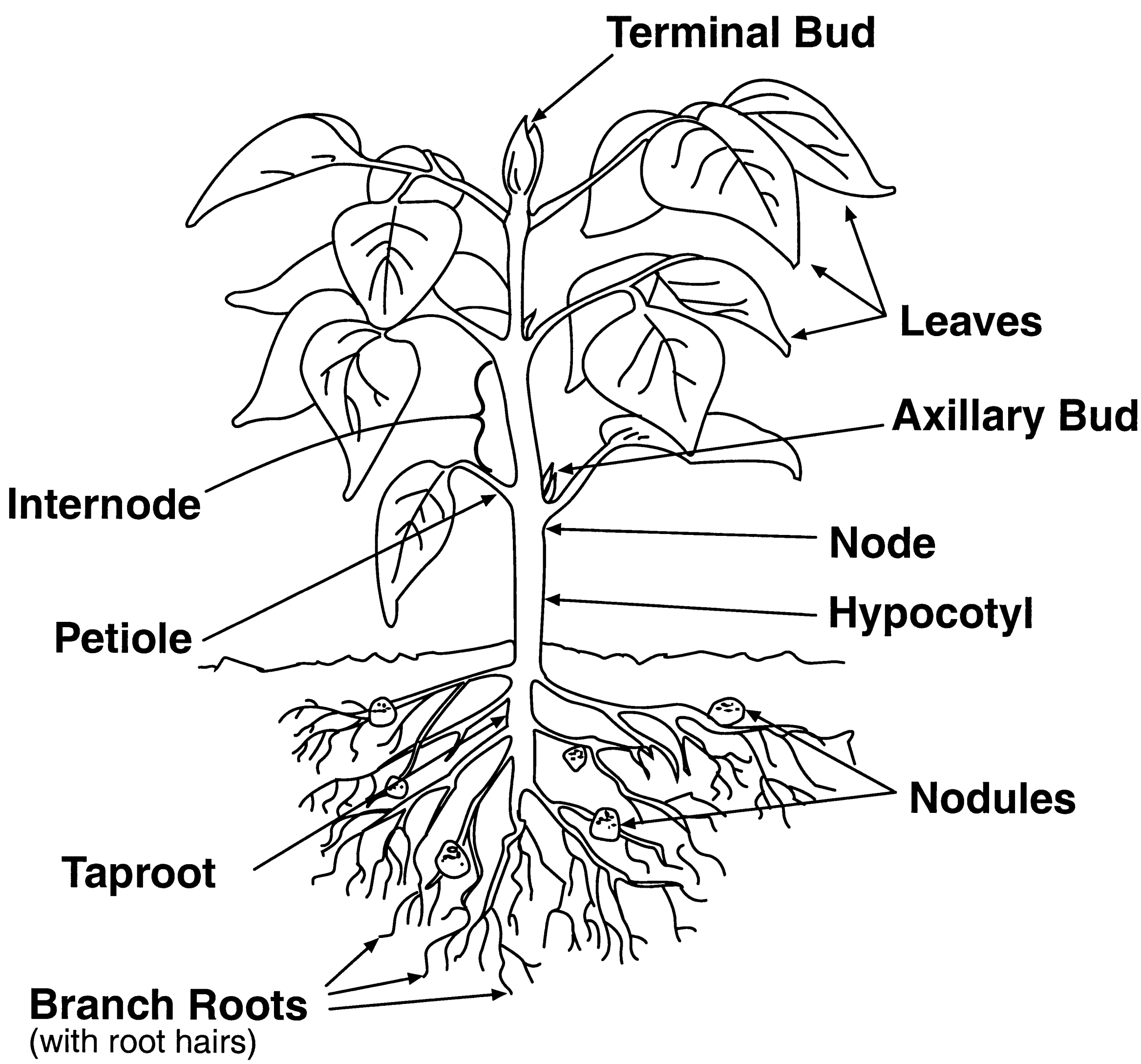
Parts of a Dicot Seed
(Soybean)



Parts of a Monocot Plant (Grain)



Parts of a Dicot Plant (Legume)



UNIT II - PLANT BIOLOGY

Lesson 2: Plant Growth and Nutrient Needs

Competency/Objective: Describe how growth stages affect crop management practices.

Study Questions

1. **What are the plant growth stages?**
2. **What is the life cycle of a plant?**
3. **What are the essential plant nutrients?**
4. **What management practices are associated with key plant growth stages?**

References

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

2. Transparency Masters

   a) TM 2.1: The Growth Stages of Corn
   b) TM 2.2: The Growth Stages of Soybeans
   c) TM 2.3: Feekes' Scale of Wheat Development
   d) TM 2.4: The Growth Stages of Grain Sorghum
   e) TM 2.5: The Growth Stages of Alfalfa
   f) TM 2.6: The Growth Stages of Cotton
   g) TM 2.7: The Growth Stages of Rice

3. Activity Sheet

   a) AS 2.1: Remembering Nutrients

UNIT II - PLANT BIOLOGY

Lesson 2: Plant Growth and Nutrient Needs

TEACHING PROCEDURES

A. ***Review***

Although plants have similar growth stages, it is important for producers to understand the differences among individual crops so they can implement the best management practices. Understanding plant life cycles and growth stages is key to successful crop production.

B. ***Motivation***

Present various crop specimens in different growth stages. Question students about the growth stages of the plant. Ask about the longevity of each specimen.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the four main growth stages of crops. Using the transparencies provided for each major crop, highlight the differences in the names of stages or the number of stages. Discuss with the students the growth stage differences between Missouri's most important crops.

   What are the plant growth stages?

   a) Germination: embryo in the seed develops into a new plant.
   b) Vegetative: plant grows by extending the stem and adding leaves.
   c) Reproductive: flowers are produced and new seeds are formed.
   d) Maturity: plants ripen, lose green pigment, and dry down.

2. A plant's life cycle is classified by the length of time required for the plant to complete its growth stages. Discuss the three major life cycles of plants. Give examples of different crops classified in each life cycle.

   What is the life cycle of a plant?

   a) Annuals - crops planted or harvested during a 1-year period or less
      1) Summer annuals - crops planted in spring or summer and harvested in the fall of the same year
         (a) Corn
         (b) Grain sorghum
         (c) Soybeans
         (d) Rice
      2) Winter annuals - crops planted in the fall and harvested the following summer
         (a) Winter wheat
         (b) Winter oats
         (c) Winter barley
         (d) Winter rye
   b) Biennials - crops completing their life cycle in the second year after planting
      1) Include very few field crops
      2) Sweet clover
      3) Common in vegetable crop seed production

c) Perennials - crops or plants remain alive 3 or more years after planting
   1) Maintained by crop's ability to reseed or spread by vegetative reproduction
   2) Life expectancy limited by weed pressure, disease, grazing intensity, and competitive species
   3) Forage crops such as fescue, alfalfa, and lespedeza

3. There are 17 elements considered essential for plant growth and development. Nine are referred to as macronutrients; eight are considered micronutrients. Explain the importance of understanding the elements needed for plant growth to correct nutrient imbalances with soil additivies.

What are the essential plant nutrients?

a) Macronutrients
   1) Supplied by water and air
      (a) Carbon (C)
      (b) Hydrogen (H)
      (c) Oxygen (O)
   2) Available in the soil
      (a) Primary
         (1) Nitrogen (N)
         (2) Phosphorus (P)
         (3) Potassium (K)
      (b) Secondary
         (1) Calcium (Ca)
         (2) Magnesium (Mg)
         (3) Sulfur (S)
b) Micronutrients - found in soil solids and chemicals
   1) Iron
   2) Zinc
   3) Chlorine
   4) Molybdenum
   5) Manganese
   6) Copper
   7) Boron
   8) Cobalt

4. Discuss the importance of knowing growth stages of crops. The application of fertilizers, herbicides, and other crop-improving management practices requires timed sequencing along with specific growth stages, for example, postemergence vs. preemergence herbicides.

What management practices are associated with key plant growth stages?

a) Nutrient management
   1) Test soil to determine nutrient content.
   2) Apply nutrients prior to planting, as necessary.
   3) Starter fertilizers and seed are placed in the ground and supply some nutrients.
   4) Some fertilizers are applied after emergence.
      (a) Applied by side dressing on soil surface
      (b) Applied by foliar fertilization through the plant's foliage
         (1) Supplemental method of feeding plant through root system
         (2) Not a practical method for large amount of nutrients
            1) Expensive to apply
            2) Severe burning of crop
   5) Amount applied and nutrients needed will vary.
      (a) Depending on the specific crop
      (b) Available nutrients in soil

(c) Soil moisture
(d) Method of application

b) Replanting
   1) Do not make a hasty decision regarding replanting.
   2) Determine the cause first.
   3) Consider the following.
      (a) Original planting date and desired plant stand
      (b) Earliest possible replanting date that may be used
      (c) Economic cost of seed and pest control measures

c) Moisture management through irrigation
   1) Ability to irrigate determined by topography of land
   2) Water source availability
   3) Capital required

d) Pest management
   1) Weed management
      (a) Mechanical methods - hand pulling, hoeing, burning, mowing, smothering with plastic mulch
      (b) Cultural methods - crop rotation, crop competition, weed-free crop seed
      (c) Biological control - natural enemies for weeds
      (d) Chemical control - herbicides
   2) Disease management
      (a) Affected at any stage of growth
         (1) Biotic (living) agents - fungi, bacteria, viruses, nematodes, parasitic plants
         (2) Abiotic (nonliving) agents - weather, water or temperature stress, combination of factors
      (b) Attack at seed level with inoculants
      (c) Early growth stages - chemical, cultural, or biological control
   3) Insect management
      (a) Physical control - direct removal by controlling light, temperature, or traps
      (b) Cultural control - crop rotations, soil tilling, resistant varieties, removal of host vegetation
      (c) Biological control - use of other insects or pathogens
      (d) Chemical control - use of liquids, gases, powders, or granules

F. ***Other Activity***

Visit a greenhouse or botanical garden to observe various stages of plant growth.

G. ***Conclusion***

Nutrients assist in the production of healthy crops. Without the 17 essential nutrients, crops would be unable to grow and produce properly. Whenever possible, producers should take advantage of the various advances available in pesticides and fertilizers.

H. ***Answers to Evaluation***

1. c
2. d
3. b
4. a
5. a
6. a
7. c
8. a
9. a
10. b

11. a
12. c
13. c
14. a
15. Carbon, hydrogen, oxygen
16. Calcium, magnesium, sulfer
17. Nitrogen, phosphorus, potassium
18. Boron, chlorine, cobalt, copper, iron, manganese, molybdenum, zinc
19. Nutrient managment, repopulation or replanting, moisture management with irrigation, and pest management
20. Original planting date and desired plant stand; earliest possible replanting date that may be used; cost of seed and pest control measures economically justified

UNIT II - PLANT BIOLOGY — Name ______________________________

Lesson 2: Plant Growth and Nutrient Needs — Date ______________________________

EVALUATION

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

1. _____Embryo develops into a new plant.
2. _____Stems lose green pigment and turn brown.
3. _____Seed formation occurs
4. _____Stem extends and leaves multiply.

a. Vegetative
b. Reproductive
c. Germination
d. Ripening

Match the crop in the left column to the plant cycle in the right column.

5. _____ Corn
6. _____ Soybeans
7. _____ Fescue
8. _____ Wheat
9. _____ Grain sorghum
10. _____ Sweet clover
11. _____ Rice
12. _____ Grass
13. _____ Alfalfa
14. _____ Cotton

a. Annual
b. Biennial
c. Perennial

Complete the following short answer questions.

15. What are the three most basic mineral elements found in all life-forms?

    a.

    b.

    c.

16. List three secondary macronutrients.

    a.

    b.

    c.

17. What are the three primary macronutrients needed by plants?

    a.

    b.

    c.

18. List the eight micronutrients.

    a.

    b.

    c.

    d.

    e.

    f.

    g.

    h.

19. List the four management practices that need to be considered during the growth of the plant.

    a.

    b.

    c.

    d.

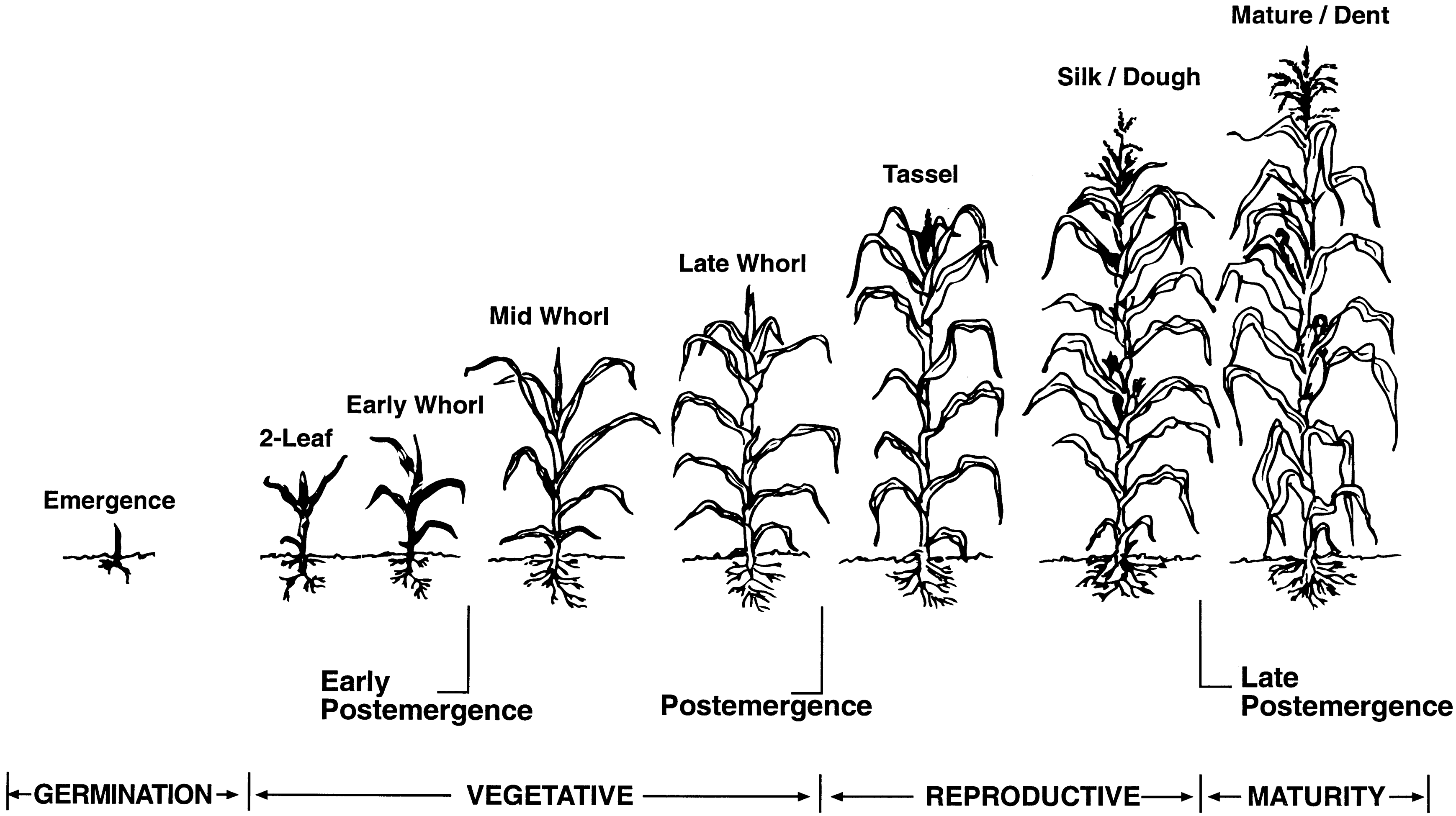
20. List three concerns of growers when deciding whether to replant a crop.

    a.

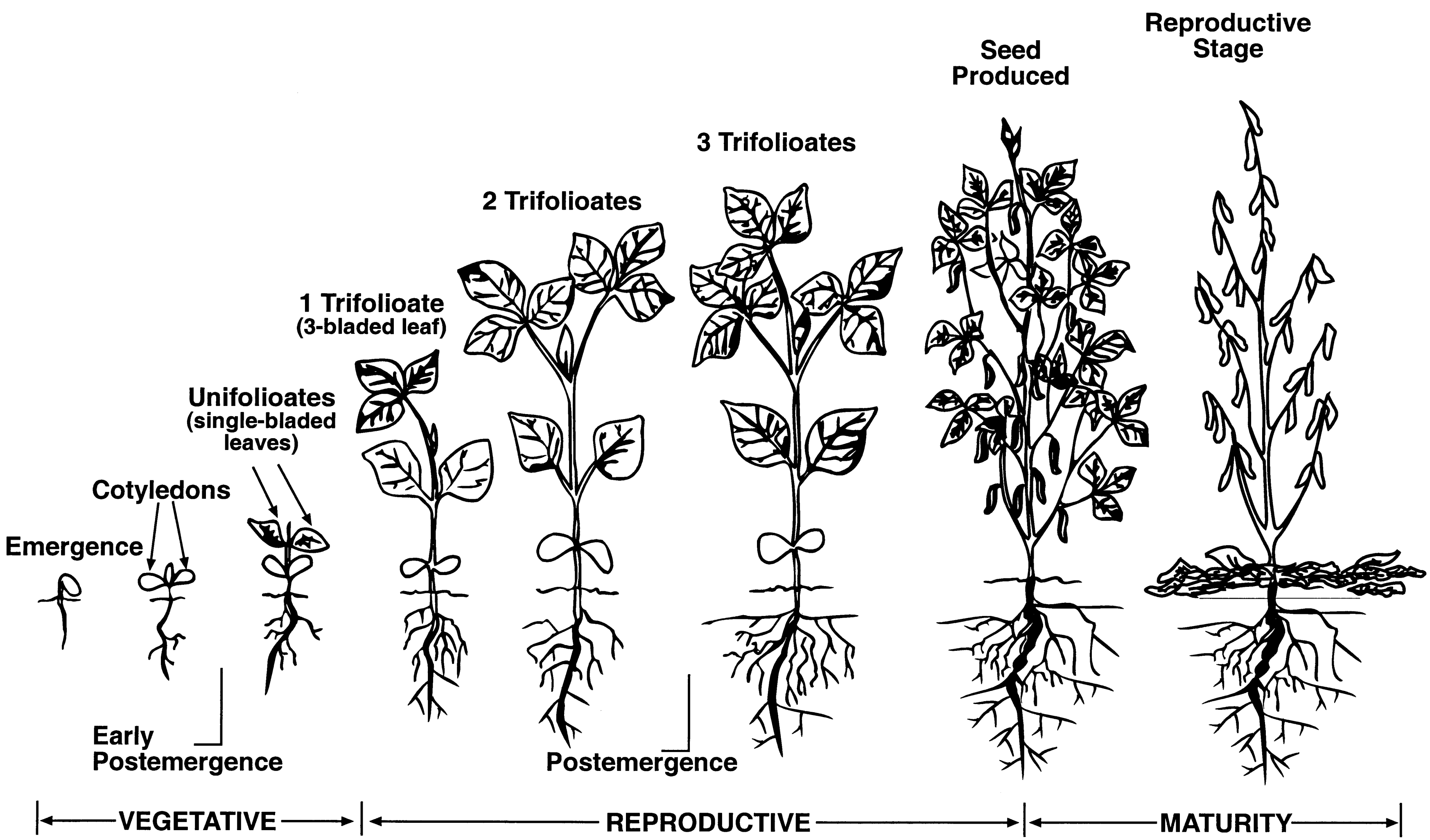
    b.

    c.

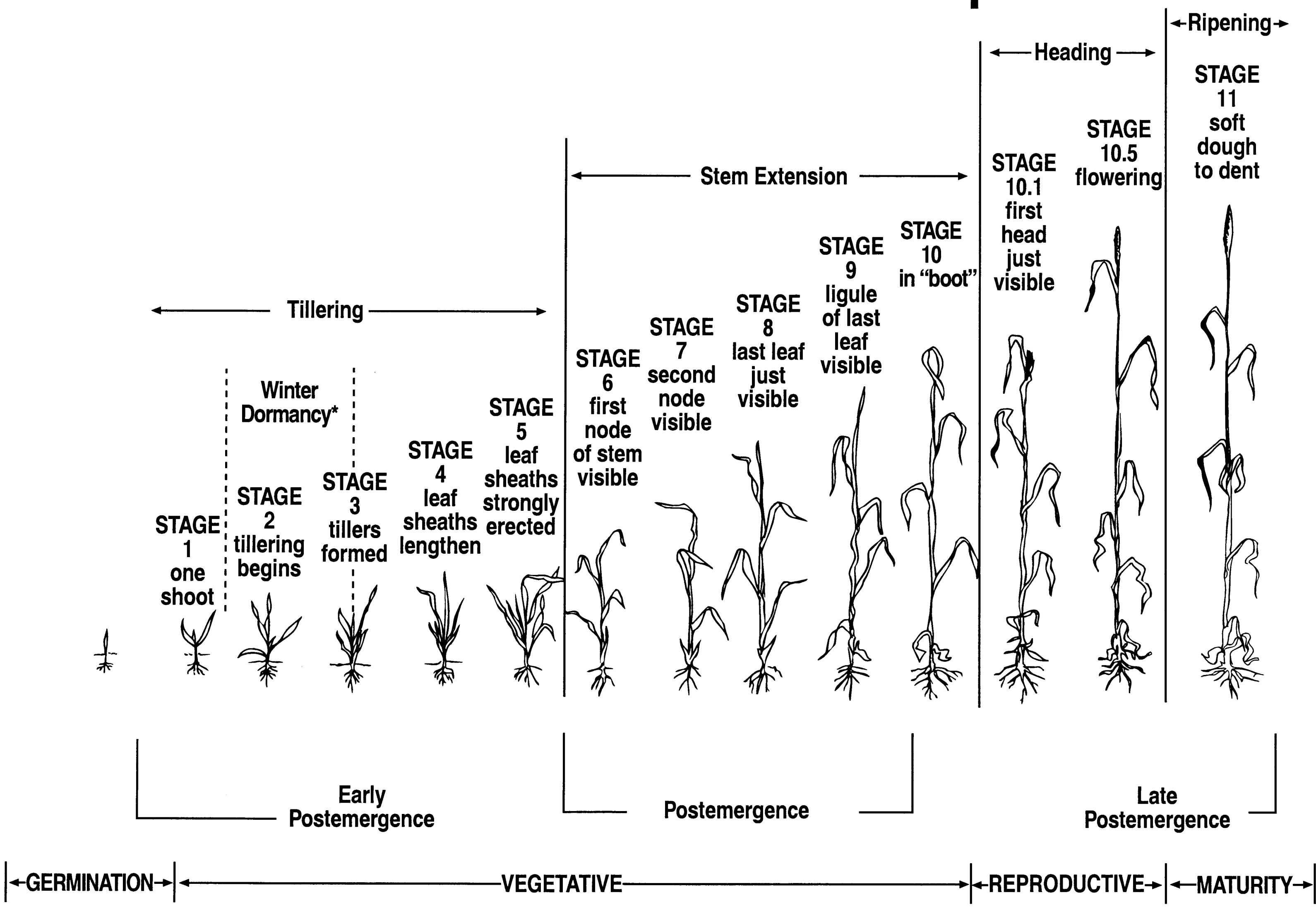
Growth Stages of Corn



Growth Stages of Soybeans

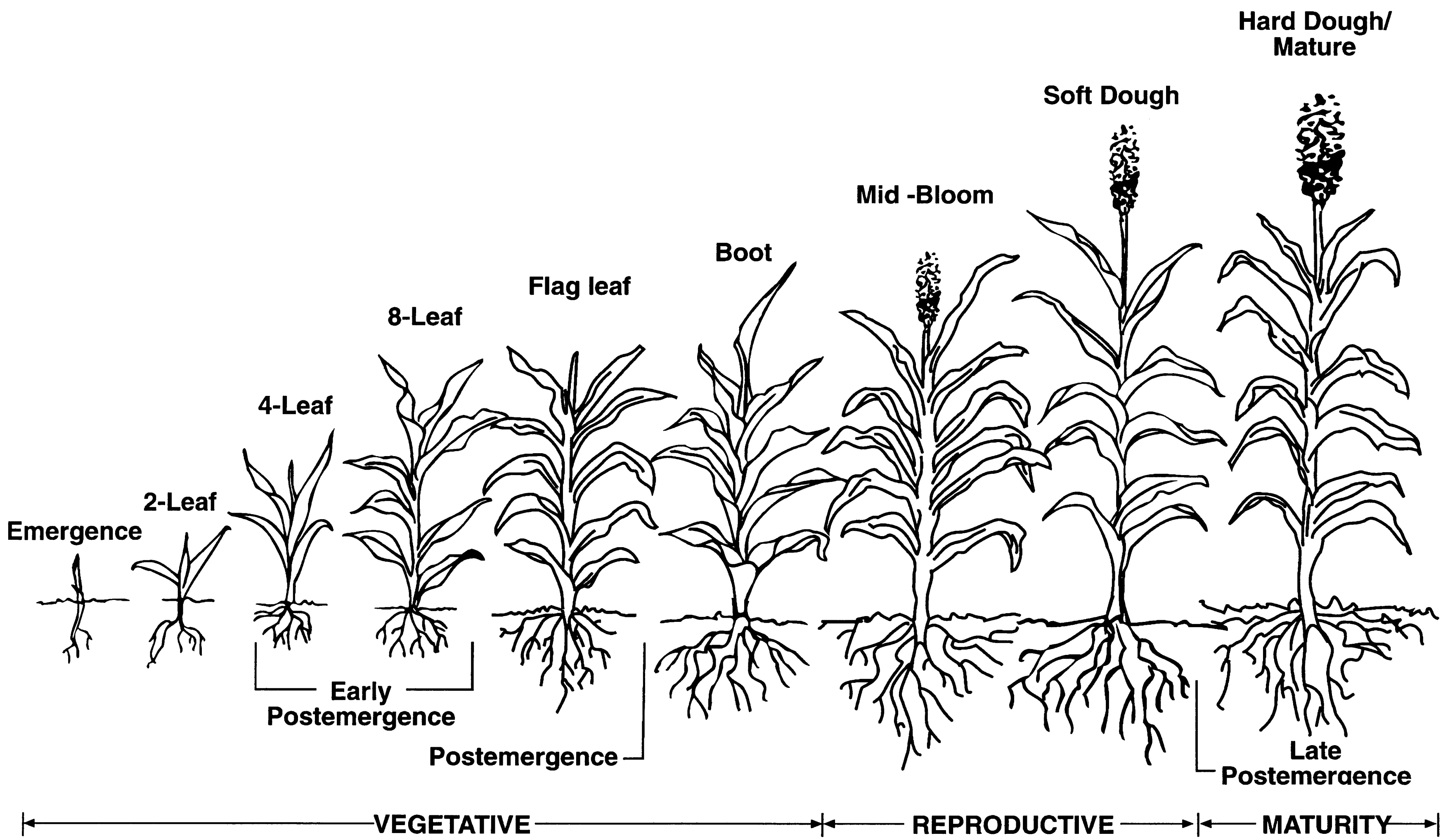


Feekes' Scale of Wheat Development

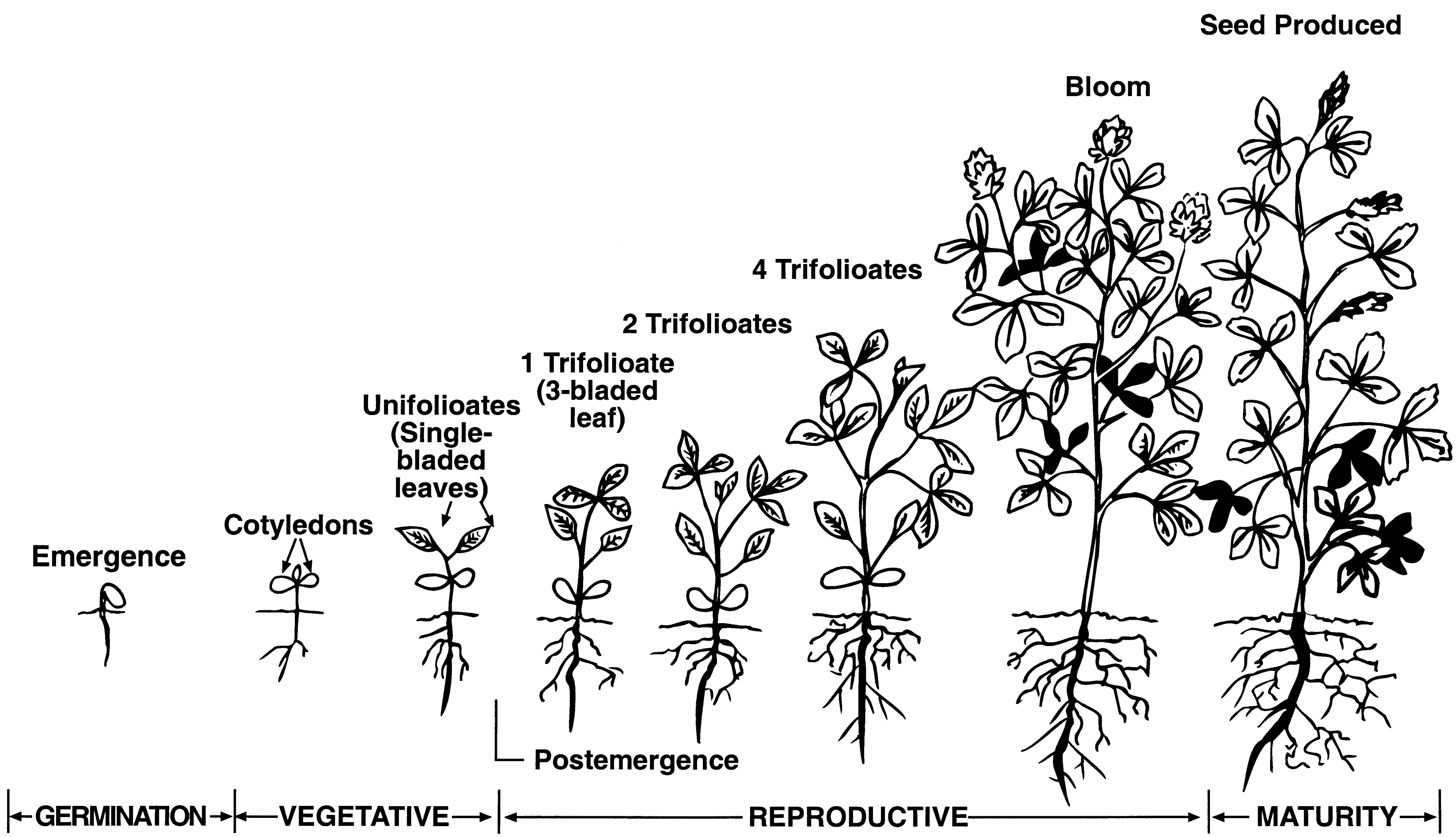


** Usual dormancy occurrence within this range, depending on weather.*

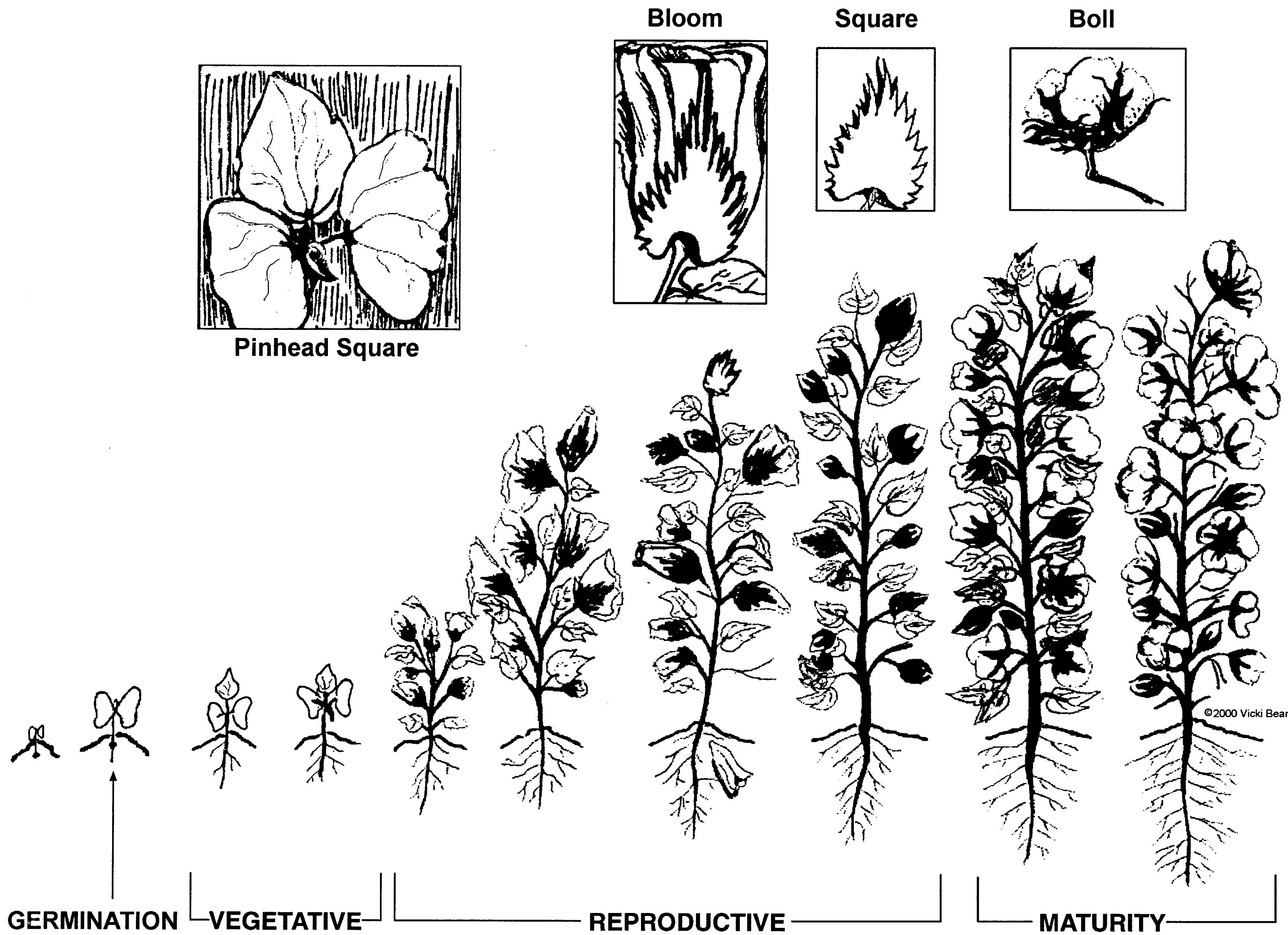
Growth Stages of Grain Sorghum



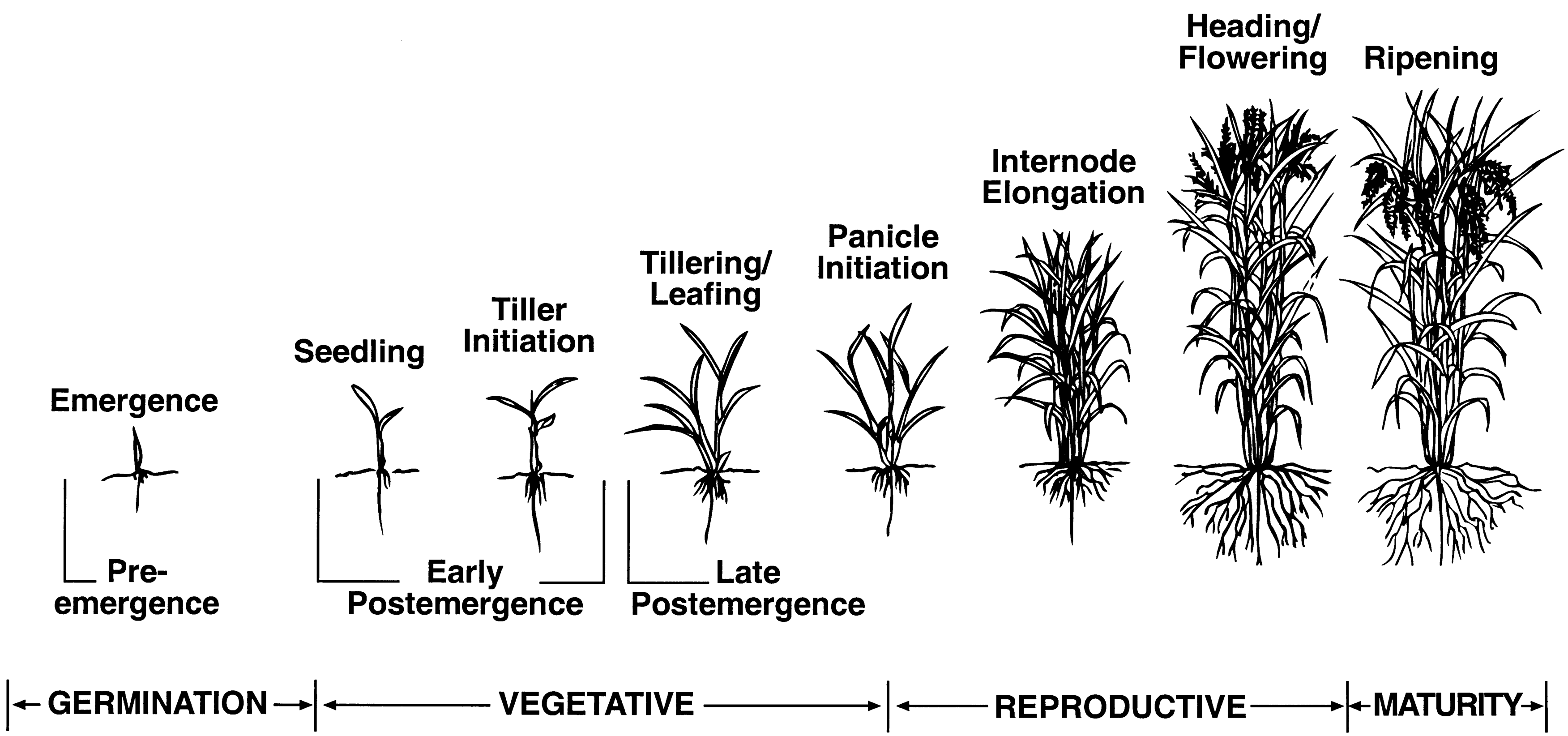
Growth Stages of Alfalfa



Growth Stages of Cotton



Growth Stages of Rice



Lesson 2: Plant Growth and Nutrient Needs Name ______________________

Remembering Nutrients

Objective: To develop a method of remembering the names of the macronutrients and micronutrients that are important in plant growth.

Directions: List the macronutrients and micronutrients below and make a sentence with words using the first letter of each nutrient to help you remember the nutrient names. The list of nutrients can be in any order to help compose your sentence.

		Word Sentences
Macronutrients:	1. ______________	______________
	2. ______________	______________
	3. ______________	______________
	4. ______________	______________
	5. ______________	______________
	6. ______________	______________
	7. ______________	______________
	8. ______________	______________
	9. ______________	______________
Micronutrients:	1. ______________	______________
	2. ______________	______________
	3. ______________	______________
	4. ______________	______________
	5. ______________	______________
	6. ______________	______________
	7. ______________	______________
	8. ______________	______________

Write each sentence below.

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 1: Soil Composition

Competency/Objective: Identify how the composition of soil affects fertility.

Study Questions

1. **What are the components of soil?**

2. **How does soil texture affect water-holding capacity and fertility?**

3. **How does soil pH affect nutrient utilization?**

References

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

2. Minor, Paul E. *Soil Science* (Student Guide). University of Missouri-Columbia: Instructional Materials Laboratory, 1995.

3. Transparency Masters

   a) TM 1.1: Contents of Average Soil
   b) TM 1.2: Pore Spaces in Soil
   c) TM 1.3: USDA Soil Textural Triangle
   d) TM 1.4: Soil pH Governs Nutrient Release

4. Activity Sheet

   a) AS 1.1: Estimating Soil Texture by Feel

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 1: Soil Composition

TEACHING PROCEDURES

A. ***Introduction***

Given the fact that it takes a thousand years for a single inch of soil to form, the efforts to conserve and protect soil are vital to crop production. This unit will review key factors of soil (composition, types and limitations, testing, fertilizers, cultural and conservation practices) in relation to fertility and management for crop production.

B. ***Motivation***

1. Perform a soil test analysis by filling a tall, narrow jar half full of soil. Add a small amount of dishwashing detergent and enough water to fill the jar to within a half inch of the top. Shake the jar vigorously. Let the soil settle and observe which particles settle first. Let the jar set overnight undisturbed. Check to see if layers of sand, silt, clay, and organic matter can be observed. Measure the thickness of each layer. Calculate the percentage of sand, silt, and clay. Use TM 1.3 to determine the textural class of the soil in the jar.

2. Demonstrate water-holding capacity by relating to students that the more surface area a soil has, the more water it can hold. Use a sponge, 6 inches long x 3 ½ inches deep. (1) To relate that a clay soil can hold more water because it has more surface area, soak the sponge until it is completely full. Hold the sponge flat and tell the students that clay has the smaller of the soil particles and that each little particle adds to the total surface area. The flat side of the sponge will be the clay and it holds "X" amount of water. (2) Then by turning the sponge on its side, the surface area decreases and the sponge cannot hold the water and it will readily drip out. This would be like a silt type of soil. (3) Finally, turn the sponge on its end edge and the water will stream out. The surface area is dramatically decreased and it cannot hold the water; it drains through quickly. This is an example of typical sandy soil. (It may be more effective to use three separate sponges, or if one sponge is used, resaturate it before each step of the demonstration.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Soil is a living, naturally occurring system at the interface of air and rock. It is comprised of minerals, organic matter, water and air. Soil is continually changing thanks to the effects of sun, rain, and temperature fluctuations. Review soil formation by using the definition of soil and discussing the natural process by which it occurs. Discuss the four components of soil using Motivation #1. Review the particle sizes of each soil mineral, stressing the difference of the size of the pores surrounding each. Use TM 1.1 and TM 1.2.

   What are the components of soil?

   a) Soil components
      1) Mineral matter - 45%
      2) Organic matter - 5%
      3) Water and air - 50%
         (a) Each contribute approximately 25%, depending on how wet the soil is at the time.
         (b) When water is added to soil, the air is driven out.

(c) As soil dries out, it contains more air.

b) Mineral matter
   1) Inorganic material (rock)
   2) Consists of three particles
      (a) Sand - .05 mm to 2 mm
      (b) Silt - .002 mm to .05 mm
      (c) Clay - less than .002 mm
   3) Combination of particles determines soil's ability to hold water and nutrients
c) Organic matter
   1) Dead and decaying plant and animal material
   2) Sources
      (a) Mostly from plant leaves, roots, and stems
      (b) Biosolids (sewage sludge)
      (c) Green manure crops such as alfalfa
   3) Provides essential nutrients for plant growth
d) Water
   1) Maintains plant life
   2) Primary functions
      (a) Provide solution for plants to take up nutrients
      (b) Dissolve soil minerals
      (c) Moisten roots
   3) Types of soil water
      (a) Gravitational - percolates down through soil through pore spaces; ground water
      (b) Capillary - held above water table by adhesion of soil particles; most readily available
      (c) Hygroscopic - thin film around individual particles; exists in driest soils; unavailable for plant use
e) Air
   1) Provides carbon dioxide and oxygen for photosynthesis and respiration
   2) Moves in and out of soil providing healthy root growth
      (a) Fills pore spaces after water drains away
      (b) Occupies most of pore spaces in dry, arid, sandy soils
      (c) Is absent in water-holding clay soils or flooded fields, reduces plant growth
   3) Balance of air and water in soil best for plants

2. Explain that the texture of a soil is determined by the amounts of sand, silt, and clay it possesses. Review how soil is classified using TM 1.3: USDA Soil Textural Triangle. Illustrate how soil particles hold water on their surfaces using Motivation #2. Continue discussion on how water-holding capacity and soil fertility are affected by various soil textures. For further information on determining soil texture, refer to Chapter 4 of IML's *Soil Science Student Guide*. Have students complete AS 1.1.

How does soil texture affect water-holding capacity and fertility?

a) Soil texture
   1) Soil texture is a proportion of sand, silt, and clay in the soil.
   2) Pore space affects air and water-holding capacity and water movement.
b) Sandy or coarse-texture soils
   1) Large pore spaces
   2) Low water-holding capacity
   3) Less fertile, nutrients pass through quickly
c) Clay or fine-textured soils
   1) Small pore spaces
   2) High water-holding capacity - lack of aeration
   3) Swelling pores - water tightly held
   4) Less fertile, nutrients not easily available

d) Silty or medium-textured soils
   1) Combination large and small pore spaces
   2) Best water-holding capacity
   3) More fertile, nutrients gradually absorbed

3. Explain the pH scale and what is considered acidic or alkaline (basic). Review soil pH: its importance, how it is determined, how soils become acidic, and how they can be corrected. Refer the students to the pH scale in the Student Reference and use TM 1.4. Review cation exchange capacity of soil.

   How does soil pH affect nutrient utilization?

   a) Soil pH is a measure of acidity or alkalinity of the soil.
      1) Scale ranges from 0 to 14.
         (a) 7 is neutral (equal ions).
         (b) 0 - 6.9 is acidic (low pH).
         (c) 7.1 - 14 is alkaline (high pH).
      2) Missouri soils average 4.5 - 8.4 pH.
   b) Soil has an ability to release important nutrients.
      1) CEC - Positive ions attracted to negative soil particles (clay) can be replaced by other positive ions in soil water such as $K+$, $Ca+2$, $Mg+$.
      2) CEC is determined by soil test.
   c) Soil pH affects CEC.
      1) Acidic or alkaline soils unable to release nutrients have low CEC.
      2) Acidity is caused by leaching or absorption of base nutrients by plants.
      3) Soil pH should match the crops' need to maximize nutrients.
      4) Soil pH can be raised by applying lime.
   d) Crops have preferred pH level.
      1) Most prefer pH range of 5.0 - 7.5.
      2) Legumes require pH of 6.8 - 7.3.
      3) Corn, small grains, and grasses prefer pH of 6.0 - 6.8.
      4) Soil tests determine the pH level needed for crops.

F. ***Other Activity***

View the video, *How Water Moves Through Soil*, available for free loan from the MRCCTE at the University of Missouri-Columbia.

G. ***Conclusion***

Knowing about the texture and pH of soil can help us in our efforts to conserve and protect this natural resource. By increasing our knowledge still further, we can likewise increase crop yields and plant survival rates.

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

Answers will vary depending on the results of the experiment.

I. ***Answers to Evaluation***

1. Mineral matter, water, air, and organic matter
2. b
3. c
4. a
5. b
6. a
7. c

8. c
9. a
10. b
11. d
12. b

UNIT III - SOIL FERTILITY AND MANAGEMENT

Name______________________________

Lesson 1: Soil Composition

Date______________________________

EVALUATION

Complete the following short answer question.

1. What are the four components of soil?

   a.

   b.

   c.

   d.

Match the characteristic on the left with the correct soil texture on the right.

2.	_____Low water-holding capacity	a.	Silty soils
3.	_____High water-holding capacity	b.	Sandy soils
4.	_____Best water-holding capacity	c.	Clay soils
5.	_____Large pore spaces		
6.	_____Mixture of pore spaces		
7.	_____Small pore spaces		
8.	_____Nutrients tightly held		
9.	_____Nutrients absorbed gradually		
10.	_____Nutrients pass through quickly		

Circle the letter that corresponds to the best answer.

11. Which of the following pH values is considered alkaline?

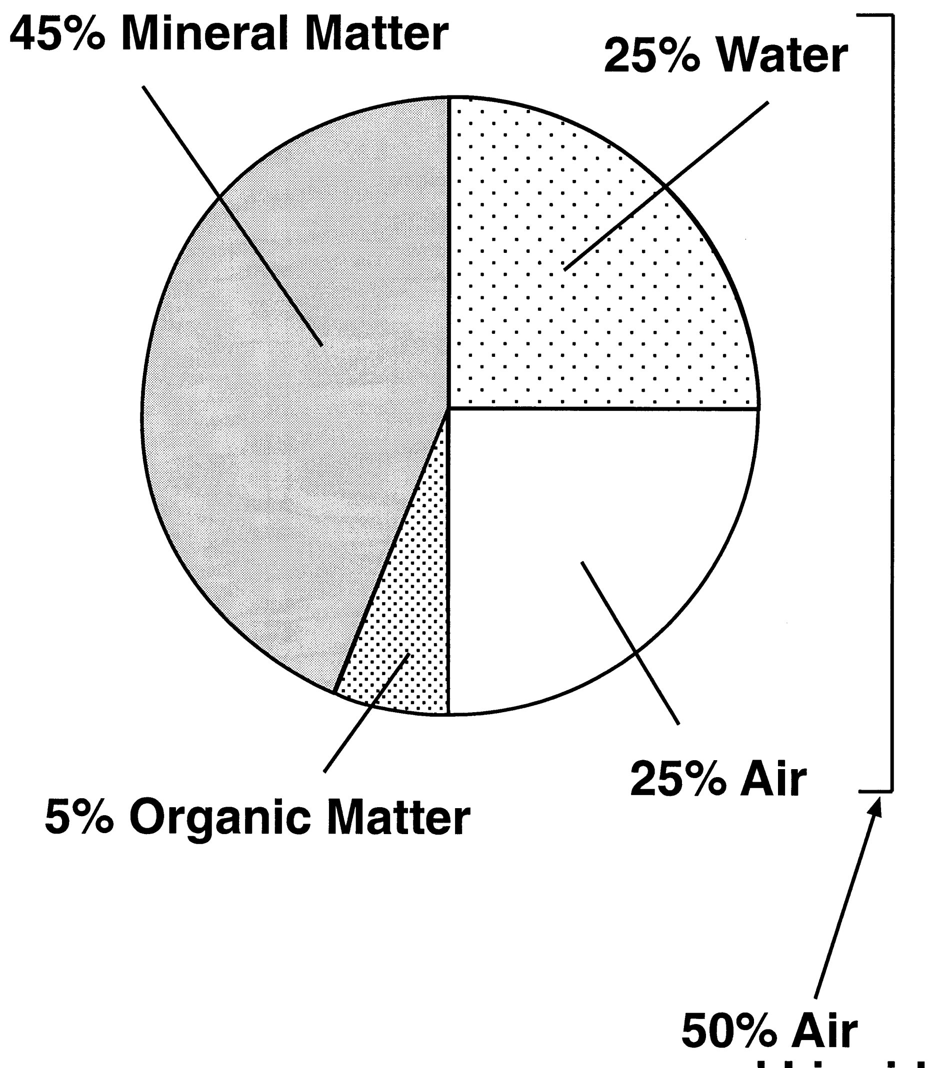
    a. 3.5
    b. 6.8
    c. 7.0
    d. 8.6

12. The depletion of which nutrient is the greatest cause for increased acidity?

    a. Potassium
    b. Calcium
    c. Magnesium
    d. Nitrogen

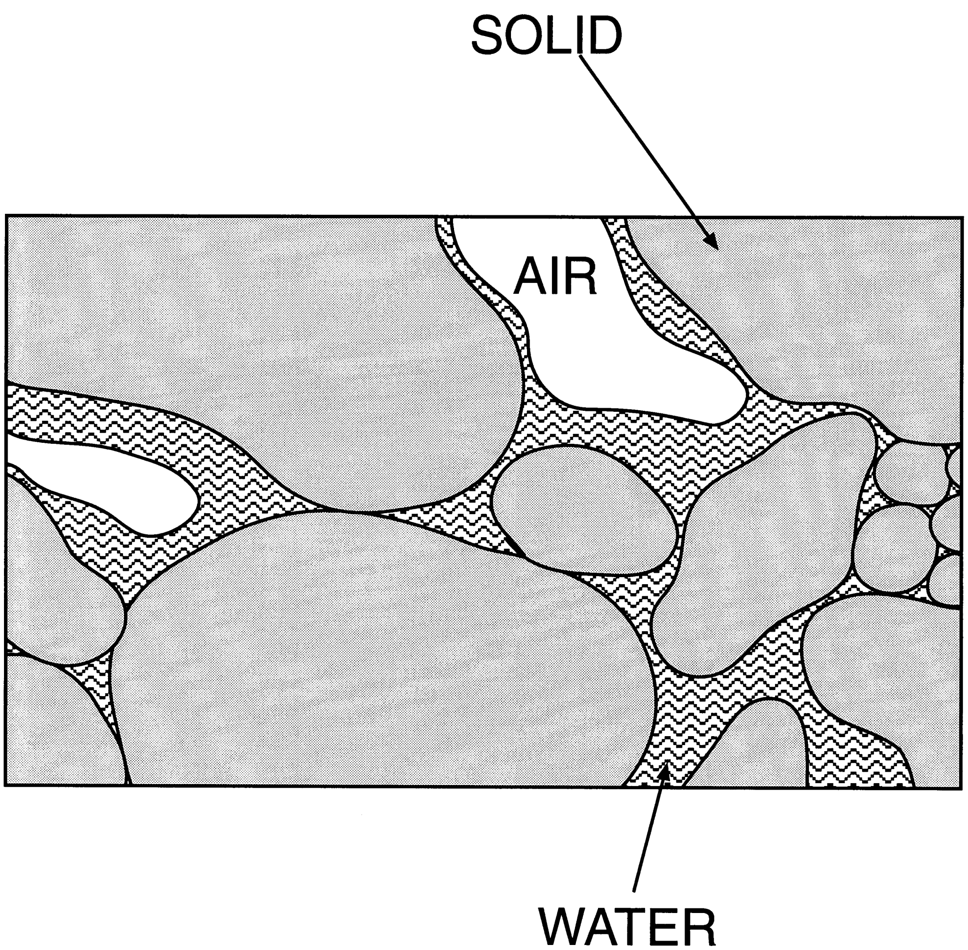
TM 1.1

Contents of Average Soil

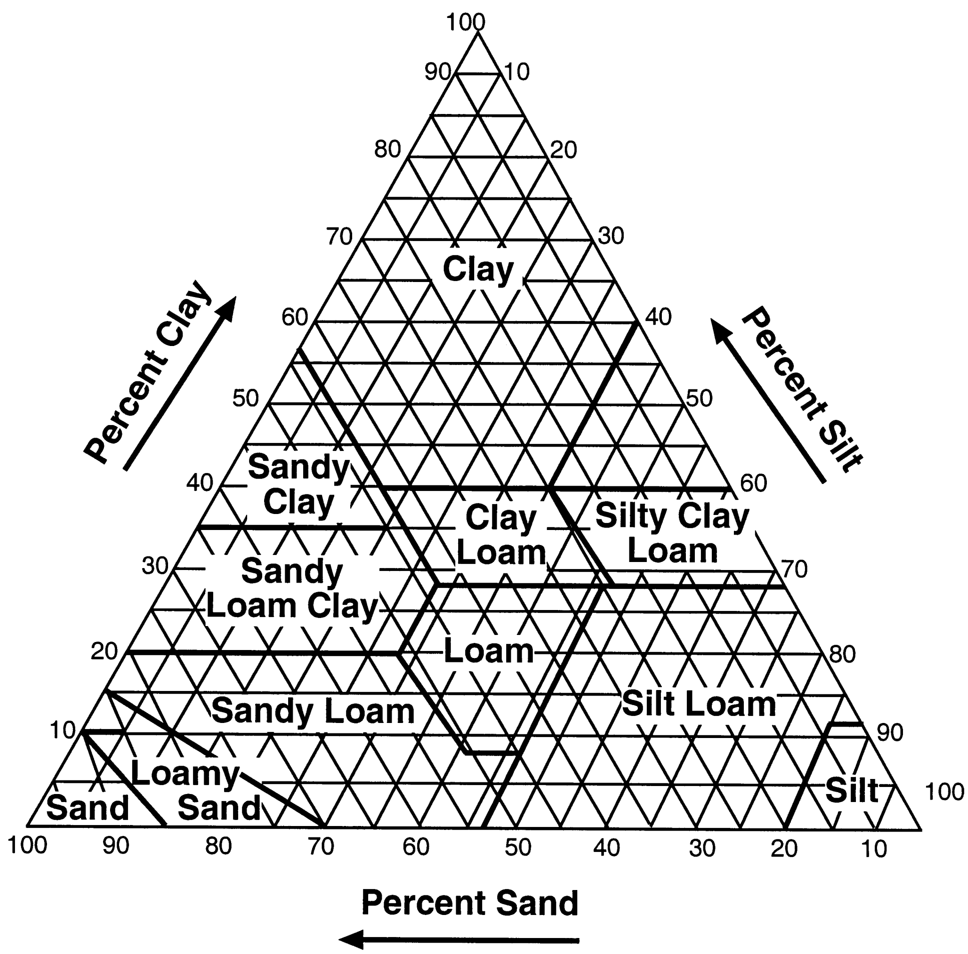


TM 1.2

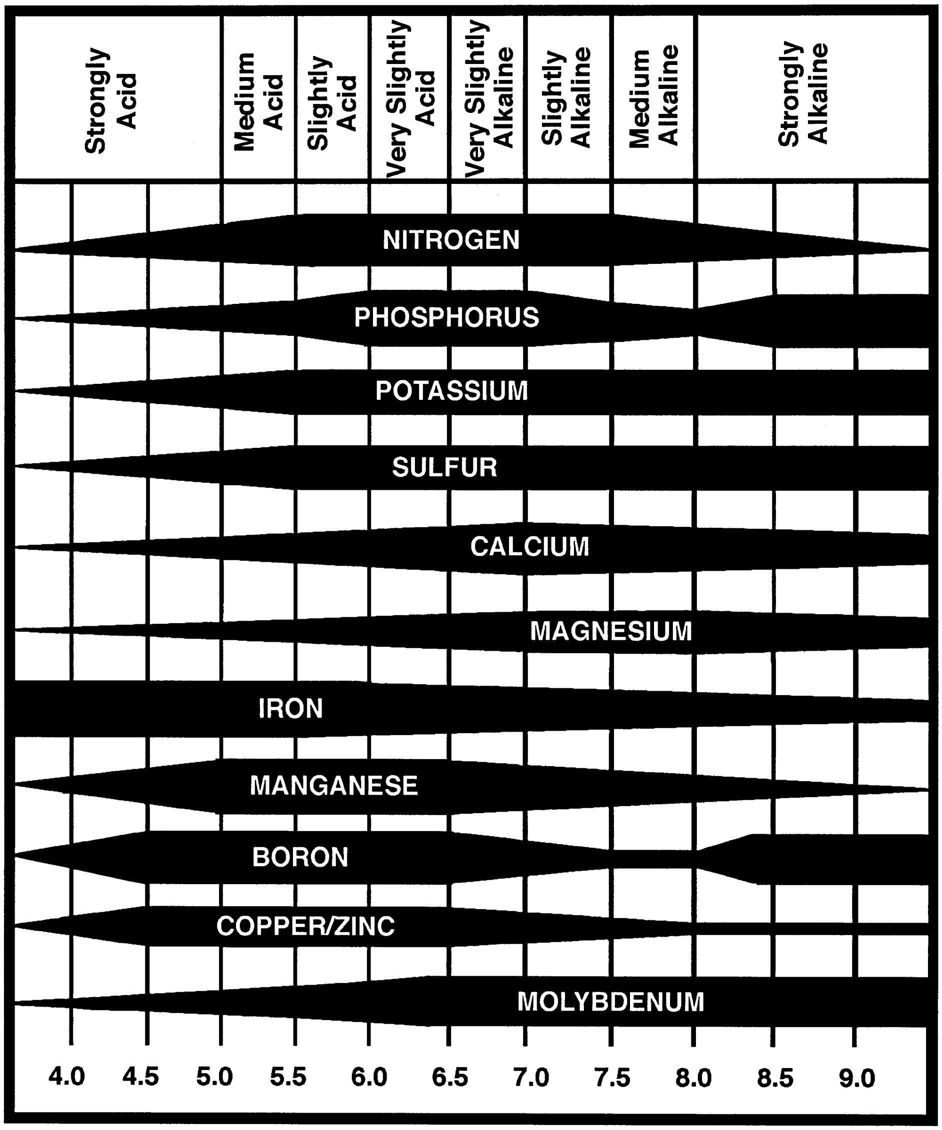
Pore Spaces in Soil



USDA Soil Textural Triangle



Soil pH Governs Nutrient Release



Soil pH Governs Nutrient Release
Acidity or alkalinity (pH) controls relative to nutrient availability.

Lesson 1: Soil Composition Name______________________________

Estimating Soil Texture by Feel

Objective: Students wil estimate the amount of sand, silt, and clay in a soil sample and determine the soil texture.

Procedures:

1. Fill the palm of your hand with dry soil.

2. Moisten the soil enough so that it sticks together and can be worked with the fingers. Do not saturate it to a runny mud. If the soil sticks to your fingers, it is too wet to texture. Add more dry soil.

3. Knead the soil between your thumb and fingers. Take out the pebbles and crush all the soil together. You may need to add a little more water. Continue working the soil until entirely mixed.

4. Estimate the **sand** content by the amount of textural grittiness you feel.
   a. More than 45% sand - Sand dominates. The textural name contains the word *sand* or *sandy*.
   b. 20-45% sand - Sand is noticeably present but not dominant. The texture is most likely *loam* or *clay loam*, though *silt loam* or *clay* is possible.
   c. Less than 20% sand - Silt and clay dominate. The textural name is *silt loam*, *silty clay loam*, or *clay*.

5. Estimate the **clay** content by the size of the soil ribbon formed by pushing the sample up between your thumb and index finger.
   a. Clay is less than 27%. A ribbon is not present or it is less than 1 inch long. Textural names contain the word *loam* but not the word *clay*.
   b. Clay is 27-40%. The ribbon is 1 - 2.5 inches long. Textural names contain both the words *clay* and *loam*.
   c. Clay is more than 40%. Clay dominates. The ribbon is more than 2.5 inches long. Textural name contains the word *clay* but not the word *loam*.

6. Combine your estimates of sand and clay to determine soil texture.

Answer the following questions.

1. What was your sand content estimate?

2. What was your clay content estimate?

3. Using these estimates and the table at the right, list the texture of the soil sample.

		SAND		
		>45	20-45	<20
CLAY	>40	Sandy Clay	Clay	Silty Clay
	27-40	Sandy Clay Loam	Clay Loam	Silty Clay Loan
	<27	Sandy Loam Loamy Sand Sand	Loam	Silt Loam

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 2: Soil Types and Limitations

Competency/Objective: Identify how soil morphology affects cropping options.

Study Questions

1. **Using a county soil survey book, how are local soil types identified?**
2. **What are the limiting factors for crop selection and growth?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.
2. *Soil Survey of (your county), Missouri.* U.S. Department of Agriculture Soil Conservation Service, Missouri Agricultural Experiment Station.
3. Transparency Master
   a) TM 2.1: Sample Survey Map and Soil Legend
4. Activity Sheet
   a) AS 2.1: Identify Soil Types by Using Soil Survey

TEACHING PROCEDURES

A. ***Review***

A county soil survey book is an important guide for determining soil types and limitations. Information provided in these books can help producers make decisions on site acquisitions, cropping options, location of land and building structures, and land improvements.

B. ***Motivation***

Have students use the local county soil survey book to identify the soil type(s) of their family farm, a relative's or friend's farm, or that of another county resident's farm. Use TM 2.1 to show an example of a soil survey map and how the soil legend details the types of soils found in that particular area.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. *Explain the term soil morphology. Discuss the history and importance of using soil surveys.* Soil survey books contain important information applicable in managing farms, ranches, and woodlands. Information includes recommendations for selecting sites for roads, ponds, buildings, and other structures, as well as procedures for determining the suitability of land tracts for farming, industry, and recreation. Explain how to interpret a soil survey book. Refer to TM 2.1 for an example of a survey map and corresponding soil legend.

   Using a county soil survey book, how are local soil types identified?

   a) County soil survey books to classify, map, and interpret Missouri soils
      1) Chemical and physical properties of county soil types
      2) Listed by national classification system
      3) Interpreted for agricultural, engineering, recreational, and urban uses
   b) Surveys to be made by soil scientists
      1) Examine aerial photographs.
         (a) Determine relationships among soil colors, native vegetation, and topography.
         (b) Characteristics of soils help predict locations of different soils.
      2) Walk the landscape to gather additional specific data.
   c) Contents of survey maps
      1) Road boundaries, water features, township sections, and cultural features (schools and farmsteads)
      2) Information about each soil - interpretations for best use and management practices
      3) Free to state residents from local soil and water conservation district offices or the state NRCS office
   d) Procedure to determine soil type
      1) Select a field, farm, or a homestead to research.
      2) Identify the township section number where the field, farm, or homestead is located.
         (a) Use the Index to Map Sheets found in the center of the book.
         (b) Sectioned and numbered townships correspond to soil survey sheets (aerial view of each township).
      3) Identify the soil type symbol(s) on soil survey sheet for the selected location.

(a) Symbol explanations are in the Index to Map Units found in the front of the survey book.
(b) Symbols may also be on the back of the Index to Map Sheets page.

4) Information on general soil associations for the county is in the color-coded General Soil Map adjacent to the Index to Map Sheets page.
   (a) Soil association groups have distinctive pattern of soils, drainage, and relief.
   (b) Descriptions of each group are found in General Soil Map Units section.
      (1) Provides information useful in planning the use and management of large areas
      (2) Explains soil classification of each soil type in the association group
5) Refer to Detailed Soil Map Units section for descriptions of each county soil type and to determine the suitability and potential use of a soil.
6) Tables section shows data on specific land use for each soil type.
7) Remaining information in the book reviews general and historical information on the county.

2. Limiting factors are soil properties that limit a soil from producing productive crops. Review the limiting factors found on Table 2.1 in the Student Reference for crop selection and growth. Additional limiting factors may be associated with specific soils. (For a more extensive explanation of soil erosion, see Lesson 6 of this unit.)

What are the limiting factors for crop selection and growth?

a) Slope
   1) Incline of the land
   2) Percentage of slope - vertical distance ÷ horizontal distance x 100
      (a) Less than 3% is considered an asset.
      (b) Over 3% is considered a liability.
   3) Characteristics
      (a) Gradient - steepness of the land surface (operation of farm equipment and irrigation more difficult on steeper slopes)
      (b) Length - affects erosion (Long slope allows runoff water to gather more volume as it flows over the surface increasing erosion.)
      (c) Shape - affects erosion (classified as linear, concave, or convex)
      (d) Aspect - refers to the effects of temperature and sun exposure on the soil; depends on compass direction
b) Erosion
   1) Wearing away of the land surface by water, wind, ice, or other geological agents
   2) Types of water erosion
      (a) Sheet - the detachment of soil particles by flowing water; usually caused when rain hits wet soil
         (1) Particles are detached and can float into rills and gullies.
         (2) Particles are transported into low places or off fields.
      (b) Rill - small steep-sided channels where runoff water concentrates
      (c) Gully - miniature valleys where water usually runs
         (1) Only after rainfall
         (2) An obstacle to farm machinery
c) Available water capacity (AWC)
   1) Soil's capacity to hold water
   2) Commonly expressed as inches of water per inch of soil
   3) Soils with low or very low available water-liability
d) Surface drainage
   1) Runoff, or surface flow of water from an area
   2) Needed on all poorly drained soils regardless of their classification
      (a) Soils that are nearly level in slope with depressional areas
      (b) Soils on sloping areas below seepy areas
e) Internal drainage (depth to high water table)

1) This is the rate at which internal free water leaves the soil to allow aeration.
2) Gravitational water must move out of the profile quickly so the roots can obtain adequate aeration.
3) Classified on seven levels
   (a) Excessive
   (b) Somewhat excessive
   (c) Well
   (d) Moderately well
   (e) Somewhat poorly
   (f) Poorly
   (g) Very poorly

f) Rock fragments
   1) Rock or mineral fragments with a diameter of 2 mm or more such as gravel, cobbles, or boulders
   2) Affect amount of irrigation water the soil can absorb

g) Stoniness
   1) Soil in which rock fragments 10 to 24 inches (25 – 60 cm) in diameter are exposed at the surface
   2) Evaluated according to the percentage of the soil surface covered by detached stones
   3) Interferes or even inhibits tillage
   4) Five general classes
      (a) Not stony
      (b) Stony
      (c) Very stony
      (d) Extremely stony
      (e) Rubbly

   (Refer to IML's Soil Science Guide*, Chapter 11, for a review of these classes.)*

F. ***Other Activity***

Assess the overall capability of the land in your area. Get an aerial photograph from the local U.S. Department of Agriculture office. Determine the slope, surface texture, depth, and other features of fields identified on the map. Occasionally, the office may have a soil scientist or conservationist who can help with this project. Prepare a bulletin board that shows what you have found.

G. ***Conclusion***

Students with an accurate understanding and comprehension of the various soil types may find themselves competing in soil judging contests. Other than winning prizes and securing titles, however, knowing the various soil types and classifications can be useful in making land use decisions.

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

The answers will vary depending on the specific location of the area to be researched.

I. ***Answers to Evaluation***

1. b
2. d
3. a
4. c
5. c
6. g
7. f
8. a
9. d

10. b
11. e
12. Gradient, length, shape, aspect
13. Sheet, rill, gully

UNIT III - SOIL FERTILITY AND MANAGEMENT　　Name ____________________

Lesson 2: Soil Types and Limitations　　Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which section in the soil survey book is color coded and divided into groups of soil associations in the survey area?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

2. Which section in the soil survey book gives data regarding specific land uses for each detailed soil map unit?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

3. Which section in the soil survey book shows the townships sectioned and numbered?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

4. Which section of the soil survey book contains soil descriptions for the soil associations and explains the soil classification of each soil type?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

Match the definition in the left column with the term In the right column.

5.	_____ Soils capacity to hold water	a.	Slope
6.	_____ 25 - 60 cm in diameter	b.	Erosion
7.	_____ 2 mm in diameter	c.	Available water capacity
8.	_____ Inclination of the land surface	d.	Surface drainage
9.	_____ Runoff from an area	e.	Internal drainage
10.	_____ Wearing away of land surface	f.	Rock fragments
11.	_____ Depth to high water table	g.	Stoniness

Complete the following short answer questions.

12. What are four slope characteristics?

    a.

    b.

    c.

    d.

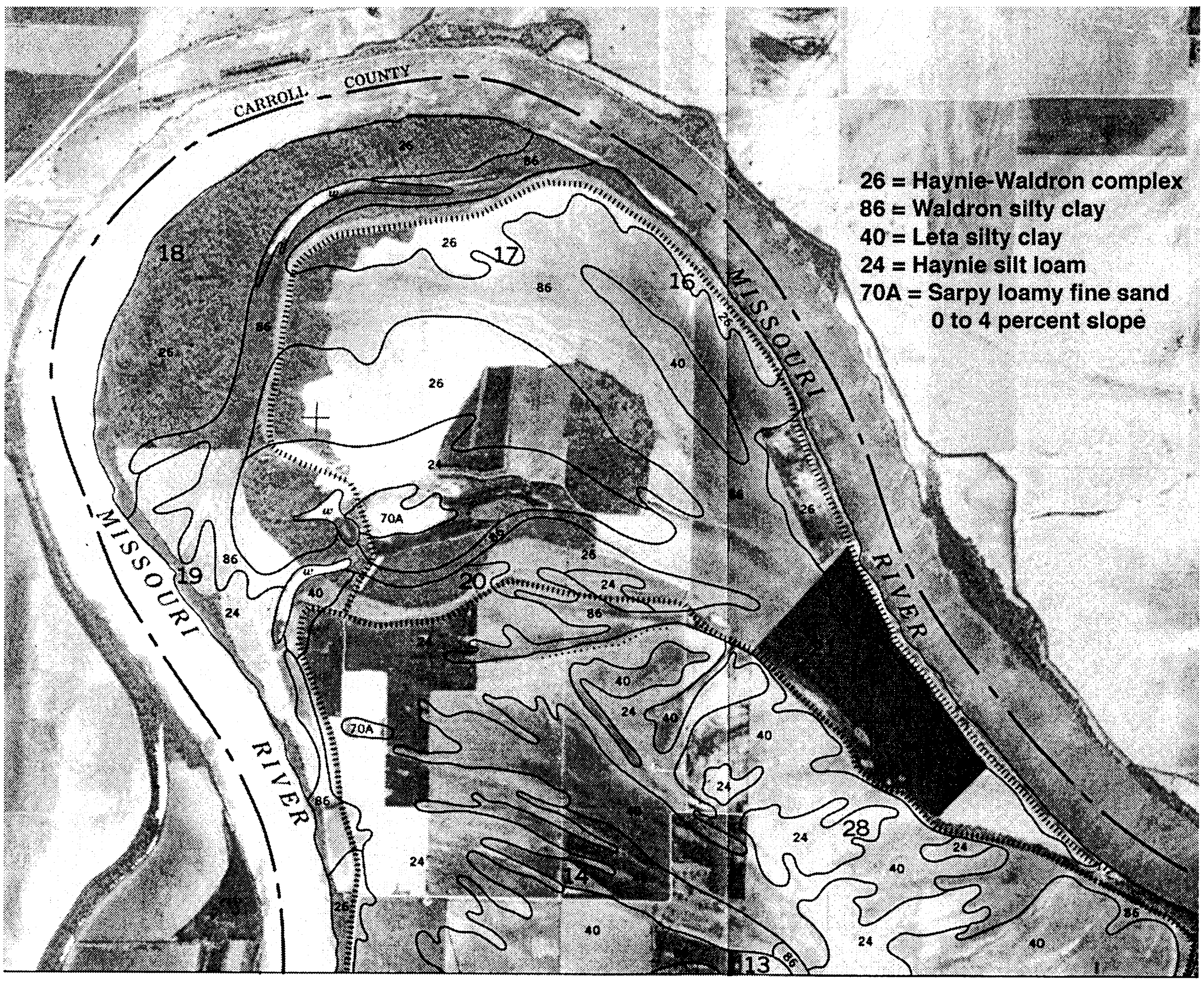
13. What are the three main types of erosion?

    a.

    b.

    c.

Sample Survey Map and Soil Legend



Lesson 2: Soil Types and Limitations Name____________________________

Interpreting Soil Survey Books

Objective: Students will become familiar with understanding and interpreting soil survey maps and guides.

Directions: Using a soil survey book provided by your instructor, answer the following questions. This activity may be completed individually or as a group.

Procedures:

1. Locate the area being researched on the Index to Map Sheets page. What is the township section number for the area to be researched?

2. Find the location of the researched area on the survey map that corresponds to the township number above. Write down the symbols and codes located for this area. Refer to the *Index to Map Units* in the front of the survey book and list what each symbol or code means and on what page detailed information can be located.

3. Turn to the Detailed Soil Map Units section of the soil survey book and use this information to determine what crop or crops will be productive in this area. Summarize the information in paragraph form listing any limitations.

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 3: Soil Testing

Competency/Objective: Use soil test results to improve soil fertility and crop production.

Study Questions

1. **What techniques should be used to obtain a representative soil sample?**
2. **Where can soil samples be tested?**
3. **What are the key parts of a soil test report?**
4. **How are soil test results interpreted?**

References

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

2. University of Missouri Outreach and Extension Publications. These are available on the Internet at <http://muextension.missouri.edu/xplor>.

   a) G9102 - *Liming Missouri Soils*
   b) G9110 - *How to Get a Good Soil Sample*
   c) G9111 - *Using Your Soil Test Results*

3. Transparency Masters

   a) TM 3.1: Field Diagram for Soil Sampling
   b) TM 3.2: Field Sampling Pattern
   c) TM 3.3: Sampling Soil for Satellite Technology
   d) TM 3.4: Results of GPS Soil Sample
   e) TM 3.5: Soil Test Report

4. Activity Sheets

   a) AS 3.1: Interpreting Soil Test Results
   b) AS 3.2: Collecting a Soil Sample

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 3: Soil Testing

TEACHING PROCEDURES

A. ***Review***

As discussed in the last lesson, a soil test report is important basic knowledge about a producer's field. However, a soil report is nearly useless if the producer does not know how to use it completely or does not know what it means. This lesson will further address interpreting soil reports and incorporating their information into production techniques.

B. ***Motivation***

1. Obtain soil samples from several students' farms or yards and have them tested prior to the lesson. Make multiple copies of the soil test report for all students to evaluate.

2. Arrange for students to visit a nearby soil testing laboratory.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the importance of why a soil sample should be taken from several locations in the given area to be tested. Soil properties can vary even over short distances. The size of the area to be tested will depend on the uniformity of the soil. Refer to the University of Missouri Extension Guide G9110 *How to Get a Good Soil Sample*. To do AS 3.2, a copy of the Soil Sample Information form from University Outreach and Extension will be needed. This is available from a local county extension office or on the Internet at <http://www.soiltest.psu.missouri.edu/>. Also use TMs 3.1, 3.2, 3.3, and 3.4 to show the methods of soil sampling.

What techniques should be used to obtain a representative soil sample?

a) Traditional soil sampling
    1) Area to be tested should be 20 acres or less.
    2) Take samples from different soil type areas.
    3) Special areas should be tested.
        (a) Where different crops have grown
        (b) Varying soil surface texture
        (c) Eroded and wet production areas
    4) Avoid taking samples from areas that are not representative of the entire field.
        (a) Driveways
        (b) Dead furrows
        (c) Road edges
        (d) Old barn lots
        (e) Severely wet or eroded areas where production is not feasible
    5) An average of 15 to 20 samples is recommended from each soil type or special area to determine average fertility of the field.
    6) Sample from top 7 inches of top soil should be prepared and taken to testing facility.
b) Sampling soil for Global Positioning Systems (GPS)
    1) Mapping software divides the field into sectors, or grids.
    2) A typical sector is 2 1/2 acres.

3) One sample, which consists of 8 to 10 core samples 5 to 10 feet apart, is taken every 2 1/2 acres.
4) Track exact location of soil samples to correspond with location on mapping software.

c) Comparison of traditional sampling method with GPS method
1) Comparison of same 20-acre plot could vary tremendously.
2) Traditional soil sample would show same results throughout the plot.
3) GPS sample may show variances for each sector throughout the plot.

2. Discuss possible locations where soil samples can be evaluated. Stress that all recommendations should be made by the local University Extension Center or an independent laboratory to confirm validity.

Where can soil samples be tested?

a) University Extension Center soil testing laboratory
b) Fertilizer dealers
c) Private soil testing laboratories
d) Testing for acidity levels
1) Salt pH measurement - used by University of Missouri Soil Testing Service
2) Water pH measurement - 0.5 unit higher than salt pH reading

3. Discuss the importance of determining the appropriate fertilizer rates for a field, garden, or lawn. Failure to sample soils before planting could lead to over- or underfertilization, which reduces income and net returns and can have a negative impact on the environment. Discuss an actual soil test from a crop field. (Show TM 3.1.)

What are the key parts of a soil test report?

a) Field information
1) Field name
2) Sample number
3) Acres in the field
4) Last crop planted

b) Soil test information
c) Rating
d) Nutrient requirements
1) Cropping options
2) Yield goal
3) Pounds per acre

e) Limestone suggestions
f) Special notes

4. Explain each section of a soil test report in detail. Refer to the University of Missouri Extension Guides G9111 *Using Your Soil Test Results* and G9102 *Liming Missouri Soils* for more detailed information. Use TM 3.1 to interpret the results of the soil test or use soil test reports from local farms.

How are soil test results interpreted?

a) Field information section identifies which field was tested.
b) Soil test information gives suggested fertilizer and limestone treatments.
1) Salt pH
2) Phosphorus
3) Potassium
4) Calcium
5) Magnesium

6) Sulfur
7) Zinc
8) Iron, manganese, and copper
9) Organic matter
10) Cation exchange capacity

c) Rating indicates probability of a yield increase from fertilizer application.

d) Nutrient requirements provide fertility management practice answers.

1) Cropping options
2) Yield goal
3) Pounds per acre

e) Limestone suggestions indicate amount of limestone needed to raise pH level to optimal level desired.

f) Special notes aid in interpreting the test results and list additional recommendations.

F. ***Other Activity***

Organize a soil judging team. Practice judging soil near your school and at nearby schools. The local Natural Resources and Conservation Service (NRCS) office may help. In some cases, the local soil and water conservation district can help.

G. ***Conclusion***

The information available in a soil report is worth the cost of the service. By following a soil report, a producer can make intelligent decisions about the types of plants most likely to thrive in a specific field and is able to make informed decisions on the amount and types of fertilizer to add to the field.

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

AS 3.1

1. Soybeans
2. 428 lb.
3. High
4. 6.3
5. Yes
6. Phosphorus, 86 lb.
7. 16.6 meq/100 g
8. Corn (grain), soybeans, and wheat
9. 60 bu./acre, 95 lb.
10. Phosphorus and potassium

(Note: These answers are from the example soil test report in the text. Answers will differ if local soil test reports are used.)

I. ***Answers to Evaluation***

1.

a) Area tested should be 20 acres or less.

b) Take samples from different soil type areas.

c) Special areas should be tested such as different crop areas, areas with varying soil surface texture, and wet and eroded production areas.

d) Avoid taking samples from areas that are not representative of the entire field such as driveways, dead furrows, road edges, old barn lots, and severely wet and eroded areas not in production.

2. Answers should include two of the following: University Extension soil laboratory, fertilizer companies, independent soil testing laboratories.

3.

   a) Field information
   b) Soil test information
   c) Rating
   d) Nutrient requirements
   e) Limestone suggestions
   f) Special notes

4. d
5. e
6. a
7. b
8. c

UNIT III - SOIL FERTILITY AND MANAGEMENT Name______________________________

Lesson 3: Soil Testing Date______________________________

EVALUATION

Complete the following short answer questions.

1. What factors or techniques should be considered in obtaining a representative soil sample using traditional methods?

   a.

   b.

   c.

   d.

2. List two locations where soil samples can be evaluated.

   a.

   b.

3. List the six key components of a soil test.

   a.

   b.

   c.

   d.

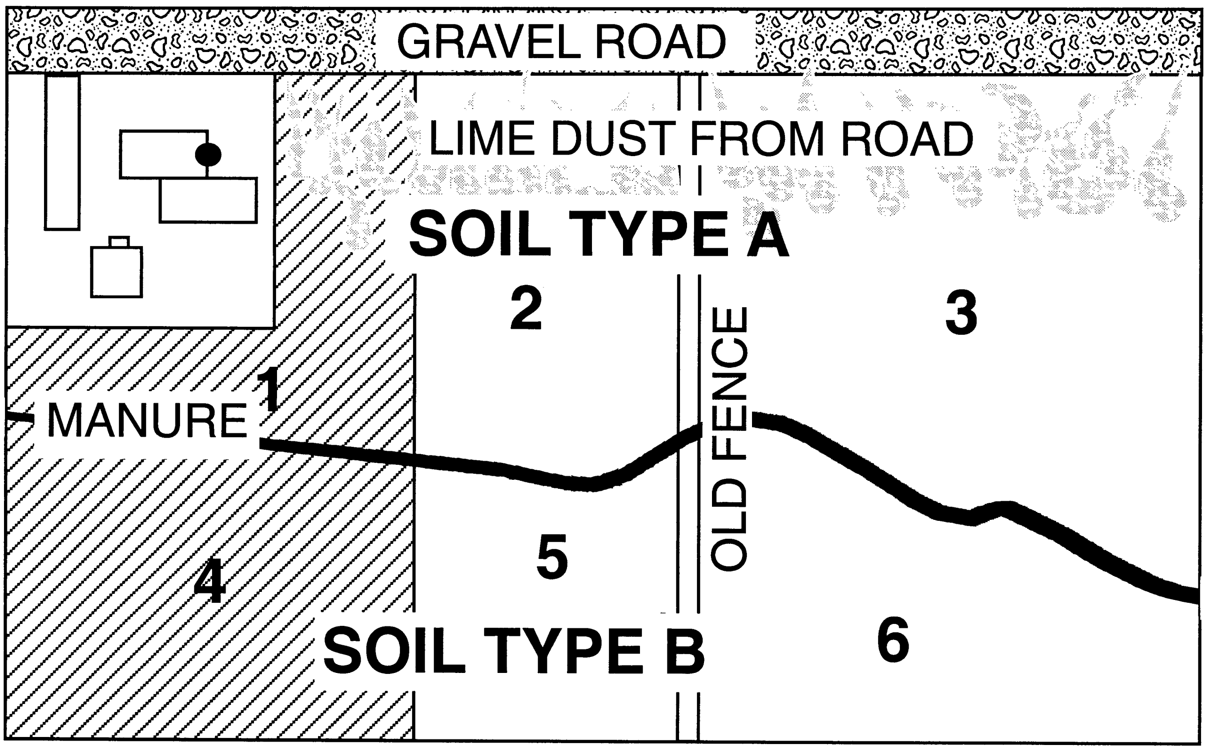
   e.

   f.

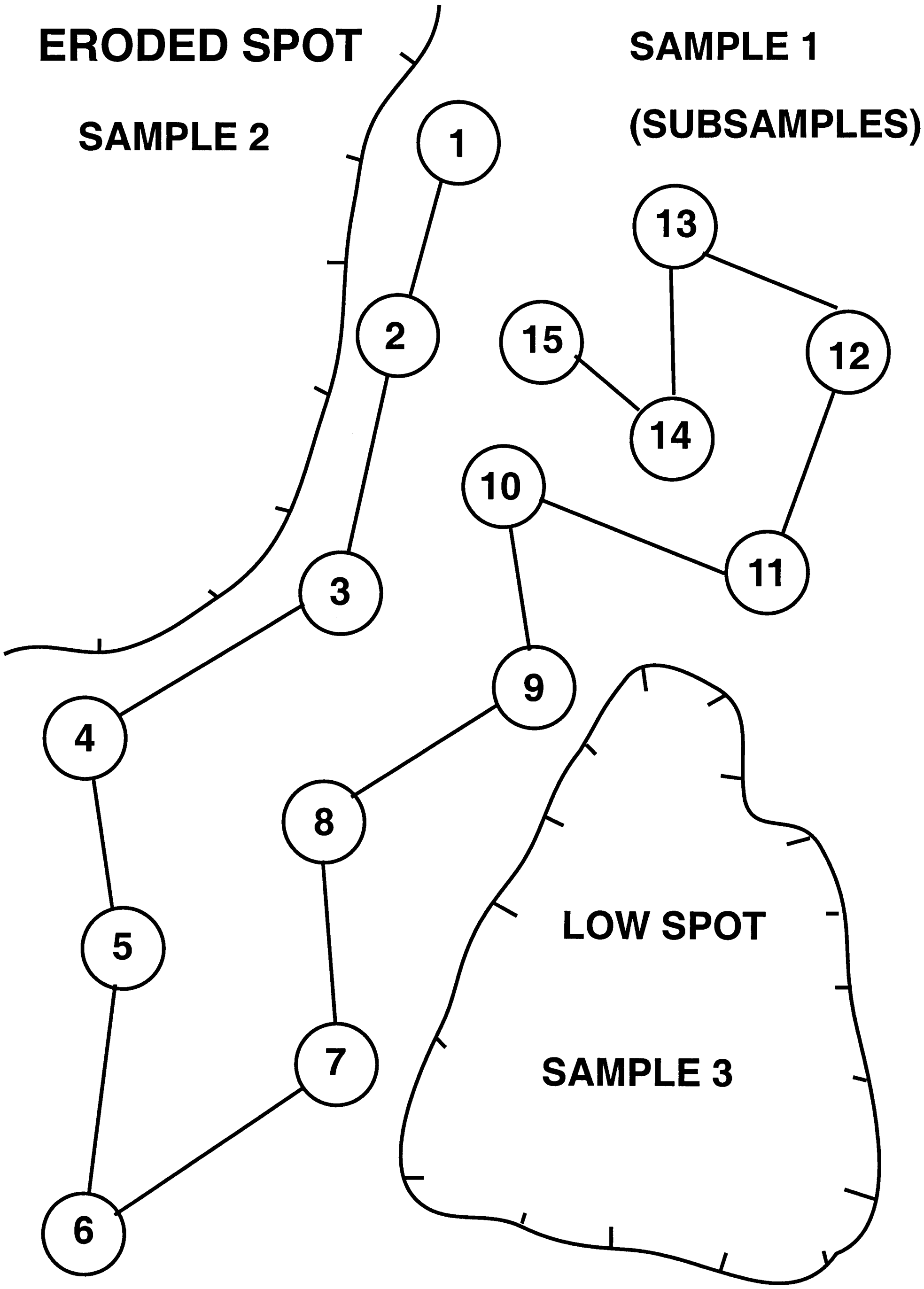
Match the following terms in the right column with the definition in the left column.

4.	_____ Indicates the level of active soil acidity.	a.	Calcium
5.	_____ Expressed in pounds of elemental P per acre.	b.	Potassium
6.	_____ Used to calculate CEC.	c.	Organic matter
7.	_____ Expressed as pounds of exchangeable K per acre.	d.	Salt pH
8.	_____ Used to estimate potential hydrogen release.	e.	Phosphorus

Field Diagram for Soil Sampling

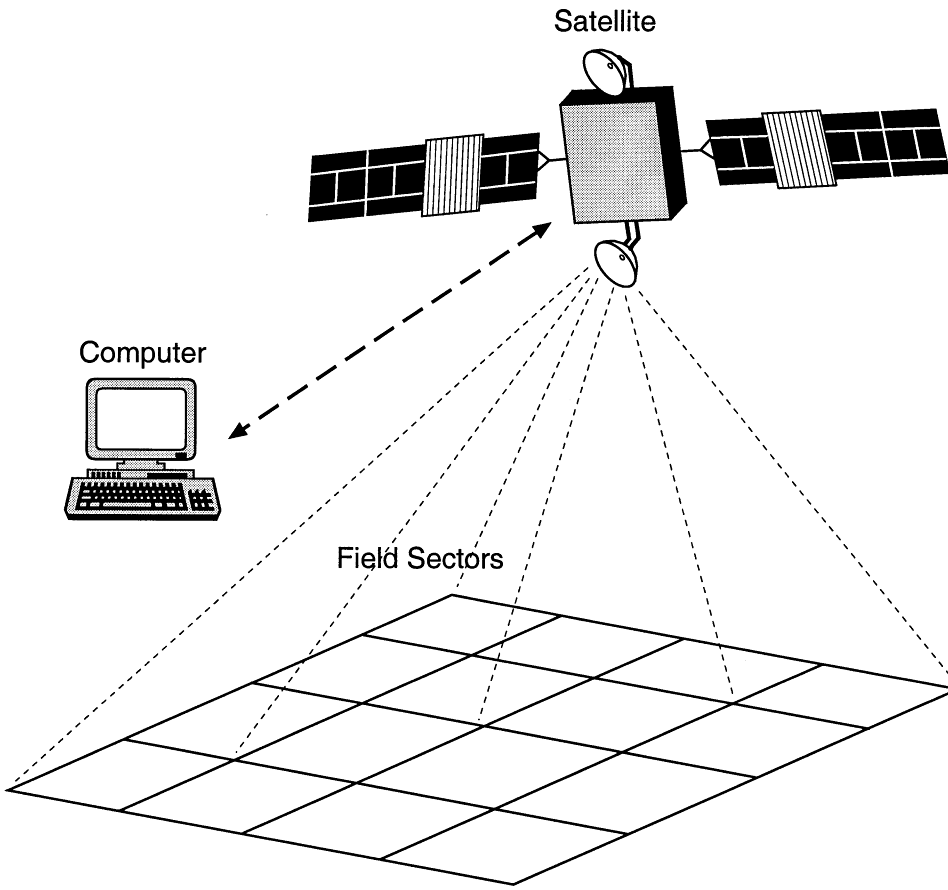


Field Sampling Pattern

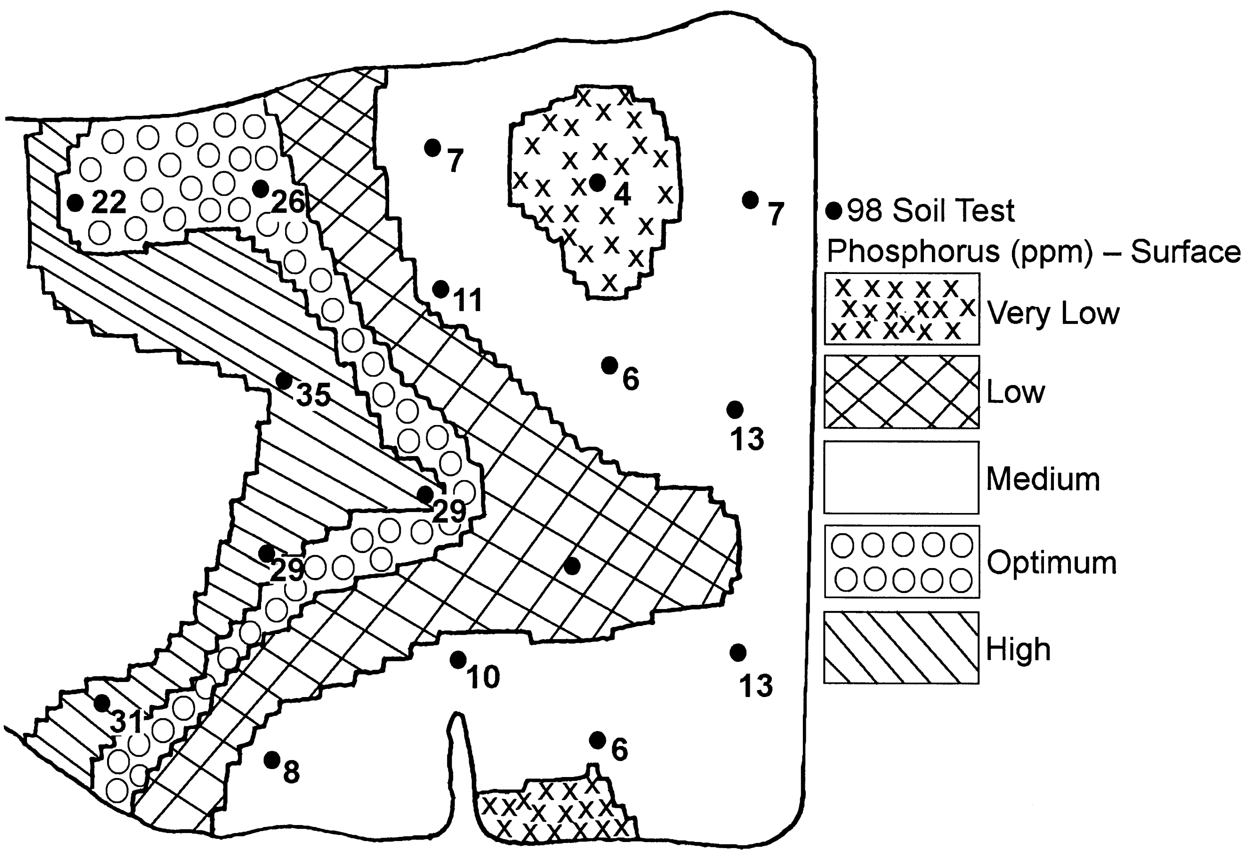


TM 3.3

Sampling Soil for Satellite Technology



Results of GPS Soil Sample



Soil Test Report

OUTREACH & EXTENSION
UNIVERSITY OF MISSOURI
LINCOLN UNIVERSITY

Soil Test Report

Soil Testing Laboratory
23 Mumford Hall, MU
Columbia, MO 65211
Phone: (573) 882-0623

or

Soil Testing Laboratory
P.O. Box 160
Portageville, MO 63873
Phone (573) 379-5431

FIELD INFORMATION			
Field ID A1 SOIL		Sample no. 1	
Acres 22	Last Limed UNKNOWN	Irrigated NO	
Last crop 115 SOYBEANS			

Serial no. P9039	Lab no. 18793
Area 15	County 010 Region 3
Submitted 11/18/98	Processed 11/24/98

Soil sample submitted by:

This report is for:

JOHN DOE
RURAL ROUTE 1, BOX 1
CENTERTOWN, MO

SOIL TEST INFORMATION			RATING (Very Low / Low / Medium / High / Very High / Excess)
pHs	(salt pH)	6.3	*************************
Phosphorus	(P)	86 lbs/a	**********************************
Potassium	(K)	428 lbs/a	******************************
Calcium	(Ca)	5071 lbs/a	****************************
Magnesium	(Mg)	568 lbs/a	*************************
Sulfur	(SO_4-S)	6.0 ppm	********************
Zinc	(Zn)	1.3 ppm	*************************
Manganese	(Mn)	ppm	
Iron	(Fe)	ppm	
Copper	(Cu)	ppm	

Organic Matter 2.9 %	Neutralizable acidity 1.0 meq/100g	Cation Exch. Capacity 16.6 meq/100g	
pH in water	Electrical Conductivity mmho/cm	Sodium (Na) lbs/a	
Nitrate (NO_3-N) Topsoil ppm	Subsoil ppm	Sampling Depth Top Inches	Subsoil Inches

NUTRIENT REQUIREMENTS		Pounds per acre				
Cropping options	Yield goal	N	P_2O_5	K_2O	Zn	S
103 CORN (GRAIN)	140 BU/A	155	0	20	0	0
115 SOYBEANS	40 BU/A	0	0	20	0	0
119 WHEAT	60 BU/A	95	0	20	0	0
103 CORN (GRAIN)	140 BU/A	155	0	20	0	0

LIMESTONE SUGGESTIONS	
Effective neutralizing material (ENM)	0
Effective magnesium (EMg)	0

Your sample has an estimated pH in water of 6.8.
The cation exchange capacity of this soil would suggest very low potential for sulfur response. Monitor the crop by plant analyses for potential need for sulfur.
Nitrogen requirements may be reduced by 30 pounds per acre for the first crop following soybeans. Not applicable for wheat.
Soils testing high in P or K should be retested annually to determine when maintenance fertilizer should be applied.

Lesson 3: Soil Testing Name____________________________

Interpreting Soil Test Results

Objective: Students will be able to identify components and interpret information on the soil test report.

Directions: Using the soil sample report from the text or results from a soil sample taken locally, answer the following questions.

1. What was the last crop planted on the field from which soil samples have been taken?

2. What is the exchangeable K per acre for potassium?

3. What is the rating for probability of yield increase for potassium?

4. What is the salt pH?

5. Is the salt pH within the favorable area for Missouri soils?

6. Which component has a very high rating and what are the pounds available per acre?

7. What is the cation exchange capacity?

8. What are the cropping options to be considered for the sample location?

9. What is the yield goal for wheat and how many pounds per acre of nitrogen are recommended?

10. Which two components should be retested annually to determine when maintenance fertilizer should be applied?

Lesson 3: Soil Testing Name____________________________

Collecting a Soil Sample

Objective: Students will be able to collect a soil sample and prepare it for a testing laboratory.

Materials and Equipment:

Soil probe, auger, or spade
Clean, plastic bucket
Soil sample boxes
Soil sample information form

Procedure:

1. Scrape away any surface mat of grass or litter from the chosen soil sample site. Make sure you are taking a soil sample from a relatively uniform area of a field. Before you take the sample, look at the site surroundings. Note the slope of the land, crop rotation, limestone, fertilizer, manure, and nearby farmsteads or feedlots.

2. Remove a soil sample using a soil probe, auger, or spade. Take a sample for fertilizer and limestone recommendations to a depth of 6 to 7 inches or to tillage depth if deeper. In long-term, no-till fields, take a separate sample of the top 2 inches of soil for soil acidity measurements.

   (Note: If you use a spade, dig a hole to the proper sampling depth. Then shave a 1-inch slice from the side of the hole to the sampling depth with the shovel. Save the vertical, 1-inch wide center portion of the soil as one subsample.)

3. Note what the soil sample looks like including color and texture.

4. If more than one sample has been taken from the sampling area, mix all of the subsamples in a clean, plastic bucket.

5. Let the sample air-dry, then place it in a small (1-pint) box or bag, and label it for analysis.

   (Note: Record sampling depth on the information form when taking depths of less than 6 inches.)

6. Properly clean and store any equipment used.

7. Complete a soil sample information sheet for each soil sample by using the form your instructor provides you.

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 4: Fertilizing Soils

Competency/Objective: Identify fertilizers and the applications needed to obtain optimal crop performance.

Study Questions

1. What are the various types of fertilizers?

2. What are the forms of fertilizer?

3. Where can fertilizer formulations be obtained?

4. What are the different application techniques?

5. When should fertilizer be applied?

6. How are fertilizer application rates calculated?

References

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

2. Activity Sheet

   a) AS 4.1: Calculating Fertilizer Needs and Cost

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 4: Fertilizing Soils

TEACHING PROCEDURES

A. ***Review***

The previous lessons reviewed the composition of the soil and how important nutrients are to maintaining healthy soil. Nutrients are easily used up or lost due to cultivation, topsoil erosion, and crop harvesting. These nutrients have to be replenished through fertilization. This lesson will review forms of fertilizer and the factors involved with the application of fertilizer.

B. ***Motivation***

Present a bag of fertilizer to the class and point out the ingredients found on the bag. Determine if the bag lists application techniques and safety warnings to be observed.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the various types of fertilizers including mineral fertilizers, organic fertilizers, and chemical (inorganic) fertilizers that can be applied to soils to supply the nutrient elements needed for optimum plant growth.

What are the various types of fertilizers?

a) Mineral fertilizers - rocks containing nutrients that are ground up and applied to the soil
    1) Limestone
        (a) Used to neutralize soil acidity
        (b) Good source of calcium, magnesium, and sulfur
    2) Phosphorus
        (a) Commonly phosphate rock (PO_4)
        (b) Processed into soluble fertilizer sources
        (c) Used only on soils with a definite phosphorus shortage
b) Organic fertilizers - plant or animal tissues that have become waste materials
    1) Plant residue, animal manure, bone, cottonseed, and soybean meal, and biosolids (sewage sludge)
    2) Advantages
        (a) Slow-releasing nutrients are less likely to cause root damage.
        (b) Organic wastes are long lasting.
        (c) Source of live bacteria needed to convert natural soil minerals and chemical fertilizers into useable forms for plants.
    3) Disadvantages
        (a) Low in major nutrients
        (b) Bulky material
        (c) Difficult to measure exact amount of fertilizer to apply
c) Chemical (inorganic) fertilizers - manufactured from a nonliving source
    1) Formulations of nitrogen (N), phosphorus (P), and potassium (K)
    2) Advantages
        (a) Higher proportion of useable nutrients than mineral or organic fertilizers
        (b) More readily soluble and immediately available for plant use
        (c) Easier to measure

3) Disadvantages
(a) They are more costly.
(b) Errors in application can damage crops and the environment.

2. Discuss the various forms in which fertilizers can be purchased and how they are applied. Include in the discussion the placement of the fertilizer, whether they are surface applied or injected into the soil, and how this affects plant growth.

What are the forms of fertilizer?

a) Fluid
1) Nutrients in true liquids are completely dissolved.
(a) Sprayed or dribbled directly on soil or plant surfaces
(b) Injected into the soil
(c) Mixed with irrigation water
2) Suspension fertilizers are mixtures of liquids and finely divided solids.
(a) Solids redispersed by easily agitating to give a uniform mixture
(b) Applied to the soil surface
b) Pressurized liquids
1) Injected directly into the soil from tanks
2) Adheres to the moisture in the soil
c) Dry
1) Applied mechanically or absorbed into soil through rainfall
2) Available in powders, granules, or prills
3) Can be mixed with liquid and applied as a fluid fertilizer
d) Slow release
1) Dissolve into the soil slowly
2) Available in dry or liquid form
3) Most commonly used in horticulture or vegetable production

3. Review how the proportions of nitrogen, phosphorus, and potassium are expressed on a fertilizer bag. Include how to figure the total pounds of each active ingredient. This information will help the student understand how bulk fertilizers are mixed. Chemical fertilizer dealers will have trained personnel who will mix and apply the fertilizer, but the producer should understand the product purchased. Complete AS 4.1 to help students understand a fertilizer bill of sale. If more detailed information is needed, obtain the *Farmland Soil Fertility Manual* available for free loan from MRCCTE.

Where can fertilizer formulations be obtained?

a) Complete commercial fertilizer mixtures contain nitrogen (N), phosphorus (P), and potassium (K).
1) Proportions known as fertilizer grade and expressed as percentages
2) Equation to figure total pounds of each active ingredient
(total lb. of fertilizer X percent of macronutrient = lb. of macronutrient)
b) There are several locations where fertilizer can be purchased.
1) Agriculture supply centers
(a) Trained personnel mix and apply fertilizers.
(b) Materials are hazardous and require specialized equipment to maintain safety.
(c) License is obtained and records are maintained as determined by state law.
2) Limestone purchased from quarries
3) Barnyards, livestock sewage pits or lagoons, or sewage treatment facility
(a) Special equipment is required to perform applications.
(b) License must be obtained to transport and comply with state regulations.

4. Explain the methods of applying dry and liquid fertilizers. Include in the discussion how the application method may affect the penetration rate of the fertilizer and the growth of the plant if placed too closely to the seed or applied too heavily.

What are the different application techniques?

a) Broadcasting
   1) Spreading dry fertilizer evenly over soil prior to planting
   2) Uses mechanical equipment or aircraft
   3) Disked or mixed into the soil to increase nutrient breakdown process
b) Soil injection or knifing
   1) Used before and during planting
   2) Anhydrous ammonia injected directly into the soil - evaporates quickly
   3) Preferred option to apply liquid manure to reduce odors
c) Banding
   1) Places dry fertilizers directly into the soil about 2 inches to each side and slightly below the seed
   2) Used extensively for row crops during planting
   3) Starter applications
      (a) Fertilizer applied in a band 1 to 2 inches from one or both sides of the seed, only at planting time
      (b) Commonly used on corn and cotton to stimulate early growth
      (c) Applied as either dry or liquid materials
d) Side-dressing
   1) Placing fertilizer in bands about 6 to 8 inches from the row of plants
   2) Common in row crops such as corn, cotton, and vegetables
   3) Minimizes leaching during planting and cultivation
e) Top-dressing
   1) Dry or fluid fertilizer is broadcast lightly over close-growing plants.
   2) It is a common method for applying nitrogen to wheat, small grains, hay fields, pastures, and lawns.
   3) Rainfall dissolves dry fertilizer and soaks into soil.
f) Foliar
   1) Application of liquid fertilizer directly on foliage or leaves
   2) Broadcasted soluble nutrients on plants for rapid utilization
   3) Can cause severe burning of leaves if sprayed too heavily
   4) Not recommended for applications of nitrogen, phosphorus, or potassium
g) Fertigation
   1) Fertilizer is applied in irrigation systems.
   2) Liquid fertilizers are typically used.
   3) Dry fertilizers may be dissolved and dispersed by irrigation.
   4) Type of irrigation system dictates type of fertilizer used.

5. Determining when fertilizer should be applied depends on many factors. The soil temperature, moisture levels, crop to be grown, and the specific nutrients to be applied are all primary factors to consider when planning fertilizer application. Discuss the various factors with the students and how the four seasons affect the appropriate application time.

When should fertilizer be applied?

a) Soil temperature
   1) Rate (speed) affects chemical activity.
   2) Nitrification begins just above freezing and continues to increase up to about 85°F.
b) Moisture
   1) The amount between fertilizer application and plant utilization affects efficiency of applied material.
   2) Nitrifying bacteria remain active in very dry conditions.

3) Saturated soils do not contain enough oxygen for nitrifying bacteria.

c) Crop to be grown
   1) Single application of primary nutrients is satisfactory for most fast-growing annual crops.
   2) Split applications of nitrogen may be desirable for perennials, cool- and warm-season grasses.

d) Nutrients
   1) Mobile nutrients are more susceptible to leaching losses than phosphates or potassium.
   2) Nitrogen applied in ammonia form must be nitrified before leaching or denitrification can occur.

e) Favorable planting season
   1) Fall application
      (a) Soil texture, average temperatures, and nitrogen carrier influence possible losses from leaching.
      (b) Applying nitrogen materials to sandy soils is discouraged.
      (c) Anhydrous ammonia is recommended.
      (d) Phosphorus and potassium are relatively safe in most areas.
   2) Winter application
      (a) Plow-down applications and anhydrous ammonia application can continue until ground freezes.
      (b) In some areas, these methods continue throughout the winter.
   3) Spring application
      (a) Most popular
      (b) Broadcast applications for plow-down or disk-in on row crops
      (c) Preplant applications of anhydrous ammonia for row crops
      (d) Starter applications for spring small grains or row crops
   4) Summer application
      (a) Provide supplemental amounts of plant nutrients not applied previously.
      (b) Side-dressing with nitrogen during irrigation applications is used.

6. Discuss fertilizer application (spread) rates. The rate will be listed on the bill of sale if the fertilizer is purchased from a service center or dealer. The spread rate is necessary to calibrate application equipment.

How are fertilizer application rates calculated?

a) Dry chemical fertilizers
   1) Pounds per acre (also called spread ratio)
   2) Formula - spread rate = total lb. of fertilizer / total acres
   3) Listed on side of bill from local supply center or dealer
   4) Spread ratio needed to calibrate application equipment

b) Lime
   1) Measuring based on rating system
      (a) ENM is the ability to reduce soil acidity and is determined by material purity and fineness.
      (b) Local quarry can provide ENM per ton.
   2) Always applied - pounds of ENM per acre
      (a) Found on soil test recommendations
      (b) Formula - ENM recommendation / ENM rate or guarantee of material = amount of lime needed per acre
   3) ENM sources
      (a) Sources are not equal in rating or price.
      (b) Use least expensive source per pound of ENM.

F. ***Other Activity***

Visit a local fertilizer supply center and ask the staff to explain the procedure of mixing bulk fertilizer from a soil test report. Use the soil test report from Lesson 3 as an example for the supply center to work from.

G. ***Conclusion***

Determining fertilizer needs for a specific crop or soil is highly technical. Many factors and variables need to be considered when choosing the most appropriate fertilizer and application process. Consultation with trained professionals is important to achieve the most productive and profitable crop.

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

1. a. 2250 lb.
   b. 5250 lb.
   c. 3750 lb.
2. 18,037 lb.
3. 240.5 lb. per acre
4. $2,351.35

(Note: Complete fertilizer bill of sale on next page.)

I. ***Answers to Evaluation***

1. Mineral, organic, chemical (inorganic)
2. Fluids, pressurized liquids, dry, slow-release
3. Nitrogen, phosphorus, potassium
4. Agriculture supply centers
5. Any or all of the following: quarries, barnyards, livestock waste pits or lagoons, sewage treatment facility
6. Temperature, moisture, crop to be grown, nutrient being applied
7. Fall
8. Total pounds of fertilizer material divided by the total acres to be fertilized
9. Lime
10. b
11. f
12. d
13. c
14. a
15. h
16. g
17. e

Agriculture Supply Center

Anyplace, Missouri   000-555-9999

Name ______________________ Delivered by ______________________

Address ______________________ Date ______________________

	Nitrogen	Phosphorus	Potassium
Soil Test Recommendation (lb./ac.)	30	70	50
Total Acres to Spread	75	75	75
Total Pounds of Fertilizer Needed	2250	5250	3750

MANUFACTURING INSTRUCTIONS

Use the Following:		*Percent of Materials Used*			*Pounds of Actual Plant Food Supplied*		
Fertilizer Source	Lb.	N	P	K	N	P_2O_5	K_2O
Diammonium Phosphate 18-46-0	11,413	18	46	0	2054	5250	0
Ammonium Nitrate 34-0-0	576	34	0	0	196	0	0
Potassium Chloride 0-0-60	6048	0	0	60	0	0	3750
Total Lb.	18,037	*Total Lb. Supplied*			2250	5250	3750

18,037 (Total Lb.) ÷ 75 (Acres) = 240.5 Spreading Rate (lb. per acre)

Guaranteed Analysis = 12.5 % N   29 % P_2O_5 20.8 % K_20 (lb. of nutrient/acre ÷ spread rate)

Fertilizer Source Used	*Cost per Lb.*	*Lb. Used*	*Cost per Source*
Diammonium Phosphate 18-46-0	$ 0.1385607	11,413	$ 1,581.39
Ammonium Nitrate 34-0-0	0.073614	576	42.40
Potassium Chloride 0-0-60	0.083093	6048	502.56

Total Fertilizer Cost $ 2,126.35

($ 3.00 per acre) Spreading Charge 225.00

TOTAL BILL $ 2,351.35

UNIT III - SOIL FERTILITY AND MANAGEMENT Name______________________________

Lesson 4: Fertilizing Soils Date______________________________

EVALUATION

Complete the following questions.

1. What are the three types of fertilizer?

   a.

   b.

   c.

2. In what four forms can mineral and chemical fertilizers be purchased?

   a.

   b.

   c.

   d.

3. What are the primary soil nutrient deficiencies that most often need to be corrected?

   a.

   b.

   c.

4. What is the primary source for purchasing fertilizer products?

5. What are alternative sources for purchasing fertilizer products?

   a.

   b.

6. What four factors affect when fertilizers are applied?

   a.

   b.

   c.

   d.

7. What time of the year is best for applying anhydrous ammonia?

8. How is the application rate determined?

9. What is the only fertilizer that requires measuring on a rating system?

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

10.	____ Application technique for anhydrous ammonia.	a.	Broadcasting
11.	____ Method used to fertilize pastures.	b.	Soil injection
12.	____ Used when planting to stimulate seed germination.	c.	Banding
13.	____ Dry fertilizer placed to each side and below seed.	d.	Starter applications
14.	____ Spreading dry fertilizer over soil prior to planting.	e.	Side-dressing
15.	____ Application of fertilizer in irrigation systems.	f.	Top-dressing
16.	____ Fertilizer applied directly to leaves of plants.	g.	Foliar
17.	____ Fertilizer applied 6 to 8 inches from the plant row.	h.	Fertigation

Lesson 4: Fertilizing Soils Name________________________

Calculating Fertilizer Needs and Cost

Objective: Students will be able to identify components of a fertilizer bill of sale and calculate fertilizer needs spreading rate, guaranteed analysis, and costs.

Directions: Using Table 4.2 from the Student Reference and the following information, complete the fertilizer bill of sale on the back of this page and answer the questions below.

Soil Test Recommendations:
N = 30
P = 70
K = 50

Total acres to spread is 75.

Fertilizer Sources and Costs per pound:

Ammonium Nitrate 18-46-0	$ 0.073614
Diammonium Phosphate 34-0-0	$ 0.1385607
Potassium Chloride 0-0-60	$ 0.083093

Spreading charge is $3.00 per acre.

Key Questions:

1. What are the total pounds needed of each of the following:

   a. Nitrogen -

   b. Phosphorus -

   c. Potassium -

2. How many total pounds of source fertilizer are to be used?

3. What is the spreading rate?

4. What is the amount of the total bill?

Agriculture Supply Center

Anyplace, Missouri 000-555-9999

Name ____________________ Delivered by ____________________

Address ____________________ Date ____________________

	Nitrogen	Phosphorus	Potassium
Soil Test Recommendation (lb./ac.)			
Total Acres to Spread			
Total Pounds of Fertilizer Needed			

MANUFACTURING INSTRUCTIONS

Use the Following:		*Percent of Materials Used*			*Pounds of Actual Plant Food Supplied*		
Fertilizer Source	Lb.	N	P	K	N	P_2O_5	K_2O
Total Lb.		*Total Lb. Supplied*					

__________ ÷ ______ = ______________ Spreading Rate (lb. per acre)

(Total Lb.) (Acres)

Guaranteed Analysis = ______ % ______ % ______ % (lb. of nutrient/acre ÷ spread rate)

N P_2O_5 K_2O

Fertilizer Source Used	*Cost per Lb.*	*Lb. Used*	*Cost per Source*
			$

Total Fertilizer Cost $

($______ per acre) Spreading Charge $

TOTAL BILL

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 5: Soil Management Practices

Competency/Objective: Identify how tillage and planting methods affect soil fertility.

Study Questions

1. **What are the advantages and disadvantages of different tillage practices?**
2. **What are the advantages and disadvantages of different planting methods?**
3. **What effects do tillage and planting methods have on soil structure?**
4. **How can crop rotation practices be used to enhance soil fertility?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.
2. Humphrey, John Kevin. *Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995, Lesson 5.
3. Minor, Paul. *Soil Science*. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995, Chapter 12.
4. Transparency Master
   a) TM 5.1: Equipment Tillage Triangle
5. Activity Sheets
   a) AS 5.1: Determining Tillage Costs
   b) AS 5.2: Soil Compaction and How It Develops
   c) AS 5.3: Estimating the Percent of Residue Cover

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 5: Soil Management Practices

TEACHING PROCEDURES

A. ***Review***

Soil is one of our most precious natural resources. Because it renews itself so slowly (it takes approximately 1 thousand years to produce an inch of soil), it is everyone's responsibility to protect what little we have available. One of the best ways producers can protect the soil is through soil conservation. This lesson will explore the many options available in soil management so that students as future producers are aware of how they can protect this valuable resource.

B. ***Motivation***

1. Invite a local soil conservation agent to discuss tillage practices and planting methods used in your area.

2. Tour a farm utilizing both conventional and conservation tillage practices. Allow a producer to explain the advantages and disadvantages of each practice.

3. Video: *No-Till, Protecting the Heartland*, 1997, Zeneca Agricultural Products. (Available free at 1-800-759-2500.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. After completing one of the motivational activities, review the advantages and disadvantages of the different tillage practices. After the review, refer to AS 5.1. Have students discuss the results of their research with the class.

What are the advantages and disadvantages of different tillage practices?

a) Tillage - the act of moving soil particles or cultivating the land
   1) Used to prepare a suitable seedbed, eliminate weed competition, and improve the condition of soil
   2) Defined by level of crop residue left on soil surface
      (a) Conventional - residue levels less than 15%
      (b) Conservation - residue levels at least 30%
      (c) Reduced or minimum tillage - residue levels between 15 and 30%

b) Conventional tillage - tilling the soil using a moldboard plow, disk, or chisel plow to prepare the seedbed; inverts the soil leaving the soil surface clean and smooth; promotes organic matter oxidation
   1) Advantages
      (a) Machinery - familiar and widely available
      (b) Adaptable to a wide range of soil and crop conditions
      (c) Allows the use of cultivation for weed control throughout the growing season
      (d) Soil warms faster when soil residues are incorporated
   2) Disadvantages
      (a) Increased fuel and labor costs
      (b) High risk of erosion
      (c) Reduced organic matter

        (d) Soil compaction due to increased field traffic

c) Conservation tillage - tillage system designed to reduce wind or water soil erosion and increase soil organic matter
    1) Advantages
        (a) Reduces soil erosion 50 to 90% depending on the tillage practice
        (b) Increases infiltration of water and conserves moisture
        (c) Reduces sediment from runoff that reaches streams and lakes
        (d) Reduces production and maintenance costs with fewer trips across field
    2) Disadvantages
        (a) Increased dependence on herbicides and equipment
        (b) Equipment modification needs
        (c) Fertilizers and chemicals require specific timing and sequencing
        (d) Delay in planting due to moist, cool soil conditions
    3) No-till - least disruptive conservation tillage method; undisturbed soil except for a narrow seedbed (10% or less of the surface tilled)
        (a) Advantages
            (1) Crop residue dramatically reduces soil erosion.
            (2) Expenses for equipment and fuel are reduced.
            (3) Soil moisture is conserved.
            (4) Less time is required for planting crops.
            (5) Evaporation is reduced.
        (b) Disadvantages
            (1) Weed control dependent on herbicides
            (2) Delayed planting due to slow soil warmup
            (3) Soil compaction in upper soil zone
            (4) Risk of insect, disease, and weed problems
    4) Mulch-till - the total soil surface disturbed by tillage before planting; various tillage tools required; 30% residue left; weeds controlled with herbicides or cultivation
        (a) Advantages
            (1) Sufficient crop residue maintained to reduce erosion
            (2) A percentage of crop residue incorporated into the soil
            (3) Easy transition from conventional tillage methods
            (4) Increased roughness and filtration
            (5) Allows for surface-applied fertilizer and pesticide usage
        (b) Disadvantages
            (1) Soil compaction similar to conventional methods
            (2) Increase in fuel and labor costs
            (3) Requires more field traffic with increased time and labor costs
            (4) Some buried residue, limiting erosion-reducing potential
    5) Ridge-till - soil undisturbed except for the seedbed on ridges; used primarily on flat ground to aid in water drainage; weeds controlled with herbicides or cultivation
        (a) Advantages
            (1) Significant erosion reduction is possible.
            (2) Residue is channeled away, reducing planting interference.
            (3) Ridges warm up and drain faster.
            (4) Residue supports tractors in wet spots.
            (5) Tops of ridges provide ideal seedbed.
            (6) Evaporation is reduced and increases soil moisture.
            (7) Weed pressure and soil compaction from cultivation are reduced.
            (8) Food and shelter are provided for wildlife.
        (b) Disadvantages
            (1) Requires special planters and/or attachments
            (2) Wheel and tire width adjustments required on equipment
            (3) Ridges present challenges when turning on end rows

d) Subsoiling - tillage method used to break up the subsoil; promotes root growth in crops such as potatoes

2. Explain types of planting methods as well as the advantages and disadvantages of each method. Give examples of crops planted using each method.

What are the advantages and disadvantages of different planting methods?

a) Row method - Seeds are evenly spaced in parallel rows; used with corn, grain sorghum, soybeans, cotton, and vegetables; rows vary from ultranarrow to wide; includes skip row.
   1) Advantages
      (a) Allows for cultivation and reduces herbicide costs
      (b) High seed germination rates
   2) Disadvantages
      (a) Increased days to canopy
      (b) Population counts limited due to spacing requirements

b) Drill method - Seeds are in narrow rows at high populations; used with small grains such as wheat, oats, and alfalfa; soybeans, grain sorghum, and rice are also drilled.
   1) Advantages
      (a) Fertilizer can be incorporated with planting attachments.
      (b) No mechanical cultivation is required.
      (c) Fewer trips across the field mean saved time and labor.
      (d) There are fewer days to canopy resulting in reduced weed pressure saved moisture.
      (e) Plant distribution is better.
   2) Disadvantages
      (a) Mechanical cultivation is not possible.
      (b) Herbicides used increasingly to control weeds.

c) Broadcast method - Seeds are scattered in a random pattern across the top of the soil; used with grasses, legumes, and small grains.
   1) Advantages
      (a) Cheapest method
      (b) Provides for faster canopy to prevent erosion and control weeds
      (c) Minimum tillage
   2) Disadvantages
      (a) Poor germination
      (b) Limited crop selection
      (c) Uneven plant distribution

d) Aerial method - Airplane or helicopter is used to scatter seeds randomly across the field; used when soil is too wet to till or plant by other methods, especially with rice.

3. Explain how soil structure can be affected both positively and negatively by the tillage or planting method chosen. The physical structure of the soil is affected by crop residue, soil compaction, and moisture levels. Refer to AS 5.2. This activity will help the students understand how field traffic affects soil compaction. AS 5.3 will help the students determine the amount of crop residue on a field. For more information on this process, refer to University of Nebraska Extension Publication G93-1133, available at <http://ianr.unl.edu/pubs/fieldcrops/g1133.htm>.

What effects do tillage and planting methods have on soil structure?

a) Crop residue
   1) Insulates the soil, resulting in cooler, wetter soils
   2) Shifts soil's physical properties to a more natural state
   3) Higher concentration of nutrients, pesticides, and organic matter
   4) Changes populations of beneficial and harmful insects
   5) Soil surface becomes rougher as tillage decreases

b) Soil compaction
   1) Smaller pores and fewer channels in the soil lead to reduced water infiltration
   2) Greater surface wetness, more runoff, longer drying times

c) Soil moisture

1) Soil moisture is affected by residue and compaction and turning over of soil in tillage.
2) Soil temperatures can increase considerably from opening up soil to air and sunshine.

4. Crop rotation is growing different crops in recurring succession on the same land. Soil fertility and crop productivity are maintained by good crop rotations. Discuss various crop rotation practices that enhance soil fertility.

How can crop rotation practices be used to enhance soil fertility?

a) Control weeds, insects, and diseases
b) Improve organic matter content of soil
c) Increase nitrogen by using legumes
d) Increase soil nutrient utilization
e) Increase fertilizer efficiency
f) Reduce erosion

F. ***Other Activity***

Compare the top 2 inches of a soil sample to the top 4 or 5 inches of the same sample. Note the amount of residue and the degree of compaction at these depths. Now compare and contrast samples that are taken from conventional- versus conservation-tilled soils.

G. ***Conclusion***

Producers are responsible for preserving soil resources for the next generation of producers. This can be done through a variety of intelligent, informed decisions regarding soil management practices including tillage, planting, and crop rotation.

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

Answers to the activity sheets will vary depending on the results of the research. Activities 5.1 and 5.2 may be easily used with a partner or as a small group project. Activity 5.3 will probably work best as a class activity with three teams or groups working in the same field and combining data.

I. ***Answers to Evaluation***

1. No-till, mulch-till, ridge-till

2. Any four of the following answers are correct: limited competition from weeds, maintain or increase organic matter, increase nitrogen by using legumes, increase soil nutrient utilization, increase fertilizer efficiency, reduce erosion.

3. b
4. a
5. a
6. b
7. a
8. b
9. b
10. a
11. b
12. a
13. b
14. d
15. r

16. r
17. d
18. r
19. b
20. b
21. b
22. d
23. +
24. -
25. +
26. -
27. +
28. -

UNIT III - SOIL FERTILITY AND MANAGEMENT Name______________________________

Lesson 5: Soil Management Practices Date______________________________

EVALUATION

Complete the following short answer questions.

1. List three types of conservation tillage.

   a.

   b.

   c.

2. List four ways in which crop rotation practices enhance soil fertility.

   a.

   b.

   c.

   d.

Determine which type of tillage practice the following characteristics apply to. Mark "A" for conventional tillage or "B" for conservation tillage.

3. _____ Reduces soil erosion

4. _____ Provides a smooth soil surface

5. _____ Requires more traffic on a field

6. _____ Crop residue remains on the field

7. _____ Weeds are controlled by tillage

8. _____ Increases the need for herbicides

9. _____ Improves soil structure and organic matter content

10. _____ Soil surface is exposed increasing erosion

11. _____ Production costs for labor and time are reduced

12. _____ Plows or disks are used

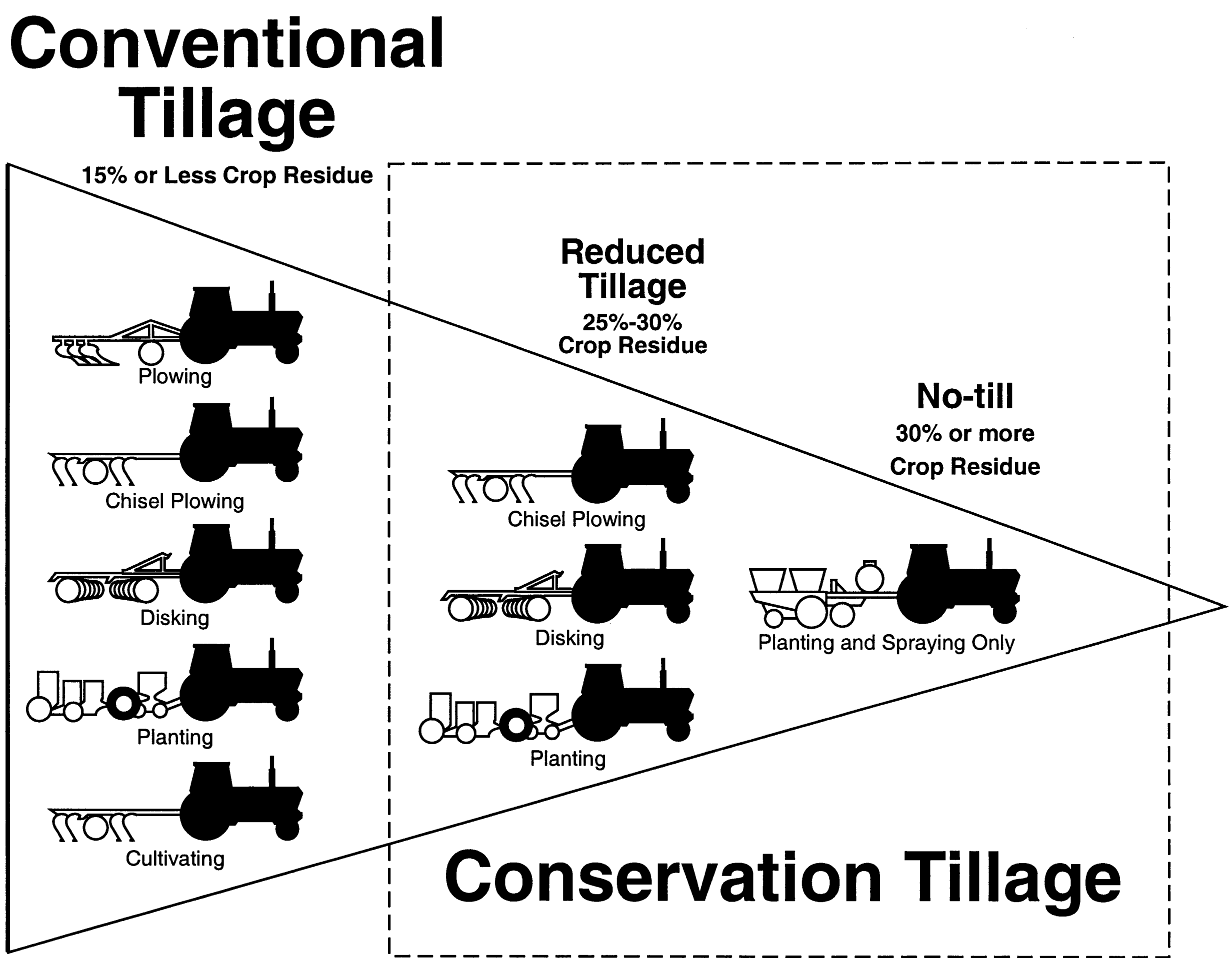
Determine which type of planting method the following characteristics apply to. Mark "R" for the row method, "D" for the drill method, or "B" for the broadcast method.

13. _____ Scattering seeds in a random pattern
14. _____ Mechanical cultivation is not possible
15. _____ Most expensive planting methods
16. _____ Ideal for planting large seeds
17. _____ Seeds placed in narrow rows
18. _____ Reduced population counts
19. _____ Poor germination
20. _____ Most economical
21. _____ Generally used to plant grasses and legumes
22. _____ Most often used to plant small cereal grains

Determine whether the following are positive or detrimental to soil structure. Use a "+" for positive and a "-" for detrimental.

23. _____ Conservation tillage
24. _____ Tilling the soil when wet
25. _____ Drill and broadcast planting
26. _____ Conventional tillage
27. _____ Maintaining crop residue
28. _____ Field traffic

Equipment Tillage Triangle



Adapted from *Fundamentals of No-Till Farming,* American Association for Vocational Instructional Materials, Athens, Georgia.

Lesson 5: Soil Management Practices Name______________________________

Determining Tillage Costs

Objective: Students will become familiar with equipment needs and cost differences between tilling a field with conventional tillage methods and with conservation tillage methods.

Procedure:

1. Choose a tillage method to research. Using equipment catalogs, brochures, or the Internet, determine the equipment needs of the tillage method chosen.
2. Make a list of equipment you would use based on your selected tillage method, for example, moldboard plow, disk, chisel plow, planter, drill.
3. Include any spray equipment and cultivators that may be needed for the tillage method chosen.
4. Also, list the approximate cost of each piece of equipment.
5. Compare your list with a fellow student who chose a different tillage method and then answer the questions below.

Key Questions:

1. What are the two tillage methods you compared?

   a.

   b.

2. From equipment costs alone, which tillage method is the most economical and which is the most expensive?

   a. Most economical -

   b. Most expensive -

3. In addition to equipment costs, what variables will also have an effect on your cash flow? Write a short paragraph or create a chart to explain your results.

Lesson 5: Soil Management Practices Name________________________

Soil Compaction and How It Develops

Objective: Students will analyze how soil compaction develops and determine ways to alleviate the effects.

Directions: In AS 5.1, you determined the equipment needs for different tillage methods. Using this information, determine which tillage method makes the most and the least trips across a field by completing the tables below. Include any field traffic that may occur from the application of herbicides and weed control. Be sure to write in the name of each method you are comparing.

Method No. 1		Method No. 2	
Equipment Used	No. of Trips	Equipment Used	No. of Trips
Total Trips Across Field		**Total Trips Across Field**	

Key Question:

Write a brief essay using the information above and from the lesson to explain how equipment size could affect the degree of soil compaction from each of these tillage methods. Include what steps might be taken such as adjusting tire pressure or combining operations to reduce compaction.

Lesson 5: Soil Management Practices Name____________________________

Estimating the Percent of Residue Cover

Objective: Students will estimate the percent of residue cover remaining after tillage/planting operations.

Directions: Accurate estimates of residue cover can only be obtained from measurements taken within the field while looking straight down at the soil and residue. The line-transect method is one of the easiest and most accurate methods of estimating residue cover. A 100-foot measuring tape is used most often, but other tape lengths, specially made cords with "beads" attached, or knotted ropes will also work. There should be 100 easily visible marks on the measuring device.

Procedure:

1. The measuring device is first stretched across a section of the field. Percent residue cover is then obtained by counting the number of marks on the measuring device that are directly over a piece of residue.

2. Select an area that is representative of the whole field. Avoid end rows or small areas of the field that have been adversely affected by flooding, drought, weed or insect infestations, compaction or other factors that have substantially reduced yields or affected residue cover.

3. Anchor one end of the tape or line and stretch it diagonally at about a 45° angle across the crop rows so it crosses more than one pass of the implements used. This avoids inaccurate readings such as those obtained if all measurements were taken in a windrow of residue left by the combine, or in an area of reduced amounts of residue. Do not take measurements parallel or perpendicular to crop rows.

4. Measure residue cover by counting the number of marks that are directly over a piece of residue. (An inexpensive click or lap counter can be useful to help keep count.) When looking at the tape and counting, follow these rules:
   - Keep both ends of the tape anchored and do not move the tape.
   - Look straight down at the tape and marks. Leaning from side to side will result in overestimation because residue may appear to be under the mark when it really is not.
   - Consistently look at the same side of the tape.
   - Consistently look at the same point at each mark.
   - Do not count if is questionable. A good way to determine this is by asking the question "If a raindrop falls at this point, will it hit residue or bare soil?"

5. When 100 points are observed, the number of marks that are directly over residue will be a direct measurement of the percent cover for that area of the field. For example, if 35 marks on a 100-foot tape were observed to be exactly over a piece of residue, then the residue cover is 35%.

6. If less than 100 points are observed, multiply the count by the appropriate conversion factor to obtain percent cover. For example, if a 50-foot tape is used, and only the foot marks are observed, multiply the count by two.

7. For increased accuracy, repeat the measuring process in three or more representative areas of the field. Average the individual measurements to obtain an estimate of percent cover for the entire field. The table on the back may be used to track the measurements.

# of Marks for 100-foot tape
1.
2.
3.
Total:
Average:

# of Marks for 50-foot tape	
1.	X 2 =
2	X 2 =
3.	X 2 =
Total:	
Average:	

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 6: Soil Conservation Practices

Competency/Objective: Identify the conservation practices that affect crop production.

Study Questions

1. **What is soil erosion?**
2. **What factors contribute to soil loss?**
3. **What management practices are used to control soil erosion?**
4. **What conservation practices enhance wildlife habitats?**

References

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

   a) AS 6.1: Measuring Slope
   b) AS 6.2: Contour Farming and Soil Erosion
   c) AS 6.2A: Contour Farming and Soil Erosion (Alternative Activity to AS 6.2)

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 6: Soil Conservation Practices

TEACHING PROCEDURES

A. ***Review***

The first five lessons of this unit explain soil composition, type and limitations, testing, fertilization, and management practices. Thorough knowledge and understanding of soil fertility and management are important when determining effective conservation methods. In an effort to conserve soil and maintain crop productivity, the producer is continually challenged to evaluate land management practices. By implementing soil conservation practices, producers can ensure the protection of our natural resources.

B. ***Motivation***

Show the 28-minute video *The Living Landscape* (VHO109) available from the Missouri Department of Conservation. The video shows how farming can function in harmony with the soil, plants, and animals. It will help the students understand the need for conservation practices.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Soil erosion is a constant concern for landowners and farmers. The land surface is worn away by water, wind, ice, and geological agents such as earthquakes, floods, and the natural wearing away of rock. Water erosion is the most prevalent in Missouri but some wind erosion can occur in the southeastern region.

   What is soil erosion?

   a) Soil erosion - wearing away of the land surface by water, wind, ice, and other geological agents
      1) No control over ice or geological erosion
      2) Wind erosion
         (a) Occurs in areas of high prevailing winds
         (b) Low annual rainfall
      3) Water erosion
         (a) Most destructive force to soil in Missouri
         (b) Caused by raindrop splash and flowing water
   b) Soil erosion by water
      1) Detaching soil particles
      2) Transporting particles
   c) Categories of water erosion
      1) Sheet - uniform removal of soil in thin layers or sheets
      2) Rill - runoff water in small, well-defined channels
      3) Gully - trenches cut to a depth of 12 inches or more
   d) Wind erosion
      1) Cannot be divided into distinct types
      2) Occurs mostly in flat, dry areas and moist sandy soils along bodies of water
      3) Removes soil and natural vegetation
      4) Causes dryness and deterioration of soil structure
      5) Detachable mucks, sands, and loamy sands

2. Soil erosion removes topsoil and causes loss of soil fertility, as well as creates environmental concerns that impair air and water quality. It is important to be aware of the factors that cause soil loss and to develop a plan that reduces the problem. Discuss the factors that make up the Universal Soil Loss Equation developed by the USDA that calculates soil loss from sheet and rill erosion. Use AS 6.1 to help students understand how slopes are measured and how they affect soil erosion.

What factors contribute to soil loss?

a) Rainfall factor (R) - measure of rainfall energy
b) Soil erodibility factor (K) - measure of soil's relative resistance to erosion
c) Slope length (L) and slope degree (S) factors - influence the amount of runoff and rate of water infiltration
d) Crop practice factor (C) - measure of the soil cover from prior crops
e) Conservation practice factor (P) - management tool that changes the flow pattern of water runoff or wind damage
f) Soil loss tolerance factor (T) - indicates the amount of soil that can be lost each year without seriously reducing productive capability

3. Discuss the major conservation practices recommended by the Natural Resources Conservation Service. Use AS 6.2 or 6.2A to demonstrate to students the conservation practice of contour farming.

What management practices are used to control soil erosion?

a) Residue management - the past year's crop residues left on the soil surface to reduce erosion
b) Contour farming - farming around a sloping cropland around the slope, rather than up and down
c) Cross slope farming - farming across the slope, nearly on the contour
    1) Provides an option for slopes that are very difficult to farm
    2) Not as effective at saving soil as contour farming
d) Contour strip cropping - growing crops on the contour with even-width strips or bands alternated with meadows or close-growing crops
e) Contour buffer strips - captures soil loss by planting bands of grass in a contoured field, similar to strip cropping
f) Field borders - stop erosion on end rows
g) Crop rotations - alternate row crop production with a high residue-producing crop to a low residue-producing crop, or a grass/legume meadow
h) Terraces - earthen embankments designed to slow down and catch runoff on moderate to steep slopes without forming erosion channels
    1) Storage terraces collect and store water until it can penetrate into the ground or release through underground outlets.
    2) Gradient terraces slow runoff water and channel it to a grassed waterway.
i) Water and sediment control basins - short earthen dams built across a slope or drainage way; used where terraces are impractical
j) Diversion - earthen embankment (similar to a terrace) that diverts runoff water from a specific area
k) Grassed waterways - grassy areas where flowing water gathers and is slowed as it is guided off the field
l) Pasture and hayland planting - builds topsoil and organic matter, making the soil better for crop growth
m) Planned grazing systems - allows resting time between two or more grazing areas in a planned sequence
n) Filter strips - bands of grass or legumes that filter runoff and other contaminants before they reach waterways

o) Cover crops - close-growing crops that temporarily protect the soil when major crops do not furnish enough cover

p) Farm ponds - control gully erosion and provide water for livestock
   1) Provide a water source for birds and animals
   2) Developed by building a dam or digging a pit

q) Windbreaks - rows of trees and shrubs that protect the soil, conserve energy, control snowdrifts, shelter livestock, and provide food and cover for wildlife

4. Discuss how the conservation management practices that reduce soil erosion also enhance wildlife habitats. Generally, any practice that provides food, cover, and water for wild birds and animals is considered a wildlife-enhancing conservation practice.

   What conservation practices enhance wildlife habitats?

   a) Cropland
      1) Use of tillage methods leave waste grain and weed seeds after harvest.
      2) Crop rotation practices provide plant diversity.
      3) Wildlife food plot is created from crops left standing after harvest.
   b) Grassland
      1) Includes all conservation methods seeded to a grass/legume mixture
      2) Should not be mowed until mid-July
   c) Idle lands
      1) Field borders, fence rows, turn-rows, or areas around farm ponds seeded with various plants that will benefit wildlife
      2) Nesting, brood-rearing, and concealment cover for wildlife

F. *Other Activities*

1. View the 18-minute video *Farming and Wildlife* available from the Missouri Resource Center for Career and Technical Education (MRCCTE) Ag Video 14.

2. Visit various farms to observe cropland and grassland areas where conservation practices have been implemented. Include areas where improvements can be made to reduce soil erosion.

G. *Conclusion*

Erosion is continuous and therefore must be a priority in all crop production enterprises. Students need to understand causes and prevention measures. NRCS and local soil conservation districts can assist landowners and producers with information and services on soil management conservation practices that can help control erosion and enhance wildlife habitats.

H. *Answers to Activity Sheet*

AS 6.1

Answers will vary depending on the results of the experiment.

AS 6.2 or 6.2A

Answers will vary depending on the results of the experiment.

I. *Answers to Evaluation*

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

5. a
6. c
7. b
8. Rainfall factor, soil erodibility factor, slope length factor, slope degree factor, crop practice factor, conservation practice factor

9. Answers will vary but should include conservation management practices from the areas of cropland, grassland, or idle lands.

10. b
11. a
12. d
13. c
14. a
15. c

UNIT III - SOIL FERTILITY AND MANAGEMENT	Name______________________________

Lesson 6: Soil Conservation Practices	Date______________________________

EVALUATION

Match the term in the left column with the definition in the right column. Terms will be used more than once.

1. _____	Uniform removal of soil by raindrop splashes	a.	Sheet erosion
2. _____	Occurs in areas with high prevailing winds and low annual rainfall	b.	Rill erosion
3._____	Forms trenches to a depth greater than 12 inches	c.	Gully erosion
4. _____	Runoff water forms into small, well-defined channels	d.	Wind erosion
5. _____	Soil is removed in thin layers		
6. _____	Develops where vegetative cover has been disturbed		
7. _____	Occurs primarily in recently tilled fields		

Complete the following short answer questions.

8. What are the six factors that contribute to soil loss from water erosion?

   a.

   b.

   c.

   d.

   e.

   f.

9. List and describe two conservation practices that enhance wildlife habitats.

   a.

   b.

Circle the letter that corresponds to the best answer.

10. ______________________________ is growing crops on the same land in an orderly sequence.

    a. Residue management
    b. Crop rotation
    c. Diversions
    d. Cover crops

11. ________________ is/are alternating contoured perennial vegetation strips with wider cultivated bands.

   a. Contour buffer strips
   b. Field borders
   c. Grassed waterways
   d. Cross slope farming

12. When two or more grazing areas are rested in a planned sequence, it is referred to as ___________.

   a. Terraces
   b. Pasture and hayland planting
   c. Field borders
   d. Planned grazing system

13. When preparing the soil, planting, and cultivating crops around a slope, rather than up and down the slope, it is referred to as _______________________.

   a. Contour buffer strips
   b. Terraces
   c. Contour farming
   d. Crop rotation

14. A ________________ is a channel or ridge that directs excess runoff from an area.

   a. Diversion
   b. Field border
   c. Filter strip
   d. Pasture and hayland planting

15. _______________________ should be planted on the north and west sides of the area to be protected.

   a. Field borders
   b. Filter strips
   c. Windbreaks
   d. Grassed waterways

Lesson 6: Soil Conservation Practices Name______________________________

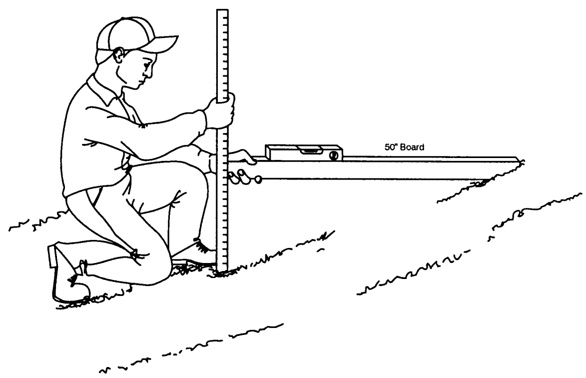
Measuring Slope

Objective: Students will identify procedure to measure the slope of a field.

Materials and Equipment:

Yardstick
1x4 board, exactly 50 inches long
Carpenter's level or bottle half full of a colored liquid

Procedure:



1. Locate an area that can be measured to determine the slope.

2. Place the 50-inch board horizontally on the ground (one end will be higher than the other because of the slope).

3. Put the level (or the bottle) on the board and move the free end of the board up or down until the bubble (or water) shows that the board is level.

4. Read on the yardstick the distance from the ground to the bottom edge of the horizontal board. Multiply this reading by 2 to get the percent of slope. (If the board used was 100 inches long, then you would not need to multiply by 2. The reading on the yardstick is the percent of slope.)

Key Questions:

1. What is the measurement reading on the yardstick?

2. What is the percent of slope?

3. Using Table 6.1, list the slope classification for the test site.

4. What erosion problems could occur from this slope classification?

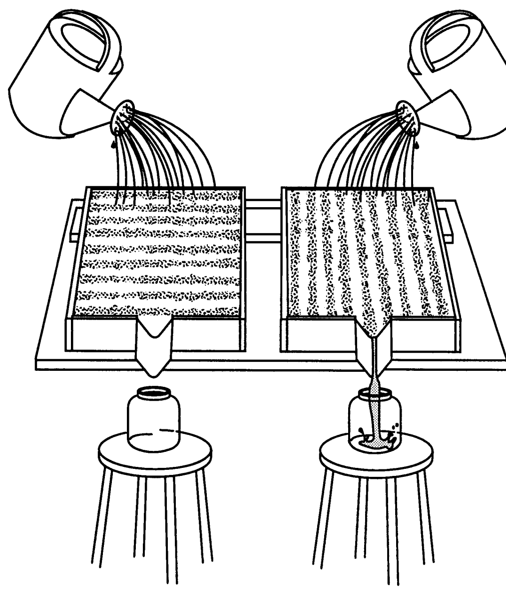
 Name______________________________

Contour Farming and Soil Erosion

Objective: Students will identify how contour farming affects soil erosion.

Materials and Equipment:

Two small boxes about 16 inches long, 12 inches wide, and 4 inches deep
Two watering cans with sprinkler nozzles
Two clear glass containers
One 2x4, 3 feet long
Soil (can use potting soil)



Procedure:

1. Cut a small V-notch about 1 to 1½ inches deep at the end of each box and fit with a tin spout to draw runoff water into a container.

2. Fill both boxes with the same type of soil taken from the same area. Set the boxes on a table and place the 2x4 under the unnotched end of both to make a slope.

3. Place a clear glass container below the V-notch or spout of the boxes.

4. Using your finger or a pencil, make furrows across the soil in one box and up and down the soil in the other box.

5. Fill the watering cans with water and slowly sprinkle the two boxes at the same time. Hold the sprinklers the same height above the soil and pour at the same rate.

6. Compare the rate of flow into the two containers and note the difference in the contents of the flow.

Key Questions:

1. What effect did the contouring (furrows) have on the rate of water flow through each box and into the container?

   a) Furrows running crosswise:

   b) Furrows running up and down:

2. How do the contents of the containers compare with each other? What is in each container?

3. What conclusions can you make about soil erosion and drainage for each?

   a) Furrows running crosswise:

   b) Furrows running up and down:

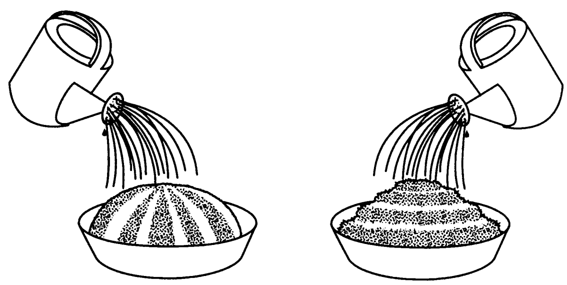
Lesson 6: Soil Conservation Practices Name_______________________________

Contour Farming and Soil Erosion

Objective: Students will identify how contour farming affects soil erosion.

Materials and Equipment:

Two large, round pie pans
Watering can with sprinkler nozzle
Soil (can use potting soil)



Procedure:

1. Put two mounds of soil in the two large round pie pans.

2. With a pencil or your finger make furrows up and down one of the mounds and circles around the other mound.

3. Fill the watering can with water. Slowly sprinkle an equal amount of water on each mound and observe the water as it flows over the mounds. (Keep in mind that these example mounds probably have much steeper slopes than most cultivated land.)

Key Questions:

1. What effect did the contouring (furrows) have on the rate of water flow in each pan?

   a) Furrows running up and down:

   b) Furrows running around:

2. What conclusions can you make about soil erosion and drainage for each?

   a) Furrows running up and down:

   b) Furrows running around:

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 1: Crop and Weed Identification

Competency/Objective: Identify crop and weed seeds and plants.

Study Questions

1. **What plant types and physical characteristics are used to identify crop and weed plants?**
2. **What are the characteristics of grass and grasslike plants?**
3. **What are the characteristics of legumes?**
4. **What are the characteristics of forbs?**
5. **What are the characteristics of woody plants?**
6. **What are the identifying characteristics of common weed plants?**
7. **What are the identifying characteristics of noxious weed plants?**
8. **What are the identifying characteristics of crop and weed seeds?**
9. **What weed seeds are included on the restricted noxious list?**
10. **What weed seeds are included on the restricted prohibited list?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IV.
2. *Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.
3. *Crop and Grassland Plant Identification Manual.* University of Missouri-Columbia: Instructional Materials Laboratory, 1997.
4. *Growers Weed Identification Handbook* (Publication 4030). Cooperative Extension. University of California, Division of Agriculture and Natural Resources, 1991. (Available for free loan from MRCCTE, University of Missouri-Columbia.)
5. Transparency Masters

   a) TM 1.1: Leaf Characteristics
   b) TM 1.2: Cool- and Warm-Season Grass Growth

6. Activity Sheet

   a) AS 1.1: Identifying Weeds of Missouri

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 1: Crop and Weed Identification

TEACHING PROCEDURES

A. ***Introduction***

This lesson will discuss the identifying characteristics of crop and weed seeds and plants. It is important for the producer to understand the differences and be able to identify, in particular, those weeds that can be harmful to the productive value of the crop. Early detection is necessary to effectively control weeds.

B. ***Motivation***

1. Have students bring in plant samples from grasslands or crop fields near their homes. Discuss what types of plants can be found locally.

2. Divide the class into groups. Give each group a package of mixed seeds (e.g., corn, sunflower, and pinto beans). Have students separate and identify them. Discuss how they identified the seeds and why identification is important. While the students are divided into groups with the seeds separated, point out to them distinguishing characteristics of specific seeds. Refer to IML's *Crop Science* Student Reference for a review of identifying characteristics of crop and weed seeds.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss how plants can be classified other than by life cycles. Plants are also categorized according to their physical characteristics. Using the plants acquired during the Motivation, group the plants found locally into the four plant types. Leaf characteristics are the most varied. Using TM 1.1, review the characteristics of leaves.

   What plant types and physical characteristics are used to identify crop and weed plants?

   a) Plant types
      1) Grasses and grasslike plants
      2) Legumes
      3) Forbs
      4) Woody plants
   b) Physical characteristics
      1) Leaf shape
      2) Stem
      3) Flower
      4) Root

2. Separate grasses according to required temperature for growth. Point out examples of cool-season grasses, such as Kentucky bluegrass, orchardgrass, and smooth bromegrass. Compare the differences to warm-season grasses, such as indiangrass, big blue stem, and switchgrass. Discuss the characteristics of both cool-season and warm-season grasses. Show TM 1.2 of Cool- and Warm-Season Grass Growth. Also refer to the *Crop and Grassland Plant Identification Manual* for more examples of grasses.

What are the characteristics of grass and grasslike plants?

a) Characteristics
   1) Herbaceous
   2) Hollow stems
   3) Blades and stems joined directly at sheath
   4) Parallel venation on leaf blade
b) Cool-season grasses
   1) Grow when soil temperatures reach 40°F in early spring,
   2) Optimum growth with air temperatures from 59° to 77°F in spring and fall
   3) Dormant in summer
   4) Annuals or perennials
c) Warm-season grasses
   1) Grow when soil temperatures reach 60°F in spring, with optimum growth occurring when air temperatures increase from 77° to 104°F in summer
   2) Dormant in winter
   3) Annuals or perennials

3. Discuss the characteristics of legumes. Point out some examples of legumes, such as clovers, alfalfa, and birdsfoot trefoil. Refer to the *Crop and Grassland Plant Identification Manual* for details.

What are the characteristics of legumes?

a) One-chambered fruit with seeds in a single row within the pod
b) Alternating leaf arrangement - usually connected to petiole
c) Network of veins
d) May be annuals, perennials, or biennials
e) Nodules with nitrogen-fixing capacity on most rooting systems

4. Other herbaceous plants that are neither grasses nor legumes are classified as forbs. Discuss the characteristics of forbs. Examples of forbs include sunflowers, thistles, and ragweed. Refer to the *Crop and Grassland Plant Identification Manual.*

What are the characteristics of forbs?

a) Herbaceous (not woody) stems
b) Broadleaf plants
c) Commonly appear in pastures, fields, and native plant habitats
d) May be annuals, perennials, or biennials
e) Valued as wildlife food and cover
f) Prevent soil erosion
g) Some are noxious

5. Other nonherbaceous plants found in grasslands are woody plants. In crop production, most woody plants will be weedy saplings or small immature trees and shrubs. Examples of woody plants include wild rose, red cedar, and oak. Discuss the characteristics of woody plants. Refer to the *Crop and Grassland Plant Identification Manual.*

What are the characteristics of woody plants?

a) Woody (nonherbaceous) stems
b) Shrubs, vines, or trees
c) Usually immature in grasslands
d) Perennials

6. Explain that common weeds are relatively easy to control but reduce crop yields and increase production costs. Remind students that plants that are considered crops, such as corn and soybeans, are weeds if they are growing in the wrong field. Refer to the *Crop and Grassland Plant Identification Manual* to identify common weed plants. The *Growers Weed Identification Handbook* available from MRCCTE can also be used.

    What are the identifying characteristics of common weed plants?

    a) Easy to control
    b) Annual or perennial
    c) Grass or forb

7. Explain that noxious weeds are difficult to control and that the presence of noxious weed seed in agricultural crop seeds is restricted in Missouri. Refer to Table 1.1 in the Student Reference for detailed characteristics of noxious weeds.

    What are the identifying characteristics of noxious weed plants?

    a) Crowds out desirable crops
    b) Robs crops of plant nutrients and moisture
    c) Causes extra labor in cultivation
    d) Annual, biennial, or perennial
    e) Grass or forb
    f) Growing plants considered noxious
        1) Musk thistle
        2) Scotch thistle
        3) Canada thistle
        4) Multiflora rose
        5) Bindweed
        6) Purple loosestrife
        7) Marijuana (*Cannabis sativa*)
        8) Johnsongrass

8. The Bureau of Feed and Seed administers laws and regulations to ensure that seeds are labeled consistently and accurately. Discuss with the class various characteristics of crop and weed seeds. Refer to IML's *Crop Science* curriculum for further information.

    What are the identifying characteristics of crop and weed seeds?

    a) Size
    b) Shape
    c) Color
    d) Surface markings
    e) Other botanical characteristics

9. Refer to the current Missouri Seed Law and Regulations for weed seeds listed as restricted noxious. Restricted noxious weed seeds are defined as highly objectional in fields, lawns, or gardens of Missouri and are difficult to control by good cultural practices. Seed companies must list these seeds, if any, on labels.

    What weed seeds are included on the restricted noxious list?

    a) Red sorrel
    b) Curled dock
    c) Dodder
    d) Buckhorn plantain
    e) Black nightshade

f) Giant foxtail
g) Hedge bindweed
h) Leafy spurge
i) Hoary cress
j) Purple moon flower
k) Quackgrass
l) Russian thistle
m) Slender oats
n) Wild garlic
o) Wild onion
p) Wild oats
q) Yellow star thistle

10. Discuss the weed seeds that are listed on the restricted prohibited list. Restricted prohibited weed seeds are defined by law as the seeds of weeds that when established are highly destructive and difficult to control in this state by good cultural practices. Explain that each state determines its own prohibited seed list. Seed companies must design seeds to certain state specifications.

    What weed seeds are included on the restricted prohibited list?

    a) Canadian thistle
    b) Field bindweed
    c) Johnsongrass
    d) Sorghum almum
    e) Musk thistle
    f) Balloon vine
    g) Serrated tussock

F. ***Other Activities***

1. Take a field trip to a nearby pasture or field and discuss the different types of plants found there. Have the students explain the different plant uses for producers, livestock, wildlife, and others.

2. Have students create their own plant guide with samples collected from local grasslands and crop field areas. Guides should include 25 different plants with at least three from each classification. Plant samples should be collected, mounted, and labeled according to plant type: grass (warm- or cool-season), legume, forb, or woody.

G. ***Conclusion***

The ability to identify the differences between crops and weeds is important to the production of a profitable crop. Proper seed and plant identification plays a part in the process of reducing weeds and in turn reducing the damage to crops.

H. *Answer to Activity Sheet*

AS 1.1

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+ + + + + + + + + + + + + + + + + B B S
+ + + + + + + + + + + + + + + + L + U S
+ + + + + W I L D G A R L I C A + + C A
+ + + + + + + + + + + + + + C + + + K R
+ + W + + + + + + + + + + K + + + + H G
+ + + I + + + + + + + + N + + + K D O K
+ + + + L + L + + + + I + + + C O + R C
+ D E E W D N I B E G D E H O D + + N A
+ + + + + + O + A H + + + D D + + + P U
+ + + + + + + N T T + + D E + + + + L Q
R + + + + + + S I + X E R + + + + + A +
E + + + + + H + + O L O + + + + + + N +
D + + + + A + + + R N + F + + + + + T +
S + + + D + + + U + + + + T + + + + A +
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L + + + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + +
```

AS 1.2

Answers will vary.

I. *Answers to Evaluation*

1. b
2. e
3. c
4. a
5. d
6. d
7. b
8. a
9. a
10. b
11. c
12. e
13. a
14. b
15. b
16. a
17. a
18. a
19. b
20. b
21. c
22. They are nonherbaceous with woody stems.
23. Common, noxious, prohibited
24. *Missouri Seed Law and Regulations*

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS Name________________________

Lesson 1: Crop and Weed Identification Date ________________________

EVALUATION

Match the characteristics in the left column with the correct plant type in the right column.

1. ____ Plant with seeds in a single row within the pod
2. ____ Herbaceous, broadleaf plant growing in a native habitat
3. ____ Nonherbaceous perennial plant
4. ____ Plant with parallel venation and optimum growth from 59° to 77°F
5. ____ Plant with parallel venation and optimum growth from 77° to 104°F

a. Cool-season grass

b. Legume

c. Woody plant

d. Warm-season grass

e. Forb

Match the plant in the left column with the plant type in the right column.

6. ____ Corn
7. ____ Soybeans
8. ____ Wheat
9. ____ Orchardgrass
10. ____ Alfalfa
11. ____ Red cedar
12. ____ Cotton

a. Cool-season grass

b. Legume

c. Woody plant

d. Warm-season grass

e. Forb

Match the weed seed in the left column with the correct designation in the right column.

13. ____ Yellow star thistle
14. ____ Johnsongrass
15. ____ Canada thistle
16. ____ Wild onion
17. ____ Giant foxtail
18. ____ Dodder
19. ____ Balloon vine

a. Restricted noxious seed

b. Restricted prohibited seed

Circle the letter that corresponds to the best answer.

20. Which plant types are the dominant species in a pasture, grassland, or range?

    a. All plant species
    b. Grasses and legumes
    c. Forbs and grasses
    d. Woody plants, grasses, and legumes

21. Which plant species is not usually cultivated for agricultural production?

    a. Grasses
    b. Legumes
    c. Forbs
    d. Grasses and legumes

Complete the following short answer questions.

22. What makes woody plants different from all the other plant types?

23. What are three types of weed plants?

    a.

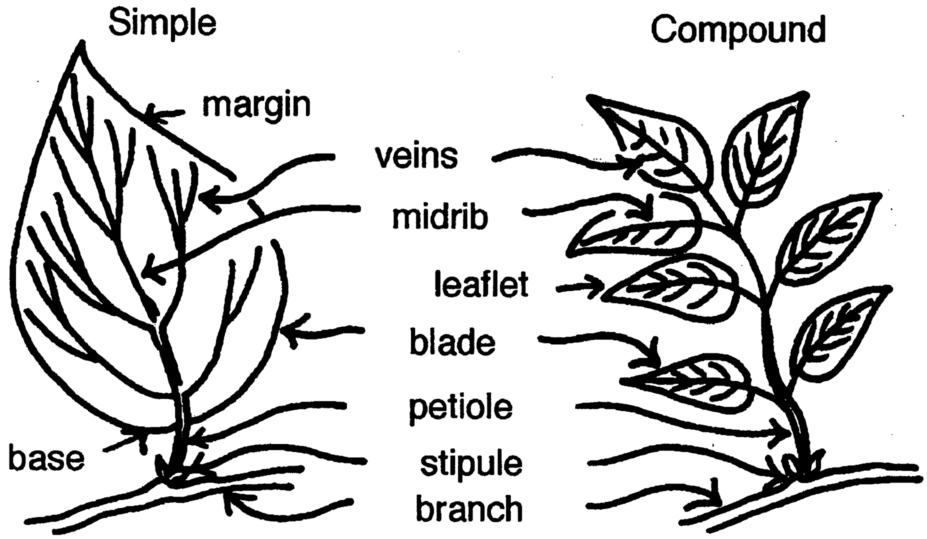
    b.

    c.

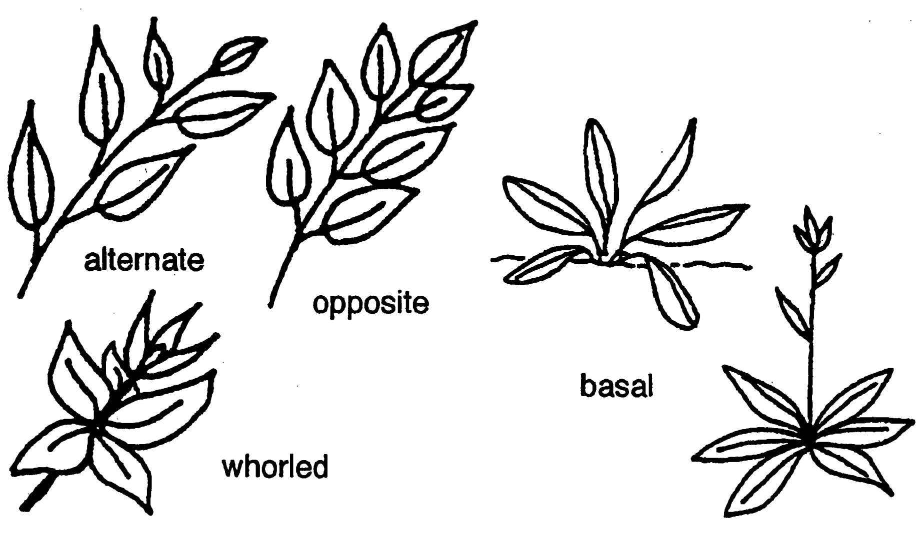
24. What reference should be used for information concerning weed seeds listed as restricted noxious?

Leaf Characteristics

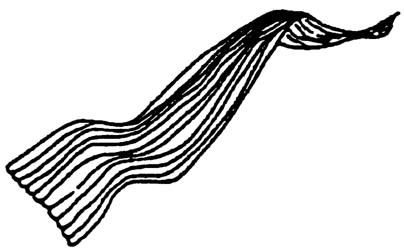
Leaf Parts



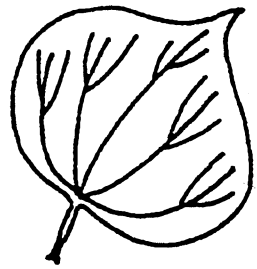
Leaf and Bud Arrangement



Leaf Venation



parallel



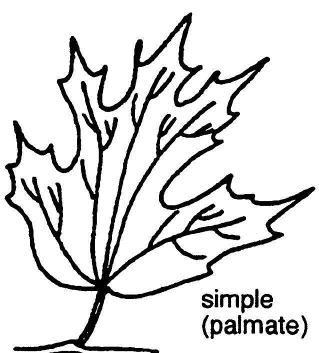
palmate

pinnate

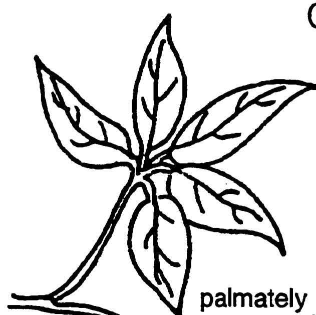
Leaf Types

Simple

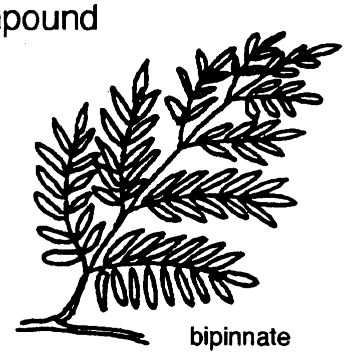
Compound



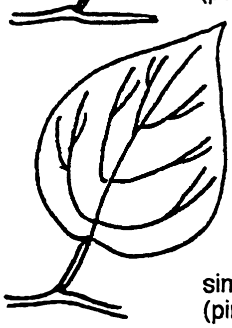
simple
(palmate)



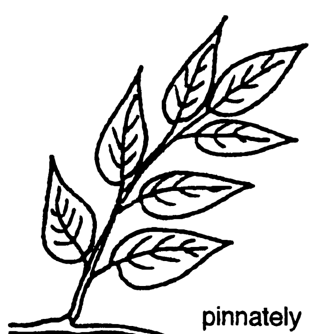
palmately
compound



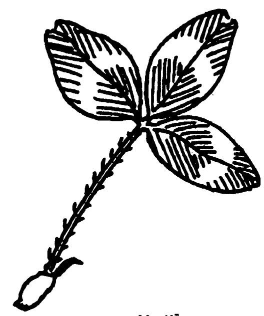
bipinnate



simple
(pinnate)

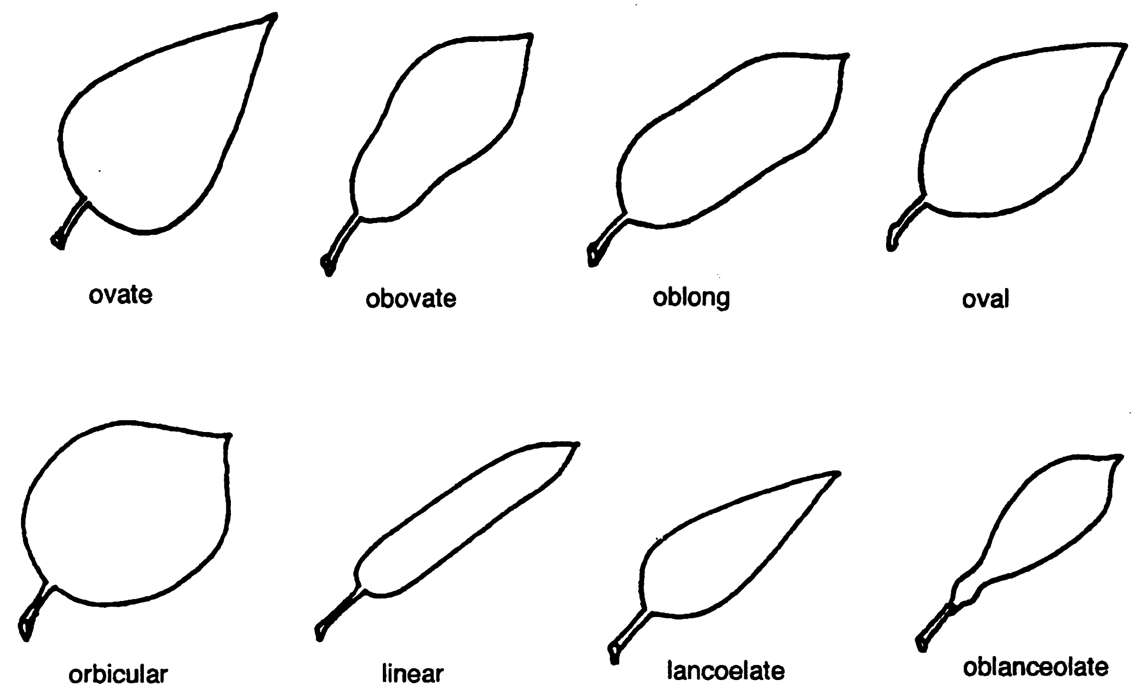


pinnately
compound

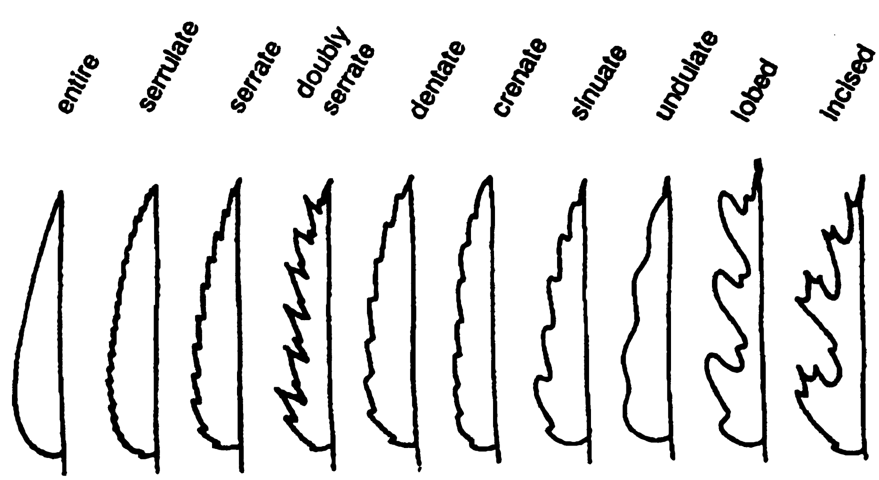


trifoliate

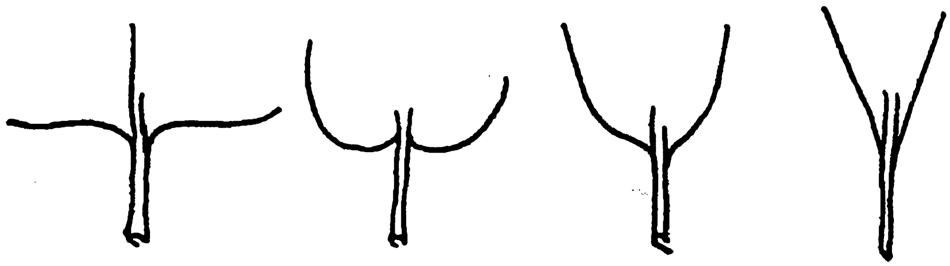
Leaf Shapes



Common Leaf Margins



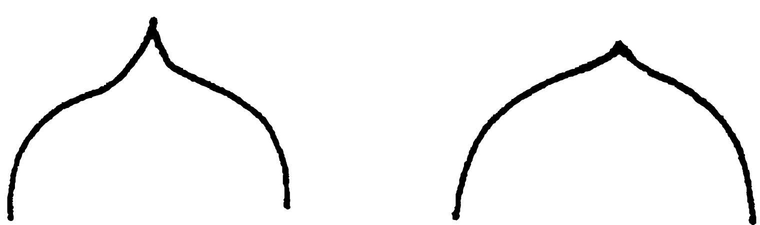
Common Base Shapes



truncate   cordate   rounded   cuneate

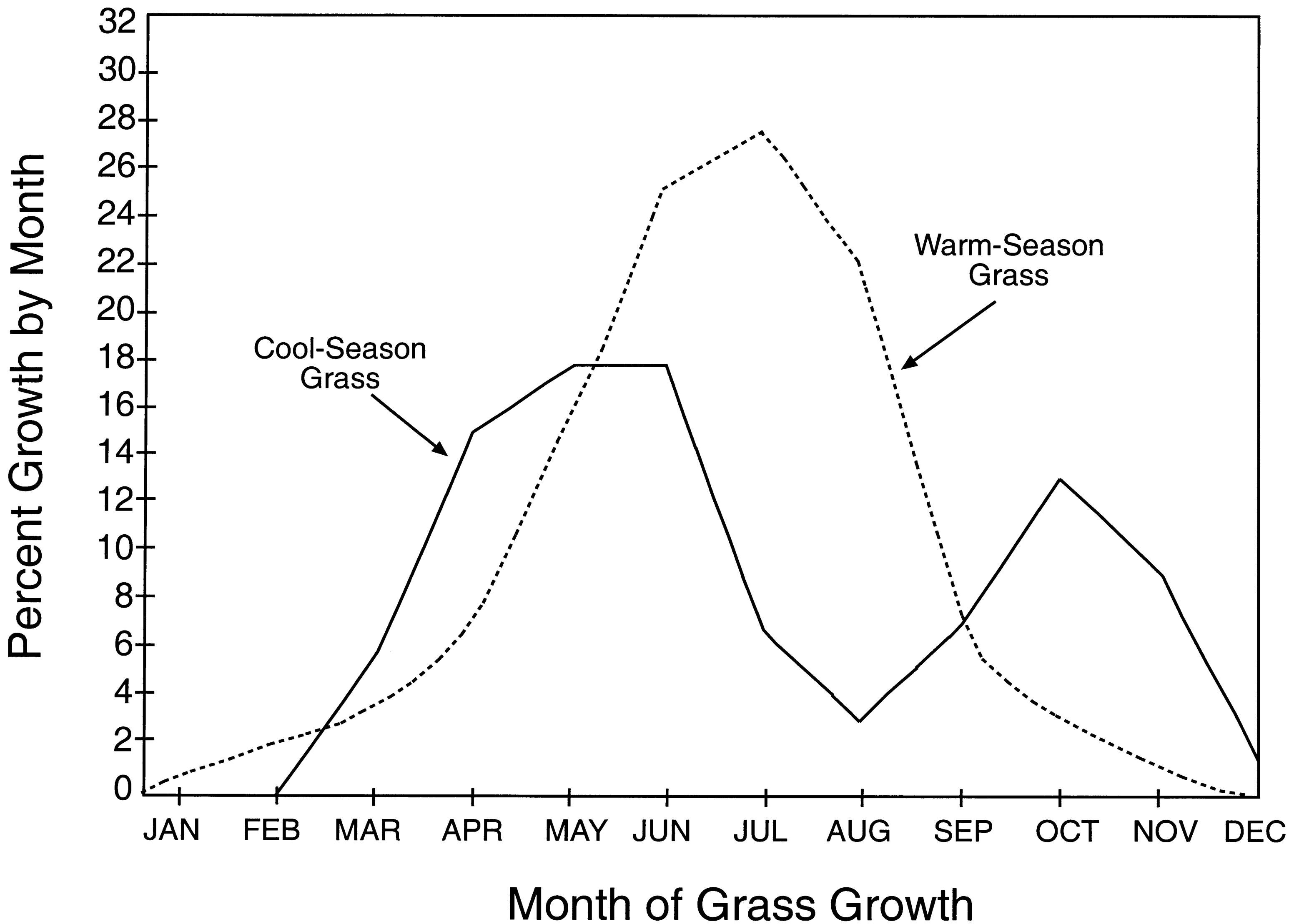
Common Tip Shapes

emarginate   obtuse



cuspidate   acute

Cool- and Warm-Season Grass Growth



TM 1.2

Lesson 1: Crop and Weed Identification Name________________________

Identifying Weeds of Missouri

Objective: Students will identify terms used to identify weeds found in Missouri.

Directions: Complete the word search puzzle below by finding the following ten noxious weeds listed below that are found in Missouri. There are no blank spaces between words in the word search.

Black Nightshade	Buckhorn Plantain	Giant Foxtail
Curled Dock	Dodder	Hedge Bindweed
Quackgrass	Red Sorrel	Wild Garlic
Wild Onion		

X	E	V	D	J	P	L	T	G	S	Y	H	C	D	C	U	A	B	B	S
N	W	A	Z	A	N	R	D	F	G	X	M	C	U	X	W	L	L	U	S
R	V	V	L	E	W	I	L	D	G	A	R	L	I	C	A	E	J	C	A
J	D	D	F	X	O	G	B	E	Q	L	K	P	C	C	E	F	N	K	R
P	X	W	H	L	Q	X	K	D	K	Y	I	N	K	F	U	D	G	H	G
X	M	A	I	W	Q	D	B	C	W	S	M	N	N	U	N	K	D	O	K
W	K	O	J	L	X	L	O	I	N	J	I	Y	D	J	C	O	B	R	C
C	D	E	E	W	D	N	I	B	E	G	D	E	H	O	D	E	A	N	A
J	A	H	H	T	E	O	V	A	H	V	W	X	D	D	P	U	L	P	U
A	D	E	W	M	D	F	N	T	T	Q	Q	D	E	L	D	M	M	L	Q
R	X	B	I	H	N	F	S	I	V	X	E	R	I	I	K	T	A	A	T
E	T	G	I	W	O	H	Q	E	O	L	O	Q	O	Z	K	J	J	N	S
D	U	N	F	N	A	L	R	W	R	N	L	F	G	W	V	H	V	T	A
S	U	H	O	D	V	I	Y	U	Z	R	X	G	T	F	W	A	A	A	W
O	H	S	E	M	G	A	C	D	I	L	N	T	R	N	C	Q	H	I	O
R	E	K	I	P	Y	R	Y	T	N	B	T	Q	F	I	A	A	S	N	N
R	X	D	E	C	O	H	Q	E	L	O	H	B	L	Y	L	I	A	O	X
E	A	I	T	A	M	P	B	A	B	K	P	Y	Y	Z	H	O	G	D	N
L	P	D	F	G	N	G	O	G	T	G	R	A	L	L	U	V	R	Y	X
W	S	P	T	W	D	F	J	Y	L	Y	O	R	T	Z	W	K	T	S	U

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 2: Crop Selection

Competency/Objective: Identify factors that determine crop selection.

Study Questions

1. **What factors affect crop selection?**
2. **How does the growing region affect crop selection?**
3. **What are the maturity groups for selected crops?**
4. **What economic factors influence crop selection?**

References

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

2. Transparency Masters

   a) TM 2.1: Spring Frost Dates
   b) TM 2.2: Fall Frost Dates
   c) TM 2.3: Average Annual Rainfall
   d) TM 2.4: Soybean Maturity Zones

3. Activity Sheet

   a) AS 2.1: Crop Selection Factors

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 2: Crop Selection

TEACHING PROCEDURES

A. ***Review***

Lesson 1 taught what characteristics to look for when identifying plants. This lesson will expand on that information to include growth characteristics to aid the producer in selecting a specific crop.

B. ***Motivation***

Ask the students to survey the grain producers in their area, listing not only what crops are grown, but also what varieties are planted. Share this information with the class to draw conclusions on a consensus of producer preferences.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss with the class various factors that affect crop selection.

   What factors affect crop selection?

   a) Climate
      1) Rainfall
      2) Temperature
   b) Soil conditions
      1) Soil type
      2) Soil fertility
         (a) Existing nutrient supplies
         (b) Fertilizer recommendations
   c) Field history
      1) Past rotations
      2) Current cropping options
      3) Current cultural and biological conditions
   d) Equipment resources
   e) Economics
      1) Input costs
      2) Crop value
   f) Market access

2. Ask students to identify how the growing region affects crop selection. Display TM 2.1 and 2.2 and discuss the average spring and fall frost dates of the United States. TM 2.3 shows the average annual rainfall amounts in Missouri. Also refer to Table 2.1 in the Student Reference to review annual water usage for crops grown in Missouri.

   How does the growing region affect crop selection?

   a) Temperature
      1) Cool- and warm-season grasses
      2) Planting dates to avoid frost damage
   b) Rainfall

1) Annual water usage of crops
2) Availability of water
c) Soil characteristics

3. Ask students to identify maturity groups for selected crops. Refer to TM 2.4 as an example of maturity groups for soybeans in Missouri.

What are the maturity groups for selected crops?

a) Corn
   1) Full season
   2) Mid-season
   3) Late season
b) Soybeans
   1) Maturity groups for Missouri include II through VI.
   2) May use an earlier maturing seed if double-cropping.
c) Wheat
   1) Hard red winter
   2) Hard red spring
   3) Soft red winter
d) Sorghum
   1) Similar to corn in planting dates
   2) Four basic maturity groups
e) Cotton
   1) New World cotton
      (a) Upland
      (b) Pima
   2) Old World cotton
      (a) Tree
      (b) Levant
f) Rice
   1) Very early maturing
   2) Early maturing
   3) Intermediate or late maturing
g) Forages
   1) Cool season
      (a) Grasses - fescue, orchard grass, ryegrass, timothy
      (b) Legumes - bird's-foot trefoil, alsike clover, ladino clover
      (c) Thrive when moisture is adquate and temperatures are between 65 and 75°F
      (d) Exhibit vigorous growth in the spring and fall months
   2) Warm season
      (a) Initiate growth during late April or early May
      (b) Produce 65 to 75% growth from mid-June to mid-August
      (c) Soils with low moisture-holding capacity, low pH, low phosphorus levels
      (d) Grasses - big bluestem, Indiangrass, switchgrass
      (e) Legumes - alfalfa, crownvetch, lespedeza

4. Discuss economic factors that influence crop selection. Emphasize the importance of developing a marketing plan.

What economic factors influence crop selection?

a) Land
b) Labor
c) Capital
d) Management

F. ***Other Activity***

Have a crop production specialist from a local seed supplier visit the class and discuss what seeds are sold to producers in that area.

G. ***Conclusion***

A grain producer has several factors to consider before selecting a specific crop and the variety of the crop planted. These factors include the climate, soil conditions, length of growing season, and economic factors. A relatively new problem has developed for producers with the advent of certain crop weeds that have developed an immunity to herbicides. This is leading producers to consider different methods of weed control.

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

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

I. ***Answers to Evaluation***

1. a
2. b
3. b
4. Any four of the following: climate, soil conditions, field history, equipment resources, economic demands, or market access
5. Temperature, rainfall, soil characteristics
6. Different maturity groups may reduce the damage of diseases and environmental stress while also spreading out the harvest time and workload.
7. Land, labor, capital, management

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS Name___________________________

Lesson 2: Crop Selection Date____________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following crops are not considered a "cool-season" plant?

   a. Corn
   b. Wheat
   c. Fescue
   d. Oats

2. Which type of wheat is predominately grown in Missouri?

   a. Hard red spring
   b. Hard red winter
   c. Soft red winter
   d. Soft red summer

3. Rice is grown in the __________ part of Missouri.

   a. Northeast
   b. Southeast
   c. Northwest
   d. Southwest

Complete the following short answer questions.

4. List four of the six major factors that must be considered when making the selection of a specific crop.

   a.

   b.

   c.

   d.

5. What three factors determine growing regions for specific crops?

   a.

   b.

   c.

6. Explain why a corn producer might plant two different maturity groups of corn.

7. List the four major economic factors that may influence a crop selection.

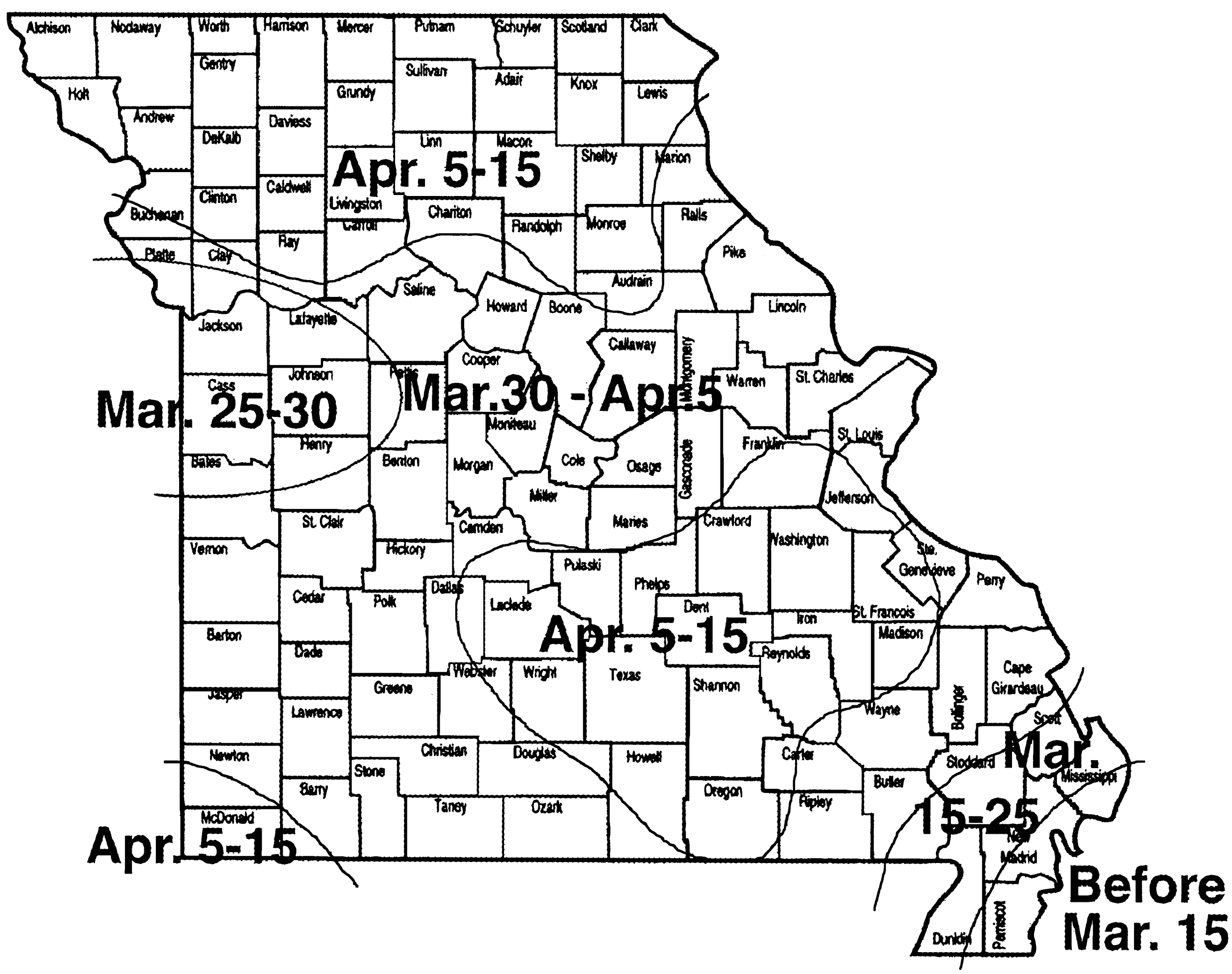
   a.

   b.

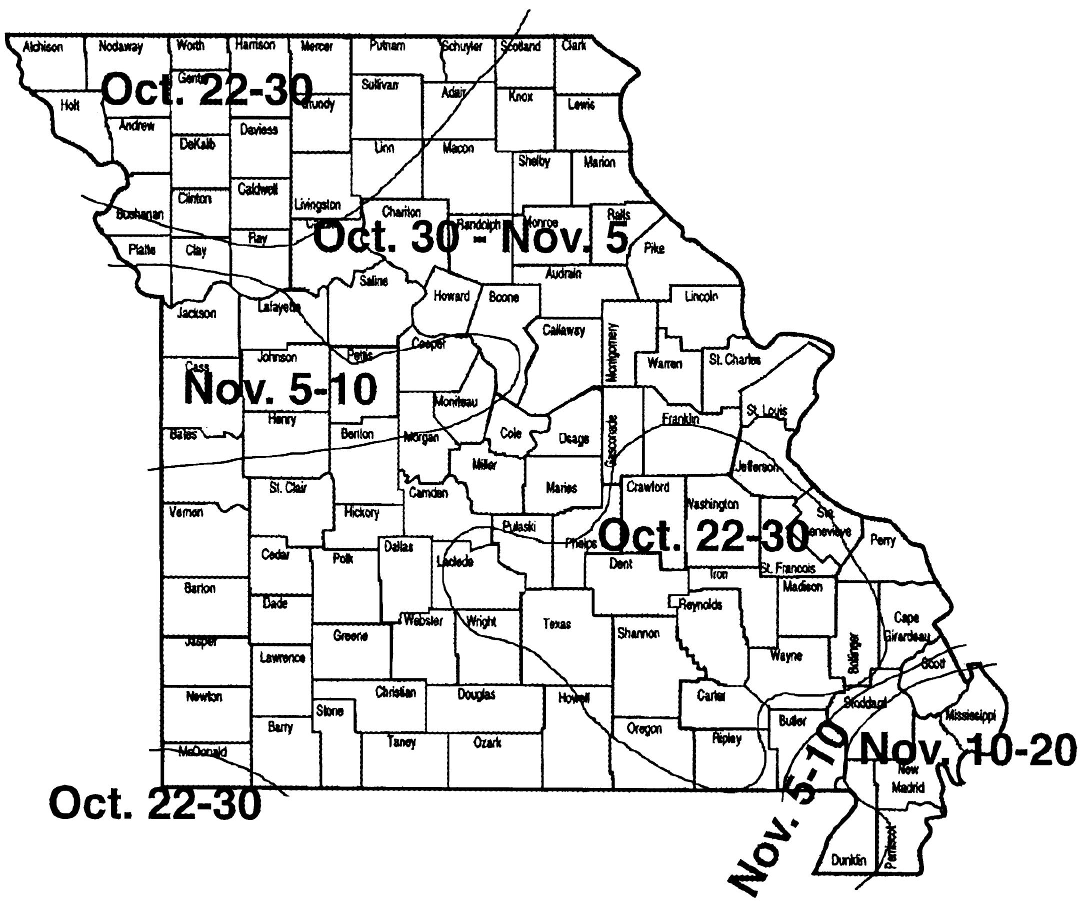
   c.

   d.

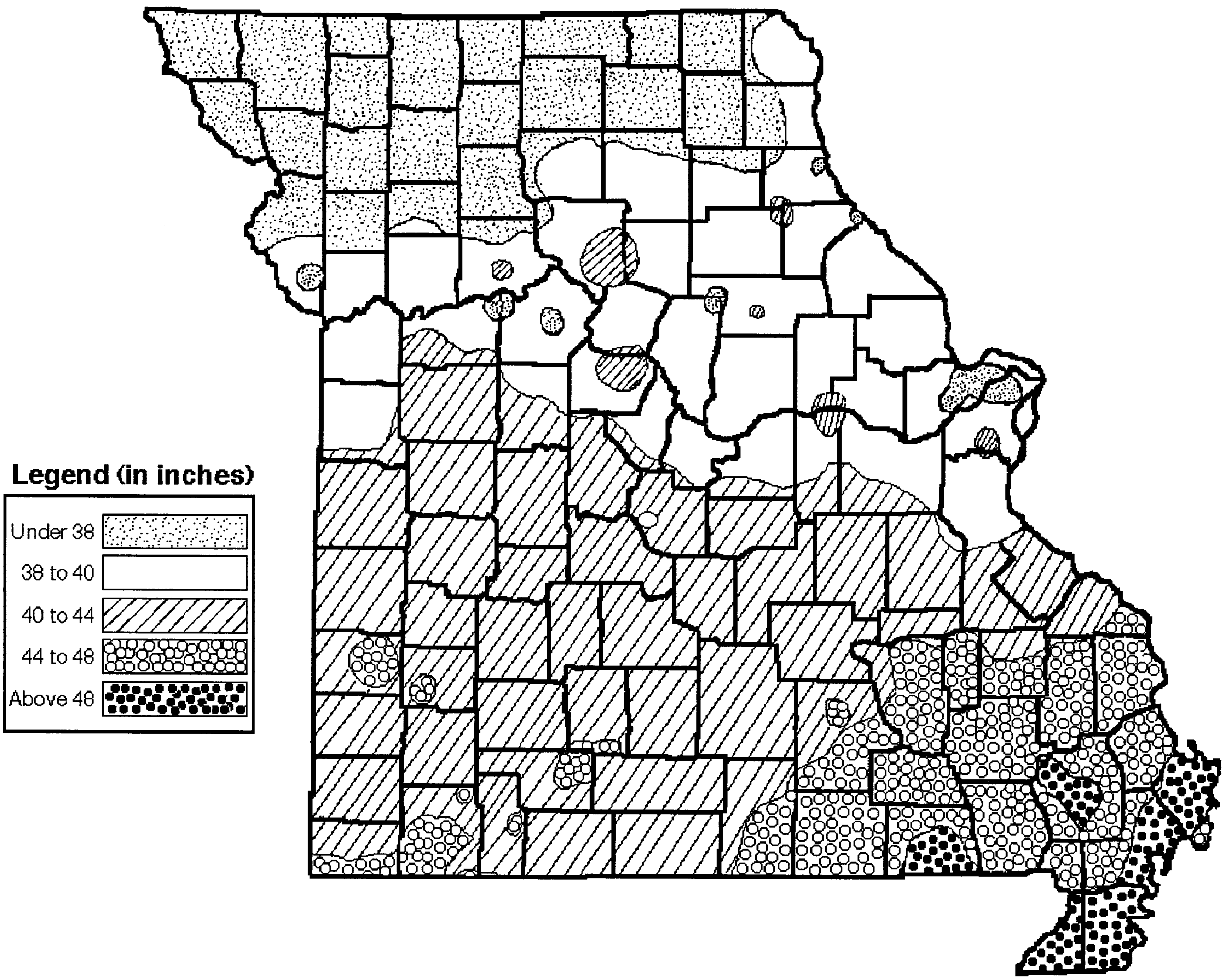
Spring Frost Dates



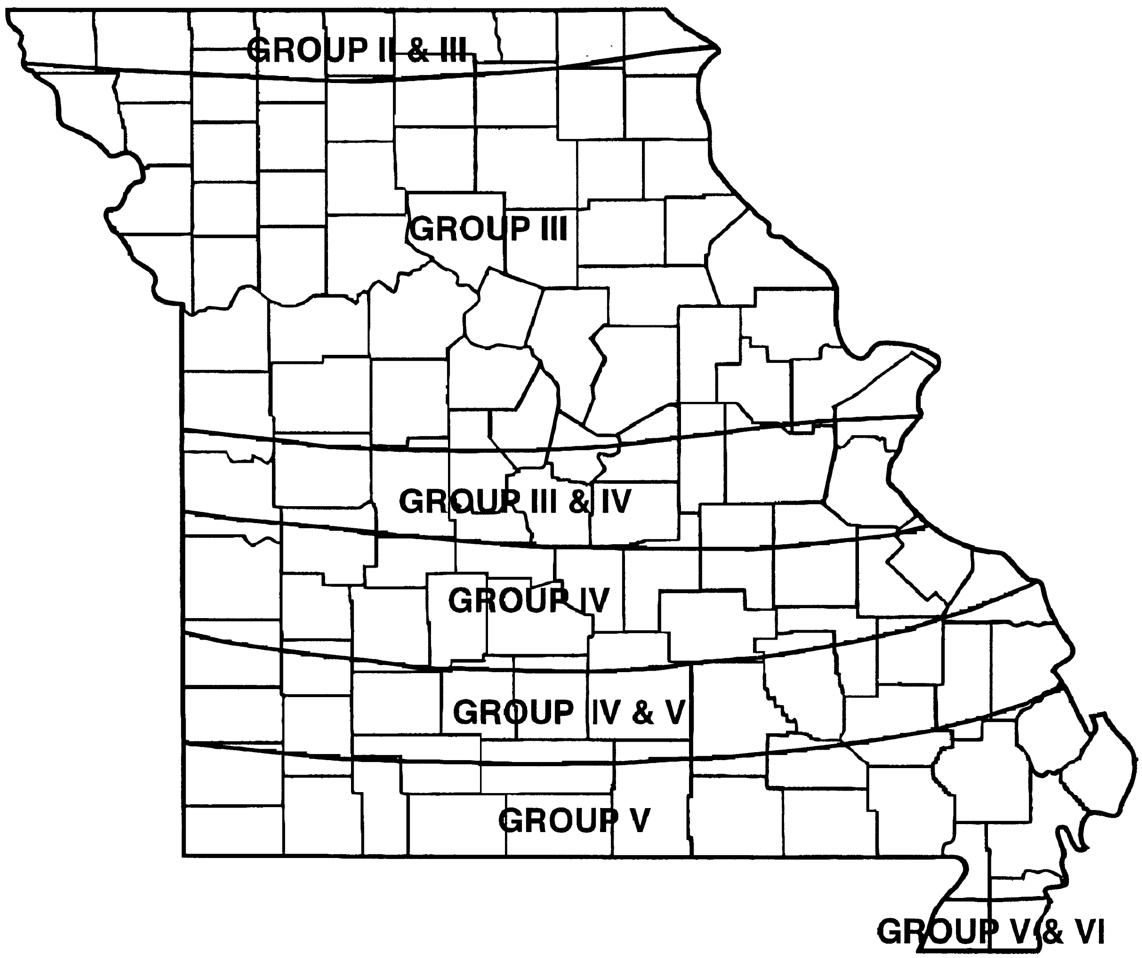
Fall Frost Dates



Average Annual Rainfall



Soybean Maturity Zones



Lesson 2: Crop Selection Name ___________________________

Crop Selection Factors

Objective: Students will demonstrate a knowledge of factors used to select certain crops.

Directions: Match the definition in the right column to the correct crop selection factor in the left column.

1. _____ Input costs
2. _____ Growing region
3. _____ Cool season crops
4. _____ Warm season crops
5. _____ Soil condition
6. _____ Maturity group
7. _____ Capital
8. _____ Weed control strategies
9. _____ Upland
10. _____ Inventory of resources
11. _____ Calendarizing a crop
12. _____ Field history

a. Determined by length of its growing season

b. Wheat, oats, barley, fescue

c. Past planting of crops and their rotation

d. Land, labor, capital, and management

e. Fuel, seed, chemicals, and fertilizer

f. Determined by soil test to find its nutritive value

g. Type of cotton grown in the United States

h. Planting more than one maturity group of a crop to spread out the harvest times

i. Corn, soybeans, cotton, grain sorghum

j. Determined by temperature, rainfall, and soil condition

k. Plowing, burning, grazing animals, crop rotation

l. Money required to purchase fuel, seed and fertilizer

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 3: Crop Seed Selection

Competency/Objective: Utilize seed tag information to select quality seed.

Study Questions

1. **What are the characteristics of quality seeds?**

2. **What information is included on a seed tag?**

3. **What factors determine optimum seeding rates?**

4. **How does the seeding rate determine equipment calibration?**

5. **What are the availability options for seed?**

6. **How do plant patents affect seed availablility?**

7. **What are the advantages and disadvantages of using certified seed?**

References

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

2. Humphrey, John Kevin. *Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992, Lessons 3 and 4.

3. *MFA Agronomy Guide*. Available from any MFA AgriService Center or MFA Incorporated, 201 Ray Young Drive, Columbia, MO 65201 (573-874-5111).

4. Transparency Master

    a) TM 3.1: Seed Tag

5. Activity Sheets

    a) AS 3.1: Seed Information and Germination Test
    b) AS 3.2: Identify Plant Seeds

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 3: Crop Seed Selection

TEACHING PROCEDURES

A. ***Review***

Previous lessons have discussed identification of weed plants and seeds. Selection of seeds requires an understanding of the information provided on the seed tag, seeding rates, and available options for seeds.

B. ***Motivation***

1. Ask students to bring to class seed tags from home or a local seed dealer. Compare label information between crop seed varieties.

2. Invite a local seed dealer to visit the class to explain how seed is acquired and marketed.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. To ensure an adequate crop stand, quality seed should be used when planting the crop. Crop yields can be affected by the seed used. Agronomists estimate the yields from using good seed to be 10 to 20% greater than yields resulting from poor quality seed. Discuss the characteristics of quality seeds. Refer to the *MFA Agronomy Guide* for information on seed selection.

   What are the characteristics of quality seeds?

   a) Good genetic potential
   b) Good germination
   c) Proper size and development
   d) Uniformity in size and shape
   e) Absence of seedborne diseases and insects
   f) Absence of prohibited, noxious, and other weed seeds
   g) Absence of other crop seeds and other varieties
   h) Absence of inert materials

2. Explain to the students that state law requires seed to be labeled with the name, complete address and zip code of the labeler, along with the quality components listed below. TM 3.1 shows an example of a seed tag containing the seed quality information.

   What information is included on a seed tag?

   a) Percent pure seed
   b) Percent inert matter
   c) Percent other crop
   d) Percent weed seed
   e) Percent germination
   f) Percent hard seed
   g) Percent total germination
   h) Net weight
   i) Lot number

j) State of origin
k) Test date
l) Kind and number of noxious weeds
m) Other possible components
    1) Seed count
    2) Treated seed (fungicide) - labels required by law

3. Proper stand establishment will increase the chances of a good yield if the weather is conducive to proper plant growth. The desired plant population depends on several factors, one of which is the seeding rate.

    What factors determine optimum seeding rates?

    a) Type of crop
    b) Use of crop
    c) Pure live-seed ratio or percent
        1) Ratio of weight of the viable seed of the cultivar being seeded to the total weight of the seed stock
        2) May include nonviable seeds, weed seeds, and inert matter
    d) Seed quality
        1) Based on germination rate and other factors
        2) Low seed quality - increase rate of seeding
    e) Time of seeding
        1) Climatic conditions can reduce stand if planted after optimum time.
        2) Increase seeding rates if planting before or after optimum planting dates.
    f) Soil moisture and productivity
        1) Productive soils sustain recommended seeding rates.
        2) Excessive moisture retards germination and may cause rotting.
    g) Method of seeding
    h) Row width

4. Discuss with students how the seeding rate will determine how equipment is calibrated. Have available a copy of an owner manual for a planter that explains how to set calibration.

    How does the seeding rate determine equipment calibration?

    a) Calibrate planting equipment
        1) Varies with type and brand of equipment
        2) Owner manual guidelines
            (a) Adjust to achieve desired seed rate
            (b) Planter's maximum speed for given planting rate
    b) Check for worn parts
    c) Check calibration before going to planting field
    d) Check calibration in the planting field

5. Certified seed is sold to producers with strict production guidelines to ensure genetic quality. Discuss certified seed and the four classes. Using the seed tags brought in for the motivation, identify the seed class for each example.

    What are the availability options for seed?

    a) Criteria for certified seed
        1) Seed must be grown from registered or certified seed stock.
        2) Crops produced must pass inspection for mixtures, weeds, and diseases.
        3) Harvested crop must attain standard of perfection set by seed association.
    b) Seed dealers
        1) Breeder seed - used to produce foundation seed

(a) Seed trade is conducted only between the breeder and the company.
(b) Small quantities are produced by commercial seed companies.

2) Foundation seed - the parent line for registered seed and/ or certified seed
   (a) Seed trade conducted only between the breeder and the company
   (b) Requires a white identification tag
3) Registered seed - produced from foundation seed
   (a) May be used to produce certified seed or is sold directly to producers
   (b) Usually grown by producers for a company
   (c) Requires a purple identification tag
4) Certified seed - produced from foundation or registered seed
   (a) Sold directly to producers by a seed dealer
   (b) Requires blue identification tag

c) Exported seed
   1) Organization for Economic Cooperation and Development (OECD) sets requirements.
   2) Seed must meet minimum requirements to be tagged with OECD tag.
d) Local producers (only if permissible under Plant Variety Protection Laws)
   1) Practice is limited due to plant patents.
   2) Saved seed allows premiums above market price.
   3) Brown bag seed (NVS - no value stated) has a generic label with no quality or performance data.

6. A patent is an exclusive property right to an invention issued by the Commissioner of Patents and Trademarks, U.S. Department of Commerce. The rights granted are limited to the claims of the patent. Plant patents are granted for 17 years for plants when they are asexually reproduced with the exception of tuber-propagated plants or plants found in an uncultivated state. Patentable plants must have been reproduced by means other than seeds, such as by the rooting of cuttings or by grafting. Plant patents limits a producer's options for seed selection.

   How do plant patents affect seed availability?

   a) Eliminates the option of saving seed from genetically superior seed
   b) Requires new seed purchases yearly
   c) May require contract agreements in specific production and marketing programs

7. Research has shown marked benefits from using certified seed. Many say the cost of purchasing new seed each year is a disadvantage, but considering the improved performance of certified or professionally grown seed over brown bag or saved seed, it is really an advantage.

   What are the advantages and disadvantages of using certified seed?

   a) Advantages
      1) Guaranteed to be the variety advertised
      2) Guaranteed minimum germination rate
      3) Guaranteed to meet weed, disease, and insect contamination standards
   b) Disadvantages - cost

F. ***Other Activities***

1. Have students research various seed companies.

2. Develop seed judging activities for the students.

G. ***Conclusion***

Each crop grown will have its own challenges regarding seed selection. The producer needs to be aware of all options available to make the best decision regarding the use of certified seed. Seeding rates can increase potential yield and affect the profit levels of the operation.

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

AS 3.1

Answers will vary.

AS 3.2

Answers will vary.

I. ***Answers to Evaluation***

1. e
2. h
3. b
4. i
5. c
6. j
7. d
8. f
9. g
10. a
11. .90 x .95 = 86%
12. 8 / .86 = 9.3 lb/acre
13. Read the owner manual
14. U.S. Department of Commerce (Bonus: Commissioner of Patents and Trademarks)
15. Any five of the following:
    a) Good genetic potential
    b) Good germination
    c) Proper size and development
    d) Uniformity in size and shape
    e) Absence of seedborne diseases and insects
    f) Absence of other crop seeds and other varieties
    g) Absence of inert materials

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS   Name____________________

Lesson 3: Crop Seed Selection   Date____________________

EVALUATION

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

1. _____Seed produced from foundation or registered seed and sold to producers
2. _____The parent line for registered or certified seed
3. _____Seed used to produce foundation seed
4. _____Seed sold in brown bags with no seed tags
5. _____Requires the producer to purchase new seed yearly
6. _____Requires labeling by law
7. _____The amount of seed planted in a given area
8. _____Planted at populations of 18,000 to 32,0000
9. _____The weight of the viable seed compared to the weight of the seed stock
10. _____Planted at populations of 130,000 to 170,000

a. Soybean seed
b. Breeder seed
c. Plant patents
d. Seeding rate
e. Certified sed
f. Corn seed
g. Pure live seed
h. Foundation seed
i. No variety stated
j. Treated seed

Answer the following short answer questions.

11. If a seed tag stated percent germination at 90% and the purity at 95%, what is the pure live-seed ratio?

12. If the recommended seeding rate is based on 100% pure live-seed at 8 pounds per acre, what is the appropriate seeding rate using the seed in question 11?

13. What is the first and most important step in setting the seeding rate and equipment calibration?

14. What agency within the U.S. govenment issues plant patents?

15. List five characteristics of quality seeds.

    a.

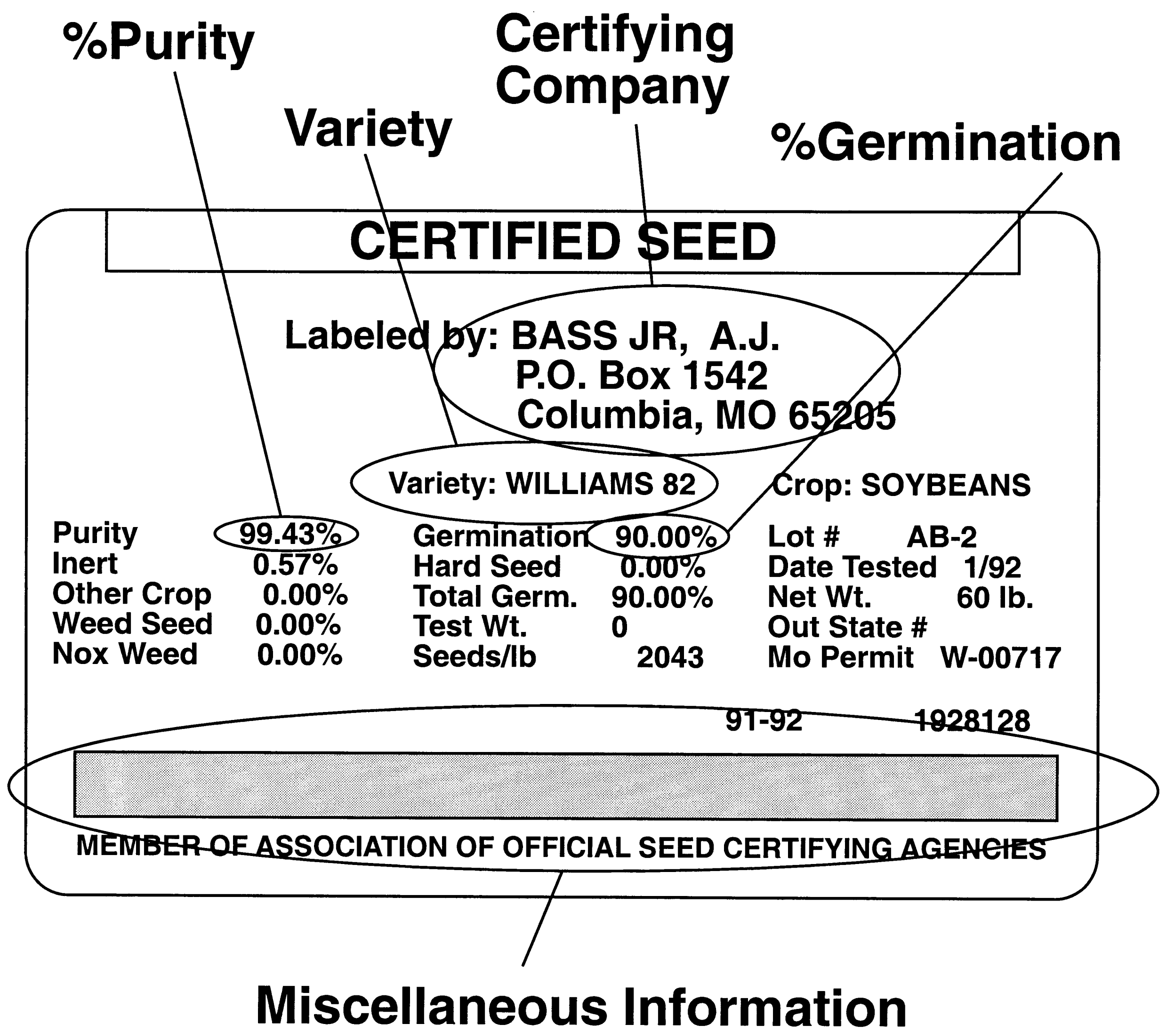
    b.

    c.

    d.

    e.

Certified Seed Tag



Lesson 3: Crop Seed Selection Name____________________

Seed Information and Germination Test

Objective: Students will determine actual germination percentages with germination percentages listed on the seed tag.

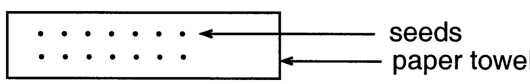
Materials:

Tin pie plate
Two paper towels
20 seeds (variety determined by instructor)
Information from seed tag
Masking tape

Procedure:

1. Transfer information from seed tag onto the table below.
2. Label your pie plate by placing a piece of tape with your name on it on the pie plate.
3. Place one paper towel into the pie plate.
4. Place the 20 seeds in a rectangular pattern on the paper towel in the pie plate.

Example:



5. Place second paper towel over seeds and gently dampen towels until completely damp.
6. Check pan daily (once or twice daily) to ensure that proper moisture is maintained.
7. After five (5) days, check seeds for germination.
8. After 10 days, count the number of sees germinated. Place in the box titled "% Test Germination" the percentage that germinated out of the 20 seeds tested.
9. Compare test germination percentage with stated germination percentage.

Note: This activity can be repeated with different varieties.

Crop Variety	Crop Origin	Lot Number	% Purity	% Inert Matter	% Other Crop Seed	% Weed Seed	%Stated Germination	%Test Germination

Lesson 3: Crop Seed Selection Name______________________

Identify Plant Seeds

Objective: Students will identify plant seeds.

Directions: The instructor will provide seeds for identification. Identify the seeds by their size, shape, color, surface markings, and common name of the plant seed.

Seed #	Size	Shape	Color	Surface Markings	Name of Plant Seed
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 1: Protecting Ourselves and Others

Competency/Objective: Identify potential crop production hazards to operators/producers.

Study Questions

1. What are potential dangers to the operator when handling chemicals?

2. What are potential dangers from equipment operation in crop production?

3. What are the potential dangers from handling and storing crops?

4. What precautions should be taken to prevent personal injury from chemicals, equipment, and crop handling and storage?

5. What government agencies regulate and enforce safety issues?

References:

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

2. U.S. Environmental Protection Agency, U.S. Department of Agriculture Extension Service, *Applying Pesticides Correctly*, *A Guide for Private and Commercial Applicators*, Missouri Core Manual, MX 328, January 1997.

3. *Pesticide Safety*. Resources in Agricultural Safety (RAS) series. Available from Instructional Materials Laboratory, University of Missouri-Columbia, 1997.

4. Activity Sheet

   a) AS 1.1: Farm Safety Survey

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 1: Protecting Ourselves and Others

TEACHING PROCEDURES

A. ***Introduction***

After a specific crop or crops have been selected for production, it is important to discuss safety practices for crop producers. There are many hazards that farm workers face. Statistics show that farming is one of the most dangerous occupations in the United States. Not only do the crop producers work with large and powerful equipment, they also must work with hazardous materials and chemicals.

B. ***Motivation***

This would be an important time to discuss farm safety with your students. Begin the lesson with some farm-related information and statistics on accidents that frequently occur. Ask students to relay any instances of farm accidents they may be familiar with.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Each year crop producers work with millions of pounds of chemicals in the form of insecticides and herbicides. The handling of this material requires knowledge and skill on the part of the farm workers to avoid injuries to themselves and others. Refer to Table 1.1 in the Student Reference for examples of effects of anhydrous ammonia on the human body. The Student Reference also lists examples of when anhydrous ammonia accidents occur.

   What are potential dangers to the operator when handling chemicals?

   a) Insecticide and pesticide contact with skin
      1) Handling the chemical when filling applicator
      2) Drift hazards
   b) Exposure to fumes from chemicals
      1) Storage area
      2) Adding dry chemicals to sprayer tank
   c) Anhydrous ammonia
      1) Colorless gas with a sharp penetrating odor
      2) Compressed as a liquid, turns to gas when absorbed with moisture in soil
      3) Contact with body tissue, destroying cells, causing dehydration and severe burns
      4) Could destroy lungs if breathed

2. Farm equipment is a major source of injuries to crop producers, farm workers, and their families. Education and the practicing of safety rules can help prevent many accidents.

   What are potential dangers from equipment operation in crop production?

   a) Many accidents occur where hazards are not as readily apparent as with danger points such as power take-offs and hydraulic arms.
   b) Most accidents occur because of human error.
   c) Equipment danger points include the following.
      1) Belt, gear, or chair drives
      2) Rotary or auger intake areas

3) Feed rollers and gather chains to pull crops into machines

d) Secondary factors may cause hazardous situations.
   1) Spilled grain, debris, slick substances may cause falls into grain augers.
   2) Icy, muddy, or manure-covered surfaces increase risk of slipping.

e) Operators sometimes overestimate their ability to control powerful equipment.

f) Reaction time to a stimulus is about 1/4 to 3/4 of a second.

g) Large round bales may weigh 1,500 to 2,000 pounds each, about the same as a small car.
   1) Can crush operators
   2) Overturn tractors

h) Other hazards include fires and explosions and roadway accidents when moving equipment.

3. Working with stored grain may have some hidden hazards. Many producers have suffocated from falling into grain storage facilities and have been overtaken by gas that develops with some stored crops.

What are the potential dangers from handling and storing crops?

a) Flowing grain can lead to suffocation when producers, workers, or their children are pulled under and covered by the grain.
   1) A 6-foot tall person can become covered in as little as 15 seconds.
   2) Children or smaller people are at a greater risk.
   3) Kernels rushing to fill the void left from flowing grain create a liquid motion.
   4) The force required to extract someone buried below the surface of grain may exceed 2,000 pounds.

b) CO_2 is a colorless, odorless gas that develops from fermenting grain or silage.
   1) Gas forms in grain bins.
   2) Gas enters bloodstream, slows breathing, induces drowsiness and headaches, and even causes death by suffocation.

c) Airborne substances such as dust, mold, and fungi may cause permanent damage to lungs and cause allergies.

d) Practice safety by reducing skin exposure to the sun by wearing protective clothing and/or sunscreen.

4. Safety on the farm is a full-time consideration. Review and explain all the precautions listed in the Student Reference regarding working with chemicals, farm equipment, and grain handling and storage facilities. It is very hard to find an all-inclusive list. Other sources may be referenced when reviewing this study question.

What precautions should be taken to prevent personal injury from chemicals, equipment, and crop handling and storage?

a) Chemicals

b) Equipment

c) Storing and handling grain

5. There are several regulatory agencies within the U.S. government that are established to protect the agricultural workers and the environment from agricultural safety hazards and concerns.

What government agencies regulate and enforce environmental and safety issues?

a) OSHA - Occupational Safety and Health Administration
   1) OSHA establishes standards of compliance for safe and healthful working conditions.
   2) OSHA provides education and safety assistance to identify and eliminate workplace hazards.

3) Producers have a legal responsibility to provide safe and healthful working conditions for themselves and their employees.
4) An amendment to the OSHA Act prevents funds from being spent on enforcing rules and regulations to producers who employ 10 or fewer workers.
   (a) Amendment does not eliminate compliance with rules or regulations.
   (b) Employee can use regulations in a lawsuit against employer.

b) NRCS - Natural Resources Conservation Service
   1) Division of U.S. Department of Agriculture
   2) Helps prevent soil erosion from wind and water
      (a) Works with local soil and water conservation districts
      (b) Assists in individual conservation plans
      (c) Other conservation measures

c) EPA - Environmental Protection Agency
   1) Protects nation's land, air, and water systems
   2) Formulates environmental standards
   3) Enforces federal environmental laws

d) DNR - Department of Natural Resources
   1) Fosters prudent use and protection of air, land, water, cultural, and energy resources
   2) Aids in preventing pollution
   3) Protects public from harmful emissions and waste disposal practices

F. ***Other Activity***

Agricultural safety experts with agencies such as University of Missouri Extension may be consulted at this time to be invited as guest speakers. There are many good videos on farm safety that may be obtained from National FFA, MRCCTE, or film agencies and shown as a motivation or after discussion to summarize major points of safety.

G. ***Conclusion***

Farm safety is an everyday job. Persons who work in grain production and their families must be educated on safety rules. There are many areas of safety to cover in agriculture. Farm accidents are one statistical area that must be improved. Only through continued education can this happen. Accidents may occur when working with chemicals, farm equipment, or grain handling and storage facilities. The safety rules applying to this unit may need to be repeated later during the course.

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

Answers will vary.

I. ***Answers to Evaluation***

1. b
2. c
3. b
4. d
5. a
6. Any of the 21 listed in the Student Reference
7. Any of the 16 listed in the Student Reference
8. Standing on the grain when it is being unloaded (from bin or wagon). Unloaded grain is quickly replaced by other grain. The worker is quickly sucked into the grain when worker may suffocate and die. This can also happen if a worker enters a grain bin that has bridged grain caused by damp or moldy grain.

9. Reduce skin exposure by wearing protective clothing and/or sunscreen.

10. OSHA - Occupational Safety and Health Administration
EPA - Environmental Protection Agency
NRCS - Natural Resources Conservation Service
DNR - Department of Natural Resources

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES Name______________________________

Lesson 1: Protecting Ourselves and Others Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the greatest cause for chemical poisoning to crop producers?

   a. Mislabeled containers
   b. Contact with the skin
   c. Fumes from the chemical
   d. Ingesting the chemical through the mouth

2. What is the cause of most machinery accidents on the farm?

   a. Faulty equipment
   b. Weather conditions
   c. Human error
   d. Engine fires

3. What is the human reaction time to a stimulus?

   a. 1/10 to 2/10 of a second
   b. 1/4 to 3/4 of a second
   c. 1 to 2 seconds
   d. 5 to 10 seconds

4. What is the gas produced by fermentation of wet grain or high moisture silage?

   a. NH_3
   b. H_2O
   c. HCl
   d. CO_2

5. An amendment to the OSHA Act of 1970 prevents enforcement of regulations for a producer that employs ______________________________.

   a. 10 or fewer employees
   b. Over 10 employees
   c. Fewer than 15 employees
   d. Never applies to producers

Complete the following short answer questions.

6. List five safety precautions to observe when working with agricultural chemicals.

    a.

    b.

    c.

    d.

    e.

7. List five potential dangers with equipment operation in crop production.

    a.

    b.

    c.

    d.

    e.

8. Explain how a farm worker may be injured or killed from stored grain.

9. Explain what is meant by "sun safety" practices.

10. Write the full name of the agencies represented by the letters below.

    OSHA -

    EPA -

    NRCS -

    DNR -

Lesson 1: Protecting Ourselves and Others Name ____________________________

Farm Safety Survey

Objective: Students will survey the agricultural crop production community for possible safety hazards.

Directions: Select a crop producer in the community and complete the following information. Safety precautions from the Student Reference should be used as a guideline to locate possible safety hazards.

1. Describe the farming operation (size, kind of crop, storage on the farm, etc.).

2. List possible chemical hazards discovered on the farm.

3. List possible equipment hazards discovered on the farm (include storage facilities).

4. Has an accident or safety concern occurred on the farm within the last 5 years? If so, describe below.

5. List or describe any safety measures initiated by the producer within the last 5 years. This can include equipment repairs, safety courses taken, etc.

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 2: Protecting the Environment

Competency/Objective: Identify the environmental and governmental issues that affect crop production.

Study Questions

1. **What crop production activities affect the environment?**
2. **What management practices can be used to minimize environmental impact?**
3. **What government agencies regulate and enforce environmental issues (laws)?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit V.
2. Activity Sheet
    a) AS 2.1: Causes of Agricultural Pollution

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 2: Protecting the Environment

TEACHING PROCEDURES

A. ***Review***

Lesson 1 emphasized the necessity to educate crop producers to the need for safety when operating equipment and working with crop storage facilities. These safety factors dealt with the personal safety of the producer. Lesson 2 discusses ways the producer can reduce the possible harmful impact of crop production on the environment.

B. ***Motivation***

Ask students to share with the class what they think might be the biggest problem or danger of crop production activities to the environment. Have them explain what environmental impact that problem may present and how they think it might be prevented.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Improper crop production activities can have a detrimental effect on the agricultural environment. Producers should know how to avoid these concerns.

   What crop production activities affect the environment?

   a) Production activities affect four major resources.
      1) Air
      2) Water
      3) Soil
      4) Aesthetic value (natural landscape beauty)
   b) There are five major contributors to agricultural pollution.
      1) Toxic products
      2) Soil loss
      3) Waste products
      4) Discharged water
      5) Litter
   d) Of these, toxic products and soil loss are the two major problems in crop production.
   e) Toxic products contain poisons or have potential to poison animals or plants.
      1) Pesticides
      2) Insecticides
      3) Engine exhaust
      4) Excessive fertilizers
   f) Soil loss is attributed to incorrect or overuse of tillage methods.
      1) Wind or water will remove exposed soil.
      2) Soil particles can get into streams and lakes.
      3) Oxygen levels in water that support aquatic life are reduced.

2. Discuss the various management practices used to minimize effects on water and air quality. Explain that practices used depend on the soil, crop, practice design, and other management characteristics.

What management practices can be used to minimize environmental impact?

a) Soil conservation management
   1) Reduce the movement of pollutants
   2) Diminish soil particle detachment
   3) Protect soil from adverse effects of wind, rain, and runoff
   4) Increase infiltration and movement of soluble nutrients and pesticides to below the root zone
   5) Tillage practices
      (a) Conservation tillage
      (b) Contour farming
      (c) Filter strips
      (d) Strip-cropping
   6) Structural practices
      (a) Terraces
      (b) Grassed waterways
      (c) Diversions

b) Waste management
   1) Control the waste or overuse of toxic substances used for pest and weed control.
   2) Follow directions on usage and dispose containers properly.

c) Nutrient management
   1) Overusage of fertilizer harms plants and rainwater transports surplus to water sources.
   2) Excessive nutrients affect groundwater used by cities and towns.

3. Ask students for their input on what governmental agencies play a role in environmental concerns that crop producers may face. See how many they can list and describe their mission.

What government agencies regulate and enforce environmental issues (laws)?

a) Natural Resources Conservation Service - Division of the U.S. Department of Agriculture
   1) Nineteen programs aid in conservation of natural resources.
   2) Five major programs affect crop producers.
      (a) Conservation Technical Assistance program assists landowners to plan and implement conservation practices.
      (b) Conservation Farm Option program provides annual payments over a 10-year contract period to producers for implementing conservation measures.
      (c) Conservation of Private Grazing Land Initiative provides technical and educational assistance to owners of private grazing land.
      (d) Conservation Reserve Program encourages producers to convert highly erodible cropland to vegetative cover.
      (e) Farmland Protection Program provides funds to help purchase development rights to keep productive farmland in agricultural uses.

b) Missouri Department of Natural Resources
   1) Works with producers through the Agricultural Assistance Unit
   2) Provides technical assistance for environmental permits, gives advice on stewardship, third-party site assessments, aids with referrals to other governmental agencies

c) Environmental Protection Agency
   1) Protects human health and safeguards the air, water, and land
   2) Enforces state and federal laws developed to protect the environment

d) Missouri Department of Conservation
   1) Protects and manages fish, forest, and wildlife resources

2) Facilitates participation in resource management activities

F. **Other Activities**

1. Conduct a lab activity on water testing. Refer to the *Missouri Department of Natural Resources Groundwater Protection Curriculum Guide*, pages 39-40, available from Missouri Resource Center for Career & Technical Education, University of Missouri-Columbia.

2. Ask students to do further research for one of the 19 programs available through the Natural Resources Conservation Service. Have the students share this information with the class.

G. ***Conclusion***

It is important for crop producers to understand the effects of cropping and crop management systems on the agricultural environment. The air, soil, and water may be polluted by chemicals practices that are not used correctly. Certain government agencies are designed to protect the agricultural environment from harmful farming practices.

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

The phrase to solve is "Toxic products and soil loss cause most environmental problems in agriculture."

I. ***Answers to Evaluation***

1. Air, land, water, and aesthetic value
2. Pesticides, herbicides, and fertilizers may be used improperly and in overabundance. Harmful substances from engine exhaust may also be released into the air.
3. Soil conservation management, waste management, and nutrient management.
4. f
5. a
6. e
7. b
8. c
9. d

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES Name______________________

Lesson 2: Protecting the Environment Date______________________

EVALUATION

Complete the following short answer questions.

1. List the four major resources that may be polluted by some agricultural practices.

   a.

   b.

   c.

   d.

2. Describe how toxic products may pollute the agricultural environment.

3. List three major management practices that may minimize environmental pollution.

   a.

   b.

   c.

Match the following agency or agency program to the following statements. Each item may only be used one time.

4. ___ Provides funds to purchase development rights to keep produtive farmland in agricultural uses.

5. ___ Ten-year contract payments to producers who follow a conservation plan on their land.

6. ___ Works with producers through Agricultural Assistance Unit.

7. ___ Primary mission is to protect fish, forest, and wildlife resources of our state.

8. ___ Enforces state and federal laws protecting human health and safeguard the natural environment.

9. ___ Pays producers to convert highly erodible cropland to vegetative cover.

a. Conservation Farm Option

b. Missouri Department of Conservation

c. Environmental Protection Agency

d. Conservation Reserve Program

e. Missouri Department of Natural Resources

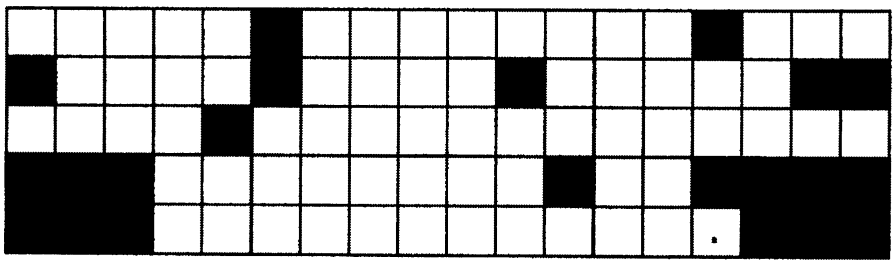
f. Farmland Protection Program

Lesson 2: Protecting the Environment Name ____________________

Causes of Agricultural Pollution

Objective: Students will determine the major causes of most pollution in the agricultural environment.

Directions: Solve the phrase below by placing the correct letter in the squares directly above each row of letters.



			A			N	C	I	R			R	U				
			I	R		B	O	S	M	U	N	M	S				
	O	O	I	C	E	L	V	O	L	O	C	A	E		A		
M	S	X	T	L	R	P	L	U	D	S	U	I	E	N	T	N	D
T	O	S	P	G	O	I	R	E	S	T	C	T	N	S	E	A	L

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 3: Knowing the Law

Competency/Objective: Identify the legal issues involved with crop production.

Study Questions

1. **What are the legal requirements for handling chemicals, wastes, and equipment?**
2. **What are the legal liabilities if chemicals, wastes, or equipment is mishandled?**
3. **What is a legal land description?**
4. **What are the legal liabilities for crossing property lines, fencing, or other damage?**
5. **What are the legal liabilities of polluting streams and groundwater?**

References:

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit V.
2. *Applying Pesticides Correctly, A Guide for Private and Commercial Applicators*, Missouri Core Manual, MX 328, U.S. Environmental Protection Agency, U.S. Department of Agriculture Extension Service, January 1997.
3. Transparency Masters
   a) TM 3.1: Base Line and Principal Meridian Affecting Missouri Land Descriptions
   b) TM 3.2: Locating a Township
   c) TM 3.3: Section Location in a Township
   d) TM 3.4: Divisions of a Section of Land
4. Activity Sheet
   a) AS 3.1: Legal Land Descriptions

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES

Lesson 3: Knowing the Law

TEACHING PROCEDURES

A. ***Review***

Our previous lesson discussed some of the problems affecting the environment that may involve crop producers, some management procedures that may reduce the environmental impact of those problems, and governmental agencies that are involved with regulating and enforcing environmental laws that may be related to agricultural practices. This lesson will continue with information concerning legal responsibilities of crop producers relating to those issues.

B. ***Motivation***

Ask students if they have witnessed a chemical spill. If so, what actions were taken to correct the problem? You may also ask them if they know the consequences of improperly handling pesticides.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Crop producers must be knowledgeable of legal requirements they must follow when working with chemicals used in agricultural production. They should also be familiar with the training required for the applicators of agricultural chemicals.

   What are the legal requirements for handling chemicals, wastes, and equipment?

   a) Producers must make sure pesticides are handled properly and safely.
   b) Federal laws set the standards for pesticide use. State laws may be more strict but not more lax.
   c) The Environmental Protection Agency (EPA) regulates the use of pesticides.
   d) Regulations are mandated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
   e) Under FIFRA , key provisions are as follows.
      1) Requires the EPA to register all pesticides, each use of all pesticides, and approve the product label
      2) Requires the classification of all registered pesticides as either general use or restricted use
      3) Requires pesticides to be used only as directed on the labeling
      4) Requires users of restricted use pesticides to be certified applicators or work under the direct supervision of a certified applicator
      5) Provides penalties for actions contrary to its provisions
      6) Gives the EPA authority to develop regulations, which are interpretations of the law and have the force of law
   f) The Missouri Pesticide Registration Act and the Missouri Pesticide Use Act bring Missouri into compliance with FIFRA.
   g) These Acts are administered by the Division of Plant Industries-Bureau of Pesticide Control of the Missouri Department of Agriculture.
   h) Chapter 281 of the Missouri State Statutes establishes requirements for persons to apply restricted use pesticides in Missouri.
   i) Applicators of pesticides in Missouri receive training in the following areas.
      1) Applicable state and federal pesticide laws and regulations

2) Pests
3) Pest control (application techniques and IPM training)
4) Pesticides
5) Pesticide waste
6) Applicator safety and worker protection
7) Groundwater protection
8) Endangered species protection
9) New developments

j) Training must be repeated for recertification every 5 years.

2. Penalties are assessed or given to persons who violate rules and regulations governing the use of agricultural chemicals. Sometimes these can be quite severe. Producers should know the consequences of violations.

What are the legal liabilities if chemicals, wastes, or equipment is mishandled?

a) Civil penalties may be imposed if FIFRA regulations are broken.
b) These may be as much as $5,000 for commercial applicators and up to $1,000 for private applicators.
c) Hearings are held before the EPA can assess a fine.
d) Criminal penalties may be as much as $25,000 or 1 year in prison for commercial applicators or $1,000 and/or 30 days in prison for private applicators.
e) All major spills must be reported to the USEPA officer in Kansas City with the following information included:
    1) Name, address, and telephone number of person reporting
    2) Exact location of the spill
    3) Name of the company involved and locations
    4) Specific pesticide spilled
    5) Estimated quantity of pesticide spilled
    6) Source of the spill
    7) Cause of the spill
    8) Name of body of water involved or nearest body of water to the spill area
    9) Action taken for containment and cleanup.
f) Many pesticide labels have emergency telephone numbers for direct access to the manufacturer to manage emergencies for a given product.
g) If a spill is on a highway, the highway patrol or the highway department must be contacted.
h) If a spill is on a city or county road, the sheriff, police, or the local country or city fire department must be contacted to assist with the cleanup.

3. Ownership or location of parcels of land are indicated by a legal land description. This method is explained in this section of the lesson. Use TM 1, TM 2, TM 3, and TM 4 to aid you in this instruction.

What is a legal land description?

a) Locations are indicated in the United States by two methods.
    1) Indiscriminate metes and bounds system that uses natural land features such as trees, streams, neighboring land owners, and distances to describe plots of land
    2) Township-Range system
b) Township-range system has the following associated terms that must be defined.
    1) Base line - reference or beginning point for measuring north or south townships
    2) Principal meridian - reference or beginning point for measuring east or west ranges
    3) Township lines - east to west lines that mark township boundaries
    4) Range lines - north to south lines that mark township boundaries
    5) Range - assigned to a township by measuring east or west of a principal meridian

6) Township - 36 sections of land arranged in a 6 x 6 array, measuring 6 miles by 6 miles; sections numbered beginning with the northeast-most section, proceeding west to 6, then south along the west edge of the township and to the east
7) Section - basic unit of the system; a square tract of land - 1 mile by 1 mile, containing 640 acres

c) Principal meridian and base line are used to indicate parcels of land in Missouri on the transparency.
d) Use the other three transparencies to explain the township location, the section location, and a specified portion of a section.
e) These legal descriptions are attached to abstracts to verify and indicate ownership of parcels of land in Missouri.

4. To prevent disputes among neighbors, property owners should understand their legal responsibilities regarding property lines and fences that mark divisions of land.

What are the legal liabilities for crossing property lines, fencing, or other damage?

a) Answers to disputes concerning fencing duties and boundary locations are supplied by Missouri State Statues and court decisions.
b) The solution to these disputes lie with the cooperative attitudes of neighboring owners.
c) There is no substitute for an attorney's skill and advice to help solve differences.
d) Crop producers are encouraged to contact their state representatives and senators with boundary law recommendations.
e) Most disputes occur when damage is caused on adjoining property.
f) Agricultural property owners in Missouri should obtain and read UMC Extension Guide G810 *Missouri Fencing and Boundary Laws*. This gives information on fencing laws, duties, and liabilities of livestock owners, the definition, building, and maintenance of "divisional" fences.

5. Discuss liabilities of polluting streams and groundwater.

What are the legal liabilities of polluting streams and groundwater?

a) Protection of surface and groundwater is receiving a great deal of attention as the scope of contamination is increasing.
b) The United States relies on ground and surface water for more than 50% of its drinking water and more than 25% of its fresh water needs.
c) EPA estimates that 1% of the nation's groundwater supply is already contaminated, and the percentage is rapidly increasing.
d) A major source of this contamination is the use and misuse of pesticides and fertilizers.
e) Polluted groundwater may contaminate wells and therefore contaminate drinking water for farmers, their families, and their livestock.
f) Pollution of streams and groundwater is from two basic sources.
   1) Point sources - traced back to a specific source of the pollution, such as a chemical spill
   2) Nonpoint sources - not traceable to a specific source, such as chemical runoff from fields
g) Misuse of chemicals can degrade water sources in several ways.
   1) Irrigation backflow - where chemicals are mixed with irrigation water; installation of backflow valves a preventative measure
   2) Overapplication of chemicals - excess chemicals leach or percolate into water table
   3) Runoff - pollutes streams; may flow across neighbors property and into larger streams or rivers
   4) Highly soluble nitrates - leach into groundwater; is an ever-increasing problem in Midwest
   5) Improper disposal of containers - some pesticide labels - distances from wells for safe mixing and loading of pesticides

h) Adherence to pesticide's label such as using the proper dosage can help reduce contamination.
i) Harsh legal judgments, especially for liability and negligence, are being assessed against polluters.
j) Civil violations are based on the fact that the violation occurred and do not require the element of intent or negligence. Violators might receive a fine of up to $10,000 per day.
k) Criminal violations are given when negligence or intent is established. There may be fines of up to $25,000 per day and possible imprisonment of 2 years.
l) Chapter 644 of the Missouri State Statutes may be used as a reference regarding stream and groundwater pollution.

F. ***Other Activities***

1. Have someone from the local fire department as a guest speaker to discuss reporting and cleanup procedures in your area.

2. Secure a county plat book and have students locate their farms or the farms of friends or relatives.

G. ***Conclusion***

There are several legal issues that must be addressed in regards to the use of agricultural chemicals. We must be aware that the EPA is responsible for administering the Federal Insecticide, Fungicide, and Rodentcide Act and may also be involved with assessing penalties and/or fines when a problem occurs. Crops producers must know the proper procedures used to report a chemical spill and what information needs to be given to the authorities. Land in Missouri is legally described by using the township-range method of indicating its location. The two sources of pollution are point sources such as a chemical spill, and nonpoint sources such as fertilizer runoff from fields. These problems may also involve a civil or criminal penalty.

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

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

I. ***Answers to Evaluation***

1. b
2. b
3. a
4. d
5. Federal Insecticide, Fungicide, and Rodentcide Act
6. Point sources - can be traced to a specific source such as a chemical spill.
   Nonpoint sources - cannot be traced to a specific source such as fertilizer run-off from fields.

UNIT V - SAFETY, ENVIRONMENT, AND LEGAL ISSUES Name______________________________

Lesson 3: Knowing the Law Date________________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What governmental agency regulates the use of pesticides?

   a. Food and Drug Administration
   b. Environmental Protection Agency
   c. United States Department of Agriculture
   d. Department of Natural Resources

2. How many sections of land are in a township?

   a. 24
   b. 36
   c. 48
   d. 52

3. What percent of the nation's groundwater is said to be contaminated?

   a. 1%
   b. 3%
   c. 10%
   d. 50%

4. Restricted use chemical applicators must recertify every _____ years.

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

Complete the following short answer questions.

5. What is the name of the Act that requires the regulation of pesticides?

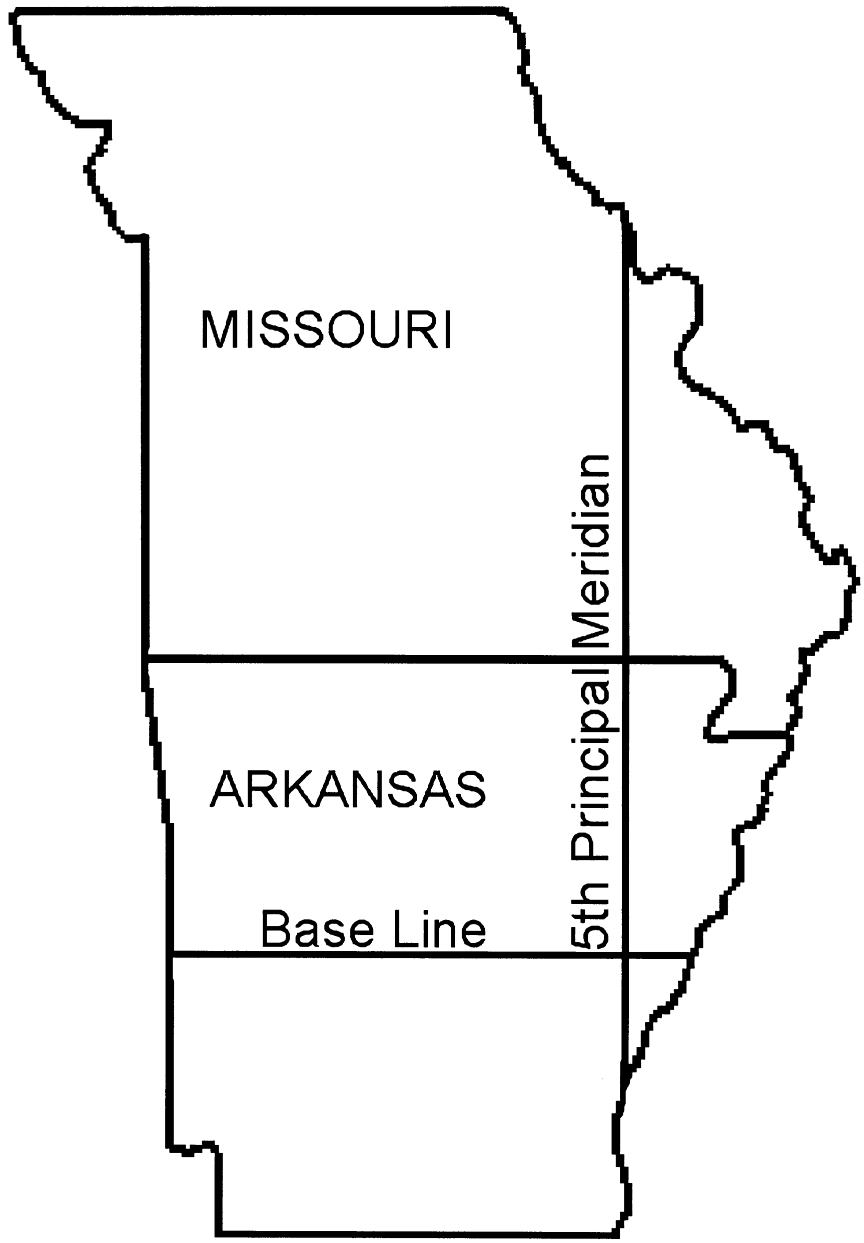
6. List and define the two types of pollution sources for surface and groundwater contamination.

   a.

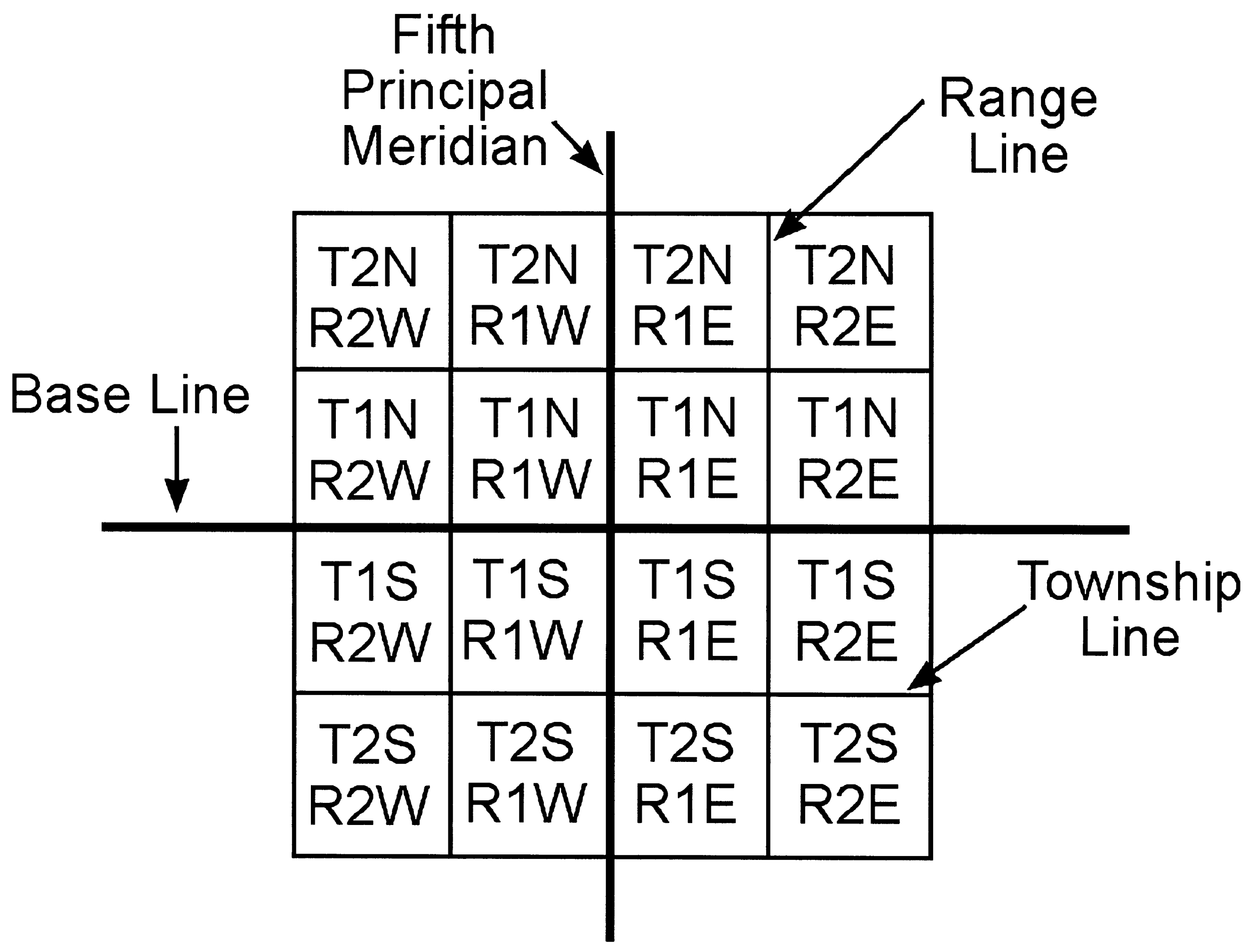
   b.

TM 3.1

Base Line and Principal Meridian Affecting Missouri Land Descriptions



Locating a Township

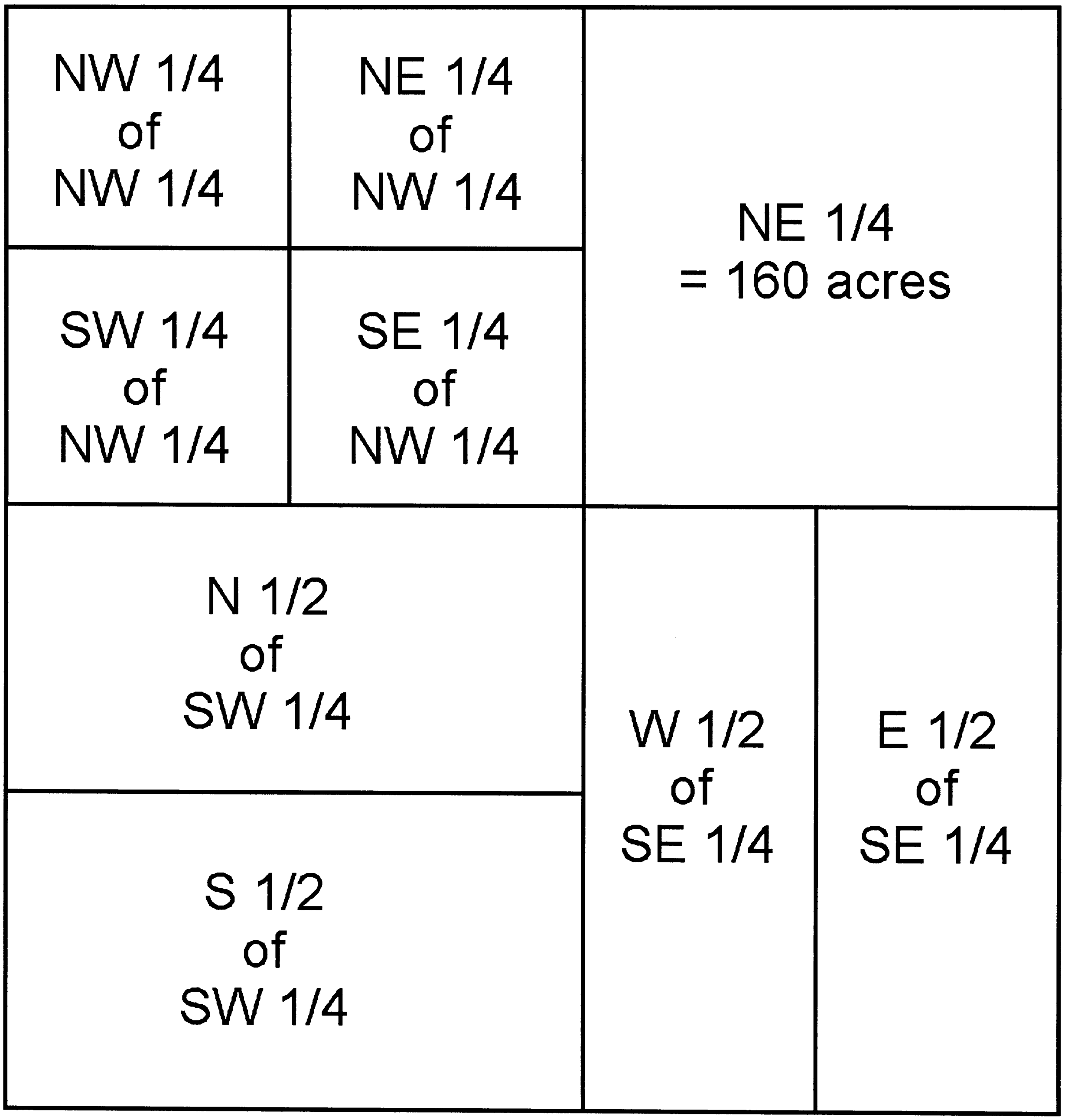


TM 3.3

Section Location in a Township

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Divisions of a Section of Land



Lesson 3: Knowing the Law Name ____________________________

Legal Land Descriptions

Objective: Students will identify and describe parcels of land using the Township-Range system of legal land descriptions.

Directions: Examine Figure A on the next page and answer the questions below.

1. The 6-mile strips of land that run north and south parallel to the principal meridian are called______________.

   a. Ranges
   b. Townships
   c. Base lines
   d. Plat areas

2. ___________ is the township and range description for the selected township in Figure A.

   a. T2E, R3N
   b. T3N, R3E
   c. T3N, R2E
   d. T2E, R2N

3. There are _______ sections in a township.

   a. 12
   b. 24
   c. 36
   d. 48

4. There are ______ acres in a section.

   a. 180
   b. 360
   c. 480
   d. 640

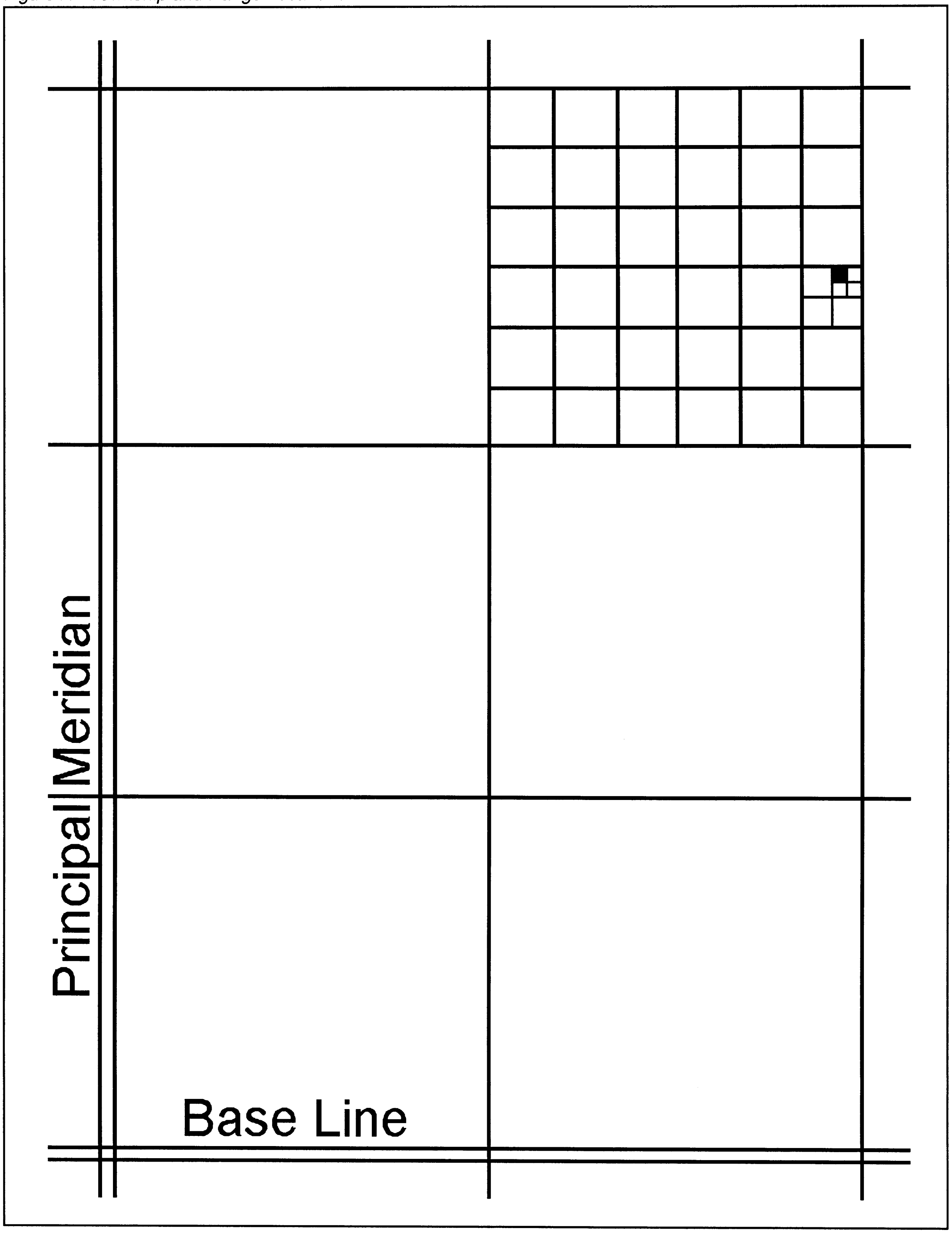
5. What is the legal description of the land tract indicated (darkened) in Figure A?

   a. NE ¼ of NW ½ of Section 12, T2N, R3E
   b. SW ½ of NE ¼ of Section 24, T3N, R2E
   c. NW ¼ of NE ¼ of Section 24, T3N, R2E
   d. NW ¼ of NE ½ of Section 24, T2E, R3N

6. How many acres would be in the indicated (darkened) area of Figure A?

   a. 40
   b. 80
   c. 120
   d. 160

Figure A - Township and Range Locations



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.

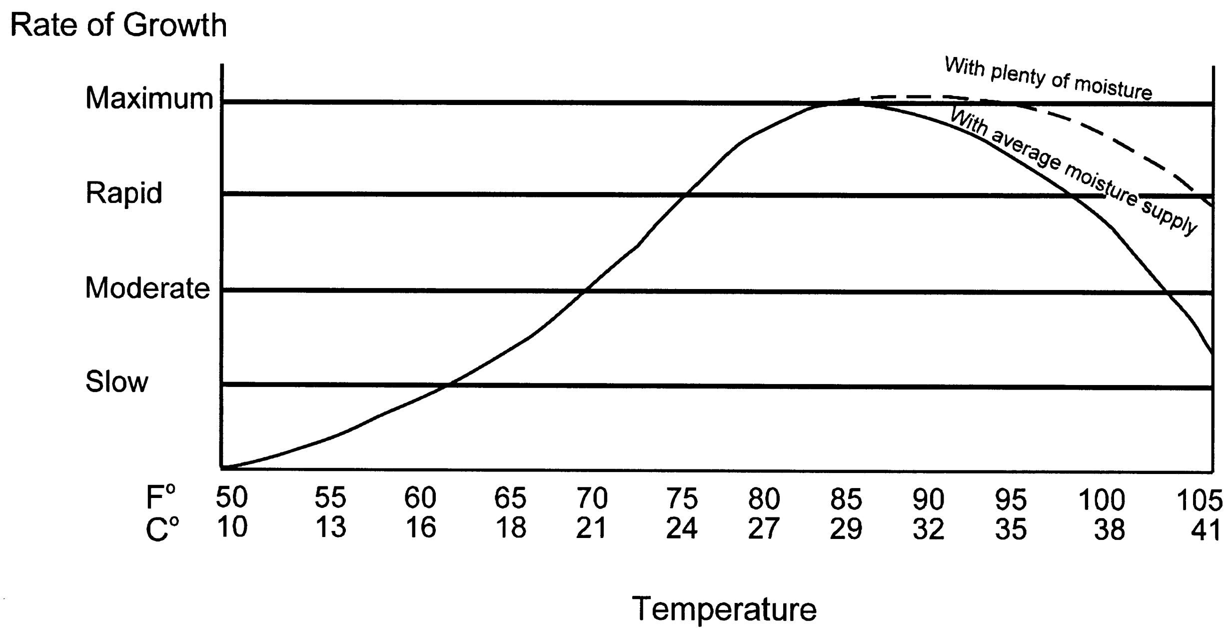
   b.

   c.

   d.

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

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.)

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 2: Selecting a Variety

Competency/Objective: Select a corn and/or grain sorghum variety.

Study Questions

1. **What are the different classes of corn and grain sorghum?**
2. **What is hybrid corn and why was it developed?**
3. **What are the factors to consider when selecting a corn or sorghum seed hybrid?**
4. **What corn maturity groups are adaptable locally?**
5. **What grain sorghum maturity groups are adaptable locally?**
6. **What diseases are common to corn and grain sorghum in Missouri?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit VI.
2. Transparency Master
   a) TM 2.1: Hybrid Crossbreeding Patterns
3. Activity Sheet
   a) AS 2.1: Identifying Corn and Sorghum Diseases

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

Lesson 1 provided the students an introduction to planning the crop for climate and fertilizer needs. This lesson will discuss seed varieties for corn and grain sorghum including the various classes, hybrids, maturity groups, and common diseases.

B. ***Motivation***

Display various types of corn and grain sorghum seeds or plants (dent, Indian, sweet, etc.) Ask students to identify them by name.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the classes of corn and grain sorghum. Include the characteristics and uses of each class.

   What are the different classes of corn and grain sorghum?

   a) Corn
      1) Dent
         (a) During ripening, denting occurs on crowns of kernel.
         (b) It occurs when soft starch of the endosperm shrinks as the grain dries out.
         (c) It is more pronounced in yellow, white, or red seeds.
      2) Flint
         (a) Made up of a small amount of soft starch, covered by a hard starch
         (b) Requires mechanical grinding before being fed to livestock
         (c) Able to germinate at cooler temperatures
         (d) Resistant to weevils
      3) Popcorn
         (a) Variant of flint corn with small hard kernels
         (b) Best results on kernels with 13.5 to 15.5% moisture
         (c) Various colored kernels - popped flake always yellow or white
         (d) Two classes depending on shape of kernel
            (1) Pearl - round and smooth
            (2) Rice - long, flat, and slender
      4) Flour or soft
         (a) Composed of soft starch, with fine, thin layer of hard starch around kernel next to hull
         (b) Easily ground into flour
      5) Sweet
         (a) It is used as vegetable for human consumption.
         (b) Sugar produced by plant does not convert to starch.
         (c) Quality depends on harvesting before maturity.
      6) Pod or Indian
         (a) Decorative - rarely used for human consumption
         (b) Multicolored varieties of flour and flint

7) Specialty
   (a) Waxy - used in manufacturing products
   (b) High lysine, protein, or oil - developed to meet nutrient requirements for livestock feed

b) Sorghum
   1) Grain
      (a) Drought tolerant
      (b) Varieties - milo, kafir, and feterita
      (c) Extensive crossing of varieties - hard to classify
      (d) Grows 2 to 5 feet depending on variety
      (e) Inflorescence with 2,000 seeds
   2) Sweet - known as cane
      (a) Grown for forage
      (b) Small amount produced for sugar or syrup
      (c) Plant heights as tall as 14 feet
      (d) Inflorescence and seeds smaller in size
   3) Grassy - known as sudangrass
      (a) Grown for forage
      (b) Grows rapidly - requires good management during harvest
      (c) Johnsongrass also considered a grass-type sorghum
   4) Broomcorn
      (a) Long, stiff strawlike stalks
      (b) Very durable inflorescence
      (c) Used widely to make brooms

2. Define inbred lines and hybrid corn. Explain how the inbred parent plants are crossed and the various crossbreeding patterns result. Refer to TM 2.1 to explain single-cross, three-way, and double, or four-way, hybrids. Review the history and importance of corn hybridization to corn production.

What is hybrid corn and why was it developed?

a) Hybrid corn
   1) Result of a cross between two parents that differ in one or more traits
   2) Inbred line
      (a) Process of self-pollination over period of 7 to 8 years
      (b) Plants almost genetically identical
      (c) Crossed to produce hybrids
   3) Single-cross hybrid seed - harvested from female parent plant
   4) Three-way hybrids
   5) Double, or four-way, hybrids

b) Developed to increase yields
   1) Hybrids became available to producers around 1933.
   2) By 1960, hybrids were planted on over 90% of all U.S. corn acres.
   3) Currently, all corn acreage is planted to hybrids.
   4) Yield is increased by as much as 25 to 50%.

3. Explain the primary factors to consider when selecting seed varieties. Understanding the seed hybrids' characteristics when choosing a variety is important for the producer.

What are the factors to consider when selecting a corn or sorghum seed hybrid?

a) Maturity date
   1) Variable growing season throughout the state
      (a) Full-season hybrids with greatest yield potential
      (b) Growing season
         (1) Affected by number of days from last frost in spring until first frost in fall

(2) Affected by latitude and altitude - varying climatic changes

b) Yield
   1) Consistently high harvestable yields
   2) Tolerance to stress
   3) Resistance to corn borer, stalk rot, disease, and insects
   4) Corn - plant and ear height
   5) Match with local growing conditions
c) Response to plant populations
   1) Some hybrids must be planted at high populations to yield well.
   2) Others do better at lower populations.
   3) Some hybrids can increase profitability but are a higher risk.
d) Seed cost - consideration for all crops
   1) This has become more of a consideration with the development of specific varieties that are herbicide and pesticide tolerant.
   2) The replant policy for the seed hybrid is also a consideration.

4. Explain how weather may affect the growing days for corn and sorghum. This in turn determines the maturity group of corn or sorghum that may be planted for maximum yield. Refer to the formula in the Student Reference for determining GDD.

   What corn maturity groups are adaptable locally?

   a) Maturity may be the most important characteristic when selecting a corn hybrid.
   b) Full-season hybrids generally yield more than earlier maturing hybrids.
   c) Early maturing varieties may yield less grain or forage and may lodge more from stalk rot.
   d) Producers should select a hybrid that will mature about 1 to 2 weeks before the first frost.
   e) Weather delays may cause a hybrid that was purchased for early May planting to yield less if planted in late May.
   f) Seed companies supply growing degree days (GDD) information with the hybrid.
      1) GDD is calculated for each 24-hour day.
      2) GDD accumulates from the time the hybrid is planted until it reaches physiological maturity in the fall.
      3) GDD is calculated as the average daily temperature minus 50.
      4) If the maximum daily temperature is greater than 86°F, 86 is used to determine the daily average.
      5) If the minimum daily temperature is less than 50°F, 50 is used to determine the daily average.
      6) Producers can also calculate GDD by recording minimum and maximum temperatures.
   g) GDD is a more precise description of relative maturity than listing the hybrid as a 100- or 120-day maturity corn.
   h) Seed dealers are the best source of information on varieties best suited for the area.
   i) State experiment stations compare maturity information on different seed companies.

5. Sorghum varieties are selected using the same rationale as corn. There are, however, a few differences. Discuss these with the students.

   What grain sorghum maturity groups are adaptable locally?

   a) As with corn varieties, selection should be based on growing season length.
   b) Sorghum variety numbers are based on days to grow from planting to 50% bloom stage.
   c) An early maturing variety of sorghum will reach mid-bloom stage at about 60 days.
   d) Later maturing varieties will reach this stage at about 75 to 80 days.
   e) A variety with a 600 number means it will reach mid-bloom at about 60 days.

6. Discuss common diseases that affect corn and grain sorghum in Missouri. Refer to Table 2.1 in the student reference for leaf symptoms of grain sorghum diseases caused by fungi. Have students complete AS 2.1 to help them become more familiar with the diseases.

What diseases are common to corn and grain sorghum in Missouri?

a) Corn diseases - more than 60 reported in the United States; some affecting only the plant, others affecting the grain

1) Common smut
   (a) Caused by a fungus
   (b) Widely distributed all over the world
   (c) Forms small to large galls on aboveground plant part
   (d) Releases black smut spores - stored in corn debris, soil, and manure
2) Diplodia stalk rot
   (a) Caused by fungus
   (b) Cause plants to die early
   (c) Leaves - dull grayish-green similar to frost injury
   (d) Weakens diseased stalks, breaking easily
3) Gibberella stalk rot
   (a) Disease is caused by fungus widely distributed in northern half of the Corn Belt.
   (b) Symptoms are similar to diplodia stalk rot.
   (c) Pink to reddish rot disintegrates the stalk pith.
   (d) Black specks on dead stalks scrape off easily.
4) Fusarium kernel or ear rot
   (a) Fungus disease attacks corn ears and is the most widespread.
   (b) Caps of kernels develop a salmon-pink to reddish-brown discoloration.
   (c) Powdery, cottony-pink mold forms later.
   (d) Fungus may also cause a stalk rot, which is difficult to distinguish from gibberella stalk rot.
5) Gibberella and diplodia ear rot
   (a) Disease is caused by the same fungi that cause stalks to rot.
   (b) It is found more frequently in cooler, more humid areas of the United States when weather during the 4 to 6 weeks before harvest are unusually wet.
   (c) Reddish-pink mold grows on ears.
   (d) Infected kernels are toxic to swine, dogs, and humans.
   (e) Diplodia ear rot usually begins at the base of the ear and progresses upward.
   (f) Part or all of the ear may have a white mold.
6) Aspergillus ear rot
   (a) Disease is caused by a number of fungi species in the genus *Aspergillus*.
   (b) Powdery mold grows on and between the kernels and is usually black, greenish-yellow, or tan.
   (c) It is common in fields where wet conditions exist the month prior to harvest.
   (d) Kernels pack together in storage, forming a crust on top of the bin.
   (e) Disease may produce a "mycotoxin" that is harmful if fed to poultry, swine, beef, and dairy cattle, or humans.
7) Stewart's bacterial wilt
   (a) Disease is caused by a bacterium that is most severe following mild winters.
   (b) Long, pale, green to yellow or tan streaks with wavy margins form in the leaves.
   (c) Dark brown cavities form in the lower stalk pith.
   (d) Infected plants produce premature, bleached, and dead tassels.
   (e) Bacterium overwinters in the corn flea beetle.
8) Yellow leaf blight
   (a) Disease is caused by a fungus that is most prevalent in the northern United States after an extended cool, moist winter.

(b) Rectangular to oval, and yellow-to-tan spots develop that are surrounded by red and purple margin and a broad yellowish area.
(c) The lower leaves turn yellow, wither, and die.
(d) Fungus winters in corn, oxtail, and sudangrass debris on the soil surface.

9) Northern and southern corn leaf blights
(a) Blights are both caused by a fungus and affect corn in their respective areas.
(b) Both are prevalent after warm, moist weather.
(c) There are two races for the southern leaf blight, Race O and Race T.
(1) Disease is practically eliminated by planting resistant hybrids.
(2) Leaf lesions are buff-to-brown borders, elongated between the veins.
(d) Northern leaf blight recognized by long, elliptical, grayish-green and tan lesions on the leaves.
(1) Blight usually appears first on lower leaves.
(2) When severe, plant turns grayish-green and dies early.
(e) Both fungus overwinters in corn debris on or near the soil surface.

10) Common rust
(a) Disease is caused by a fungus and appears after silking, following warm, moist weather.
(b) Small round to elongated, golden to cinnamon-brown pustules form on leaf surfaces and other aboveground plant parts.
(c) Pustules turn chocolate-brown to black when plant matures.
(d) Fungus overwinters on living plants in southern states and spreads northward by windborne spores.

b) Corn stunting viruses
1) First reported in Missouri in 1963 in three southeastern counties
2) Infects 7,000 acres annually
3) Losses ranging from 5 to 95%
4) Most severe in Gasconade and Missouri river bottomland fields
(a) Most of these fields are surrounded by Johnsongrass-infested land.
(b) Johnsongrass is proven to be an overwintering host.
5) Maize dwarf mosaic virus (MDMV)
(a) Symptoms vary in same field, same hybrid.
(b) Symptoms may show early in some plants and later (after pollination) in other plants.
(c) Symptoms appear first in younger leaves as indistinct light and dark green mottling between the veins. Some leaves may become yellow.
(d) Corn plants become dwarfed or stunted due to shortening of the upper internodes.
(e) MDMV has reduced ear size, poorly filled ears, and poor seed set.
6) Maize chlorotic dwarf virus (MCDV)
(a) This virus causes vein clearing.
(b) When leaves held up to light, vein clearing is easily observed in the tertiary veins near the base of the leaf.
7) Wheat steak mosaic virus
(a) Early symptoms appear as chlorotic spots or broken streaks at the tips of the young leaves. Streaks elongate.
(b) Older leaves become chlorotic near the tips with green margins bordering the veins.
(c) Yellowing and stunting may occur as with MCDV and MDMV.

c) Development of resistant and tolerant hybrids - the best, longest lasting method of control; eradication of Johnsongrass in corn and sorghum also desirable

d) Sorghum diseases
1) Fungi in the soil
(a) *Fusarium*
(b) *Pythium*
(c) *Penicillium*
2) Diseases of the leaves

(a) Bacteria causing leaf diseases
   (1) Bacterial stripe
   (2) Bacterial streak
   (3) Bacterial spot
(b) Fungi causing leaf diseases
   (1) Helminthosporium leaf blight
   (2) Target spot
   (3) Gray leaf spot
   (4) Zonate leaf spot
   (5) Rough spot
   (6) Sooty strip
   (7) Rust

3) Diseases of leaves and stems
   (a) Anthracnose
   (b) Sorghum downy mildew
   (c) Crazy top
   (d) Maize dwarf mosaic virus
4) Root and stalk diseases
   (a) Charcoal rot
   (b) Fusarium stalk rot
5) Diseases of the heads
   (a) Smut
      (1) Covered kernel
      (2) Loose kernel
      (3) Head smut
   (b) Mold
      (1) Head molds due to fungi occur during rainy periods after maturity
      (2) Concern primarily during storage
6) Other leaf problems
   (a) Nutrient deficiencies
   (b) Extremes in soil pH
   (c) Extremes in temperature
   (d) Air pollutants
   (e) Insect and bird damage
   (f) Mechanical injury

F. ***Other Activity***

Obtain current copies of the *Missouri Crop Performance Reports* for corn and grain sorghum. Refer to these booklets for test data from the closest site and discuss the reports' findings for the varieties listed as top performers in their area. Discuss why one variety is better than another in a particular locality.

G. ***Conclusion***

The seed variety has a large impact on the profitability of the crop. Producers should conduct their own tests and evaluation to determine which seed variety works best in the soil and climate of the region. Maturity of the hybrid should be appropriate for the area where it is to be grown. Determining the GDD helps to determine the best planting date. Diseases are managed by planting resistant varieties and adopting appropriate tillage and planting practices.

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

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

5. f
6. b
7. g

I. ***Answers to Evaluation***

1. e
2. d
3. f
4. a
5. c
6. b
7. h
8. j
9. i
10. g
11. The result of a cross between two parents that differ in one or more traits
12. Inbred A x Inbred B = single cross hybrid AB
13. Inbred A x Inbred B = single cross hybrid AB
    AB x inbred C = three-way hybrid ABC
14. Maturity date, yield, plant population, cost
15. Maize dwarf mosaic virus
16. GDD
17. c
18. a
19. c
20. d

UNIT VI - CORN AND GRAIN SORGHUM PRODUCTION

Name______________________________

Lesson 2: Selecting a Variety

Date______________________________

EVALUATION

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

1. _____ Decorative corn rarely used for human consumption
2. _____ Grown for human consumption as a vegetable
3. _____ Easily ground and contains an abundance of soft starch
4. _____ Very popular as a snack food and classified as pearls or rice
5. _____ Requires mechanical grinding and is grown in Argentina
6. _____ The most popular corn grown in the United States
7. _____ Grown for fodder and pasture; one variety is a weed
8. _____ Very drought tolerant; grain all over the world
9. _____ Generally grown for forage with small amounts produced for syrup
10. _____ Has stiff strawlike stalks

a. Popcorn
b. Dent corn
c. Flint corn
d. Sweet corn
e. Pod/Indian corn
f. Flour or soft corn
g. Broomcorn sorghum
h. Grass sorghum
i. Sweet sorghum
j. Grain sorghum

Complete the following short answer questions.

11. Define hybrid corn.

12. Describe the cross pattern to achieve a single-cross hybrid.

13. Describe the cross pattern to achieve a three-way hybrid.

14. List the four primary factors to consider when selecting a seed variety.

    a.

    b.

    c.

    d.

15. One of the most common corn stunting diseases is MDMV. What do these letters stand for?

    M _________________ D________________ M_______________ V_____________________

16. A more accurate measure of maturity length of corn varieties would be to use _________________ instead of days to maturity such as 100 or 120 days.

Circle the answer that corresponds to the best answer.

17. Which of the following corn diseases shows symptoms of large galls growing on the plant, which later releases black spores?

    a. Gibberella stalk rot
    b. Aspergillus ear rot
    c. Common smut
    d. Common rust

18. Covered kernel, loose kernel, and head smut affect the _________________ of grain sorghum.

    a. Heads
    b. Leaves
    c. Stems
    d. Stalks

19. Anthracnose, sorghum downy mildew crazy top, and maize dwarf mosaic viruses are diseases that affect the _________________________________ of grain sorghum.

    a. Root and stalk
    b. Head and stalk
    c. Leaves and stems
    d. Kernels and stems

20. Charcoal rot is a disease that affects the _________________________ of the grain sorghum plant.

    a. Head
    b. Leaves
    c. Stems
    d. Stalk

Hybrid Crossbreeding Patterns

Single Hybrid

Inbred A X Inbred B

Single-cross hybrid AB

Three-way Hybrid

Inbred A X Inbred B

Single-cross hybrid AB

AB X Inbred C

Three-way hybrid ABC

Double or Four-way Hybrid

Inbred A X Inbred B Inbred C X Inbred D

Single-cross hybrid AB X Single-cross hybrid CD

Double or four-way hybrid ABCD

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.

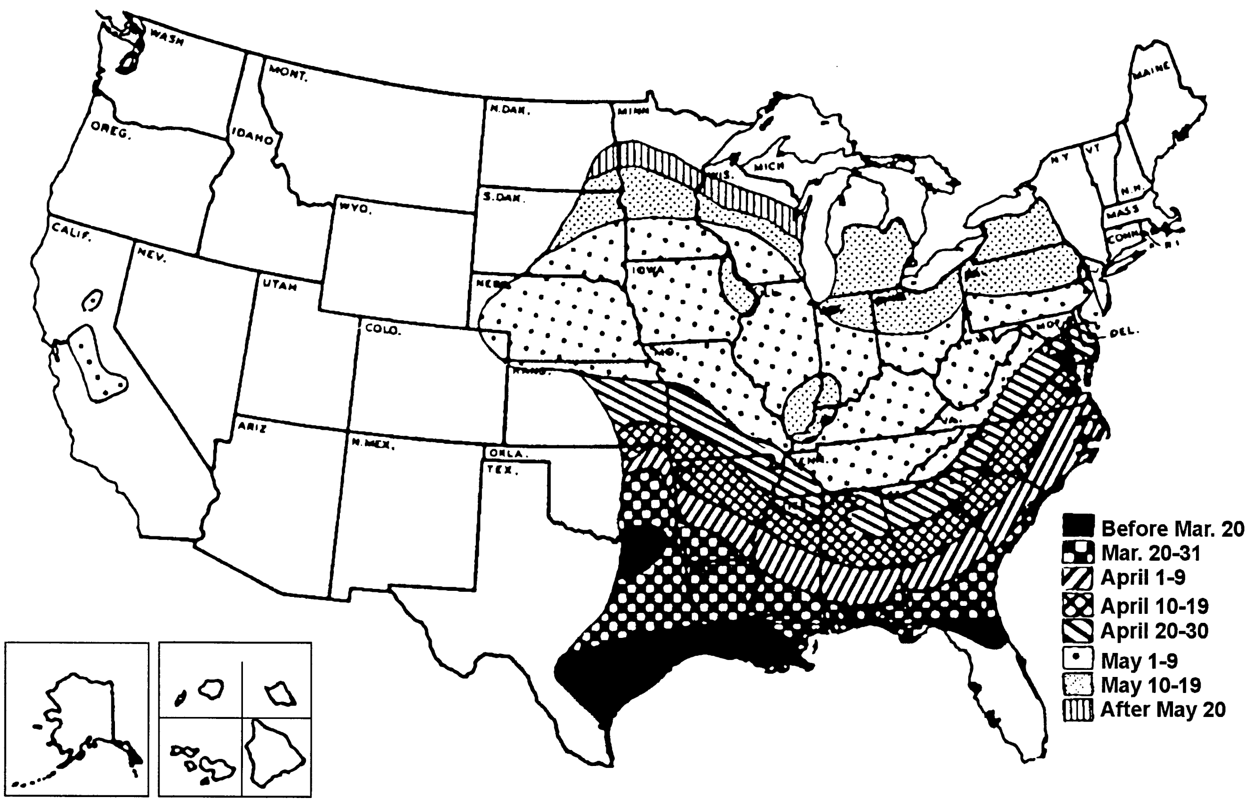
   a. 30,000
   b. 50,000
   c. 75,000
   d. 100,000

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

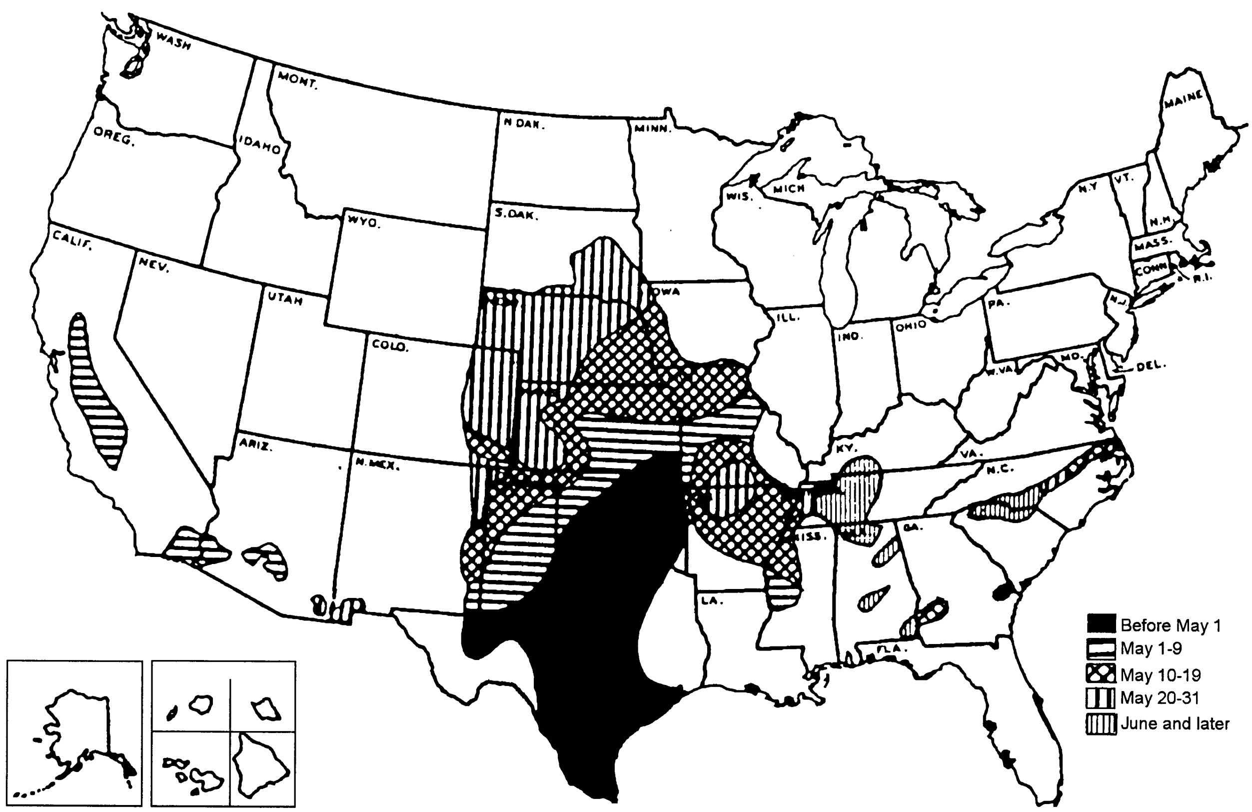
Corn Planting Calendar



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.

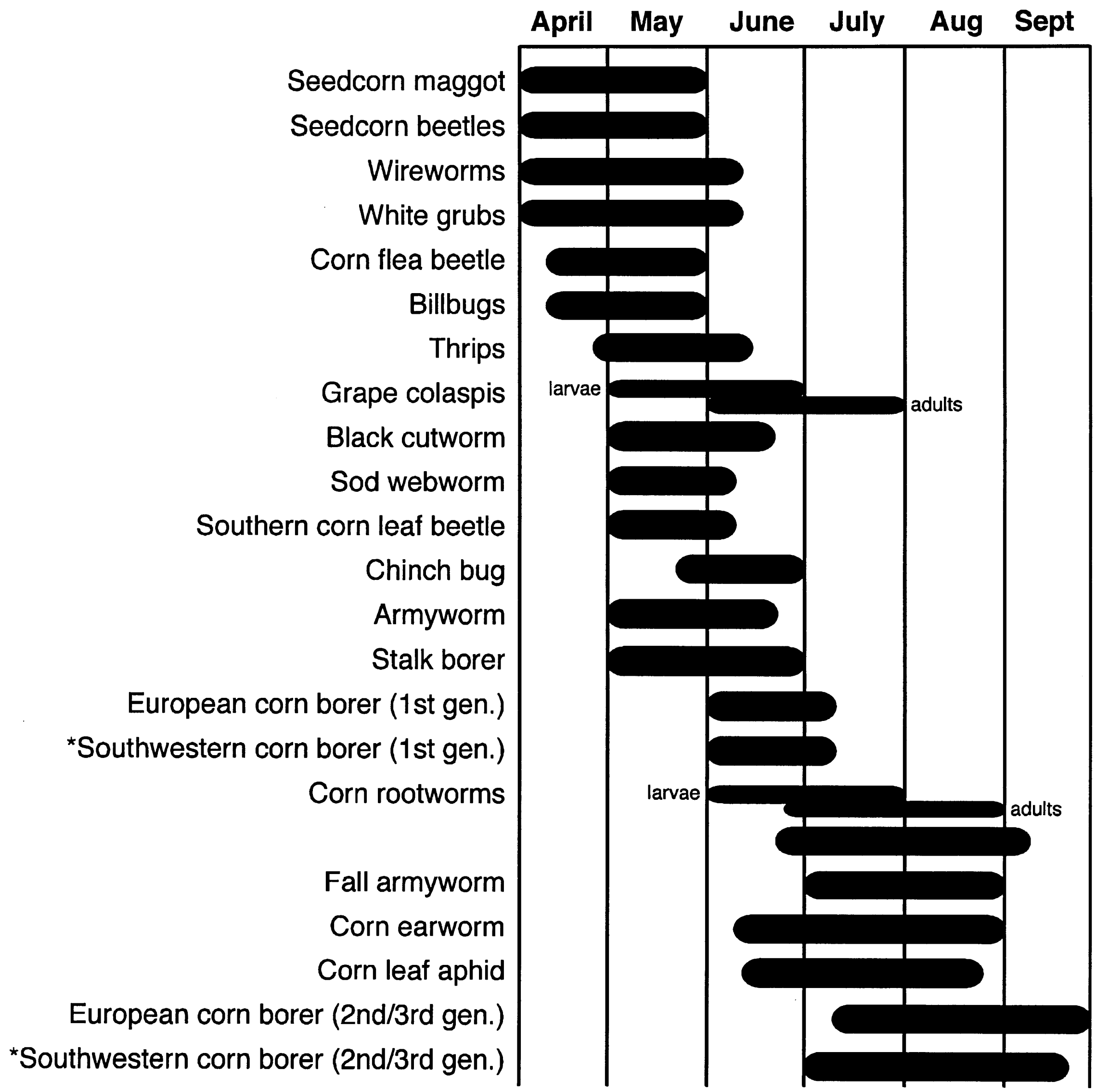
   b.

   c.

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

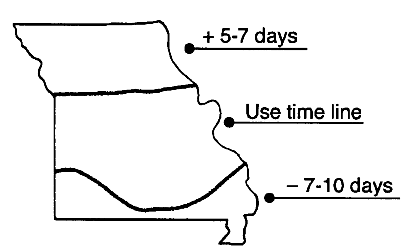
TM 4.1

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

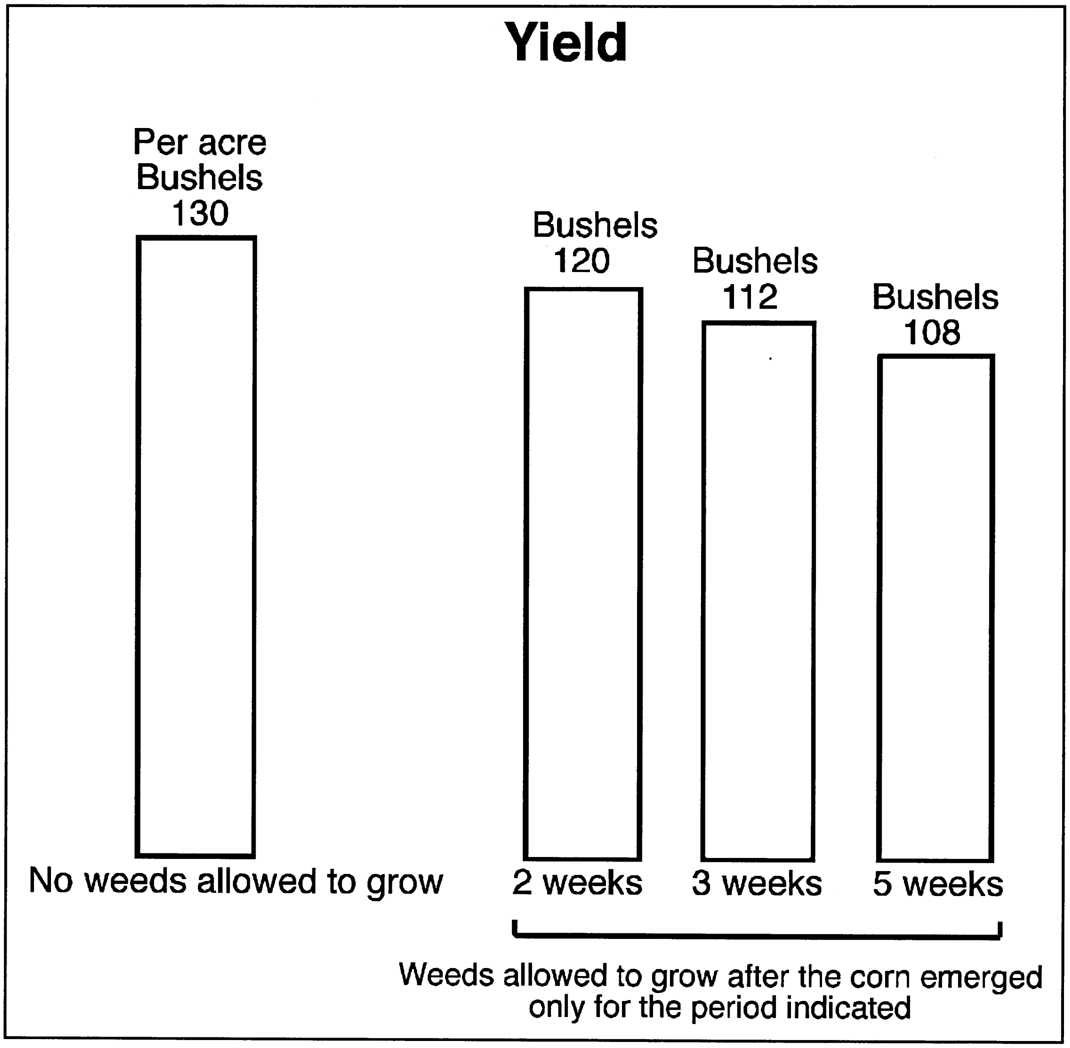
Central and North Missouri

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

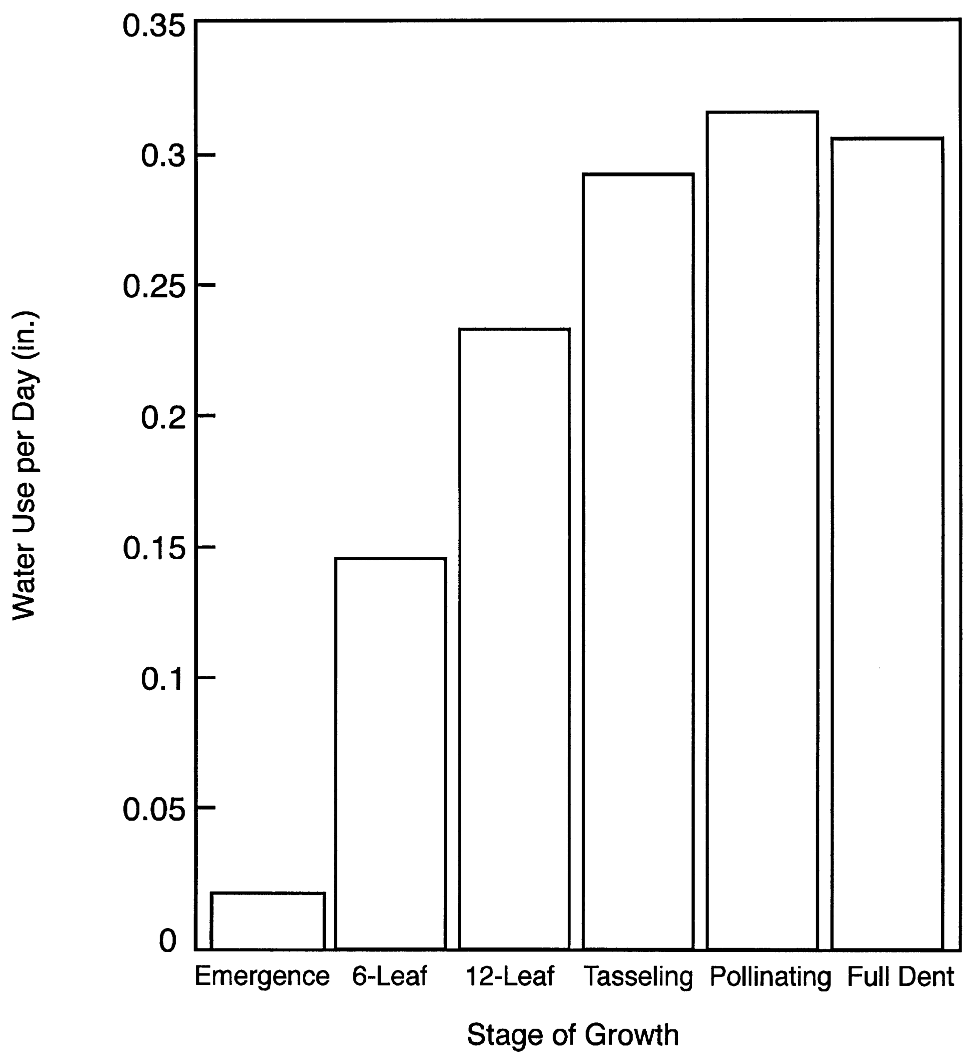
Effect of Pigweed Stand on Corn

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.

<u>Estimated planting income</u>:

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

<u>Estimated planting costs</u>:

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.

    <u>Ensiling Process</u>: 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?

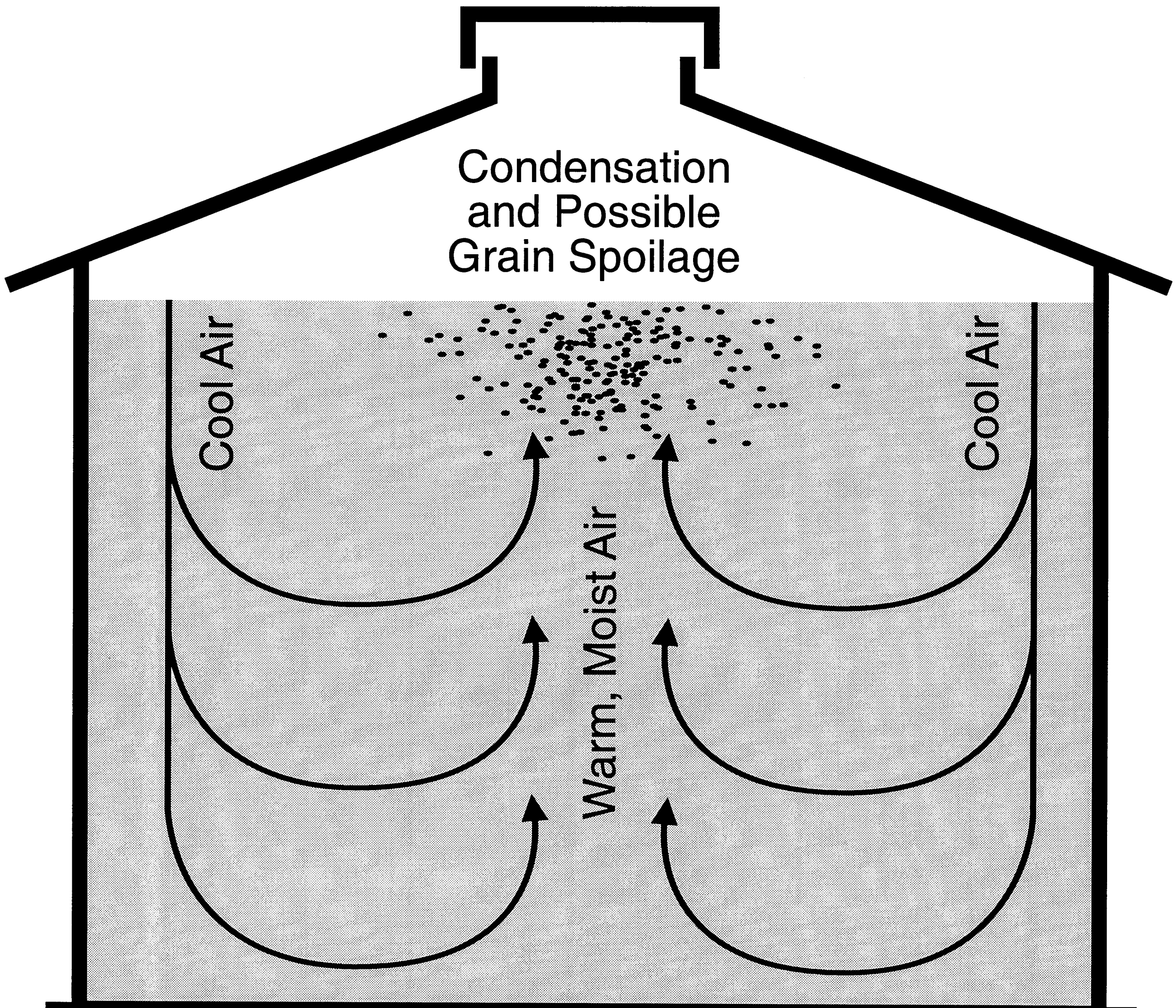
    a.

    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.

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? $ _______________

UNIT VII - SOYBEAN PRODUCTION

Lesson 1: Planning the Crop

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

Study Questions

1. What environmental conditions are necessary for soybean production?

2. What factors are considered when evaluating field history?

3. What are the fertilizer requirements for soybeans?

References:

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

2. *Missouri Soybean Handbook* (Manual 123). University of Missouri Extension publication, 1982.

UNIT VII - SOYBEAN PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

Introduce the unit by giving a brief history on soybeans. Review the major uses of soybeans and alternative uses discussed in Unit I. Discuss the importance of soybeans in the state, country, and global markets. Explain that the first lesson covers factors to consider when planning a soybean crop: the necessary environmental conditions, the history of the field, and fertilizer requirements.

B. ***Motivation***

Obtain soil samples from several fields that are being prepared for soybean planting and from fields that have recently had soybeans harvested from them. Show the students the results of the soil samples. Point out what nutrients are going to be needed for the potential soybean crop and look at the variances for the field that recently had a soybean harvest.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Growing season, rainfall, field topography, and soil type are the most important environmental conditions affecting soybean production. Discuss each of these factors in respect to planning a soybean crop. Soybean maturity groups are discussed in detail in Lesson 2.

   What environmental conditions are necessary for soybean production?

   a) Growing season
      1) Average season for soybeans is 175 days from mid-April to end of October.
      2) Optimum temperature for soybean germination is 68°F.
      3) Late planting can result in reduction in yields.
      4) Soybeans flower in maturity stage in response to temperature and photoperiod (day length).
         (a) Photoperiod sensitive means to move from vegetative to flowering stage in response to day length.
         (b) Soybeans begin flowering after day lengths become shorter.
         (c) Warm and/or short days hasten flowering and maturity.
   b) Rainfall
      1) Optimum is 18 to 22 inches over the growing season.
         (a) Normal rainfall amounts are adequate during planting.
         (b) Normal rainfall amounts are inadequate during June, July, and August.
         (c) Reproductive growth stage needs 2.5 inches per week.
      2) Soybeans are most sensitive to moisture deficiency during flowering and pod development.
         (a) Lack of water will result in yield reduction and cause pods to abort.
         (b) Irrigation provides relief during dry weather but is costly to maintain.
      3) United Soybean Board (USB) continues research on genetically altered drought- and flood-resistant soybeans.
   c) Topography (drainage)
      1) Waterlogged soils
         (a) Delays planting date
         (b) Creates environment for fungus and bacteria to thrive

(c) Nitrogen fixation and nutrient uptake reduced
(d) Occurs in fine-textured, flatland soils with hardpans and claypans
2) Preventing or removing excess water
(a) Tillage methods
(b) Terracing systems
d) Soil
1) Ideal soil - well-drained, silty clay loam
(a) Adequate water-holding capacity
(b) Releases water to plants as needed
2) Sandy clay or heavy clay soils
(a) Neither too wet nor too dry
(b) Better adapted to clay soils than corn or cotton
3) Counties with high yields
(a) Have silty clay loam soil
(b) Utilize current technology and make sound decisions

2. Ask the students what factors should be considered about a field before planting a crop of soybeans. Discuss the importance of knowing the previous crop or activity of a field and how that can impact management decisions on fertilizer, pest control, and tillage and/or planting options.

What factors are considered when evaluating field history?

a) Previous crop
1) Soybeans develop better after grass-type crops, such as corn or grains.
(a) Leave nutrients for soybeans
(b) Reduces fertilizer costs
2) Knowing previous crop helps determine fertilizer needs.
b) Previous tillage and/or planting method
1) Helps project pest problems
(a) Test soil if SCN problem is suspected.
(b) SCN can cause severe yield loss.
2) Helps determine what tillage and/or planting method to use
(a) Conventional to no-till to reduce soil compaction
(b) CRP ground to no-till to maintain soil, water, and wildlife improvements gained

3. Ask the students to describe what nutrients and pH level are needed to produce soybeans. Describe to them the different deficiency symptoms that soybeans have when they lack certain nutrients. Then have the students indicate those nutrients that are needed to correct the deficiencies. Use Table 1.1 to show the amount of nutrients removed from a field in a 50-bushel crop yield.

What are the fertilizer requirements for soybeans?

a) Nutrient levels and soil pH
1) Soybeans less tolerant to acidity than other row crops
2) Require low soil acidity for nodulation, nitrogen fixation, and plant growth
3) Develop better with soil pH of 6.2 - 7.0
(a) Acidic subsoils (pH 4.0 - 6.0) need lime.
(b) In soil with a pH above 7.0, nutrients are tied up and unavailable, causing deficiencies.
4) Nutrients needed by soybeans
(a) Nitrogen
(1) Needs
a. The soybean plant is a legume that supplies its own needs from the atmosphere.
b. It is generally nonprofitable to apply; it can delay nodulation and reduce available nitrogen.
c. Small amounts can be applied on sandy or cold soils to stimulate

plant growth and nodulation until nitrogen fixation begins.

- (2) Deficiencies
  - a. Stressful environmental conditions - wet; very hot, dry conditions; or very acidic soils
  - b. Inadequate supply of *Rhizobium japonicum* - bacterium needed for nitrogen fixation
    - i. Adequate in fields previously planted with soybeans
    - ii. Where inadequate, need to plant inoculated soybeans

(b) Phosphorus

- (1) Needs
  - a. Large amounts are absorbed throughout the growing season.
  - b. Greatest demand starts just before pods form to 10 days before seeds are fully developed.
  - c. One bushel of soybeans removes 0.8 - 0.9 pound of phosphorus per acre.
  - d. Recommendations are based on building levels over 8 years.
  - e. Amounts vary due to previous crop history, seed variety, and soil type.
- (2) Deficiencies
  - a. Phosphorus reduces nodule bacteria needed for nitrogen fixation and good root development.
  - b. Symptoms are thin, dwarfed stem; lack of luster in leaves; early defoliation; and poor or nonefficient nodulation.

(c) Potassium

- (1) Needs
  - a. Requires large amounts; 1 bushel of soybeans removes 1.4 pounds of potassium from the soil.
  - b. Uptake peaks during rapid vegetative growth and slows when beans form.
  - c. Soil levels can be high because it leaches very little (except in sandy soils), is not used in excess by soybeans, and is released every year in slowly available forms.
- (2) Deficiencies
  - a. Symptoms are stunted growth with shortened internodes, edges of leaves scorched or yellow and curl downward (especially lower leaves).
  - b. Severe symptoms are brown or black edges on leaves.

(d) Secondary macronutrients

- (1) Deficiencies are not as common as with major nutrients.
- (2) Soybeans contain more secondary nutrients than other grain crops, except for corn's sulfur content.
- (3) Limestone used to adjust pH provides adequate amounts of calcium and magnesium.
- (4) Magnesium deficiency will occur in lower leaves and appear as pale, green color between main veins.
- (5) Sulfur deficiency is visible in young leaves and veins appear pale.
  - a. Similar to nitrogen deficiencies except in upper leaves
  - b. Few cases in Missouri except on sandy-textured, low-organic soils

(e) Micronutrients

- (1) Adequate amounts maintained at proper soybean pH level
- (2) Iron deficiencies
  - a. Occur in river bottom soils with pH levels of 7.5 or higher
  - b. Yellowing of leaves between the veins
  - c. Leaves almost white
- (3) Manganese deficiencies
  - a. Occur in old lake beds, glacial outwashes, peat soil
  - b. Sandy soils high in organic matter or heavily textured, acidic soils

c. White or yellow leaves with green veins *(Interveinal chlorosis)*

(4) Molybdenum deficiency
   a. Occurs on very acid, sandy soils
   b. Needed by legumes for nitrogen fixation
   c. Shortage of nitrogen with pale green or yellow plants

(5) Zinc deficiencies
   a. Soybeans are less sensitive to zinc deficiency than corn.
   b. Normal corn growth on same soil indicates adequate supply.
   c. Deficiencies are found in graded, severely eroded, or low-organic soils.
   d. Symptoms are stunted plants with interveinal areas of leaves becoming yellow.
   e. Distant field areas appear yellowish-brown.

F. ***Other Activity***

Visit the George Washington Carver National Monument near Diamond, MO (extreme southwest Missouri). This national park consists of 210 acres of the original Moses Carver farm. Students can experience Missouri's natural grass prairie vegetation by hiking the ¾ mile Carver Trail and learning about Carver's life and work at the park's Visitor's Center. Additional information can be found on the Internet at <http://www.nps.gov/gwal>.

G. ***Conclusion***

In order for soybeans to have productive yields, they require a suitable growing season, correct rainfall amounts, suitable drainage or topography, and appropriate soil type. Field history will determine what fertilizer, tillage, and planting methods should be used. Soil test recommendations will indicate the soil pH and nutrient levels and guide the producer in the fertility needs of the fields to be planted.

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

I. ***Answers to Evaluation***

1. b
2. a
3. b
4. Plants move from the vegetative to the flowering stage in direct response to day length.
5. Answers will vary but should include two of the following:
   a) Delays planting dates
   b) Creates environment for plant diseases
   c) Reduces nitrogen fixation
   d) Reduces nutrient uptake
6. Silty clay loam
7. Bacterium needed for nitrogen fixation
8. Grass-type crops
9. Tested, SCN
10. f
11. c
12. e
13. a
14. g
15. b
16. d

UNIT VII - SOYBEAN PRODUCTION　　　　Name ______________________________

Lesson 1:　Planning the Crop　　　　Date ________________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the optimum rainfall for soybeans?

   a. 10 to 20 inches
   b. 18 to 22 inches
   c. 20 to 32 inches
   d. Over 25 inches

2. Soybeans are most sensitive to moisture deficiency during ____________________________.

   a. Pod development
   b. Nodulation
   c. Irrigation
   d. Harvest

3. The optimum temperature for soybeans to germinate is __________ °F.

   a. 86
   b. 80
   c. 76
   d. 68

Complete the following short answer questions.

4. Define photoperiod sensitivity.

5. List two problems caused by poor drainage.

   a.

   b.

6. The optimum soil for soybeans is a well-drained ____________________________________.

7. *Rhizobium japonicum* is ____.

8. Soybeans develop better when planted behind ______________________________________.

9. Soil should be _________________ if there is a possibility of a _____________ problem.

Match the term in the left column with the statement in the right column.

10.	_____ Occurs in very acid, sandy soil.	a.	Nitrogen
11.	_____ Peaks during rapid vegetative growth.	b.	Phosphorus
12.	_____ Occurs in sandy soils high in organic matter.	c.	Potassium
13.	_____ Extracts adequate supply from atmosphere.	d.	Iron deficiency
14.	_____ Found in graded, severly eroded, or low organic soils.	e.	Manganese deficiency
15.	_____ Greatest demand starts in the late reproductive stage.	f.	Molybdenum deficiency
16.	_____ Occurs in river bottom soils with high pH of 7.5 or higher.	g.	Zinc deficiency

UNIT VII - SOYBEAN PRODUCTION

Lesson 2: Selecting a Variety

Competency/Objective: Select a soybean variety suitable for your area.

Study Questions:

1. **What is the difference between indeterminate and determinate soybeans?**

2. **What factors should be considered when selecting a seed variety?**

3. **What diseases are prevalent locally?**

References:

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

2. *Missouri Soybean Handbook* (Manual 123). University of Missouri Extension agricultural publication, 1982.

3. Missouri Soybean Variety Performance Test Results available on the Internet at <http://agebb.missouri.edu/cropperf/soybean/index.htm>

4. *Soybean Diseases I and II* (PS103). University Extension. University of Missouri-Columbia Agricultural Picture Sheet.

5. Transparency Master

   a) TM 2.1: Missouri Soybean Maturity Groups

6. Activity Sheets

   a) AS 2.1: Selecting a Seed Variety
   b) AS 2.2: Identify Soybean Diseases

UNIT VII - SOYBEAN PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

Once the local growing conditions have been evaluated (considering the field history and current fertility needs), the producer must select a soybean variety to plant. Discuss with students the importance of soybean growth types (indeterminate and determinate) and the various factors that affect variety selection. Also discuss prevalent diseases of your area that may determine which resistant varieties can be planted. (Pages 44 and 45 of the *Missouri Soybean Handbook* can be used as a pictorial reference for most of the listed diseases.)

B. ***Motivation***

Describe a situation in which a local soybean producer is preparing to choose a variety of soybeans to grow. Ask the students what information the producer might need to make a decision and where the producer could get that information.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the role that ongoing research has on the development of new varieties of soybeans. Soybean varieties differ by their ability to grow under various environmental conditions and ability to survive pests that may be prevalent in the local areas.

   What is the difference between indeterminate and determinate soybeans?

   a) Indeterminate – plant continues to grow along with flowering and podding stages
      1) Doubles in height after first flowers appear
      2) Commonly grown in northern Missouri
      3) Some early-maturing varieties used with double cropping in southern Missouri
   b) Determinate – main stem stops growing when flowering begins
      1) Semi-dwarf – (true determinate) about half the height of normal varieties
      2) Semi-determinate – shorter flowering period, grow 6 to 10 inches less
         (a) Add only a small amount of vegetative grow after flowering.
         (b) May yield more in high productivity areas.
      3) Both - more lodging resistant than taller types

2. Discuss the five primary factors that need to be evaluated when selecting a seed variety. These are the factors that a producer should evaluate when choosing which variety to plant. Emphasize how these factors will affect profitablity. Complete AS 2.1 to familiarize students with variety performance test results.

   What factors should be considered when selecting a seed variety?

   a) Maturity
      1) Classified by ability to mature and be harvested within available growing season of a particular location
      2) Varieties matched to season by photoperiod (day length)
      3) Classified within 13 maturity groups (5 groups grown in Missouri)
         (a) Maturity Group II - extreme northern Missouri

        (b) Maturity Group III - northern and central Missouri
        (c) Maturity Group IV - central Missouri and southern Missouri
        (d) Maturity Group V - southern Missouri and Missouri Bootheel
        (e) Maturity Group VI – Missouri Bootheel counties of Dunkin and Pemiscot
    4) Choosing maturity within a growing season
        (a) Full season – generally more productive, use with small grain rotation in south Missouri
        (b) Early season – use with winter wheat rotation or wet weather at harvest
        (c) Mid-season – use with small grain rotation in central Missouri
        (d) Late season – flower longer and grow taller, more competitive with weeds, have excessive growth, and lodge in highly fertile and moist soil

b) Standability
    1) Lodging can decrease yields 20 to 30%.
    2) Lodging is controlled genetically but altered by environment.
        (a) Increased by high fertility, narrow row spacing, high plant population, and irrigation
        (b) Reduced by semi-dwarf varieties

c) Pest resistance (insects, weeds, disease, and nematodes)
    1) Some pests are difficult to recognize but may reduce yields as much as 15%.
    2) Varieties are being developed to resist disease, nematodes, and nutrient problems.
    3) Few varieties resist insects.
    4) Many varieties carry resistance to Phytophthora root rot and soybean cyst nematode.

d) Additional considerations
    1) Double-crop
        (a) Best when wheat follows soybeans, except in northern counties
        (b) Mid-season varieties best
            (1) Produce necessary canopy to shade out weeds
            (2) Mature fast enough to avoid frost losses
        (c) Determinate semi-dwarf varieties not used
            (1) Low height
            (2) Short flowering period
        (d) Sufficient soil moisture to ensure seed germination
        (e) Variety that will mature before frost
    2) Shatter resistance
        (a) Common during dry conditions, especially in western Missouri
        (b) Nonresistant varieties used only if other aspects are exceptional and early harvest expected
    3) Seed cost
        (a) Potential yield difference high enough to justify expense
        (b) Find best price on highest quality seed of a given variety
        (c) Smaller seeds - fewer pounds per acre, resulting in reduced cost
    4) Seed quality
        (a) Minimal cost per acre difference between good seed and poor seed
        (b) Guarantees varietal purity, germination, freedom from weed and other crop seeds
        (c) Free testing available at the Missouri Department of Agriculture
    5) Availablity of seed and marketability of GMO crops
    6) Intended use of the crop

e) Yield
    1) Choose high-yield variety only if other necessary characteristics are available for specific planting location.
    2) Information is available on variety testing results.
        (a) *Missouri Crop Performance: Soybean*
        (b) Agricultural Electronic Bulletin Board (AgEBB) at: <http://www.ext.missouri.edu/agebb/index.htm>

3. Review the various diseases, their causes, symptoms, and control methods. Refer to the tables in the Student Reference for a breakdown of each disease. Additional information, with full-colored photos of common diseases, is available from the University of Missouri Extension Agricultural picture sheet PS103, Soybean Diseases I and II. These photos may be used with AS 2.2 to help the students identify soybean diseases.

   What diseases are prevalent locally?

   a) Cost Missouri producers over $100 million annually in losses, more in wet years
   b) Causes of disease
      1) Pathogenic fungi
      2) Bacteria
      3) Viruses
      4) Nematodes
   c) Causes of injury that may be mistaken as disease
      1) Herbicides
      2) Environmental causes (excessive wind, rain, temperature, hail)
   d) Classification of most serious diseases prevalent in Missouri
      1) Seedling diseases
         (a) Pythium
         (b) Phytophthora
         (c) Rhizoctonia
         (d) Fusarium
      2) Root and stem diseases
         (a) Phytophthora root and stem rot
         (b) Fusarium root rot
         (c) Charcoal rot
         (d) Southern blight
         (e) Sudden death syndrome (SDS)
      3) Pod and stem diseases
         (a) Pod and stem blight
         (b) Stem canker
         (c) Anthracnose
      4) Foliar (Leaf) diseases
         (a) Brown spot
         (b) Downy mildew
         (c) Bacterial blight
         (d) Frogeye leaf spot
      5) Virus diseases
         (a) Soybean mosaic
         (b) Bean pod mottle
         (c) Bud blight
      6) Nematodes
         (a) Soybean cyst nematode (SCN)
         (b) Root-knot nematode

F. ***Conclusion***

Producers need to consider many things when choosing a soybean variety that is appropriate for the specific location. New varieties of soybeans are always being developed to resist disease and still maintain a good crop yield. A producer needs to be familiar with and be able to identify diseases that affect the soybean crop and identify preventive measures to control the diseases.

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

Answers will vary for both activities.

H. ***Answers to Evaluation***

1. Answers should include two of the following: other producers, seed dealers, University and extension variety trials, or the producer's own strip trial.

2. *Indeterminate:* the plant continues to grow along with flowering and podding stages, frequently doubling in height after the first flowers appear.
   Determinate: the main stem stops growing when flowering begins; shorter than indeterminate type.

3. *Semi-dwarf:* true determinates only half the height of normal determinate varieties.
   Semi-determinate: shorter flowering period and grow 6 to 10 inches less than determinate varieties; after flowering only a small amount of vegetative growth occurs.

4. Answers should include three of the following: maturity, standability, pest resistance, additional considerations, or yield.

5. Groups II through VI

6. Answers should include two of the following: high soil fertility, narrow row spacing, high plant population, or irrigation.

7. Phytophthora root rot and soybean cyst nematode

8. Answer should include one of the following:
   Double cropping – whatever crop is to follow or precede a soybean crop will determine whether a full-, early-, mid-, or late-season soybean variety should be planted.
   Shatter resistance – nonresistant varieties should be used only if they are exceptional in other aspects and an early harvest is expected.
   Seed cost – producers should be sure there is enough potential yield difference to justify the expense. Smaller seed size varieties need fewer pounds of seeds per acre and may reduce cost.
   Seed quality - there is very little difference in cost per acre of good seed versus poor seed or seed of unknown quality and the purchase of certified seed guarantees varietal purity, germination, and freedom from weed and other crop seeds.
   Use of herbicide-resistant varieties - producers are caught in the middle of the world-wide debate on the use of GMOs and they should stay current with developments in the market.
   Intended use of the crop - producers can focus on planting soybeans for a variety of uses.

9. When it also has other necessary characteristics (maturity, disease resistance, etc.) that are needed for the specific planting location.

10. c
11. a
12. d
13. e
14. a
15. d
16. b
17. e
18. b
19. b
20. c
21. d
22. a
23. d
24. e
25. a

UNIT VII - SOYBEAN PRODUCTION

Name______________________________

Lesson 2: Selecting a Variety

Date ______________________________

EVALUATION

Complete the following short answer questions.

1. List two sources of information on soybean varieties.

   a.

   b.

2. What is the difference between indeterminate and determinate growth types?

3. What is the difference between semi-dwarf and semi-determinate varieties?

4. List three of the five factors that should be considered when selecting seed variety.

   a.

   b.

   c.

5. What maturity groups are adaptable to Missouri?

6. List two environmental conditions that can affect lodging.

   a.

   b.

7. What are the two diseases that most soybean varieties carry a resistance to?

   a.

   b.

8. List one additional consideration that might be used when selecting a variety and why it should be considered.

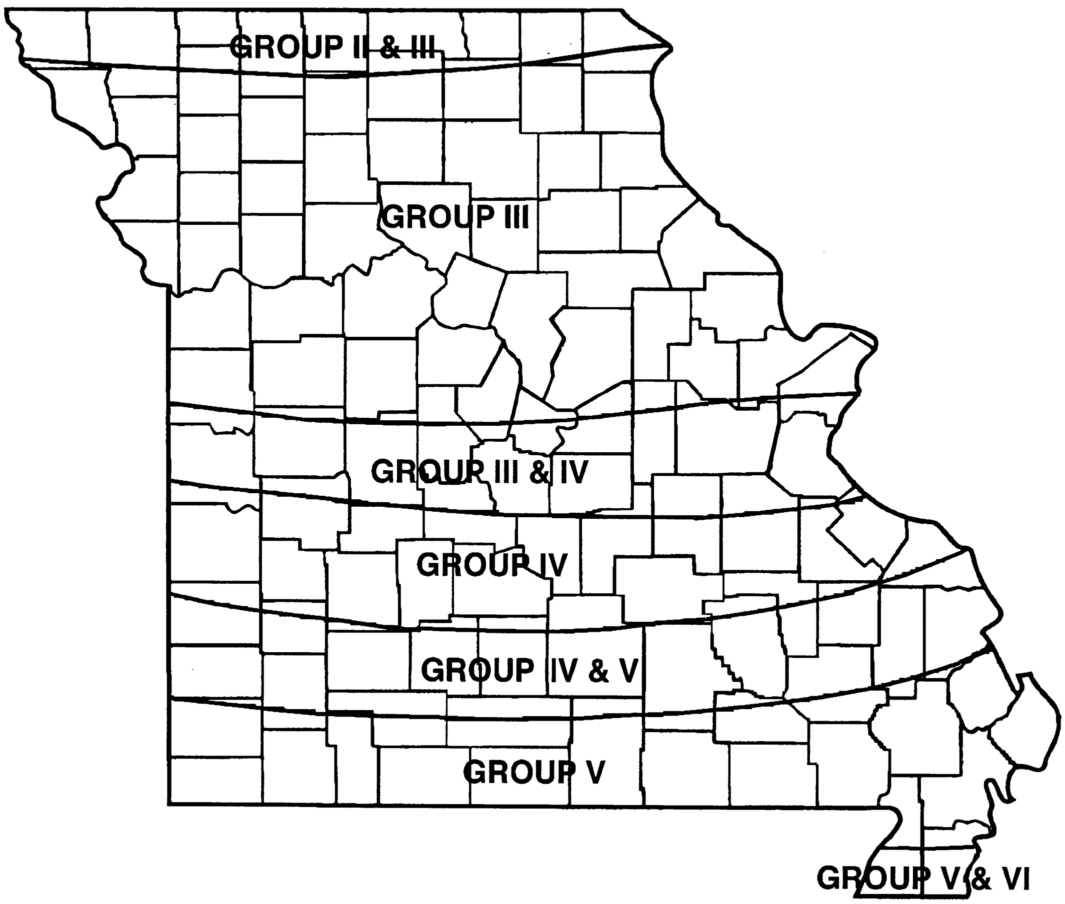
9. When should a producer choose the highest yielding variety?

Match each disease with its classification.

10.	Anthracnose	a.	Seedling disease
11.	Rhizoctonia	b.	Root and stem disease
12.	Bacterial blight	c.	Pod and stem disease
13.	Bud blight	d.	Leaf disease
14.	Fusarium	e.	Virus disease
15.	Brown spot		
16.	Charcoal rot		
17.	Soybean mosaic		
18.	Southern blight		
19.	Sudden death syndrome		
20.	Stem canker		
21.	Frogeye leaf spot		
22.	Pythium		
23.	Downy mildew		
24.	Bean pod mottle		
25.	Phytophthora		

TM 2.1

Missouri Soybean Maturity Groups



Lesson 2: Selecting a Variety Name ______________________________

Selecting a Seed Variety

Objective: Students will research seed varieties appropriate for their particular area.

Directions: Compare and evaluate the seed varieties appropriate for the Maturity Group for your area. Your instructor will assign different varieties to research. Access the University of Missouri Variety Performance Tests available on the Internet at <http://agebb.missouri.edu/cropperf/soybeans/index.htm>. Locate the performance tests for your county. Answer the following questions.

Variety name ______________________________________

1. What date was the crop planted? ____
2. What was the previous crop planted at the test site? ___________________________
3. What is the row spacing for the test site?
4. What is the soil type for the test site? ____
5. What is the maturity date for your variety? ____________________________________
6. What is the plant height for your variety?_____________________________________
7. What is the lodging score for your variety? ____________________________________
8. What is the yield for the most current year? ____________________________(bu/acre)
9. What is the average plant height for your maturity group? ______________________
10. What is the average lodging score for your maturity group? ____________________
11. What is the average crop yield for the maturity group? ________________________
12. Is your variety above or below the average crop yield for the maturity group?_____________________
13. Would you recommend planting this variety based on the performance test results? ______________

Locate the company web site for your seed variety on the Internet or obtain information from a local seed dealer. Compare the company information with the results of the performance tests. Write your findings in the space below.

Lesson 2: Selecting a Variety Name ____________________________

Identify Soybean Diseases

Objective: Students will identify the distinguishing characteristics of major soybean diseases.

Directions: The instructor will provide photos of diseases for you to identify. Complete the table by answering at least one cause, symptom, or control method for each photo or specific disease.

Disease	Cause	Symptoms	Control
1.			
2.			
3.			
4.			
5.			
6.			

Disease	Cause	Symptoms	Control
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

UNIT VII - SOYBEAN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

Competency/Objective: Determine tillage and/or planting method.

Study Questions

1. **What are optional tillage methods?**

2. **What are optional planting methods?**

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

References

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

2. Activity Sheet

   a) AS 3.1: Determining Planting Rates

UNIT VII - SOYBEAN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

As stated in Unit III, Lesson 5, tillage is the act of moving soil particles or cultivating the land. In this lesson students will be introduced to the types of tillage and planting methods used in Missouri. They will also be introduced to recommended seeding rates and the importance of making proper adjustments to planting equipment.

B. ***Motivation***

Obtain a 1-gallon glass jar. Fill the jar with soybean seeds. The jar will hold approximately 17,000 seeds. Have the students write down an estimate as to how many seeds are in the jar. You might consider a prize for the student with the most accurate estimate. This exercise should give the students a better spatial understanding of how many seeds it would take to plant an acre of soybeans (185,000 seeds).

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the tillage methods used in your area or region of the state and the advantages and disadvantages. In your discussion, include reasons why some tillage methods are not as suitable for your area.

   What are optional tillage methods?

   a) Conventional
      1) Advantages
         (a) Machinery is familiar and widely available.
         (b) It is adaptable to a wide range of soil and crop conditions.
         (c) It allows the use of cultivation for weed control throughout the growing season.
         (d) Soils warm faster when soil residues are incorporated into the soil.
      2) Disadvantages
         (a) Higher fuel and labor costs
         (b) Greater field traffic that can lead to soil compaction
         (c) High risk of erosion
         (d) Reduction in organic material
   b) Minimum tillage
      1) Mulch-till
         (a) Advantages
            (1) Reduced soil erosion
            (2) Lower fuel and labor costs
            (3) Advantages of conventional tillage methods maintained
         (b) Disadvantages
            (1) Requires modifications to equipment
            (2) Warming of soil slowed
            (3) Less effective under wet conditions
            (4) May require a larger tractor

2) Ridge-till
   (a) Advantages
      (1) Reduced erosion
      (2) Lower fuel and labor costs
      (3) Controlled traffic reduces compaction
      (4) Inter-row cultivation controls weeds
   (b) Disadvantages
      (1) Inter-row cultivation is required to build ridges.
      (2) Ridges must be level.
      (3) Wheels of machinery must be modified to avoid damaging ridges.
3) No-till
   (a) Advantages
      (1) Lower cost
      (2) Greatly reduced erosion
   (b) Disadvantages
      (1) High residues slow the warming of soils.
      (2) Attachments must be added to equipment.
      (3) Weed control is dependent on herbicides.
      (4) High management by the producer is required.
4) Remedial tillage - used only under special conditions
   (a) Subsoiling - loosening soil in severely compacted soils
   (b) Land-leveling - leveling off the top layer of soil
      (1) Controlled - uses a laser to put a consistent slope on a flat field to move surface water
      (2) Uncontrolled - scraps the top layer of soil from high areas to fill in low areas

2. Discuss the different planting methods used in your area or region of the state. Include the advantages and disadvantages of each method.

What are optional planting methods?

a) Row cropping
   1) Consistently produces good stands
   2) Row widths based on environmental conditions and tillage methods used
   3) Does not require special equipment
   4) Convenient and familiar
b) Skip row
   1) Width based on size of equipment
   2) Manages soil compaction or field traffic
   3) Not typically used for soybeans in Missouri
c) Drilled or solid-seeding
   1) Wide use of no-till makes drilling method favorable in Missouri
   2) Weed control improvements increase crop yields
   3) Harvest loss is reduced because combine can operate closer to the ground
   4) Seed depth less uniform resulting in poorer emergence
d) Broadcast and aerial
   1) Require a firm, level seedbed to establish a stand
   2) Success rate lower because seeds are placed at random depths
   3) Not typically used in Missouri for soybeans

3. Recommended seeding rates are designed to provide a starting point. Many planters seed at different rates than indicated by most manufacturer charts. Discuss how the seeding rates differ for various row widths. Refer to Table 3.1 in the student reference.

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

a) Desired soybean plant population is 70,000 per acre (approximately 4 plants/ft of 30-inch rows and 1 plant/ft in drilled rows).
b) Plant populations
   1) Lower than 70,000
      (a) Yield reductions due to insufficient plant numbers
      (b) Affect low podding and excessive branching
      (c) Produce better lodging resistance
   2) Higher than 150,000
      (a) Produce increased lodging
      (b) Result in yield reduction due to overcrowding
      (c) Higher podding and less branching

F. ***Other Activity***

Instruct students to contact different equipment dealers and order manuals and specifications of several types of planters and drills. Have them try to obtain an actual planter or drill to practice making adjustments.

G. ***Conclusion***

Tillage systems used in Missouri soybean production are conventional, minimum, no-till, and remedial. No-till is the most widely used tillage method used in Missouri. Planting methods available to Missouri producers include row cropping, skip row, driller or solid-seeding, broadcast, and aerial. Plant populations under 70,000 plants per acre may result in yield reductions due to insufficient plant numbers. Populations above 150,000 plants per acre may result in yield reductions due to overcrowding. It is important for producers to become familiar with the method that works best in their particular area or region of the state.

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

Actual seeding rate: 212,750 seeds per acre

+10% for no-till	185,000 seeds/acre	185,000
+10% for rough seedbed	x 15%	+27,750
- 5% for high quality seed	27,750	212,750 seeds/acre
15% total increase		

I. ***Answers to Evaluation***

1. Conventional, minimum, no-till, remedial
2. No-till; Advantages - lower cost and erosion is reduced
3. Row cropping; skip row; drilled or solid-seeding; broadcast; aerial
4. Row cropping; consistency in producing good stands
5. 70,000 plants per acre
6. 150,000

UNIT VII - SOYBEAN PRODUCTION Name______________________________

Lesson 3: Selecting a Tillage and Planting Method Date_______________________________

EVALUATION

1. List the four tillage methods used by Missouri soybean producers.

   a.

   b.

   c.

   d.

2. Which of the tillage methods listed above is the most commonly used in Missouri? What are two advantages to using this method?

3. List the five planting options available to Missouri soybean producers.

   a.

   b.

   c.

   d.

   e.

4. Which of the five planting methods listed above is the most cmmonly used in Missouri and why?

5. What is the desired plant population for soybeans?

6. Plant populations above ___________________ plants per acre may result in yield reductions due to overcrowding.

Lesson 3: Selecting a Tillage and Planting Method Name ___________________________

Determining Planting Rates

Objective: Students will determine a soybean planting rate given specific conditions.

Directions: Determine the planting rates for the soybean situation below. Use the guidelines given in the Student Reference.

You will be planting with 20-inch rows and want to achieve a plant population of 125,000 plants per acre. The suggested seeding rate is 185,000 seeds per acre. What should the seeding rate be if you are using a no-till planter in a rough seedbed with high-quality seed (germination of 92%). Show your work below.

Actual seeding rate: __________________ seeds per acre.

UNIT VII - SOYBEAN PRODUCTION

Lesson 4: Selecting a Weed Control Program

Competency/Objective: Select a weed control program.

Study Questions

1. **What factors determine a weed control program?**

2. **What weeds are specific problems in soybeans?**

3. **How does weed pressure affect yield?**

4. **What weed control options are available?**

References

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

2. Activity Sheet

    a) AS 4.1: Matching Herbicides to Specific Weeds

UNIT VII - SOYBEAN PRODUCTION

Lesson 4: Selecting a Weed Control Program

TEACHING PROCEDURES

A. ***Review***

Weed control is one of the most expensive components and one of the most difficult decisions of soybean production. This lesson will address the factors and options to consider when making that decision. Refer to Unit IV for a review of weeds.

B. ***Motivation***

Take students out to collect different weeds. Use pictures to identify weeds that are troublesome to soybeans. (The *Missouri Soybean Handbook* provides some pictures.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Give examples of problems that can occur in a field that may carry over into the next year. Use pictures to identify the problem weeds in Missouri soybean fields.

   What factors determine a weed control program?

   a) Early planning and good execution
   b) Mechanical measures or chemical control measures or both
   c) Weed control program factors
      1) Annual recurrence of weeds in the field
      2) Previous weed control program
      3) Crop rotations used and planned for the field
      4) Variety of seed (herbicide-resistant varieties)
      5) Seed planting method
      6) Planting date
      7) Environmental conditions

2. Display posters or photos of weeds around the classroom for the duration of this lesson. Let the students become familiar with various types of weeds that cause problems in Missouri soybeans. Refer the students to Table 4.1 in the Student Reference.

   What weeds are specific problems in soybeans?

   a) Broadleaf
      1) Buckwheat, wild
      2) Cocklebur, common
      3) Jimsonweed
      4) Morningglory, ivyleaf
      5) Morningglory, pitted
      6) Lambsquarters, common
      7) Mustard, wild
      8) Nightshade, black
      9) Pigweed
      10) Ragweed, common

11) Ragweed, giant
12) Smartweed, Pennsylvania
13) Sunflower, wild
14) Velvetleaf

b) Annual grasses and perennial weeds
1) Barnyardgrass
2) Bindweed, field
3) Bindweed, hedge
4) Cane, wild
5) Crabgrass, large
6) Foxtail, giant
7) Foxtail, green
8) Foxtail, yellow
9) Hemp, dogbane
10) Horsenettle
11) Johnsongrass
12) Milkweed
13) Nutsedge, yellow
14) Panicum, fall
15) Proso millet, wild

3. Weed pressure affects growth because of competition for nutrients and moisture (review growth stages). The amount of damage caused by weed pressure varies depending on the growth stage of the soybean plant. For examples, refer to Tables 4.2 and 4.3 in the Student Reference to see the effect of weed pressure on yield.

How does weed pressure affect yield?

a) Weeds controlled 2 to 4 weeks after soybeans emerge result in little damage to yield.
b) Weed damage varies depending on the growth stage of soybeans.
c) Late growth stage of soybeans will shade the ground and damage from weeds is minimized.

4. Discuss the most common weed control options for soybeans and the advantages and disadvantages of each.

What weed control options are available?

a) Cultivation - mowing and removing weeds manually or mechanically
1) Advantages
(a) Environmentally safer
(b) More economic than chemical use
2) Disadvantages
(a) Low effectiveness on weeds growing directly in row or grass weeds
(b) Increased cost of labor and fuel
(c) Dependent on timing and severity of problem

b) Herbicide - chemicals applied either to prevent or destroy weed growth
1) Advantages
(a) Controls weeds throughout field
(b) No need to reapply during growing season
(c) Kills roots, slowing or preventing new growth
2) Disadvantages
(a) Toxic effects on the environment
(b) Cost of chemicals
(c) Chance of plant injury

c) Herbicide-tolerant system - planting herbicide resistant varieties
1) Advantages

(a) Less trips across field
(b) Reduced cultivation costs

2) Disadvantages
(a) No residual control through the growing season
(b) Damage to plant if applied incorrectly
(c) No spraying after V-6 stage

F. ***Other Activity***

(Consult with the biology teacher.) Have students make a weed collection and identify each, especially those associated with soybeans.

G. ***Conclusion***

Before ending this lesson students should understand the factors considered when selecting a weed control program. Weeds can be combated using either chemical or mechanical control. The effectiveness of each depends on environmental conditions of the area.

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

Answers will vary.

I. ***Answers to Evaluation***

1. Answers should include the following:
   a) Knowledge of the annual recurrence of weeds in the field
   b) Knowledge of what type of weed control program was used previously in the field
   c) Crop rotations used and planned for the field
   d) Variety of seed to be planted
   e) How the seed is to be planted
   f) Planting date
   g) Environmental conditions
2. a) Broadleaf
   b) Annual grasses and perennial weeds
3. Cultivation and herbicides
   a) Cultivation advantages
      1) Environmentally safer
      2) Cheaper depending on acreage and amount of weed growth
   b) Cultivation disadvantages
      1) Ineffective for controlling weeds directly in the row
      2) Not very effective on grass weeds
      3) May need repeating often
   c) Herbicides advantages
      1) Controls weeds throughout field
      2) No need to reapply during growing season
   d) Herbicide disadvantages
      1) Toxic effects on environment
      2) Cost of chemicals
      3) Chance of plant injury
   e) Herbicide tolerant system advantages
      1) Less trips across field
      2) Reduced cultivation costs
   f) Herbicide tolerant system disadvantages
      1) No residual control through the growing season
      2) Damage to plant if applied incorrectly
      3) No spray after V-6 stage
4. Growth stage

UNIT VII - SOYBEAN PRODUCTION Name______________________________

Lesson 4: Selecting a Weed Control Program Date_______________________________

EVALUATION

Complete the following short answer questions.

1. What factors should be considered before choosing a weed control program?

   a.

   b.

   c.

   d.

   e.

   f.

   g.

2. What types of weeds cause problems for Missouri farmers?

   a.

   b.

3. List the methods of weed control and discuss the advantages and disadvantages associated with them.

   a.

      Advantages

      Disadvantages

   b.

      Advantages

      Disadvantages

c.

Advantages

Disadvantages

4. The amount of damage caused by weed pressure varies depending on the ______________________ if the soybean plant.

Lesson 4: Selecting a Weed Control Program Name____________________________

Matching Herbicides to Specific Weeds

Objective: Students will select a herbicide that is recommended to control a specific weed in soybeans.

Directions: Secure a copy of the *Missouri Soybean Handbook*, Manual 123, from a University of Missouri Extension office or the MFA Agronomy Guide published by MFA Incorporated. Refer to the "Guide to Weed Response to Herbicides" chart in Chapter 10. Use this information to select the most recommended herbicide for a specific weed problem. You may select more than one if several have received the same high recommendation.

Weed Name	**Herbicide Recommendation**
Barnyardgrass	
Crabgrass	
Fall Panicum	
Foxtails	
Shattercane	
Volunteer Corn	
Yellow Nutsedge	
Cocklebur	
Ivyleaf Morningglory	
Pigweed	
Common Ragweed	
Velvetleaf	

UNIT VII - SOYBEAN 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. **How does one determine if weeds should be removed mechanically or by herbicide application?**

4. **What insects are prevalent locally?**

References

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

2. Diseases and Pests of Field Crop Plants. Available from the University of Missouri-Columbia: Instructional Materials Laboratory, 1996.

3. *Missouri Soybean Handbook*. Manual 123. University of Missouri-Columbia: Instructional Materials Laboratory, 1987.

4. Transparency Master

    a) TM 5.1: Levels of Soybean Leaf Defoliation

5. Activity Sheet

    a) AS 5.1: Soybean Replant Worksheet

UNIT VII - SOYBEAN PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

Scouting, or evaluating the crop, during the growing season is the only way to know when it is appropriate to incorporate management practices such as irrigation, IPM, herbicides, and pesticides. This unit addresses the factors to consider when scouting the growing crop. It may be necessary to review the lessons on soybean growth stages and weeds.

B. ***Motivation***

Take students on a field scouting trip. Explain the hula hoop method and have them try it.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Many factors should be considered when scouting the growing crop. Discuss these options with the students. Refer to TM 5.1 when discussing presence of insect damage.

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

   a) Insect or disease presence and/or damage
      1) Amount of injury exceeds tolerance of the plant (injury threshold).
      2) Defoliation is the most common and visible form of chewing insect damage.
   b) Herbicide and insecticide effectiveness
      1) Contact chemical representative if problems exist or become present.
      2) Correct early by a tillage method such as rotary hoeing.
   c) Moisture management
      1) Water must be provided to the roots when needed by the plant to produce most economical yield.
      2) Overly wet soils may need drainage practices employed.
      3) Irrigation may be a consideration for moisture deficiency.
   d) Plant nutrition practices and outcomes
   e) Crop readiness for harvest

2. Discuss the factors that must be considered when making the decision to replant. Identify the methods for evaluating plant stands and the costs that can be incurred with replanting. Use the seeding chart from Lesson 3 to see the expected plant stand rates. Also, mention that seed companies provide recommended seeding rates on the package label. Identify that filing a crop insurance claim is an option. Use AS 5.1 to help students determine when replanting is necessary. A University Extension interactive replant worksheet can be found on the Internet at <http:muextension.missouri.edu/xplor/agguides/crops/g04091.htm>.

   How does one determine when replanting is appropriate?

   a) Determine cause of damage
      1) Poor seed quality
      2) Planting too deep or too shallow
      3) Herbicide injury

        4) Insect or disease problems
        5) Cold, wet soils or hot, dry soils
        6) Soil crusting
    b) Evaluate stand density
        1) To estimate live plant populations
        2) Row crops - count plants equal to 1/1000th acre
        3) Hula hoop method for drilled soybeans (Refer to Table 5.1.)
        4) May be necessary to replant
            (a) Remaining stand at 40% or less
            (b) 3 weeks or less since planting
    c) Predict yield potential
        1) Estimated yield at various populations (Refer to Table 5.2.)
        2) Effect of planting date on yield (Refer to Table 5.3.)
    d) Determine income - multiply yield by predicted market price
    e) Total loss - more profitable to file insurance claim
    f) Replanting costs
        1) Cost of seed
        2) Fuel and machinery costs
        3) Additional pesticides and herbicides
        4) Labor
        5) Interest on loans
        6) Late harvesting costs

3. Explain to students that the decisions producers make prior to planting regarding row width and cultivation methods will determine how weeds will be removed.

How does one determine if weeds should be removed mechanically or by herbicide application?

    a) Cultural methods
        1) Deep plowing in the fall or spring will reduce most perennial weed problems.
        2) Wide rows (greater than 20 inches) allows for cultivation between rows.
        3) Cultivation is ineffective for controlling weeds growing directly in the row.
        4) Drilled soybeans - depend on herbicides for weed control and are more competitive with weeds due to early canopy
    b) Herbicides
        1) Primary method of weed control
        2) Species specific

4. Discuss some of the major soybean pests. Emphasize that pesticides should not be applied until the economic threshold is reached. Economic thresholds are always changing and it is important to obtain current information from the University Extension Centers.

What insects are prevalent locally?

    a) Most soybean insects do not pose a threat to profitability but a few can significantly reduce yields if their numbers are high.
    b) Insect problems are low early in the season, until late July or early August.
    c) Thesholds have been established for most major insect pests and for several minor pests.
    d) Insecticides should be applied only when pest levels reach economic thresholds.
    e) Some of the more common soybean insects are as follows.
        1) Bean leaf beetle
            (a) Overwinter under debris
            (b) Attack germinating soybeans
            (c) 1/4 inch long
            (d) Vary in coloration and markings
            (e) Black triangle at base of forewings

(f) Two generations per year in Missouri
2) Stink bugs
(a) Overwinter as adults underneath leaf litter, tree bark, and other materials in areas not used for crops
(b) Attack primarily the seeds and pods
(c) Feed on plant stems, foilage, and blooms
(d) Small brown or black spots - indicate feeding punctures
3) Corn earworm
(a) Attack soybean foliage and pods, especially in southern counties
(b) Newly hatched larvae
(1) Feed on terminal foliage for a few days
(2) Move down to small pods and eventually to larger pods
(c) Three generations annually - last generation most likely to cause damage
4) Grasshoppers
(a) Feed on leaves and pods, especially during dry summers
(b) Overwinter as eggs in the soil
(c) Mate during May and June
(d) Move into crops during July and August when surrounding vegetation becomes scarce and matures

f) Economic thresholds are always changing to include the following factors.
1) Stage of development of the crop
2) Stage of development of pest(s)
3) Weather
4) Yield potential
5) Market price of commodity
6) Cost of pesticide and its application

F. ***Other Activity***

Using the Soybean Replant Worksheet, Activity Sheet 5.1, give the students various scenarios for determining replanting profitability margins.

G. ***Conclusion***

Scouting the growing crop is a crucial step for the producer. Factors such as the stand, moisture, insect, weed, and disease damage warn producers when to implement management practices. If the crop is damaged, steps such as determining the cause of damage and evaluating the stand density, yield potential, and potential income are used to decide if replanting is necessary. Pesticides should be applied only when the economic thresholds for insect pests are reached.

H. **Answers to Activity Sheet**

1. 40,000 plants per acre
2. 35 bushels per acre
3. 88%
4. 31 bushels per acre
5. $4.50 per bushel
6. $396 per acre
7. $70 per acre
   a) $25
   b) $10
   c) $25
   d) $10
8. 94%
9. 33 bushel per acre
10. $149 per acre
11. $79 per acre

12. $61 per acre
13. Yes

I. ***Answers to Evaluation***

1. Presence of insect or disease damage; herbicide and insecticide effectiveness; moisture availability
2. 40%; 3 weeks
3. Hula hoop
4. Answers should include three of the following: cause of damage, stand density, yield potential, potential income, replanting costs.
5. Answers should include three of the following: cost of seed, fuel and machinery costs, additional pesticides and herbicides, labor, interest on loans, late harvesting costs.
6. Before planting
7. Herbicides
8. Economic threshold

UNIT VII - SOYBEAN PRODUCTION

Name_______________________________

Lesson 5: Scouting and Maintaining the Crop

Date________________________________

EVALUATION

Complete the following short answer questions.

1. What are the three primary factors to consider when scouting the growing crop?

   a.

   b.

   c.

2. It may be necessary to replant when ______% or less of the stand remains, and it has been ____________ weeks or less since planting.

3. To determine plant populations in drilled soybeans, the ____________________ method can be used.

4. Name three factors that should be considered when deciding to replant.

   a.

   b.

   c.

5. Name three factors that should be considered when determining replanting costs.

   a.

   b.

   c.

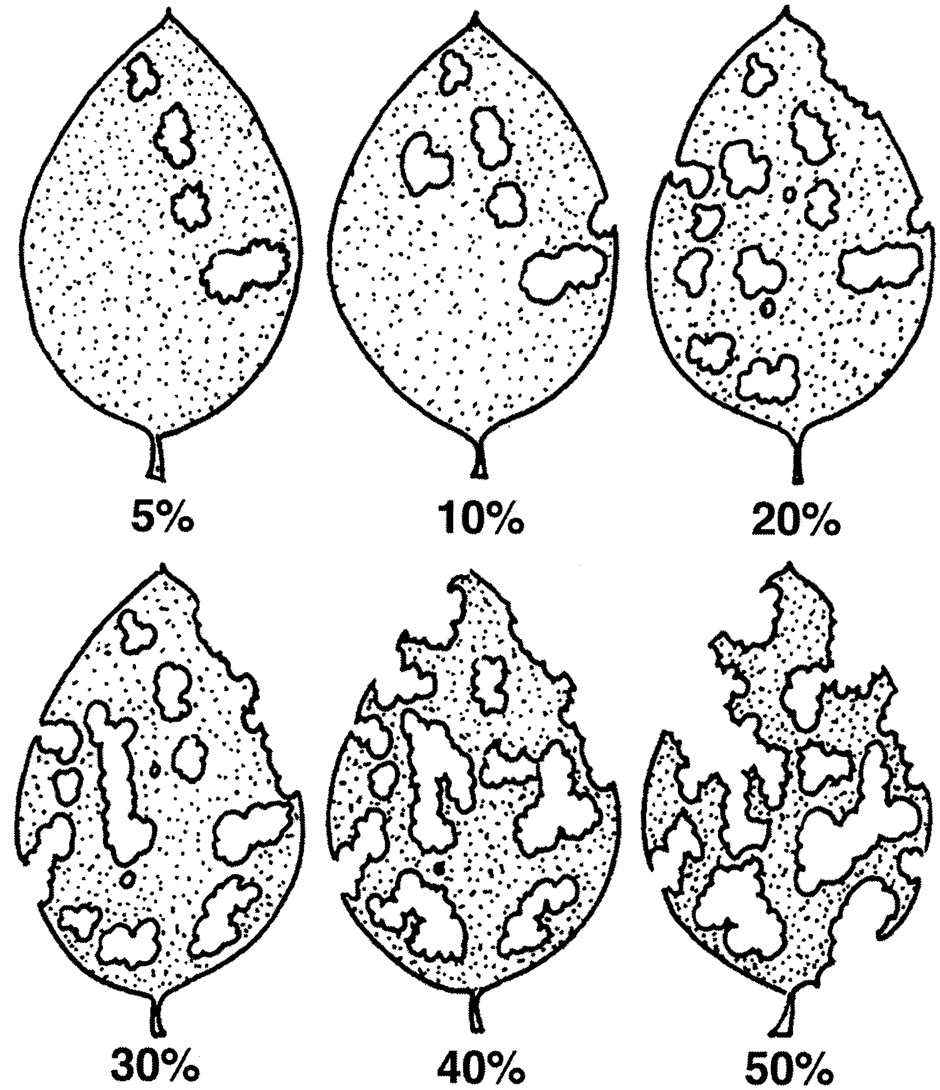
6. When are weed control methods determined?

7. What is the primary method of weed control in soybean production?

8. Apply insecticides only when pest numbers reach or exceed ______________ ________________ levels.

TM 5.1

Levels of Soybean Leaf Defoliation



 Name______________________________

Soybean Replant Worksheet

Objective: Students will be able to determine when replanting is necessary.

Directions: Use the following worksheet and the tables in the Student Reference to determine if replanting is appropriate for the following situation. An interactive worksheet can be found on the Internet at <http://muextension.missouri.edu/xplor/agguides/crops/g04091.htm>.

Assume a weak stand of soybeans was replanted on May 30 in 30-inch rows. Estimated normal yield is 35 bushels per acre. Soybean price is estimated to b $4.50 per bushel. Plant populations is 40,000. Expenses: seed - $25; fuel - $10; chemicals - $25; other - $10. Round up the results to the nearest whole number.

9. Estimated stand density of weak stand __________ plants/acre
10. "Normal" yield in bushels per acre __________ bushels per acre
11. Effect of weak stand on yield potential from Table 5.2 __________ %
12. Estimated yield from weak stand; multiply line 2 by line 3, divide by 100 __________ bushels per acre
13. Estimate market value of crop $__________ per bushel
14. Estimated income from weak stand; multiply line 5 by line 4 $__________ per acre
15. Estimated cost to replant: total of 7.1+7.2+7.3+7.4 $__________ per acre
    1. Seed __________
    2. Fuel, machinery, labor __________
    3. Pesticides __________
    4. Other costs __________
16. Effect of planting date on yield from Table 5.3 __________ %
17. Estimated yield from replanted stand; multiply line 2 by line 8, divide by 100 __________ bushels per acre
18. Estimated income from replanted stand; multiply line 5 by line 9 $__________ per acre
19. Net income from replanted stand; subtract line 7 from line 10 $__________ per acre
20. Profit or loss from replanting; subtract line 6 from line 11 $__________ per acre
21. Is replanting appropriate? __________

UNIT VII - SOYBEAN 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 major causes of crop loss during harvest?

3. What factors should be considered when harvesting soybeans for seed?

4. What are local storage options?

5. What are storage problems associated with soybeans?

6. What factors affect grain quality during storage?

References

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

2. *Missouri Soybean Handbook*. (Manual 123). University Extension. University of Missouri-Columbia. 1982.

3. Transparency Master

   a) TM 6.1: Moisture Migration in a Grain Bin

4. Activity Sheet

   a) AS 6.1: Measuring Harvest Loss

UNIT VII - SOYBEAN PRODUCTION

Lesson 6: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

This lesson discusses soybean harvesting and storage methods. Determining when to harvest to reduce crop loss is important to ensure profitability. This lesson will also examine why crop losses occur and how they can be avoided. Once the crop is harvested, appropriate storage methods need to be implemented to maintain the appropriate moisture level of the soybean.

B. ***Motivation***

Introduce the lesson and then ask students what problems would they expect to face during harvesting and storage. Discuss the reasons given and how they would reduce crop loss. At the end of the lesson, go through this same discussion.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. When discussing soybean maturity, a review of seed varieties may be necessary. Show pictures or an actual sample of a soybean plant that has reached maturity. Discuss the climatic conditions that are favorable to harvesting soybeans.

   What factors determine harvest timing?

   a) Mature beans, leaves fallen off, and brown stalks and pods
   b) Maturity level
      1) Based on seed variety - long season and short season
      2) Moisture content
         (a) 13% ideal level for short-term storage
         (b) 11 or 12% for long-term storage
   c) Climatic conditions
      1) Soybeans give up and reabsorb moisture (hygroscopic).
      2) Low moisture levels can cause shattering losses.
      3) High humidity of the air can reduce shattering.
      4) Harvest after first frost reduces problems with green weeds.

2. Discuss the two categories of harvest loss—preharvest and harvest loss. Explain the importance of moisture levels of the soybean both during the maturation process and the harvesting process. If this lesson is taught during harvest season, use Activity Sheet 6.1 to demonstrate how to measure crop losses.

   What are the major causes of crop loss during harvest?

   a) Preharvest loss
      1) Influenced by variety, weather, and timeliness of harvest
      2) Lodging of plants
      3) Shattering of pods
   b) Harvest loss
      1) Shatter loss

(a) Occurs when crop tends to shatter easily
(1) Increase with crop dryness
(2) Reduce loss - properly adjusted header
(b) Occurs when the header is operated improperly
(1) Fast reel speed
(2) Reel positioned too far forward
(3) Set according to operator manual guidelines

2) Stubble loss
(a) Occurs when pods are missed by the cutter bar and left on the stalk
(b) Level seedbed with cutter bar at proper level

3) Lodged or loose stalk loss
(a) Occurs when beans are left in the pods on downed stalks or cut but do not pass through the combine
(b) Pickup reel with pickup guards on the cutter bar
(c) Sharp combine knives
(d) Correct reel height

4) Cylinder loss
(a) Occurs when beans are left in the pods after passing through combine
(b) Moisture content too high and incorrect cylinder-concave settings
(c) Cylinder speeds - according to manual guidelines and moisture levels

5) Separation loss
(a) Occurs when loose beans pass out of the combine
(b) Blower and sieve settings - according to operators' manual

3. Soybean seeds kept for planting the following year should be handled with special attention in order to produce a high-quality, good-germinating seed. Include in the discussions the reasons producers keep beans for reseeding purposes. Refer to Missouri Extension publication G04410.

What factors should be considered when harvesting soybeans for seed?

a) Genetically altered seeds cannot be saved because of patents on the original product.
b) Consider genetic purity, freedom from weed seeds, and overall quality.
  1) Certified seed growers must use foundation, or registered, seed.
  2) Certified seed ensures varietal purity.
c) Plant on land not previously planted in soybeans unless same variety planted.
d) Avoid early planting to ensure better quality seed.
e) Control weeds.
f) Harvest at 13% moisture to avoid cracked seed coats and splits.
g) Use foliar-applied fungicide during reproductive stages.
h) Maintain combine adjustments.
i) Avoid harvesting during hot, dry afternoons when pods and beans are brittle.
j) Avoid dropping beans frequently and at great distances to reduce seed coat cracks.
k) Avoid using auger elevators.

4. Discuss the various storage options available to producers. Include how these options may vary depending on the area of the state the soybeans are harvested.

What are local storage options?

a) Grain bins located on the farm
b) Local grain elevators
c) Grain-buying stations
d) Processing plants
e) Regional transport facility

5. Explain the importance of the moisture levels in harvesting soybeans and how this affects storage. Discuss the various factors that can affect the equilibrium of soybeans.

What are storage problems associated with soybeans?

a) High oil content and ability to absorb moisture require beans to be kept at equilibrium.
b) Equilibrium describes the ratio between relative humidity and moisture content of beans.
c) Soybeans can be dried with high temperature driers or natural air.
d) Storage bins should not be overloaded.
    1) Excessive depths of wet grain increase drying costs and delay harvest.
    2) Do not add new grain to old grain in storage.
e) Avoid accumulation of trash that will affect drying.
f) Insects are not typically a problem unless stored for longer periods.

6. Discuss the factors involved with maintaining the temperature levels after the soybeans are stored. Maintaining the moisture levels once the soybeans have been harvested is vital to crop quality. Explain how condensation can form within the storage bin as temperatures fluctuate.

What factors affect crop quality during storage?

a) Temperature and moisture levels must be controlled.
b) Aeration controls moisture in soybeans.
    1) Keeps soybeans at seasonally cool temperature, within 10 degrees of the average monthly, ambient air temperature
    2) Maintains relatively uniform temperature within the soybean mass, preferably no more than a 10-degree difference from one part of the bin to another
c) Control mass temperature of soybeans throughout the year.
    1) Run fan continuously if grain is above 16% moisture.
    2) Let fan run during periods of rain or bad weather.
    3) Cool beans to 40°F in the fall and warmed to 60°F in the early spring.
    4) Maintain no more than 15-degree difference between beans in storage and average outdoor temperature.
    5) Start fans for cooling in the spring when the outdoor temperatures are about 10 degrees warmer than grain temperatures.

F. ***Other Activity***

To familiarize students with the various grain storage bins and drying systems, have them research different types and compile an analysis of the various storage bins available. They can contact equipment dealers, research farm magazines and brochures, or search the Internet for information.

G. ***Conclusion***

Preharvest losses are caused by lodging of plants and shattering of pods and are beyond the producers' control. Harvesting loss occurs during combining. Observing the appropriate combine settings will reduce harvest loss. Storage of soybeans after harvest requires close monitoring of the moisture levels to maintain a quality crop.

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

Answers will vary depending on the crop evaluated.

I. ***Answers to Evaluation***

1. a) Maturity level
   b) Climatic conditions
2. 13% or lower
3. Hygroscopic
4. Harvesting at moisture levels that are too low

5. e
6. c
7. a
8. b
9. f
10. d
11. Quality of seed produced is better with later plantings.
12. Drop the beans as few times and as short a distance as possible.
13. Yes, so that the soybeans mature at different times.

14. Any of the following are correct: grain bins on the farm, local grain elevators, grain buying stations, processing plants, regional transport facility

15. The ratio between a relative humidity and the moisture content in soybeans
16. Trash can cause even moisture levels and cause hot spots.

17. a) To keep the soybeans at a seasonally cool temperature
    b) To maintain relatively uniform temperature within the soybean mass

18. 40°F, 60°F
19. 16
20. 10

UNIT VII - SOYBEAN PRODUCTION　　　　Name______________________

Lesson 6: Harvesting the Crop　　　　Date______________________

EVALUATION

Complete the following short answer questions.

1. What two factors determine when to harvest soybeans?

   a.

   b.

2. What is the ideal moisture level at harvest if short-term storage is used?

3. What is the term that means to give up and reabsorb moisture?

4. What causes high shattering losses?

Match the term in the right column with the statement in the left column.

5. ____ Occurs when beans are left in the pods after passing through the combine.
6. ____ Occurs when pods are left on the stalk because they were missed by the cutter bar.
7. ____ Caused by lodging of plants and shattering of pods.
8. ____ Occurs when the header is operated improperly.
9. ____ Occurs when loose beans pass out of the combine.
10. ____ Occurs when beans are left in the pods on downed stalks.

a. Preharvest loss

b. Shatter loss

c. Stubble loss

d. Lodged or loose stalk loss

e. Cylinder loss

f. Separation loss

Answer the following short answer questions.

11. When harvesting soybeans for reseeding, why should early planting be avoided?

12. When moving and storing soybeans for reseeding, what should be done to reduce seed coat cracks?

13. Should the planting dates for the same variety have staggered planting dates? Why?

14. What are three storage options for soybeans?

    a.

    b.

    c.

15. Explain the term equilibrium.

16. How does trash in the soybeans affect drying?

17. What are the primary objectives of aeration?

    a.

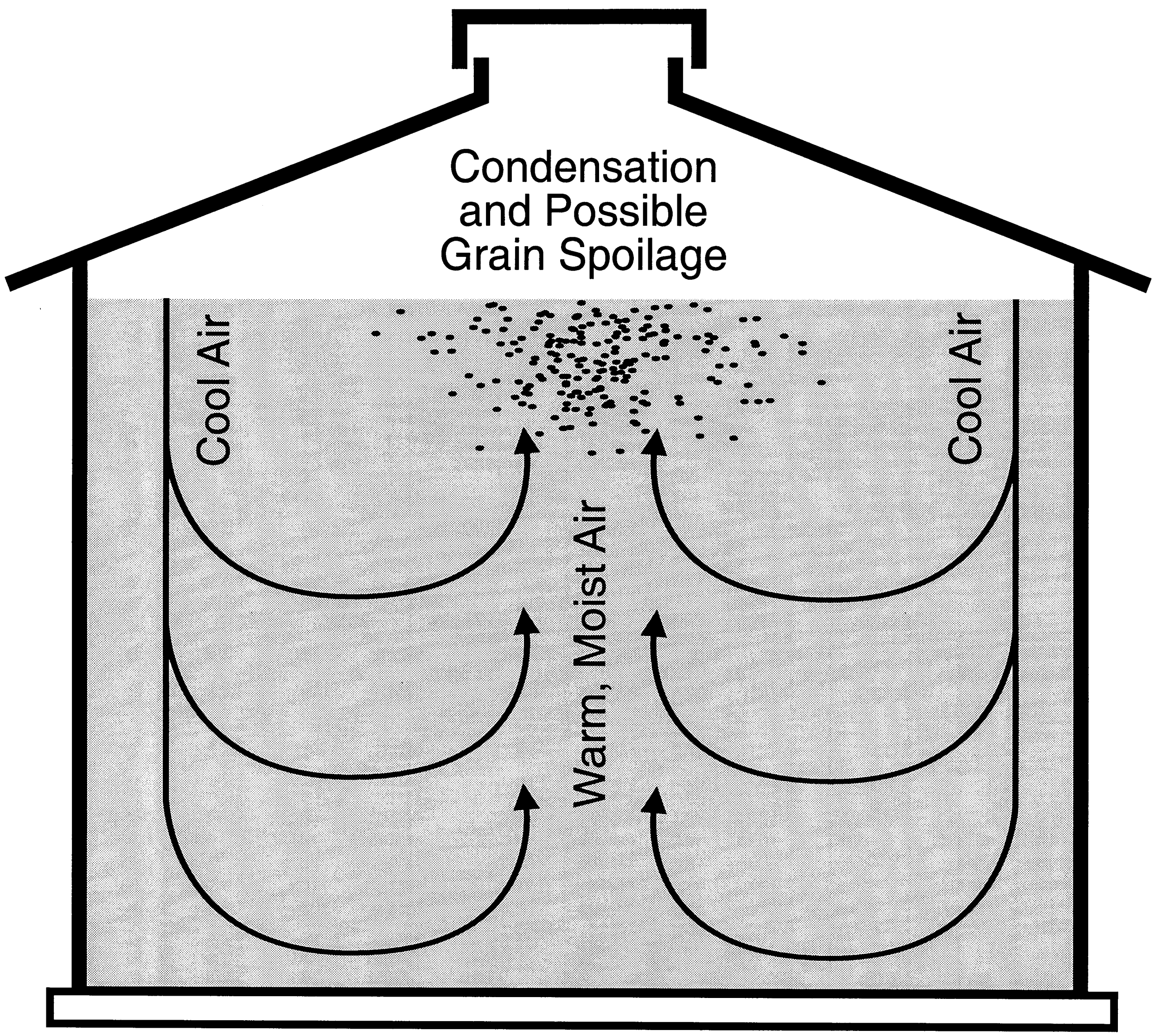
    b.

18. Beans should be cooled to ________°F in the fall and warmed to _______°F in the early spring.

19. The fan should be run continuously if the grain is above _____ % moisture.

20. Cooling fans should be started in the spring when the outdoor temperature reaches ______ degrees warmer than grain temperatures.

Moisture Migration in a Grain Bin



Lesson 6: Harvesting the Crop Name____________________________

Measuring Harvest Loss

Objective: Students will identify and measure crop loss during preharvest and harvest from combine.

Directions: To determine losses, count the unharvested beans in an area of 10 square feet. An average of four beans per square foot equals one bushel per acre loss. Make the area of 10 square feet equal in width to the combine header. (See Table 1.) A plastic clothesline and four pins made from No. 9 wire make excellent material for forming the rectangle.

Table 1 - Dimensions for Rectangular Frame

Machine Swath (feet)	Frame (inches)
8	15
10	12
12	10
13	9.25
14	8.6
15	8
16	7.5
20	6
22	5.45
24	5

Before checking for losses, disconnect the straw spreader or chopper in order to get a more accurate count. Stop the combine where the crop is representative of the entire field. Stop the header and threshing mechanism. Back the combine a distance equal to its length. Shut off the engine.

Place the rectangular frame across the machine swath and make counts for total crop loss, preharvest loss, and header loss.

Procedures:

1. Total Crop Loss

Place the rectangular frame across the swath harvested at the rear of the combine. Count all loose beans, as well as the beans in loose and missed pods. Enter the number of beans per 10 square feet in Table 2, line 1. A total crop loss of 3% of the crop yield is average. If losses are greater than 3%, locate the source of the losses to determine where adjustments are needed.

2. Preharvest Loss

Place the rectangular frame in standing beans. Count the loose beans on the ground and the beans in loose pods on the ground. Enter the number of beans per 10 square feet in Table 2, line 2.

3. Machine Loss

Subtract the preharvest loss from the total crop loss. Enter this number in Table 2, line 3. A machine loss of 3% is average. If the loss is greater than 3%, check the header losses.

4. Header Loss

Place the rectangular frame across the swath harvested in front of the parked combine. Place it over an area where there has been no discharge from the rear of the combine. Then make bean counts as follows and enter the number in Table 2.

a. Shatter loss. Count all loose beans on the ground and beans in loose pods on the ground. Enter the number of beans per 10 square feet in line 4a.
b. Loose stalk loss. Count all the beans in pods attached to soybean stalks that were cut but not gathered into the machine. Enter the number of beans per 10 square feet in line 4b.
c. Lodged stalk loss. Count all the beans in pods attached to soybean stalks that were lodged and are still attached to the ground. Enter the number of beans per 10 square feet in line 4c.
d. Stubble loss. Count all the beans in pods still attached to stubble. Enter the number of beans per 10 square feet in line 4d.

Obtain the total header loss by adding lines 4a - 4d. Enter the total header loss in line 4.

5. Cylinder and Separation Loss

Subtract the total header loss from the machine loss. Enter this difference in Table 2, line 5.

Table 2 - Loss Data Table

Source of Loss	Beans found in 10 sq. ft. area	Number of beans = 1 bu./acre	Bean loss in bu./acre	Acceptable loss in bu./acre (40 bu. yield)
1. Total crop loss		40		1.3
2. Preharvest loss		40		0.1
3. Machine loss		40		1.2
4. Gather unit loss		40		1.1
a. Shatter		40		0.4
b. Loose stalk		40		0.2
c. Lodged stalk		40		0.2
d. Stubble		40		0.3
5. Cylinder and separation loss		40		0.1

UNIT VII - SOYBEAN PRODUCTION

Lesson 7: Marketing the Crop

Competency/Objective: Describe marketing opportunities.

Study Questions:

1. **What options are available for marketing soybeans?**

2. **How do producers determine when to sell or store soybeans?**

3. **How does grain quality affect price?**

4. **What are soybean checkoff dollars and how are these funds used?**

References

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

2. Activity Sheet

   a) AS 7.1: Figuring Soybean Returns

UNIT VII - SOYBEAN PRODUCTION

Lesson 7: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons have discussed the production and harvesting of the soybean crops. The final step is selling the crop to obtain the most profit margin. Producers can improve their marketing decisions by properly using and analyzing market information. This lesson covers marketing options, grain quality, and checkoff dollars.

B. ***Motivation***

1. Introduce the lesson by asking students what risks they believe are associated with marketing soybeans.

2. Invite a marketing specialist from the extension service to speak with the class. Ask the specialist to focus on the marketing options available to producers in the futures markets.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Explain the marketing options available to the soybean producer, specifically the futures market. Ag Video 74, *Introduction to the Futures Market* and Ag Video 75, *Futures Market - Hedging* are available for free loan from MRCCTE at the University of Missouri-Columbia.

What options are available for marketing soybeans?

a) Sell for cash at harvest
    1) Transport grain from combine directly to the grain elevator.
    2) Sell grain upon delivery at that day's cash market price.
    3) Receive payment from the elevator.
b) Store at harvest and sell for cash later
    1) Cash market unseasonably low at harvest
    2) Expectation and forecast of increased prices in near future
    3) Transport grain when cash price at greatest profit level
c) Forward price
    1) Contracting with a grain elevator or on futures market
    2) Established in advance
    3) Locks prices in place
    4) Uncertainty of market prices - may rise above price locked in
d) Hedging
    1) Use of futures market as temporary substitute for cash purchase or sale made at later date
    2) Reduces some risk of holding investments
e) Options
    1) Put option
        (a) Gives buyer right, but not obligation, to sell commodity
        (b) Market fails - producer protected
        (c) Market rises - loss suffered
    2) Call option
        (a) Gives buyer right, but not obligation, to buy commodity

(b) Valuable if market rises

f) Delayed pricing or cash contracts
 1) Price is delayed until product delivery.
 2) Buyer can inspect the product and pay according to quality after arrival.

g) Grain pooling agreements
 1) Producers join in agreement to combine their harvest.
 2) Increase in volume allows bargaining directly with exporter for highest price.

h) Combination of all options

i) Government programs
 1) Price support programs offer loans in return for pledging the grain crop as loan collateral.
 2) Defaulting on the loan allows producers to keep the loan money and forfeit ownership of the grain to the government.
 3) Producers will benefit from defaulting on the loan if market prices are below the loan rate.

2. Ask students if they can tell what factors may be taken into consideration when determining whether to store or sell a soybean crop. How does the production of other countries affect their decision?

How do producers determine when to sell or store soybeans?

a) Decision is made by the producer after becoming more informed of the soybean pricing structure.

b) Soybean pricing structure has two segments.
 1) Supply, demand, and governmental programs
 2) Market forces that change pricing behavior

c) Factors may alter supply and demand causing variations in price.
 1) A decline in Brazil's crop can result in a significant increase in U.S. export markets for soybean products.
 2) This will ultimately increase soybean prices.
 3) Price is the hub of the system, regardless of whether soybeans are sold in the domestic or foreign markets.

d) Decision can be made only by the producer.
 1) Learn how to analyze and use market information.
 2) Have knowledge of the marketing alternatives (options).
 3) Use marketing information services.

3. Discuss how a quality crop affects the price a producer will get for the soybean crop. Soybeans that violate grading factors result in price discounts or deductions from gross weight. Review the federally established classes and grades of soybeans. Table 7.1 shows soybean grading factors.

How does grain quality affect price?

a) Classes
 1) Yellow soybeans
  (a) Yellow or green seed coats with cross sections of yellow or yellow tinge
  (b) Not more than 10.0% of other colors
 2) Mixed soybeans - any soybean that does not meet class Yellow soybean requirements

b) Grade standards - five grades, 1 - 4 and sample grade
 1) Amount of damaged kernels due to heat or other means
 2) Amount of foreign material
 3) Amount of splits
 4) Amount of soybeans of other colors
 5) Sample grade

(a) Do not meet requirements for U.S. Nos. 1, 2, 3, 4
(b) Have a musty, sour, or commercially objectionable foreign odor (except garlic odor)
(c) Are heating or otherwise of distinctly low quality

4. Explain the national checkoff program and how the funds are used for marketing and research projects designed to improve the demand for soybeans.

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

a) Producers charged 0.5% of the market price per bushel when crop is sold.
b) Half of all checkoff funds remain in the states where collected and are used as directed by producer-controlled boards.
c) Other half of the checkoff funds are forwarded to the United Soybean Board, which uses funds on national level.
    1) Fund marketing and research projects
    2) Designed to improve demand for U.S. soybeans - home and overseas
    3) Invested in four major program areas
        (a) International marketing
        (b) Domestic marketing
        (c) Production
        (d) New uses

F. ***Other Activities***

1. During the introduction of this lesson, split the class into teams and put on mock investments. Give each team a certain amount of crops to invest. The instructor should serve as the broker and have the class follow the market using the various means, e.g., Internet, DTN, newspaper, television, radio.

2. Have the students research the weather and climate in Brazil. Successful Farming sponsors a web site <www.agriculture.com> that contains weather maps for Brazil. Use this as a means for the students to develop an understanding of how international weather and markets affect the prices in the United States.

G. ***Conclusion***

Students should gain an understanding of what risks are involved with marketing and how to manage those risks. An understanding of the classes and grading standards established by the U.S. Department of Agriculture is necessary to determine the price received for the crop. Checkoff funds that go toward marketing the soybean crop will benefit the producer by creating higher demands for the products.

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

1. $5.90
2. $8.54 - $6.55 = $1.99
3. $5.90 + $1.99 = $7.89
4. $7.89 - $ .06 = $7.83

I. ***Answers to Evaluation***

1. Sell for cash at harvest, store at harvest and sell for cash later, use forward pricing in the futures market, or use delayed pricing
2. Put
3. Call
4. Hedging

5. Price determination involves supply, demand, and governmental programs shaping the pricing behavior of the market. Price discovery is the market forces that change and direct pricing behavior.

6. Yellow and Mixed
7. Price discounts or deductions

8. Amount of damaged kernels due to heat or other means, amount of foreign material, amount of splits, amount of soybeans of other colors

9. Fund marketing and research projects designed to improve demand for U.S. soybeans

UNIT 7 - SOYBEAN PRODUCTION Name ____________________

Lesson 7: Marketing the Crop Date ______________________

EVALUATION

Complete the following short answer questions.

1. What are the four most common marketing options available for soybeans?

   a.

   b.

   c.

   d.

2. Using the ____________ option gives the buyer the right, but not the obligation, to sell the commodity.

3. Using the ___________ option give the buyer the right, but not the obligation, to buy the commodity.

4. Using the futures market as a temporary substitute for a cash purchase or sale to be made later is referred to as __________________.

5. Explain the difference between price determination and price discovery.

6. What are the two classes of soybeans?

   a.

   b.

7. Soybeans that violate grading factors result in ____ from gross weight.

8. What four standards determine the grade of a soybean?

   a.

   b.

   c.

   d.

9. How does the United Soybean Board (USB) use with their portion of funds from the national checkoff program?

Lesson 7: Marketing the Crop Name ______________________

Figuring Soybean Returns

Objective: Students will determine the effect of forward pricing a soybean harvest.

Directions: Read the scenario below and answer the following questions. Determine the gross price received per bushel for a 5,000 bushel soybean futures contract with the Chicago Board of Trade.

The cash price for a bushel of soybeans on November 24 at the local elevator was $8.46 per bushel. The producer stored his soybeans on the farm and sold one (5,000-bushel) November soybean contract on the Chicago Board of Trade for $8.54. One year later, the cash price for soybeans at the local elevator was $5.90 per bushel. At that time, the producer sold his soybeans at the elevator and bought back one 5,000-bushel contract on the Board of Trade for $6.55 per bushel. The commissions and interest amounted to 6¢ per bushel. Answer the questions below and show your work in the spaces provided.

1. What was the cash price the producer received per bushel when selling his soybeans at the local elevator?

2. What was the gain (per bushel) from the futures market forward pricing trade?

3. What was the gross price received per bushel?

4. After subtracting the cost of commission and interest, what was the net price the producer received per bushel for his soybeans?

UNIT VII - SOYBEAN PRODUCTION

Lesson 8: Figuring Crop Cost

Competency/Objective: Calculate cost per acre.

Study Questions:

1. **What variable costs are associated with soybean production?**
2. **What fixed costs are associated with soybean production?**
3. **How is cost per acre calculated?**
4. **What factors do producers consider when determining an acceptable return on investment?**

References

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

UNIT VII - SOYBEAN PRODUCTION

Lesson 8: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

This lesson addresses the costs and returns associated with soybean production. After completing this lesson, students should be able to determine what are variable costs and fixed costs. Students should also be able to calculate the break-even point and profitability of the crop. Explain how this information is used to calculate returns and how it is used in planning for the next crop.

B. ***Motivation***

Ask students how they would determine profitability. What items would they include in costs of production? Ask for an estimate about how large the returns would be per acre of soybeans.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Explain that variable costs change each year depending on the level of production. Review each item that would be considered a variable cost. Refer to Table 8.1 in the Student Reference to show average variable costs.

   What variable costs are associated with soybean production?

   a) Seed
   b) Fertilizer and lime
   c) Chemicals and materials
   d) Machinery fuel, oil, and repair
   e) Machinery hire and services
   f) Average labor costs
   g) Taxes and insurance
   h) Miscellaneous
   i) Operating interest

2. Explain to students that fixed costs remain constant. Review the costs that would be considered fixed in a soybean operation. Refer to Table 8.1 in the Student Reference for average fixed costs.

   What fixed costs are associated with soybean production?

   a) Depreciation and interest on machinery
   b) Interest, taxes on land and other land costs
   c) Possible labor costs

3. Explain to the students how to figure cost per acre.

   How is cost per acre calculated?

a) Total (operating) variable cost
<u>+ Total (ownership) fixed cost</u>
Total cost of production

Total returns
<u>- Total fixed cost</u>
Return above variable cost

4. Ask students what they would expect as an acceptable return per acre of soybean production? What factors did they consider when arriving at their answer? Use AS 8.1 to determine soybean costs.

What factors do producers consider when determining an acceptable return on investment?

a) Total variable cost
b) Total fixed cost
c) Total cost
d) Total returns

F. ***Other Activity***

Invite a guest speaker to the class to discuss soybean production in their area. A nonproducer such as an Extension agronomist would be a good selection. This person could present some information on how costs of production vary in his/her county.

G. ***Conclusion***

One of the hardest things to do in the production of a crop such as soybeans is to determine the crop's profitability. True returns to management must include all variable and fixed costs. The skill of the producer and level of production may increase or decrease these costs, thereby changing the profit picture.

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

Answers will vary.

I. ***Answers to Evaluation***

1. b
2. b
3. b
4. a
5. b
6. b
7. b
8. b
9. a
10. b
11. b
12. $1,183
13. b ($1183 ÷ $4.80 = $246.46 or 247 bushel)
14. c (320 bu. x $4.80 = $1536 - $1183 = $353)

UNIT VII - SOYBEAN PRODUCTION Name ____________________

Lesson 8: Figuring Crop Costs Date ____________________

EVALUATION

Match the cost factor in the left column with the correct term from the right column on the right.

1. _____ Miscellaneous
2. _____ Seed
3. _____ Chemicals and materials
4. _____ Land costs, taxes, and interest
5. _____ Machinery hire and services
6. _____ Machinery fuel, oil, and repairs
7. _____ Operating interest
8. _____ Fertilizer and lime
9. _____ Machinery depreciation and interest
10. _____ Taxes and insurance
11. _____ Labor costs

a. Fixed cost

b. Variable cost

Answer the following questions using the data provided. (A calculator may be used for these questions.)

Seed	$100.00
Fertilizer	200.00
Chemicals	250.00
Machinery	45.00
Repairs	10.00
Fuel	50.00
Interest	12.00
Labor	36.00
Miscellaneous	10.00
Real Estate Taxes	320.00
Depreciation	100.00
Machinery Interest	50.00

12. What is the total cost of production? ______________

13. Using the above information calculate how many bushels of soybeans, valued at $4.80 per bushel, would have to be produced to break even (cover the cost of production). Round the answer to the next whole number.

    a. 233
    b. 247
    c. 259
    d. 280

14. Using the above information, what would be the profit (return to labor) if the producer harvested 320 bushels of soybeans and sold them on the cash market for $4.80 per bushel?

a. $284
b. $326
c. $353
d. $419

Lesson 8: Figuring Crop Costs Name ____________________

Determining Soybean Costs

Objective: Students will determine the cost of production for an acre of soybeans.

Directions: Survey a soybean producer in your area and determine the costs listed below, per acre. After the costs are determined, figure the profit or loss per acre and the profit or loss per bushel with the given levels of production.

1. Variable costs: Per Acre

    Seed ____________________
    Fertilizer ____________________
    Chemicals ____________________
    Machinery costs (fuel, oil, and repair) ____________________
    Machinery hire ____________________
    Miscellaneous ____________________
    Operating interest ____________________

    Total Variable Costs ____________________

2. Fixed costs:

    Machinery depreciation ____________________
    Land costs ____________________
    Interest on investment ____________________
    Taxes ____________________

    Total Fixed Costs ____________________

3. Labor costs per acre ____________________

4. Total all costs (variable, fixed, and labor) ____________________

Use the following levels of production and determine the total costs per bushel using the figures above.

30 bushels per acre $ ___________ per bushel

40 bushels per acre $ ___________ per bushel

50 bushels per acre $ ___________ per bushel

If soybeans were $5.25 per bushel, what would be the profit on 1 acre of soybeans that produced 40 bushels per acre?

____

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 1: Planning the Crop

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

Study Questions

1. **What environmental conditions are necessary for wheat and small grain production?**
2. **What factors are considered when evaluating field history?**
3. **What are the fertilizer requirements for wheat and small grains?**

References:

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

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

(c) Most planted in the spring in Missouri

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

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

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

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

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

What factors are considered when evaluating field history?

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

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

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

What are the fertilizer requirements for wheat and small grain?

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

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

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

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

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

c) Phosphorus

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

d) Potassium

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

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

F. *Other Activities*

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

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

G. *Conclusion*

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

H. *Answers to Evaluation*

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Name____________________________

Lesson 1: Planning the Crop

Date____________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

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

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

Complete the following short answer questions.

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

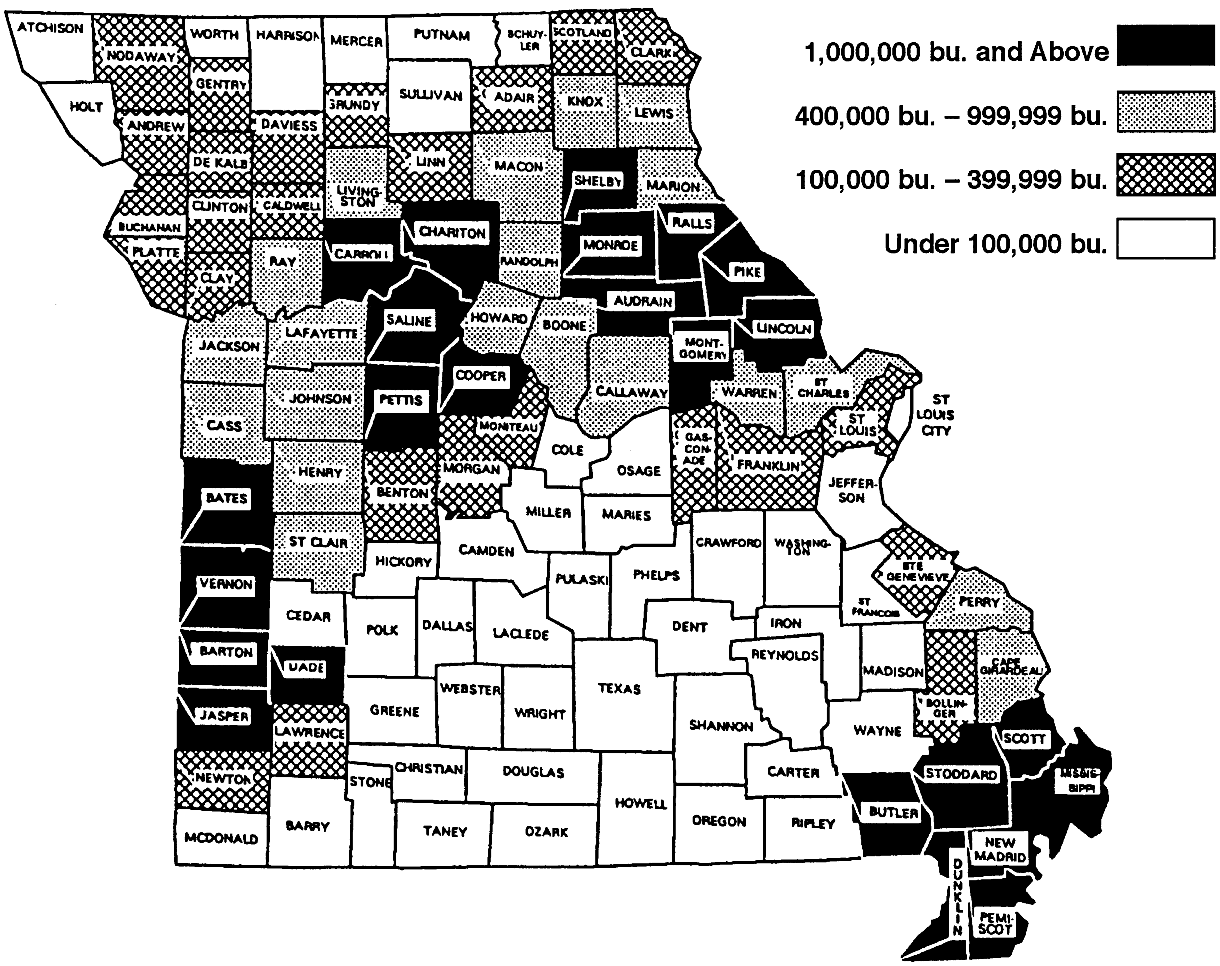
    a.

    b.

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

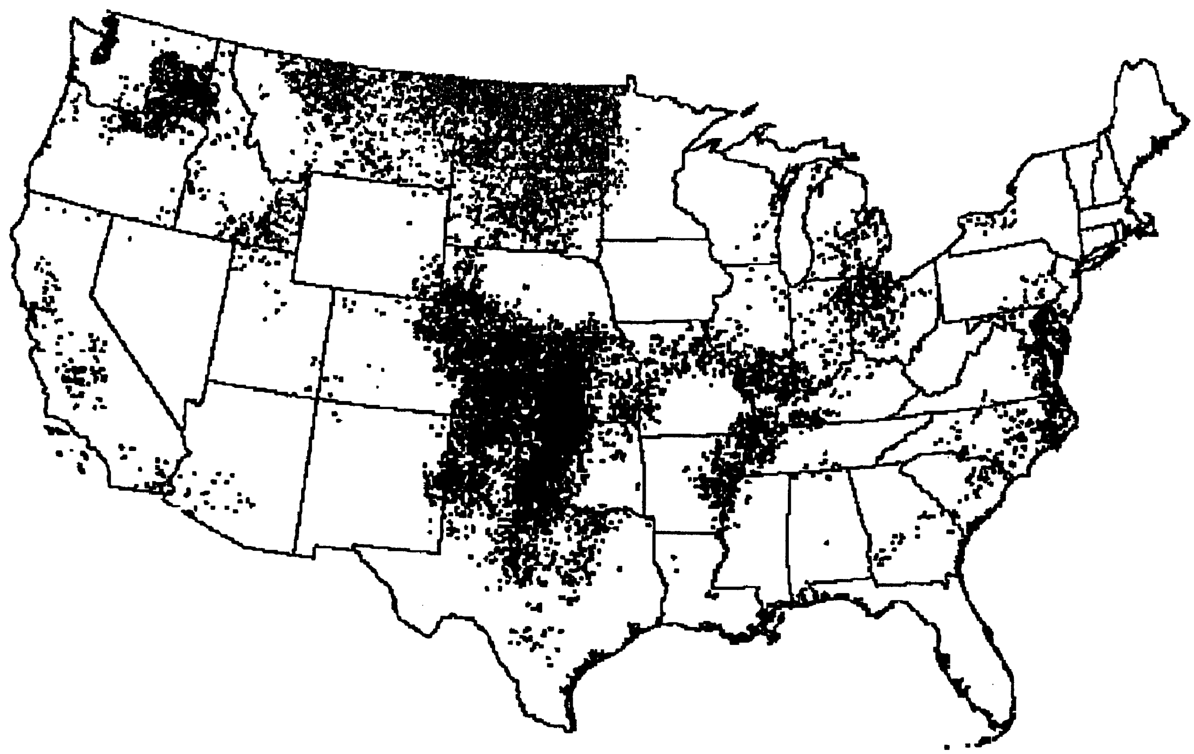
7. What is vernalization?

Production of Wheat in Missouri (1998)



Source: 1999 Missouri Farm Facts

Wheat Growing Regions in the United States



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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 2: Selecting a Variety

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

Study Questions

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

References:

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

2. Activity Sheets

   a) AS 2.1: Solve the Puzzle
   b) AS 2.2: Wheat Variety Crop Performance
   c) AS 2.3: Wheat and Small Grain Diseases

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

What are the different classes of wheat?

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

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

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

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

What are wheat varieties?

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

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

What are the different classes of other small grains?

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

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

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

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

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

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

   What diseases are prevalent locally?

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

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

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

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

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

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

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

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

F. ***Other Activity***

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

G. ***Conclusion***

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

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

AS 2.1

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

AS 2.2

Answers will vary.

AS 2.3

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

I. ***Answers to Evaluation***

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

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

6. d
7. b
8. c

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION   Name________________________

Lesson 2: Selecting a Variety   Date_________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

Complete the following short answer questions.

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

   a.

   b.

   c.

   d.

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

   a.

   b.

   c.

   d.

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

6. _____ Barley yellow dwarf virus
7. _____ Stripe rust
8. _____ Loose smut
9. _____ Wheat yellow mosaic
10. _____ Downy mildew
11. _____ Ergot
12. _____ Wheat take-all
13. _____ Tan spot
14. _____ Black point

a. Seedling blights and root rots

b. Leaf diseases

c. Head diseases

d. Viral diseases

Lesson 2: Selecting a Vareity Name____________________________

Solve the Puzzle

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

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

NAISESH

	3	14				

NIWRTE

1			5	10	

RUUMD

13	16			

PRSIGN

		12			

DRE

	7	

AERECL

				4	8

RADH

2	9		11

													O			
1	2	3	4	5	6	7	8	9	5	10	11	1		12	13	14

Lesson 2: Selecting a Variety Name ___________________________

Wheat Variety Crop Performance

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

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

Variety name: ____________________________________

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

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

Lesson 2: Selecting a Variety Name______________________________

Wheat and Small Grain Diseases

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

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

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

a. Dusty black appearance of diseased heads.

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

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

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

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

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

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

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

Competency/Objective: Determine tillage or planting methods.

Study Questions

1. **What are tillage methods?**

2. **What are factors to consider when choosing a tillage method?**

3. **What are planting methods?**

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

5. **How is a wheat or small grain planting calendar used?**

References:

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

2. Transparency Master

   a) TM 3.1: Hessian Fly-Free Dates for Missouri

3. Activity Sheet

   a) AS 3.1: Making Planting Decisions

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What are tillage methods?

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

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

   What are factors to consider when choosing a tillage method?

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

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

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

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

What are planting methods?

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

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

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

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

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

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

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

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

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

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

   How is a wheat or small grain planting calendar used?

   a) Winter wheat and barley should be planted within a week after the fly-free date.
      1) Early planting will allow plants to establish crown roots and three to five tillers before winter dormancy, reducing chance of winterkill.
      2) Planting too early increases chances of insect hazards and diseases such as leaf rust and wheat streak mosaic virus.
   b) Barley planting should follow the wheat planting schedule because barley is subject to the same insects and diseases as wheat.
   c) Spring oats should be planted as early in the spring as soil conditions will allow.
      1) The planting range is from March 1 to April 15.
      2) After April 15, the yields decrease.

F. ***Other Activity***

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

G. ***Conclusion***

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

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

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

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

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

I. ***Answers to Evaluation***

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

7. Increases hazards of insects and disease

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name__________________________

Lesson 3: Selecting a Tillage and Planting Method Date__________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

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

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

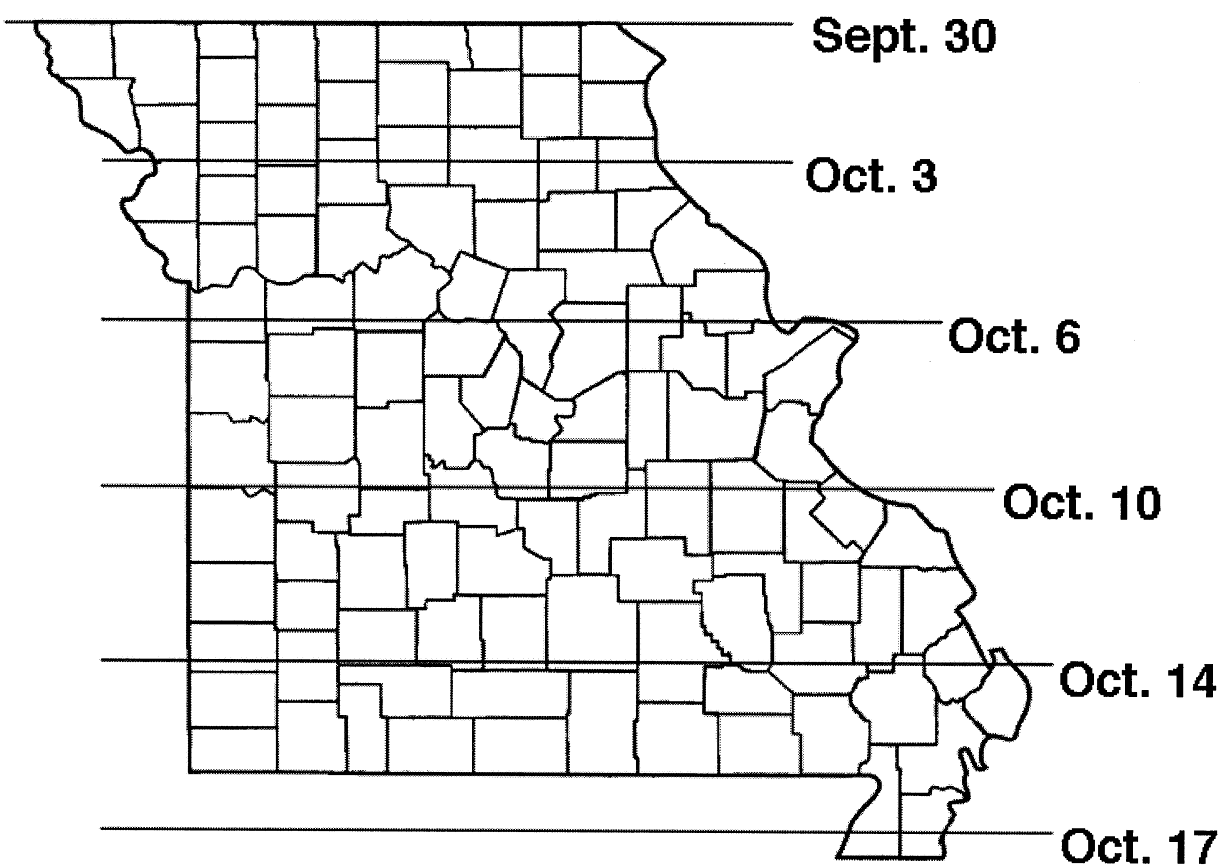
Complete the following short answer questions.

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

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

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

Hessian Fly-Free Dates for Missouri



Lesson 3: Selecting a Tillage and Planting Method Name____________________

Making Planting Decisions

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

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

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

   Justify (explain) your decision.

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

   Explain how you arrived at this number.

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

   Explain why you selected these methods.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 4: Selecting a Pest Control Program

Competency/Objective: Select a pest control program.

Study Questions

1. **What are the factors that determine a pest control program?**

2. **What pests are specific to wheat and small grains?**

3. **What pest control options are available?**

References:

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

2. Activity Sheet

    a) AS 4.1: Hessian Fly Report

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 4: Selecting a Pest Control Program

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What are the factors that determine a pest control program?

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

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

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

What pests are specific to wheat and small grains?

a) Aphids
    1) Widespread pests of cereal grains
    2) May cause significant feeding damage if in large numbers
    3) May also act as "vectors" or carriers of BYDM
    4) Cause yellowing and premature death of leaves
    5) Symptoms of infestation
        (a) Deposits of sugary liquid, known as honeydew, leave scorch marks on the leaves.
        (b) Sooty molds develop.
        (c) Necrotic (dead) areas may develop.
        (d) Purpling and rolling of the infested leaves may occur.
    6) Species
        (a) Bird cherry-oat aphid
        (b) Greenbug
        (c) Corn leaf aphid
        (d) Rose grass aphid
        (e) English grain aphid
        (f) Russian wheat aphid
b) Stink bugs
    1) Losses due to stink bugs are variable due to weather, density of insects, and length of the growing season.
    2) Mild winters and low rainfall favor outbreaks of the insect.
    3) They will feed on grasses and weeds as well as cereal grains.
    4) Losses result primarily in reduced baking quality of the grain.
    5) Saliva of the insect is toxic to the plant and a puncture can kill the stem.
    6) They feed on the kernels of the grain during the milk dough stage and badly shrivel the grain.
    7) Bugs have a shield-shaped body and foul smell when crushed.
    8) They lay eggs on various parts of the plant.
    9) Hatched nymphs feed on the plant.
c) Armyworms, cutworms, and stalk borers
    1) Pests may cause severe damage and devastate large areas.
    2) Primary symptom is the defoliation of leaves.
    3) Larvae chew from the edges of the leaf to the midrib.
    4) Some species may feed on the soil surface, others underground on the roots, and others on the stems.
    5) Eggs are laid on the leaf and leaf sheaths near the ground.
    6) Larvae hatch within a few days and feed at night or early in the morning.
    7) In damp weather, larvae may feed all day.
d) Cereal leaf beetle
    1) Beetles cause significant losses to winter wheat and fall-sown spring wheat.
    2) Yield losses may be 15% to more than 25%.
    3) Adult beetles are 4-5 mm long, have a black head, light brown thorax, and shiny blue-green wings with parallel lines of small dots.
    4) Most prominent symptom is the distinct longitudinal stripes on the leaves.
    5) The insect produces one generation per year.

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

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

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

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

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

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

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

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

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

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

What pest control options are available?

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

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

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

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

Answers will vary

I. ***Answers to Evaluation***

1. b
2. d
3. a
4. Using a combination of chemical, biological, and physical controls to manage pests.
5. Any three of the following: residue management, seed treatment, foliar spraying, storage facility treatment (spraying), poisons for rodents.
6. Any three of the following: plowing under residues, using predator or parasitic insects, using pest resistant varieties, or using sterilized male insects that cause females to produce infertile eggs.

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION	Name___________________________

Lesson 4: Selecting a Pest Control Program	Date___________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

Complete the following short answer questions.

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

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

    a.

    b.

    c.

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

    a.

    b.

    c.

Lesson 4: Selecting a Pest Control Program Name________________________

Hessian Fly Report

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

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

Study Questions

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

References:

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

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

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

   How does one determine when replanting is necessary?

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

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

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

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

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

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

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

What amount of insect pressure justifies an insecticide application?

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

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

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

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

F. ***Other Activities***

G. ***Conclusion***

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

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

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

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

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

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

I. ***Answers to Evaluation***

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Name____________________________

Lesson 5: Scouting and Maintaining the Crop

Date____________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

Complete the following short answer questions.

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

   a.

   b.

   c.

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

   a.

   b.

   c.

Aphid Threshold in Wheat

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

Lesson 5: Scouting and Maintaining the Crop Name______________________

Determining the Corrective Action

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

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

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

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 6: Harvesting the Crop

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

Study Questions

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

References:

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 6: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What factors determine harvest timing?

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

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

   What factors affect seed damage at harvest?

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

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

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

What are the major sources of crop loss during harvest?

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

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

What are local storage options?

a) On-farm storage
   1) Advantages
      (a) More efficient use of labor and equipment
      (b) Earlier harvest possible
      (c) Potential for grain drying returns
      (d) Additional marketing flexibility
      (e) Potential for higher net returns (if cash markets go up)
      (f) Provides tax management flexibility
   2) Disadvantages
      (a) On-farm storage of grain is costly.
      (b) Additional labor and management are required.
      (c) There is risk of grain quality loss.
      (d) There is a potential for lower net prices (if markets go down).
      (e) There are risks of selling overdry grain.
b) Commercial storage
   1) Space is rented at a grain elevator.
   2) Storage rent is usually 3 to 4¢ per bushel per month.
   3) Producers will not recover the exact grain but it will be the same quality.
c) Price-later contracts
   1) This is a deferred price agreement with the elevator that receives the grain.
   2) Producers retain the right to price at a later date, usually the same price offered on the particular day on the cash grain market.
d) Futures market positioning
   1) This means selling the grain on the cash market at harvest and purchasing a long (buy) position in the grain futures market.
   2) This option is considered a method of "storing on paper."
   3) Substantial risk is involved. The price of grain could go down and would be the same as a cash loss.

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

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

a) Poor initial grain quality
   1) Kernels may be cracked during threshing (harvesting).
   2) This may occur due to unfavorable harvest conditions at the time.
   3) Damaged kernels lead to storage mold development and possible insect invasion.
b) Moisture migration
   1) Moisture may shift from place to place.
   2) Changes in temperature may lead to air currents carrying moisture from one part of the bin to another.
   3) Pockets of moisture may be created and can spoil the grain.
   4) Problems may be corrected with aeration.
c) Storage mold development
   1) Significant damage is caused to the grain.
   2) Fungi are always involved when spoilage occurs.
   3) High moisture and high temperature cause serious grain quality losses.
d) Insect and rodent invasion
   1) Insects and rodents are a major cause of loss in stored grain.
   2) They consume grain and contaminate it with insect fragments, feces, webbing, and bad smelling metabolic products.
   3) Several hundred insects are associated with stored grain, but only a few cause serious damage.
   4) Insect invasion is usually associated with dirty facilities and inadequate control of moisture and temperatures.

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

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

How is crop quality maintained during storage?

a) Many physical factors affect the market quality of grain.
   1) Moisture content
   2) Test weight
   3) Shrunken and broken kernels
b) Deteriorated grain
   1) Molds discolor the germs of the grain, leading to increased damaged kernel counts.
   2) Discounts may range from 1¢ to 15¢ per bushel.
   3) Presence of insects may lead to 5-10¢ per bushel discounts.
   4) Uncontrolled molds lead to objectionable odors.
   5) Problems may lead to grain being designated as "sample grade" with discounts of 10¢ per bushel or complete rejection.
c) Preventing discounts
   1) Sanitation
   2) Monitoring
   3) Aeration
   4) Proper use of chemicals
d) Drying grain
   1) Grain must be dried to less than 12.5% moisture and cooled within 4 days to ensure against growth of molds and invasion of insects.
   2) The higher the moisture of stored grain, the faster heated air should be moved through the storage bin.
e) Insect damage
   1) Insects are the most difficult part of farm storage to control.
   2) Over 20 different insects survive in grain.
   3) Stored grain insects have a life cycle of 4-12 months.
   4) Insect reproduction is related to temperature during their life cycle.
   5) Optimal feeding temperatures are from 70 to 90°F.
   6) The lesser grain borer is the most damaging grain insect during storage.
   7) Temperatures below 50°F control insect reproduction.
   8) Discounts related to insect presence can be reduced with IPM (integrated pest management).
   9) There are minimum insect densities at which controls are cost-effective.
      (a) If more than two insects are found in samples, take a total of five samples/bin.
      (b) If lesser grain borers or weevils (internal feeders) are found in more than one sample, fumigation may be necessary unless entire grain mass can be cooled to below 50°F within 3 weeks.
      (c) If only external-feeding insects (flat or rusty grain beetles, flour beetles, meal moths, saw-tooth grain beetles, etc.) are found, an average of two per sample is usually acceptable if the grain can be cooled to below 50°F within 2 months.
f) Structures
   1) Should hold the grain without loss from leaks or spills
   2) Prevent rain, snow, or soil moisture from reaching the grain
   3) Protect grain from rodents, birds, objectionable odors, and theft
   4) Provide safety from fire and wind damage
   5) Permit effective treatment to prevent or control insect infestation
   6) Provide headroom over the binned grain for sampling, inspecting, and ventilating
g) Sanitation

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

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

F. *Other Activities*

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

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

G. *Conclusion*

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

H. *Answers to Activity Sheet*

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

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

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

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

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

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

I. ***Answers to Evaluation***

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name____________________________

Lesson 6: Harvesting the Crop Date_____________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

3. Grain bins should be cleaned and sanitized ___________________________________

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

Complete the following short answer questions.

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

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

   a.

   b.

   c.

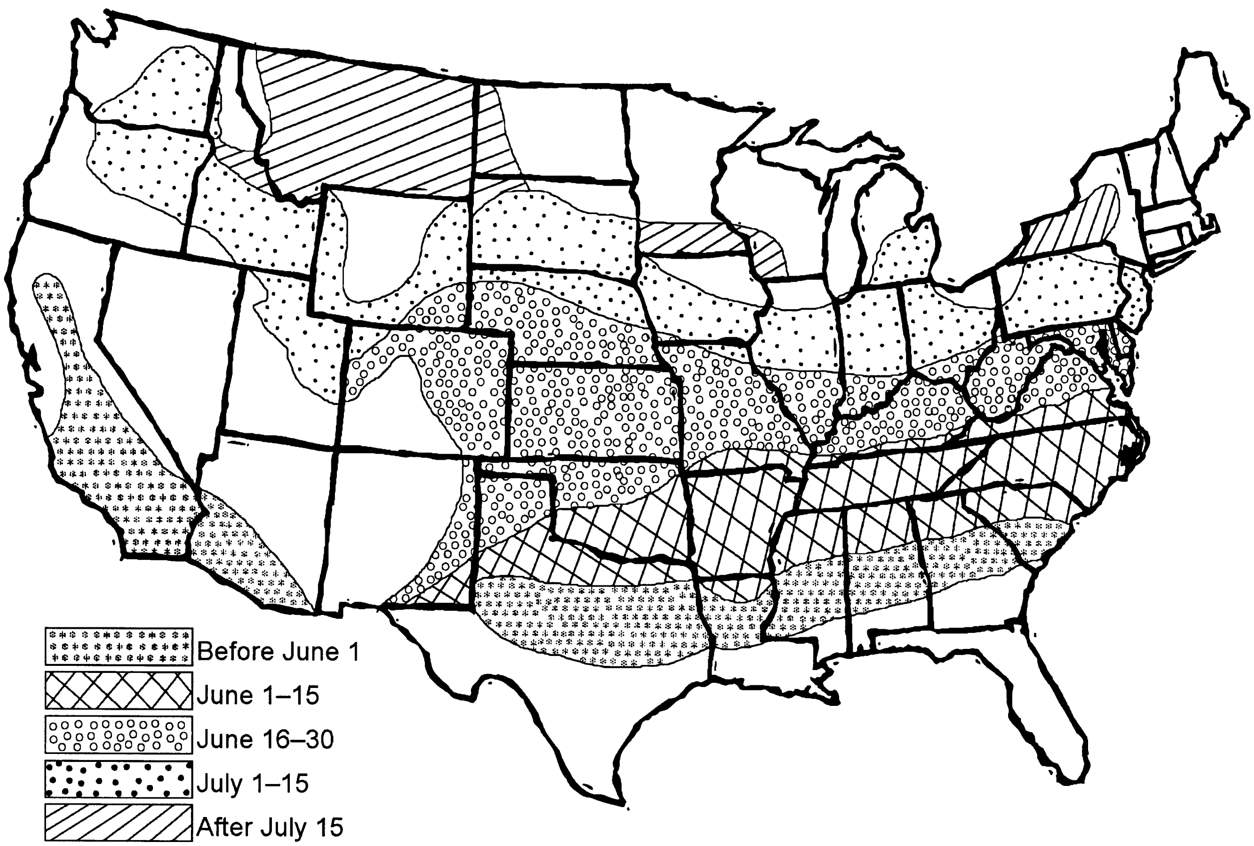
6. What are three possible problem areas that may develop in stored grain?

   a.

   b.

   c.

Beginning Dates for Winter Wheat Harvest in the United States



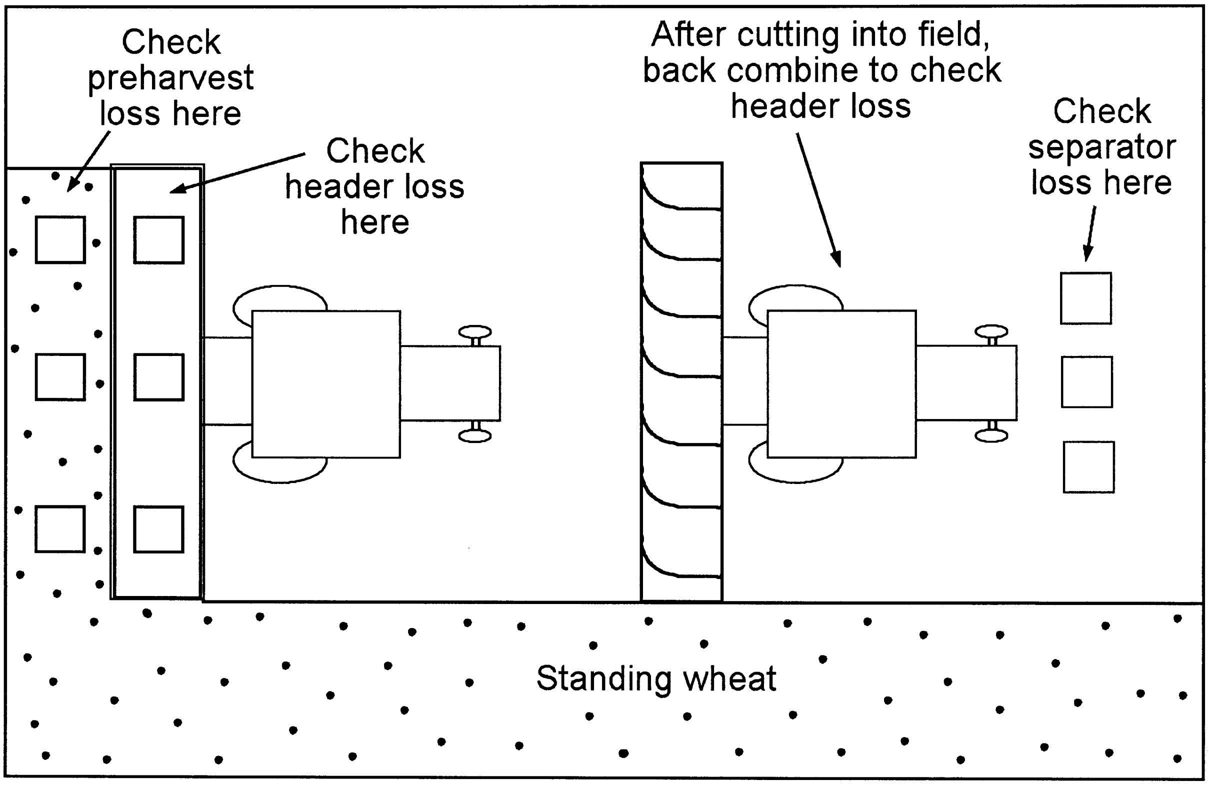
Harvest Time Indications

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

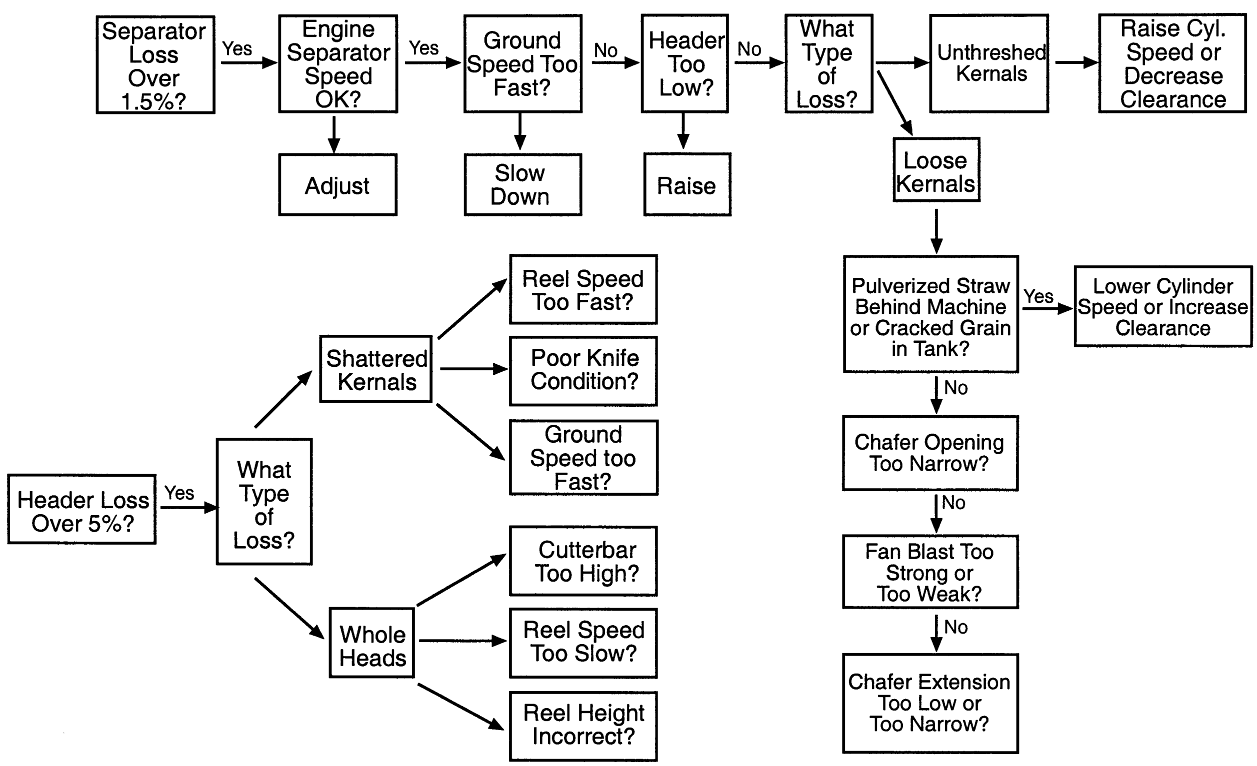
Combine Settings for Wheat Harvesting

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

Checking Wheat Harvest Losses



Correcting Wheat Harvest Losses



Lesson 6: Harvesting the Crop Name________________________

Determining Grain Loss and Moisture

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

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

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

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 7: Marketing the Crop

Competency/Objective: Describe marketing opportunities.

Study Questions

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

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

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

4. **How are wheat prices affected by international markets?**

References:

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

2. Transparency Masters

   a) TM 7.1: The Marketing Greed Chart
   b) TM 7.2: Grades and Grade Requirements for Wheat
   c) TM 7.3: Grades and Grade Requirements for Barley
   d) TM 7.4: Grades and Grade Requirements for Oats

3. Activity Sheet

   a) AS 7.1: World Wheat Production and Projections

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 7: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

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

(1) Sell on cash market.
(2) Hold (store) for later sales.
(c) Retaining ownership may be done on the farm or through the purchase of a futures contract.
(d) Both concepts involve risk and provide an opportunity to speculate on improved grain prices.
2) Use for grazing and then harvest for grain
(a) This option is used if traditional forages are low or depleted, or if planting date, growing conditions, moisture levels have produced expected growth.
(b) Research shows little or no effect on yields if managed properly.
(c) Remove livestock before jointing takes place in the fall.
(d) Fertilize in spring after removing spring-grazing animals.
3) Used in a forage system
(a) Crop is used for early spring pasture; animals are removed; then cut, bale, and store the forage for use the following winter.
(b) Determining the net returns through this type of marketing will be difficult.
(c) Genetic potential, feed conversion, setbacks due to disease/parasites, etc., will affect value received through the forage.

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

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

a) Good marketing requires getting a clear picture of pricing and delivery alternatives.
b) Marketing goal is to aim for higher than average net returns.
c) Some producers sell for reasons not related to maximizing returns.
1) Bin space is limited.
2) Fertilizer payments are due.
3) It is the end of the calendar year.
4) The weather is good, promising a bumper future crop.
5) Make room for next year's crop.
d) Experienced marketers have two things in common.
1) A market plan
2) Selling discipline
e) One of the first things producers must know before deciding to sell, feed, or store is their cost of production.
1) They should consider spreading sales over 12-24 months.
2) This allows an opportunity to price into three or four market rallies in an average crop year.
f) There are some typical price slumps producers should avoid.
1) During harvest
2) As 90-day storage expires
3) During cash flow selling periods such as spring
g) Another key component is for producers to stay informed of market data.
1) Gather sources of information.
2) The telephone is still a powerful tool and information source.
3) Contact buyers, dealers, millers, brokers, and analysts on a regular basis.
4) Use the Internet, printed market reports, television and radio market new services.
h) The most common selling strategy is the "wait and see" approach.

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

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

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

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

How are wheat prices affected by international markets?

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

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

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

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

Answers will vary each year.

I. ***Answers to Evaluation***

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

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name____________________

Lesson 7: Marketing the Crop Date____________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

Complete the following short answer questions.

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

   a.

   b.

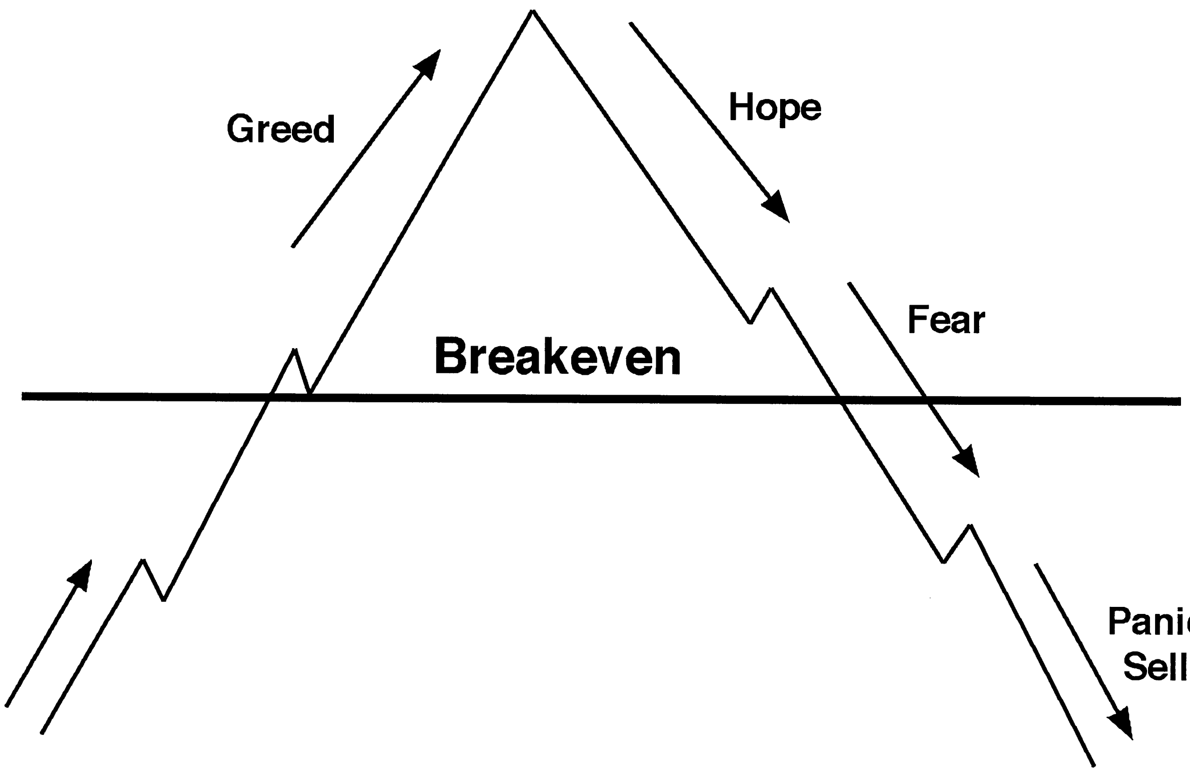
   c.

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

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

TM 7.1

Marketing Greed Chart



Grades and Grade Requirements for Wheat

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

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

Grades and Grade Requirements for Barley

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

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

---

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

Grades and Grade Requirements for Oats

Grade	Minimum limits		Maximum limits		
	Test weight per bushel (pounds)	Sound oats (%)	Heat-damaged kernels (%)	Foreign material (%)	Wild oats (%)
U.S. No. 1	36.0	97.0	0.1	2.0	2.0
U.S. No. 2	33.0	94.0	0.3	3.0	3.0
U.S. No. 3[6]	30.0	90.0	1.0	4.0	5.0
U.S. No. 4[7]	27.0	80.0	3.0	5.0	10.0

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

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

Lesson 7: Marketing the Crop Name________________________

World Wheat Production and Projections

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

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

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

   a. ______________

   b. ______________

   c. ______________

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

   a. ____________________________________

   b. ____________________________________

   c. ____________________________________

   d. ____________________________________

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

   a. ____________________________________

   b. ____________________________________

   c. ____________________________________

   d. ____________________________________

   e. ____________________________________

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

   a. ____

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 8: Figuring Crop Costs

Competency/Objective: Calculate cost per acre.

Study Questions

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

References

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION

Lesson 8: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

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

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

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

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

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

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

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

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

How is cost per acre calculated?

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

F. ***Other Activity***

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

G. ***Conclusion***

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

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

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

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

I. ***Answers to Evaluation***

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

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

UNIT VIII - WHEAT AND SMALL GRAIN PRODUCTION Name________________________

Lesson 8: Figuring Crop Costs Date________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

3. Net returns per acre are figured by ____.

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

Complete the following short answer questions.

4. What are two examples of variable costs?

   a.

   b.

5. What are two examples of fixed costs?

   a.

   b.

6. Explain how total costs per acre are calculated.

Variable Costs per Acre for Wheat

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

Fixed Costs per Acre for Wheat

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

Lesson 8: Figuring Crop Costs Name ______________________

Determining Crop Costs and Returns

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

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

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

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

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

UNIT IX - FORAGE PRODUCTION

Lesson 1: Planning the Crop

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

Study Questions

1. **What is a forage?**

2. **What is the difference between the types of forages?**

3. **What factors are involved in evaluating a forage site?**

References

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

2. Activity Sheet

    a) AS 1.1: Evaluating Topography and Soil Quality for Forage Crops

UNIT IX - FORAGE PRODUCTION

Lesson 1: Planning the Crop

TEACHING PROCEDURES

A. ***Introduction***

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

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What is a forage?

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

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

   What is the difference between the types of forages?

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

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

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

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

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

What factors are involved in evaluating a forage site?

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

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

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

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

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

F. ***Other Activities***

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

G. ***Conclusion***

Forage production is a major secondary industry in relation to the utilization of forages in livestock production. The decision to establish a forage crop and the factors in determining the types of forages to establish are all major considerations in this decision.

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

Answers will vary.

J. ***Answers to Evaluation***

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

UNIT IX - FORAGE PRODUCTION — Name ______________________________

Lesson 1: Planning the Crop — Date ______________________________

EVALUATION

Complete the following short answer questions.

1. What are the three different forage production systems?

   a.

   b.

   c.

2. What are the two types of pastures?

   a.

   b.

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

   a.

   b.

   c.

   d.

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

Circle the letter that corresponds to the best answer.

5. Pastures are **generally** harvested ___________________________________.

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

6. Hay is **primarily** harvested ____.

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

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

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

Lesson 1: Planning the Crop Name ____________________________

Evaluating Topography and Soil for Forage Crops

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

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

UNIT IX - FORAGE PRODUCTION

Lesson 2: Selecting a Forage

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

Study Questions

1. **What are cool-season grasses grown in Missouri?**
2. **What are warm-season grasses grown in Missouri?**
3. **How do cool- and warm-season grasses complement each other?**
4. **What are forage legumes grown in Missouri?**
5. **How do forage legumes complement various grasses?**
6. **What types of small grains are used in a pasture management system?**
7. **What species can be used for silage or haylage?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IX.
2. *Crop and Grassland Plant Identification Manual.* University of Missouri-Columbia: Instructional Materials Laboratory, 1997.
3. Extension publications on the various forages to use as possible handouts for students. Available at <http://muextension.missouri.edu/xplor/agguides/crops/#Forages>

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

4. Activity Sheet

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

UNIT IX - FORAGE PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What are cool-season grasses grown in Missouri?

   a) Growth habit of cool-season grasses - grass plants exhibiting vigorous growth habits in the spring and fall months
      1) Plants turn green and initiate new growth.
         (a) Late February or early March
         (b) When soil temperatures reach 40°F
      2) Plants begin rapid growth period.
         (a) Soil and air temperatures rise.
         (b) Spring rains occur.
         (c) Optimum growth occurs when air temperature reaches 59° to 77°F in late spring and early to mid-fall.
      3) Plant growth slows down and plants become brown and dormant during summer.
         (a) Inefficient use of water and sunlight energy during hot, dry weather
         (b) Dormancy temperature variable by species
         (c) Irrigation prolonging growth but growth potential less than spring and fall
   b) Most common cool-season grasses grown in Missouri (Table 2.1)
      1) Perennials
         (a) Kentucky bluegrass (*Poa pratensis*)
         (b) Orchardgrass (*Dactylis glomerata*)
         (c) Reed canarygrass (*Phalaris arundinacea*)
         (d) Smooth bromegrass (*Bromus inermis*)
         (e) Tall fescue (*Festuca arundinacea*)

            (f) Timothy (*Phleum pratense*)
      2) Annuals - small grains

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

What are warm-season grasses grown in Missouri?

a) Growth habit of warm-season grasses - plants exhibiting vigorous growth in spring and summer
    1) Plants - green, new growth when soil temperature at 60°F
    2) Optimum growth with air temperature between 77°F and 104°F
    3) Annual warm-season grasses
        (a) Used as pasture, hay, or silage
        (b) Rapid production important for summer grazing systems
        (c) Work well in crop rotation systems but expensive source for animal gain
b) Most common warm-season grasses grown in Missouri (Table 2.2)
    1) Perennials
        (a) Bermudagrass (*Cynodon dactylon*)
        (b) Big bluestem (*Andropogon gerardi*)
        (c) Caucasian bluestem (*Bothriochloa caucasica*)
        (d) Easter gamagrass (*Tripsacum dactyloides*)
        (e) Indiangrass (*Sorghastrum nutans*)
        (f) Little bluestem (*Schizachyrium scoparium*)
        (g) Sideoats grama (*Bouteloua curtipendula*)
        (h) Switchgrass (*Panicum virgatum*)
    2) Annuals
        (a) Pearl millet (*Digitaria sanguinalis*)
        (b) Sorghum - sudangrass and hybrids

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

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

a) Provide a continuous supply of available forage for grazing due to different growth habits
    1) Warm-season grasses grow best in summer.
    2) Cool-season grasses grow best in spring and fall.
    3) One-third of grass pasture mixes should be warm-season grasses.
b) Complementary grasses in pasture situations
    1) Provide balanced nutritional quality throughout the grazing season
    2) Reduces risks of crop losses
        (a) Weather conditions
        (b) Plant specific diseases
        (c) Insect outbreaks
        (d) Other factors that affect pure crop stands

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

What are forage legumes grown in Missouri?

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

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

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

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

How do forage legumes complement various grasses?

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

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

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

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

        1) Provide high-quality pasture forages in winter and spring months
        2) Increase pasture yields
        3) Extend grazing period
    f) Benefits of small grains as cover crops for new pastures
        1) Reduce weeds
        2) Control erosion
        3) Furnish winter protection to young forage seedlings

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

What species can be used for silage or haylage?

a) Any crop that can be fed green as pasture or harvested for hay
    1) Silage - forage stored at 60 to 65% moisture
    2) Haylage - forage stored at 40 to 50% moisture
b) Typical crops
    1) Grasses - smooth bromegrass, timothy, ryegrass, millets, orchardgrass, sudangrass, reed canarygrass
    2) Legumes - alfalfa, sweet clover, red clover, ladino clover, alsike clover, soybeans, field peas, vetch, lespedeza, birdsfoot trefoil
    3) Grains - corn, grain sorghum, wheat, oats, barley, rye, triticale

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

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

I. ***Answers to Evaluation***

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

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

UNIT IX - FORAGE PRODUCTION Name______________________________

Lesson 2: Selecting a Variety Date_______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

4. Forage legumes ____________________ digestible protein compared to grasses.

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

5. Forage legumes complement grasses by _________________________________.

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

6. Haylage is forages stored at ______________ percent moisture.

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

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

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

Lesson 2: Selecting a Variety

Name______________________________

Identify Characteristics of Cool- and Warm-Season Grasses

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

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

Cool-Season Grasses

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

Warm-Season Grasses

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

UNIT IX - FORAGE PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

Competency/Objective: Identify the principles for establishing forages.

Study Questions

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

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

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

References

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

2. Activity Sheet

    a) AS 3.1: Forage Crossword Puzzle

UNIT IX - FORAGE PRODUCTION

Lesson 3: Selecting a Tillage and Planting Method

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

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

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

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

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

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

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

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

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

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

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

F. ***Other Activity***

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

G. ***Conclusion***

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

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

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

Down
2. Overgrazing
5. Legume
6. Lime

I. ***Answers to Evaluation***

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

UNIT IX - FORAGE PRODUCTION Name ______________________________

Lesson 3: Selecting a Tillage and Planting Method Date ______________________________

EVALUATION

Complete the following short answer questions.

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

   a.

   b.

   c.

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

   a.

   b.

   c.

   d.

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

   a.

   b.

   c.

Circle the letter that corresponds to the best answer.

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

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

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

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

Lesson 3: Selecting a Tillage and Planting Method Name ____________________________

Forage Crossword Puzzle

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

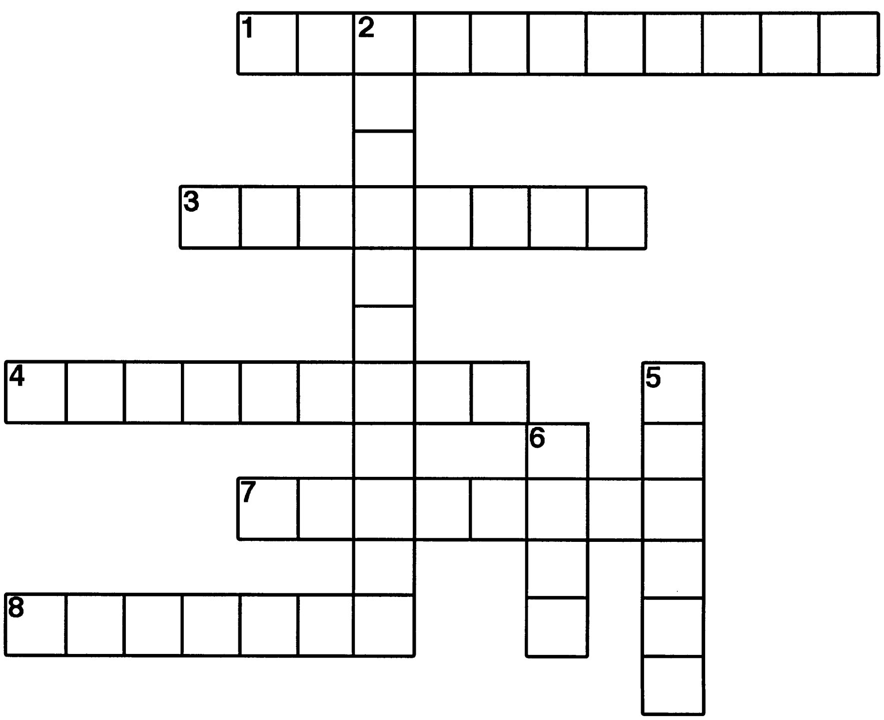
Directions: Complete the crossword puzzle below by filling in the blanks with the correct words associated with the down and across phrases.

Across

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

Down

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



UNIT IX - FORAGE PRODUCTION

Lesson 4: Scouting and Maintaining the Crop

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

Study Questions

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

References

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

UNIT IX - FORAGE PRODUCTION

Lesson 4: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

What pests are associated with forage production?

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

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

What pest control options are available?

a) Forage condition
   1) Heathy, properly maintained forage systems
      (a) Less likely to be susceptible to encroachment of weeds
      (b) Able to withstand minor insect damage
   2) Without proper management
      (a) Broadleaved weeds can directly compete with forage grasses or pasture to reduce nutritional value and quality.
      (b) Weeds can replace desirable grass species.
      (c) Plants that have toxic properties can cause livestock injury or loss.
b) Forage monitoring
   1) Regular inspection of forage areas that pose a concern for pest populations
      (a) Fencerows
      (b) Near waterways
      (c) Areas where pests have been a problem in the past
   2) Monitoring programs
      (a) Determine economic injury level: the lowest pest population density at which economic impact is felt
      (b) Determine economic/action threshold: the pest population density at which control measures should be enacted
   3) Conducting monitoring programs
      (a) Walk-through inspections of forage systems
      (b) Use of insect traps located throughout the forage system
c) Methods of pest control
   1) Mechanical
      (a) Tilling
      (b) Mowing
      (c) Pulling of weed species
      (d) Best for small infestations, easily controlled infestations
   2) Cultural control
      (a) Manipulation of the environment to reduce a favorable climate for pests
      (b) Crop rotation
      (c) Trap crops
      (d) Controlled burn
   3) Pesticides - chemical or organic mixtures developed with the intention of controlling pests

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

What methods of brush control are available?

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

(d) Various reactions to herbicides
3) Grazing management - healthy forage ecosystems choking out encroaching brush plants
(a) Rotational grazing restricts animals from overgrazing.
(b) Stressed forage systems are open to brush and weed infestations.
b) Combination of methods - best option
1) Tailor a control program based on extent of problem.
2) Plan and expect long-term results.

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

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

a) Testing the soil and amending it
1) Spreading fertilizer - based on soil tests and prescribed nutrient requirements for those forage species present
2) Liming - amends and adjusts pH of the soil
3) Disking
(a) Incorporates organic material into soil
(b) Breaks up surface layer for better water and air penetration
b) Suppressing and/or destroying unwanted plant
1) Mechanical
(a) Mowing
(b) Pulling
(c) Cutting
(d) Tilling
2) Cultural - rotational grazing
3) Chemical - herbicide used to destroy unwanted plant species
c) Introducing other forage species
1) Overseeding
(a) Broadcasting grass or legume seed into an existing forage stand that may be thinned or overgrazed
(b) Typically done in late winter or early fall
2) No-till planting
(a) Places seed into the soil at the optimal depth without tillage of soil surface
(b) Allows for lower seeding rates
(c) Precise placement of seed
(d) Reduction in loss of organic material and water loss from tillage
(e) Reduction from tillage erosion
(f) Seed in January and February on frozen ground
d) Prescribed burning
1) Commonly used for warm-season grasses
2) Removes previous years growth
3) Keeps invading woody plants in check
4) Reduces competition from invading cool-season grasses
5) Usually conducted in the spring
6) Encourages fast and vigorous growth right after the burn by releasing nutrients locked up from previous years growth
7) Must be done with safety in mind
(a) Procedures selected that will cool the fire
(b) Wind conditions
(c) Relative humidity
(d) Air temperature
(e) Cool, damp conditions - best
(f) Fire barriers to stop the path of a blaze
8) Seek the advice of experienced persons

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

   What are fertilizer requirements for an established stand?

   a) Forage nutrient status and needs
      1) Plant and soil analyses- used to optimize plant yields
         (a) Based upon available nutrients
         (b) Maximizes economic and nutrient inputs
      2) Soil analysis
         (a) Typically just the surface sampled
         (b) Deeper subsoil samples taken for deep rooted perennials
      3) Plant analysis
         (a) Samples of plant tissue are analyzed to determine current plant nutrient status.
         (b) Look at more nutrients than soil tests to detect plant deficiencies.
   b) Important nutrients
      1) Phosphorus
         (a) Especially critical when legumes are established
         (b) Better stands usually obtained if applied just before or at the time of seeding
      2) Potassium
         (a) Not as critical at time of establishment
         (b) Legume persistence greater if used in a topdressing program
      3) Nitrogen
         (a) Should not be used when establishing legumes in a grass sod
         (b) Increases the growth and vigor of the grass and increases the competition for the new legume seedling
      4) Boron
         (a) Important to alfalfa and should be applied in the topdress fertilizer
         (b) Toxic to alfalfa seedlings and should not be applied at seeding
   c) Protecting soil and water resources
      1) Leaching and erosion of nutrients - Nitrogen and phosphorus are very soluble and tend readily move into the water table and/or streams, ponds, etc.
      2) It is important to apply correct amounts of these nutrients at the proper plant stage of growth so as to minimize losses to water movement.

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

I. ***Answers to Evaluation***

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

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

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

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

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

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

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

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

UNIT IX - FORAGE PRODUCTION Name________________________________

Lesson 4: Scouting and Maintaining the Crop Date________________________________

EVALUATION

Complete the following short answer questions.

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

   a.

   b.

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

   a.

   b.

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

   a.

   b.

   c.

4. Describe two activities that occur during “forage monitoring.”

   a.

   b.

5. List two methods of pest control.

   a.

   b.

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

   a.

   b.

7. List two methods of controlling brush.

   a.

   b.

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

   a.

   b.

   c.

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

   a.

   b.

10. List three important nutrients for forage systems.

    a.

    b.

    c.

UNIT IX - FORAGE PRODUCTION

Lesson 5 : Selecting a Grazing System

Competency/Objective: Identify various forage grazing methods.

Study Questions

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

References

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

2. Transparency Masters

   a) TM 5.1: Basic 140-Acre Grazing Unit
   b) TM 5.2: Simple 4-Paddock Grazing System
   c) TM 5.3: A 12-Paddock Intensive Grazing System

3. Activity Sheet

   a) AS 5.1: Determining Carrying Capacity

UNIT IX - FORAGE PRODUCTION

Lesson 5: Selecting a Grazing System

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

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

a) Continuous grazing systems - traditional method of using single or few pastures for full season grazing
    1) Advantages
        (a) Higher initial animal performance due to selective grazing
        (b) Low maintenance
    2) Disadvantages
        (a) Pasture composition altered by selective grazing
        (b) Poor forage utilization
b) Rotational grazing systems - sequenced movement of animals between two to seven smaller pastures
    1) Advantages
        (a) Match grazing to plant growth
        (b) Provides rest periods for desirable plants
        (c) Increases forage and animal production
        (d) Reduces brush invasion
        (e) Set aside fields for haying and fall stockpiling
    2) Disadvantages
        (a) Requires more time and labor to manage
        (b) Requires additional expenses in fencing, waterers, and maintenace
c) Management intensive grazing (MIG) system - a form of rotational grazing using a short duration (5-day) rotation between pastures
    1) Advantages
        (a) Maintains desired pasture composition
        (b) Causes less damage from compaction
        (c) Higher production per acre than traditional rotation grazing
        (d) Provides for longer regrowth periods
        (e) Allows operator more contact with animals allowing for identification and correction of potential problems

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

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

How do water resource locations influence grazing patterns?

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

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

What determines the livestock carrying capacity of a grazing system?

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

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

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

a) Steps to calculate "cow-days"
   1) Look at the pasture and determine if it is thin, average, or thick.
   2) Measure or estimate the height of the pasture.
   3) Subtract from the total height the height of the stubble the animals should leave.
   4) Multiply the difference between starting height and ending height by the cow-days per inch to figure available cow days/acre.
   5) Divide the number of cows in the herd by cow-days/acre to determine how much area should be allocated.
b) Adjustments for different classes of livestock and different weights

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

How do different grazing patterns influence cow-calf days?

a) Size of the pastured area

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

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

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

I. ***Answers to Evaluation***

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

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

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

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

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Lesson 5: Selecting a Grazing System Date ____________________________

EVALUATION

Complete the following short answer questions.

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

   a.

   b.

   c.

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

   a.

   b.

   c.

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

   a.

   b.

   c.

   d.

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

   a.

   b.

Circle the letter that corresponds to the best answer.

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

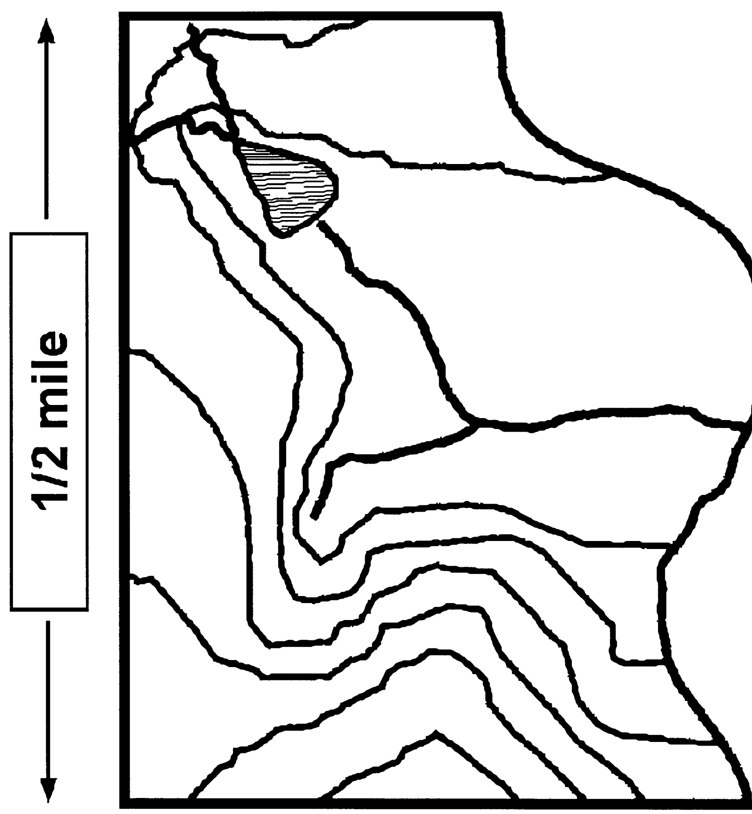
   a. 5-10
   b. 10-15
   c. 15-20
   d. 25-30

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

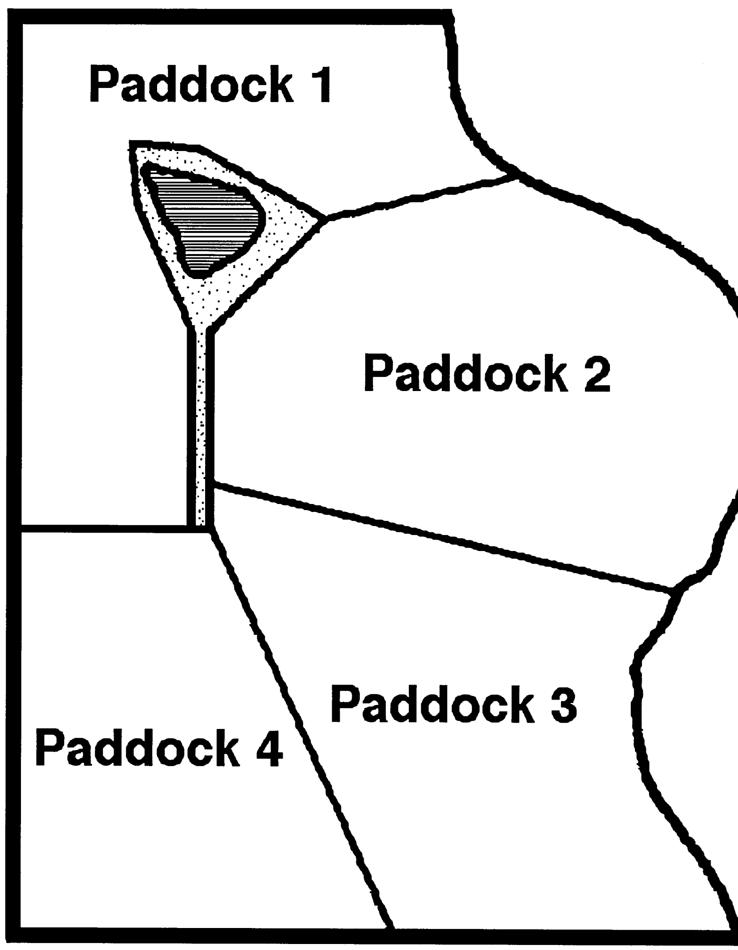
   a. 20
   b. 30
   c. 40
   d. 50

TM 5.1

Basic 140-Acre Grazing Unit

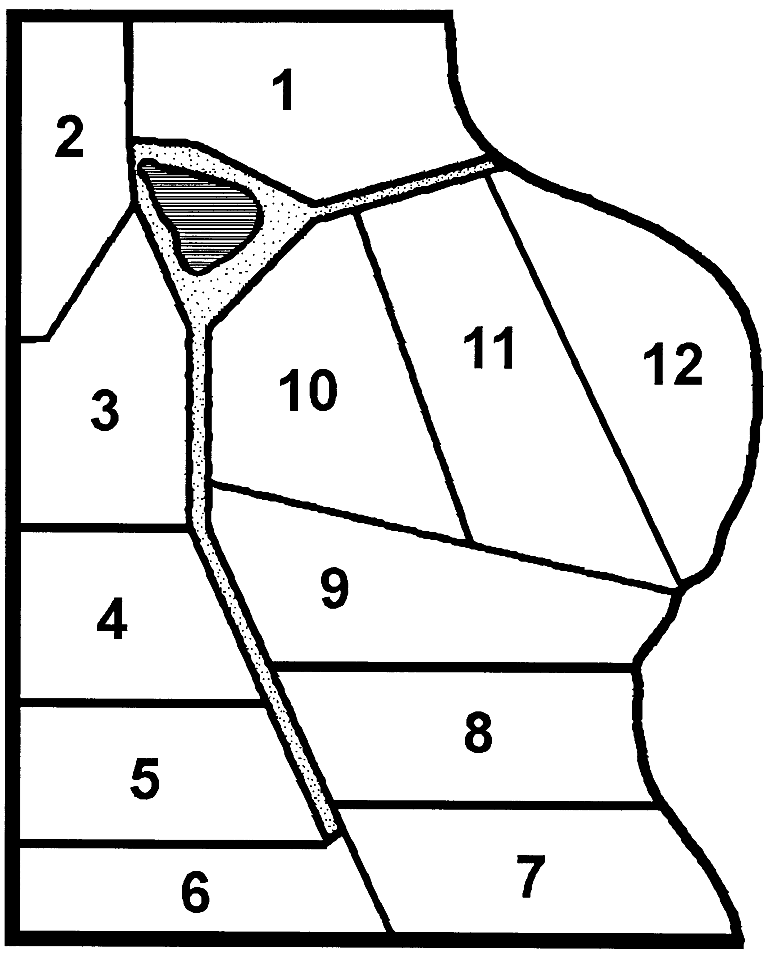


Simple 4-Paddock Rotational Grazing System



TM 5.3

12-Paddock Intensive Grazing System



Lesson 5: Selecting a Grazing System Name____________________________

Determining Carrying Capacity

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

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

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

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

UNIT IX - FORAGE PRODUCTION

Lesson 6: Harvesting for Seed

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

Study Questions

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

References

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

UNIT IX - FORAGE PRODUCTION

Lesson 6: Harvesting for Seed

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What are the factors to consider for producing forage seed?

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

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

   What additional costs are incurred in producing forage seed?

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

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

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

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

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

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

What are the methods for harvesting forage seed?

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

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

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

F. ***Conclusion***

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

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

Answers will vary.

H. ***Answers to Evaluation***

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

UNIT IX - FORAGE PRODUCTION

Name ______________________________

Lesson 6: Harvesting for Seed

Date ______________________________

EVALUATION

Complete the following short answer questions.

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

   a.

   b.

   c.

2. List three costs incurred in producing forage seed.

   a.

   b.

   c.

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

   a.

   b.

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

Lesson 6: Harvesting for Seed Name ______________________________

Forage Seed and Plant Identification

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

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

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

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

UNIT IX - FORAGE PRODUCTION

Lesson 7: Harvesting for Feed

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

Study Questions

1. **What factors determine harvest timing?**

2. **What factors affect forage quality at or during harvesting?**

3. **What are the advantages and disadvantages of various harvesting methods?**

4. **What forage quality factors are affected during storage?**

5. **What are the advantages and disadvantages of various storage methods?**

6. **What methods are used to enhance poor quality forage?**

References

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

2. Activity Sheet

   a) AS 7.1: Testing Forages for Moisture Content

UNIT IX - FORAGE PRODUCTION

Lesson 7: Harvesting for Feed

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What factors determine harvest timing?

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

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

What factors affect forage quality at or during harvesting?

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

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

What are the advantages and disadvantages of various harvesting methods?

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

(c) Advantages
(1) Efficient with legume crops
(2) Increases drying rates in second and third cuttings
(d) Disadvantages
(1) Additional equipment needed to apply chemical during cutting
(2) Does not work well with grasses
c) Mower conditioner - mowing and conditioning process in one machine
1) Advantages
(a) Less damage to forage due to single cutting/crimping process
(b) Fewer trips across field saving on fuel, maintenance, and labor costs
2) Disadvantage -
(a) Rollers adjusted incorrectly - great losses in dry matter
(b) More costly than a mower
d) Swath manipulation - mechanical turning or spreading of forage to enhance even drying
1) Raking - hay crop mechanically inverted into tight windrows
(a) Advantages
(1) Efficiently inverts and fluffs windrows for drying
(2) Rolls windrows for better pickup with the baler
(b) Disadvantages
(1) If crop is thick, wet sections in the middle may not dry completely.
(2) There is loss of dry matter, especially leaves in legumes.
2) Swath inversion - (similar to raking) mowed swath moved on belts and inverted with the bottom moving to the top and the top to bottom
(a) Advantages
(1) Gentler method, does not "beat" hay during pickup, knocking leaves off of legumes
(2) Inverts and fluffs windrows
(b) Disadvantage - not as efficient as tedding in drying time
3) Tedding - a machine with rotating tines that stirs, spreads, and fluffs the hay
(a) Advantages
(1) Allows for uniform drying by spreading out the hay
(2) Spreads swaths and may decrease drying time by up to 2 days
(b) Disadvantages
(1) Beating action is more damaging to legumes with fragile leaf structures.
(2) Leaf loss leads to nutritional loss.
e) Baling
1) Rectangular bales
(a) Common size - 14 x 18 x 48-50 inches; weighing between 80 and 120 pounds
(1) Advantages
a. Ease of handling in stacking and feeding
b. Easier in transportation and marketing operations
(2) Disadvantages
a. More labor intensive in hauling and stacking
b. Indoor storage needed to maintain highest quality
(b) Large, high density bales - sizes ranging from 24 to 50 inches wide and tall by 48 to 98 inches long; weighing 440 to 2000 pounds
(1) Advantage - harvested and transported more efficiently
(2) Disadvantages
a. More specialized equipment is needed for harvest and feeding, which increases the cost.
b. Wind damage can occur if bales are not covered.
2) Round bales - typically used for on-farm use; sizes range from 36 to 72 inches in diameter, 48 to 64 inches in length; weighing 440 to 2000 pounds
(a) Advantages
(1) Less labor intensive than small rectangular bales
(2) Can be stored outside in convenient locations for consumption
(b) Disadvantages

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

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

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

What forage quality factors are affected during storage?

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

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

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

What are the advantages and disadvantages of various storage methods?

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

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

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

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

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

What methods are used to enhance poor quality forage?

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

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

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

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

F. ***Other Activities***

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

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

G. ***Conclusion***

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

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

Answers will vary.

I. ***Answers to Evaluation***

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

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

UNIT IX - FORAGE PRODUCTION | Name______________________________

Lesson 7: Harvesting for Feed | Date______________________________

EVALUATION

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

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

Answer the following short answer questions.

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

   a.

   b.

   c.

   d.

9. Why is swath inversion preferred over raking?

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

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

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

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

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

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

    a.

    b.

    c.

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

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

Lesson 7: Harvesting for Feed Name ____________________________

Testing Forage for Moisture Content

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

Materials:

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

Directions:

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

UNIT IX - FORAGE PRODUCTION

Lesson 8 : Marketing the Crop and Figuring Crop Costs

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

Study Questions

1. **What forage marketing options are available locally?**

2. **What effect does forage quality have on price?**

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

4. **How are the costs per acre of forage production calculated?**

References

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

2. Activity Sheet

    a) AS 8.1: Figuring Crop Costs

UNIT IX - FORAGE PRODUCTION

Lesson 8: Marketing the Crop and Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

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

B. ***Motivation***

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

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

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

   What forage marketing options are available locally?

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

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

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

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

What effect does forage quality have on price?

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

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

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

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

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

How are the costs per acre of forage production calculated?

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

F. ***Other Activity***

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

G. ***Conclusion***

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

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

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

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

I. ***Answers to Evaluation***

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

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

UNIT IX - FORAGE PRODUCTION Name ____________________________

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

EVALUATION

Circle the letter that corresponds to the best answer.

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

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

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

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

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

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

Complete the following short answer questions.

4. Explain the difference between variable and fixed costs.

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

   a.

   b.

   c.

   d.

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

Figuring Crop Costs

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

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

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

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

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

Net receipts: $__________ (gross receipts) - $_____________ (total cost of production) = $________/ton

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

UNIT X - COTTON PRODUCTION

Lesson 1: Planning the Crop

Competency/Objective: Evaluate local growing conditions.

Study Questions

1. **What environmental conditions are necessary for cotton production?**
2. **What factors are considered when evaluating field history?**
3. **What are the fertilizer requirements for cotton?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit X.
2. Activity Sheet
   a) AS 1.1: Soil Nutrients Needed by Cotton

UNIT X - COTTON PRODUCTION

Lesson 1: Planning the crop

TEACHING PROCEDURES

A. ***Introduction***

Cotton is an economically important crop to agriculture and to Missouri. An important factor in growing cotton is the planning phase, the first step in producing a cotton crop. This lesson will discuss what conditions and factors need to be considered when planning the crop.

B. ***Motivation***

1. To prepare for AS 1.1, plant single cotton seeds in pots of soil containing approximately 2 pounds of soil (preferably a potting soil or soil that lacks nutrients) 3 to 4 weeks before the start of the lesson. The class will be separated into three student groups with each group receiving four potted plants each. Refer to AS 1.1 for detailed procedures to complete the activity.

2. The instructor should bring in samples of a cotton plant, a cotton boll, and products made from cotton. Students should then be asked how important cotton is to Missouri and where cotton can be grown. From this discussion students should discover that cotton needs specific conditions to grow well. These conditions will be examined in this lesson.

3. Show the video *Early Season Crop Assessment and Management*, Part 2 of the Cotton Crop Monitoring for Optimum Management video series, Ag Video 225, available for free loan from MRCCTE (formerly MVRC), University of Missouri-Columbia.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Cotton, like any other plant, requires specific conditions to grow well. Before a producer plants cotton, he or she should have a working knowledge of these necessary environmental conditions. Ask students what environmental conditions they think are necessary to grow cotton. Refer to Table 1.1 in the Student Reference for the average heat units (DD-60s) required for cotton.

What environmental conditions are necessary for cotton production?

a) Growing season
  1) Warm season crop - grows best during summer months in warm climates
  2) Requires frost-free period (the number of days from the last frost in the spring until the first frost in the fall)
    (a) Main reason not grown in northern climates
    (b) Mostly grown in southern regions of the United States including southeast Missouri
  3) Newer varieties - able to produce in climates with shorter growing seasons
  4) Growing season in Missouri - falls between early May and late October
  5) Temperature requirements
    (a) Planting and germination stages
      (1) Only planted in spring when average soil temperature at least 65°F for 3 consecutive days
      (2) Will not germinate unless the average air temperature at least 75°F, 85°F optimum

(3) Spring planting dates in Missouri - between May 5 and May 15
  a. Before May 5
    i. Risk cool soil temperatures
    ii. May be able to establish a stand in some years
  b. After May 15 but before May 20
    i. Will probably not have significantly lower yields
    ii. Can delay plant maturity and harvest
  c. After May 20
    i. Usually results in reduced yields
    ii. Not recommended

(b) Cotton plant development
  (1) Temperatures between 65 and 85°F - grows predictably
  (2) Little or no development at temperatures below 60°F
  (3) Heat units (DD-60s) - method of temperature measurement
    a. Used to manage and monitor crop
    b. Calculated by averaging the maximum and minimum temperatures for a day and subtracting the base temperature
    c. [(max. temp. + min. temp.) ÷ 2] - 60 = DD-60s

6) Rainfall
  (a) Impacts soil temperature
    (1) Over 1 inch rainfall - drop soil temperature at least 5 degrees
    (2) Delay warming of soil for 4 to 5 days
  (b) During plant development
    (1) Before first bloom - ¾ to 1 inch of water weekly
    (2) During peak bloom - 1 to 1½ inch of water weekly
    (3) Late bloom to early maturity - no water required
  (c) Must be monitored
    (1) Wilting (loss of strength or turgor) - needs water
    (2) Increased vegetative growth and reduced reproductive growth - excessive water

7) Soil type
  (a) Sandy soils
    (1) Will not hold water as well as other types
    (2) May need to be irrigated more often
  (b) Clay soils
    (1) Better water-holding capacity
    (2) Restrict drainage
    (3) Seldom need irrigation
    (4) Excessive clay
      a. Root growth resisted
      b. Can stunt cotton plants
  (c) Silty soils - compromise between clay and sand

2. Once the growing conditions have been evaluated, the field itself should be evaluated. Ask students if the field conditions and history will have any impact on growing cotton.

What factors are considered when evaluating field history?

a) Weeds
  1) Previous weeds and current herbicide can impact cotton.
  2) Severe weed problems affect germination and growth.
b) Soil fertility and soil nutrients - excessive nitrogen a potential problem in vegetative and reproductive growth
c) Insects
  1) Insecticide used on previous crop could harm cotton.
  2) Insect eggs could remain in soil.

3. Like many other plants, cotton has certain fertilizer requirements for varying levels of production. Ask students what soil nutrients they think cotton needs and why. Complete AS 1.1.

What are the fertilizer requirements for cotton?

a) Variables affecting fertilizer requirements
 1) Stress
  (a) Affects amount of nutrients plant absorbs from soil
  (b) Causes
   (1) Soil texture
   (2) Drainage
   (3) Field preparation
   (4) Weather
   (5) Variety of crop selected
   (6) Planting date
   (7) Planting and germination rate
   (8) Emergence rate
   (9) Previous crop
   (10) Nutrients and chemicals in soil
 2) Amount of nutrients needed
  (a) Varies throughout the plant's growing cycle
   (1) Spring and early summer when temperature is low - requires small amounts of nutrients
   (2) Temperatures and plant size increases - need for nutrients increases
  (b) Peak amounts of nutrients needed - late June and throughout July
 3) Soil pH - prefer 6.0 to 6.5
b) Nutrients required
 1) Nitrogen
  (a) Used in chlorophyll - the process of making new tissues in the plant
  (b) Nitrification
   (1) Changes the levels of each type of nitrogen in the soil
   (2) Excess water in soil
    a. Slows or stops nitrification
    b. Nitrogen given off in form of gas
  (c) Levels
   (1) Excessive nitrogen
    a. Delay plant maturity
    b. Slow flowering
    c. Cause excessive vegative growth
    d. Increase insect infestations
    e. Reduce resistance to diseases
    f. Increase the risk of boll rot disease and lint (boll fiber) quality
   (2) Young plant - little nitrogen needed
   (3) Flowering and forming the boll - large amounts of nitrogen needed
   (4) Common rate - 80 pounds per acre on irrigated fields
  (d) Application
   (1) 30 pounds at planting
   (2) 50 pounds before blooming
 2) Phosphorous
  (a) Does not move well through soil
  (b) Mycorrhizal fungi
   (1) Take food from plant
   (2) Help absorb phosphorous from areas around roots
  (c) Cold soils
   (1) Inhibit phosphorous intake
   (2) Slow root growth
 3) Potassium

(a) Needed in large amounts while bolls are setting
(b) Important to pH of plant
(c) Taken directly into roots - desired levels vary

4) Boron
   (a) Important in cell formation and production of fruit
   (b) Plentiful in southern soils
   (c) Less available in drier soils
5) Secondary macronutrients - may sometimes be applied in fertilizer if needed
   (a) Calcium
      (1) Strengthen cell wall
      (2) Increase plant growth
      (3) Produce protein
      (4) Move carbohydrates
      (5) Balance cell acidity
      (6) Calcium deficiency
         a. Makes plant more susceptible to plant diseases
         b. Leads to weaker plant stalks
   (b) Magnesium - used in making chlorophyll
   (c) Sulfur - produces amino acids
6) Micronutrients
   (a) Needed in very small amounts
   (b) Common micronutrients
      (1) Boron
      (2) Molybdenum
      (3) Zinc
      (4) Iron
      (5) Manganese
      (6) Copper
      (7) Chlorine

F. ***Other Activity***

Have the students evaluate a soil test report to determine levels of each nutrient in the soil, whether cotton would grow well on that soil as it is, or if fertilizer needs to be applied.

G. ***Conclusion***

Careful consideration and evaluation should be given to field history, previous cropping, moisture, irrigation, and soil fertility when considering planting cotton. A soil fertility test can accurately determine nutrient levels found in the soil and what nutrients should be applied to maximize cotton production.

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

Answers will vary

I. ***Answers to Evaluation***

1. c
2. a
3. b
4. b
5. d
6. Nitrogen, phosphorous, potassium
7. Nitrate and ammonium nitrogen
8. Phosphorous
9. Making a boll
10. Cell formation, production of fruit

UNIT X - COTTON PRODUCTION Name______________________________

Lesson 1: Planning the Crop Date_______________________________

EVALUATION

Circle the letter that corresponds with the best answer.

1. Cotton in Missouri is typically planted between ________________________ .

   a. May 1 and May 5
   b. May 1 and May 15
   c. May 5 and May 15
   d. May 15 and May 20

2. Cotton should be planted when the average soil temperature is at least ______ °F for three consecutive days.

   a. 65
   b. 75
   c. 85
   d. 45

3. During peak bloom period, cotton requires ______ inch of water per week.

   a. ½ to ¾
   b. 1 to 1½
   c. 1½ to 2½
   d. 0 to ½

4. Cotton prefers a soil pH of _______________.

   a. 5.5 - 6.0
   b. 6.0 - 6.5
   c. 6.5 - 7.0
   d. 7.0 -7.5

5. The type of nutrients that the plant needs large amounts of are called _________________________.

   a. Secondary nutrients
   b. Important nutrients
   c. Micronutrients
   d. Macronutrients

Complete the following short answer questions.

6. Name three common macronutrients.

   a.

   b.

   c.

7. Name two common forms of nitrogen in soil.

   a.

   b.

8. The nutrient that does not move easily through soil is ____________________________.

9. Potassium is needed by a cotton plant especially when the plant is ______________________.

10. Boron is used by the plant in ____________________________.

Lesson 1: Planning the Crop Name______________________________

Soil Nutrients Needed by Cotton

Objective: Students will identify and compare the effect soil nutrients have on growing cotton.

Materials needed:

Four cotton plants per student group (seeded 3 to 4 weeks before the start of the lesson)
Pure fertilizer samples of nitrogen, phosphorus, and potassium
Measuring device to measure grams

Procedure:

1. Give each student group four cotton plants and assign one of the three nutrients to each group.

2. Give the plants varying levels of the assigned nutrient daily using the amounts listed below as the basic amount. Use one plant as a "control," where no additional fertilizer is applied. Add the nutrient assigned to your group per the following measurements.

   a. Plant 1: Group 1: 2 grams of nitrogen
   Group 2: 1.5 grams of phosphorus
   Group 3: 1 gram of potassium

   b. Plant 2: Use half of the amount used on plant 1.

   c. Plant 3: Double the amount used on plant 1.

   d. Plant 4: Control plant - no additional fertilizer applied.

3. Over a 2-week period, observe the cotton plants as varying amounts of each fertilizer is applied.

4. In your notebook, note any changes observed in the plant, including death.

5. After 2-3 weeks, compare your results with the rest of the class.

Questions to consider:

1. What changes did you observe in the plant at each level of fertilization and why?

2. How did the control plant compare to the other three plants and why?

3. Which nutrient seemed most important to plant growth and why?

UNIT X - COTTON PRODUCTION

Lesson 2: Selecting a Variety

Competency/Objective: Select cotton variety with a local cotton consultant.

Study Questions

1. **Why and how are consultants used in cotton production?**
2. **What factors are considered when selecting a cotton seed variety?**
3. **What diseases are prevalent to cotton locally (in Missouri)?**

References

1. *Advanced Crop Sciences* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit X.
2. Activity Sheet
   a) AS 2.1: Cotton Variety Seed Selection

UNIT X - COTTON PRODUCTION

Lesson 2: Selecting a Variety

TEACHING PROCEDURES

A. ***Review***

The previous lesson addressed factors involved in planning a cotton crop. This lesson will address factors to consider when selecting a cotton seed variety, the role of cotton consultants, and what diseases are found locally that may impact cotton seed selection.

B. ***Motivation***

Obtain a list of cotton varieties from a seed company or from Internet references. Show the list on the overhead projector or write on the chalk/whiteboard as students select the most appropriate variety of cotton seed for local growing conditions. Ask them why they chose a particular variety and how producers would know which variety to select for their fields.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Extensive research in cotton production and cotton-growing conditions has resulted in many varieties of cotton seed. Ask students how a producer might select seeds without knowing what varieties grow well in the local area.

   Why and how are consultants used in cotton production?

   a) Hired professionals - help make correct management decisions based on local conditions
      1) Give recommendations
         (a) Variety selection
         (b) Pest control
         (c) Irrigation and water management
         (d) Soil fertility determination
         (e) Cotton classification
         (f) Gin selection
         (g) Product marketing
      2) Evaluate fields during growing season
         (a) Insect infestations
         (b) Soil fertility problems
         (c) Irrigation scheduling
         (d) Other problems
      3) Offer solutions to problems, including alternative methods

2. There are a number of factors involved in selecting a variety of cotton seed. Producers work with consultants and evaluate local production data when selecting the appropriate variety of seed for their field conditions. Refer to the Motivation listing of the many varieties of cotton seed available. Ask students if any one variety would work in all situations and why or why not.

   What factors are considered when selecting a cotton seed variety?

   a) Yield ability - total production of a variety of saleable cotton
      1) Determines crop income

2) Varies
    (a) State to state
    (b) County to county
    (c) Depends on local growing conditions

b) Maturity - average number of growing days needed from seeding to harvest
    1) Variety selected to mature during hot, dry days based upon:
        (a) Local climate
        (b) Average planting date
        (c) Length of time required for variety to mature
        (d) Harvest date
    2) Rain stains cotton - bolls open in hot, dry days not during rain

c) Plant size - measure of how tall the cotton plant will grow upon maturity
    1) Too much vegetative growth (plant height)
        (a) Reduces boll production
        (b) Causes harvesting problems
    2) Growth regulators
        (a) Sometimes used to limit plant height
        (b) Cost reduced or eliminated by selecting a shorter variety

d) Hairiness - hairs growing on the leaves
    1) Can pose a problem in harvesting
        (a) Get into cotton fibers or lint
        (b) Decrease cotton's value
        (c) Not typical in varieties grown in Missouri
    2) Smooth or semi-smooth leaf varieties - reduce amount of trash in lint

e) Transgenes - varieties of cotton that have been developed that are resistant to particular herbicides
    1) Enable producers to kill weeds with the herbicides without affecting the health of the cotton plant
    2) More expensive
    3) Not readily available
    4) Varieties resistant to particular insects - reduce the cost of insect control

f) Fiber properties
    1) Staple length (fiber length)
    2) Color
    3) Cleanliness
    4) Uniformity
    5) Fiber strength
    6) Elongation
    7) Fiber diameter

g) Seed size
    1) Important in ginning process - difficult to separate very small seeds from lint
    2) Determines number of seeds per pound - important in purchasing seed

h) Herbicide program
    1) Used to kill weeds
    2) Transgenic varieties - resistant to certain herbicides
    3) Some varieties - do not compete as well with weeds
    4) Important to know weed history of field

i) Tolerance
    1) Some varieties - withstand damage from insects better
    2) Ability to withstand stresses during the growth stages

j) Cost
    1) Older varieties - less expensive
    2) New varieties - more productive
    3) Transgenic seeds
        (a) Cost more
        (b) Allow for different management practices in pest control

k) Insect resistance

1) Numerous insects that may infest cotton
2) Spraying for harmful insects
    (a) Often kills beneficial insects
    (b) Harmful insects return sooner after spraying than beneficial insects

3. Cotton is susceptible to a number of different diseases. Ask students if they can name any common cotton diseases and what the diseases do to the plant.

    What diseases are prevalent to cotton locally (in Missouri)?

    a) Causes
        1) Fungi
        2) Nematodes
        3) Bacteria
    b) Most common diseases
        1) Seedling disease
        2) Boll rots
        3) Bacterial blight
        4) Leaf spots
        5) *Cercospora gossypina*
        6) *Asochyta gossypii*
        7) *Alternaria*
        8) Fusarium wilt
        9) Verticillium wilt
        10) Root knot nematode
        11) Reniform nematode
        12) Lance nematode
    c) Symptoms
        1) Stunted plants
        2) Poor color
        3) Reduced vigor
        4) Lower yields
        5) Death
    d) Resistance
        1) No varieties immune to all or most diseases
        2) Limited levels of resistance to certain cotton diseases
            (a) Root-knot nematode
            (b) Fusarium wilt
            (c) Verticillium wilt
    e) Effects on plants
        1) Seedlings
            (a) Especially susceptible to diseases
            (b) Usually die
        2) Older plants
            (a) Able to survive some diseases
            (b) Reduced production
    f) Ability to withstand - related to amount of stress on plant
    g) Methods for managing cotton diseases
        1) Four most common
            (a) Rotating crops and crop varieties
            (b) Planting resistant varieties
            (c) Planting in warm, well-drained soil
            (d) Integration of all three most effective method
        2) Fungicide
            (a) Method of applying
                (1) Applied to seed
                (2) Sprayed onto plant

(3) Injected into the ground after plant is growing

(b) Fight several common diseases

F. ***Other Activity***

Invite a cotton consultant to speak to the class outlining what his or her job entails, what consultants need to know, and other pertinent information.

G. ***Conclusion***

Selecting a cotton seed variety is not a simple task. A number of factors need to be considered to select the variety most appropriate to the local setting. Diseases can cause major damage to the cotton and should be managed to reduce crop damage resulting in reduced production.

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

Answers will vary.

I. ***Answers to Evaluation***

1. b
2. a
3. b
4. c
5. a
6. Applied to seed, sprayed on plant, injected into ground
7. Fungi, bacteria, nematodes
8. Rotating crops and crop varieties, planting resistant varieties, planting in warm, well-drained soil
9. Answers may include any four of the following: boll rots, bacterial blight, leaf spots, *Cercospora gossypina*, *Asochyta gossypii*, *Alternaria*, Fusarium wilt, Verticillium wilt, root knot nematode, Reniform nematode, Lance nematode.
10. Answers may include any three of the following: stunted plants, poor color, reduced vigor, lower yields, and death.

UNIT X - COTTON PRODUCTION Name______________________________

Lesson 2: Selecting a Variety Date______________________________

EVALUATION

Circle the letter that corresponds with the best answer.

1. A local expert trained to aid the producer in making cotton decisions is called a ________________.

   a. Cotton buyer
   b. Cotton consultant
   c. Crop expert
   d. Cotton picker

2. When referring to cotton seed selection, yield refers to ____________________________________.

   a. Total production of saleable cotton
   b. Number of seeds in a pound
   c. Height of the plant
   d. Resistance to disease

3. Maturity is important in cotton seed selection in relation to _______________________________.

   a. Total size of the plant
   b. Local climate information
   c. Seeding rate
   d. Amount of lint in bolls

4. Transgenes refer to varieties of cotton that have been developed to _________________________.

   a. Be fertile
   b. Be less expensive as a seed
   c. Resist herbicides
   d. Produce two crops a year

5. Insect resistance is important in a cotton variety because it ________________________________.

   a. Eliminates the need for spraying that also kills beneficial insects
   b. Completely stops insect problems
   c. Sterilizes the soil
   d. Prevents diseases

6. List three methods of applying fungicides to a cotton field.

   a.

   b.

   c.

7. List three organisms that commonly cause cotton diseases.

   a.

   b.

   c.

8. List three important methods of managing cotton diseases.

   a.

   b.

   c.

9. List four common diseases of cotton found in Missouri.

   a.

   b.

   c.

   d.

10. List three common symptoms of diseased cotton.

   a.

   b.

   c.

Lesson 2: Selecting a Variety Name______________________________

Cotton Variety Seed Selection

Objective: Compare cotton varieties to determine their advantages and disadvantages in the local growing conditions.

Directions: Compare and evaluate cotton varieties' advantages and disadvantages. Evaluate the seed varieties using the guidelines presented below. Individually or in teams, evaluate a different variety of cotton.

Materials needed:

Cotton variety information sheets (can be found on the Internet - see references)

Procedure:

Determine the following information about your variety of cotton. When finished, compare information with your classmates (write information in table form on the board).

1. Ability to yield
2. Maturity
3. Plant size
4. Hairiness
5. Transgenes
6. Fiber properties
7. Seed size
8. Herbicide program to be used
9. Tolerance
10. Cost
11. Insects

Questions to consider:

1. Is there an ideal cotton variety? Why?
2. Which variety evaluated by your class seemed best? Why?
3. Would your answer be different if you lived in Alabama, and what might affect your decision?

UNIT X - COTTON PRODUCTION

Lesson 3: Tilling and Planting the Crop

Competency/Objective: Describe the tillage and planting method for cotton.

Study Questions

1. **What is considered proper seedbed preparation for cotton?**

2. **What is the proper plant population and row spacing?**

3. **How is a cotton planting calendar used?**

References

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

2. Activity Sheet

   a) AS 3.1: Germination Percentages

UNIT X - COTTON PRODUCTION

Lesson 3: Tilling and Planting the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons have included factors involved in planning the crop and in selecting the seed variety planted. This lesson will concentrate on the factors to consider in soil tillage, seeding rates, and the use of a cotton planting calendar.

B. ***Motivation***

1. Hypothetical situation: students are raising roses for sale. Weather conditions allow for the roses to be planted anytime during the year. Ask the students if they would plant the roses on a specific date or whenever they felt like it. Those who say on a specific date, ask them why. It is hoped that students will recognize that having the roses flowering and maturing at or near Valentine's Day would be ideal. Relate this to growing cotton. Instead of aiming for a specific date, producers are looking for optimal weather to produce and open bolls.

2. Show the video *Stand and Population Evaluation*, Part 1 of the Cotton Crop Monitoring for Optimum Management video series, available for loan from the Missouri Resource Center for Career & Technical Education (MRCCTE, formerly MVRC), Ag Video 224, University of Missouri-Columbia.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Preparing the soil for seeding is an important task in producing crops, and cotton is not any different. Ask students how the soil should be prepared before planting a garden and why those steps are taken.

What is considered proper seedbed preparation for cotton?

- a) Correct seedbed preparation for cotton
    - 1) Bed that is firm, well drained, and free of vegetative growth like weeds
    - 2) Proper environment for the cotton seed to grow
- b) Two main types of seedbed cultivation
    - 1) Conventional tillage
        - (a) Plowing fields after fall harvest
            - (1) Shredding stalks from previous crop
            - (2) Mixing stalks into soil for use as fertilizer
        - (b) Spring tillage
            - (1) Deep subsoil chiseling to break up hardpan clay
            - (2) Mixes any remaining residue and incorporates herbicides into the soil
        - (c) Beds formed using "hipper" - specialized tillage implement that mounds soil in rows leaving an irrigation trough between the mounded rows
            - (1) Seeds planted in peak of mounded rows
            - (2) Beds raised to allow more sunshine
                - a. Warms soil
                - b. Increases germination

(3) Procedure done 2 to 3 weeks before planting - allows rainfall to settle the soil

(d) Table for advantages and disadvantages of various conventional tillage operations

Tillage	Purpose	Advantages	Disadvantages
Shred stalks in fall	Allows stalk to decompose and reduce insect overwintering sites	Can reduce insect pressure the following season	None
Disk in fall	Mixes residue into top layer of soil	Hastens decomposition of residue	Less residue on soil surface can allow blowing soil in spring
Deep subsoil	Breaks traffic pan layer	Can improve rooting and water infiltration	Costly operation and pan traffic may reform if soil is tilled while wet after subsoiling
Disk/chisel in spring	Mixes residue in top layer of soil and/or herbicide incorporation	Removes any winter weed growth	Less residue on soil surface can permit blowing soil; traffic pan can reform if disking occurs while soil is wet
Form beds with "hipper"	Provides a fresh bed to plant on	Allows the soil to warm up before planting	May reduce surface drainage and require water furrows in some poorly drained fields

2) Conservation or reduced tillage
   (a) Reduced tillage or no-till cotton
      (1) Labor and fuel savings
      (2) Fewer trips over field needed
      (3) Crop seeded directly into mounds from previous seasons
      (4) Fertilizer and herbicides applied at same time
   (b) No-till - special planter used
      (1) Cuts through crop residue
      (2) Places seed
      (3) Covers seed
      (4) Firms soil over seed
      (5) Stubble - protects seedlings from wind and sand

2. Once the seedbed has been prepared, the producer is ready to begin seeding. To seed the crop, the proper seeding rate and row spacing need to be determined. Ask students how far apart cotton rows should be, how far apart the plants should be, and why such distance is important.

What is the proper plant population and row spacing?

a) Row spacing for cotton
   1) Ranges from 30 to 38 inches apart
   2) Diminished yields on rows narrower than 30 inches
   3) Set by adjusting the planter units on the row crop planter
b) Seed spacing - 2 to 4 inches apart or 3 to 4 plants per foot
c) Seed germination - percentage of seeds that actually grow
   1) Typical germination about 80%
   2) One extra seed per foot dropped to make up for the germination percentage
   3) Adjust seeding rates higher if germination percentage is lower
d) Seeding rates
   1) Typical - 50,000 to 60,000 plants per acre

2) Overseeding
   (a) Too many plants grow
   (b) Competition for limited water, nutrients, and sunlight
   (c) Leads to lower cotton production
   (d) Lodging
   (e) Extreme cases - thin crop for maximum production

e) Proper seeding depth - 3/4 inch deep
   1) Emerges from soil 7 to 9 days after planting
   2) Cannot penetrate a heavy soil crust
      (a) Caused by rain occurring just after seeding
      (b) Leaves harder crust on top of soil
      (c) Seeding rate increased in anticipation of packing rain

f) Low germination
   1) May opt for reseeding directly over the first crop seedlings
   2) Second seeding planting rates adjusted to lower rate

3. Keeping accurate records is an important management tool in any area of agriculture. Cotton producers often use many records. Discuss with the students what a planting calendar is and how it is used.

How is a cotton planting calendar used?

a) Planting calendar allows the producer to pick a good planting date.
   1) Based on expected rainfall, temperatures, and other climate conditions
   2) Focuses on climate when cotton bolls are opening and later when the cotton is ready to be harvested

b) Use crop calendar to maximize cotton production.
   1) The earlier cotton is planted, the more frost-free days are available.
   2) Cotton should not be planted until soil temperature has reached at least 65°F.

c) Most cotton is planted in Missouri between May 5 and May 15.

d) Planting after May 20 generally shows diminished production due to the shorter growing season.

F. ***Other Activity***

Tour recently tilled cotton fields to see methods of cotton tillage. Speak with the local producer and ask about tillage management concerns, preferred methods, etc. Ask the producer what dates crops are planted and why.

G. ***Conclusion***

Preparing the field for seeding is very important for cotton production. Careful consideration of the factors affecting germination and seedling growth will result in higher-quality cotton and higher income later in the growing season. Seeding rates and row spacing also impact the production of a cotton field. Using a cotton planting calendar can assist producer to base planting and harvesting date on climatic conditions.

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

1. Answers will vary
2. Answers will vary
3. Seeding rates may need to be adjusted higher if fewer seeds germinate.

I. ***Answers to Evaluation***

1. b
2. b

3. a
4. a
5. d
6. c
7. Answers may include any two of the following: reduced fuel, labor, or time.
8. The percentage of seeds that will actually grow. Impacts seeding rate.
9. Cotton planting calendar

UNIT X - COTTON PRODUCTION Name______________________________

Lesson 3: Tilling and Planting the Crop Date_______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. In addition to cultivation, what is the other main method for cultivating the land before tillage?

   a. Deep
   b. Reduced
   c. Chemical
   d. Continuous

2. How many inches apart should cotton rows be planted?

   a. 20 to 30
   b. 30 to 38
   c. 25 to 30
   d. 40 to 48

3. Why is shredding the stalks beneficial?

   a. Adds fertilizer to the soil
   b. Helps to pack the soil
   c. Reduces insect pressure the following season
   d. Increases weed growth

4. Why is deep subsoiling sometimes done?

   a. Breaks the traffic pan layer
   b. Decreases water movement in the soil
   c. Allows for deep seeding
   d. Allows for deep fertilization

5. What is used to seed cotton into a mound of soil?

   a. Mounder
   b. Disk plow
   c. Subsoiler
   d. Hipper

6. The proper seeding depth for cotton is _________-inch deep.

   a. ¼
   b. ½
   c. ¾
   d. 1

Complete the following short answer questions.

7. List two advantages of using reduced tillage.

   a.

   b.

8. What is germination percentage and what does it mean when determining seeding rate?

9. What type of record is recommended to determine the best planting date for cotton?

Lesson 3: Tilling and Planting the Crop Name____________________________

Germination Percentages

Objective: Students will determine germination percentage from a sample of seeds.

Directions: Determine germination percentage for a seed sample. Cotton seeds would be ideal, but soybeans, corn, oats, or other seeds can be used.

Materials needed:

Seeds (at least 10 per student)
Paper towels
Water
Dark storage cabinet

Procedures:

1. Using the seeds provided in class, you will determine the germination percentage by actually germinating seeds.
2. Wet one paper towel down so the entire towel is wet.
3. Lay the moistened paper towel flat on the table.
4. Lay 10 seeds out on the paper towel, spacing the seeds evenly around the middle of the towel.
5. Wet another paper towel and lay over the seeds, forming a "seed sandwich."
6. Carefully place your towels and seeds in the dark place suggested by your instructor.
7. Check your seeds daily for the next 2 weeks and record how many seeds grow each day.

Questions to consider:

1. What day did your seeds start to sprout?
2. What was the final day you got seeds to sprout, and what was your final germination percentage? (Take the number of seeds that sprouted and divide by 10.)
3. How would the germination percentage affect your seeding rate?

UNIT X - COTTON PRODUCTION

Lesson 4: Selecting a Weed Control Program

Competency: Select a weed control program

Study Questions

1. **What factors influence a weed control program?**

2. **What weeds are specific to cotton?**

3. **What is the effect of weed pressure on cotton yields?**

4. **What weed control options are available?**

Reference

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

UNIT X - COTTON PRODUCTION

Lesson 4: Selecting a Weed Control Program

TEACHING PROCEDURES

A. ***Review***

Previous lessons have addressed planning the crop, selecting a seed variety, and tilling and planting the crop. This lesson will explore the factors to consider when selecting and implementing a weed control program, the effects of weeds on cotton yield, control options, and technological advances impacting weed control in cotton production.

B. ***Motivation***

Ask students why weeds are considered harmful to a family garden. (The average dandelion or other weed consumes as much or more water than a carrot or pea.) Then compare the family garden where total production is not measured in dollars or pounds to a cotton crop where the product is sold by total pounds. Discuss why weed control would be important to cotton production.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Unfortunately, whenever a crop of any kind is grown, weeds will also be present. There are a number of factors that influence what weed control program is selected and how successful the program will be. Ask students how weeds are commonly controlled (herbicides, pulling, mechanically cutting, etc.). Then ask the students which of those methods might work with cotton and why or why not.

   What factors influence a weed control program?

   a) Field history
      1) To evaluate what crops have been planted before
      2) Known weed problems
      3) Previous herbicide applications
      4) Use of transgenic varieties
   b) Soil type and structure to determine how well the herbicide moves through the soil
   c) Herbicides
      1) Limited number developed for cotton
      2) If designed to kill broadleaf weeds will also impact or kill the cotton plant
      3) Weeds - not taller than cotton plant
         (a) More difficult to spray weeds
         (b) Possibility of cotton plant damage
      4) Use of preplant and preemergence herbicides
      5) Selective over-the-top sprayed broadleaf herbicides not effective in controlling the weeds without harming the cotton plant
      6) Grass-type weeds effectively controlled and do not affect the cotton plant
   d) Method of application
      1) Some herbicides work well with only certain methods of application.
      2) Not all herbicides work well in a hooded type sprayer.
      3) Follow herbicide label directions.

2. By definition, a weed is any plant growing out of place. In a yard or garden, dandelions are considered weeds. Ask students what weeds are a specific problem in a garden and why that weed grows well in the garden.

What weeds are specific to cotton?

a) Common cotton weeds
   1) Signalgrass
   2) Barnyardgrass
   3) Bermudagrass
   4) Fall panicum
   5) Foxtails
   6) Goosegrass
   7) Jimsonweed
   8) Hemp sesbania
   9) Hophornbean copperleaf
   10) Lambsquarters
   11) Pigweed
   12) Crabgrass
   13) Nutsedge
   14) Johnsongrass
   15) Cockleburs
   16) Morning glory
   17) Velvetleaf
   18) Spurred anoda
   19) Prickly sida
b) Grass-type weeds
   1) Can be controlled with any herbicide that contains floumeturon
   2) Should be applied directly to the soil
c) Broadleaf weeds
   1) More difficult to control
   2) Include velvetleaf, prickly sida, and spurred anoda

3. Once weeds get established in a field, they will impact the crop. Ask students why weeds are removed from a crop, whether cotton or a garden.

What is the effect of weed pressure on cotton yields?

a) Weeds growing in a cotton field
   1) Compete with the cotton for the available nutrients
      (a) Fertilizer
      (b) Water
   2) Results in reduced yield by the cotton plant, less income for the producer
b) Amount of crop loss due to weeds
   1) Varies according to moisture levels
   2) Soil fertility
   3) Cotton's vegetative growth
      (a) Weeds with more leaves and other vegetative growth than the cotton absorb more sunlight.
      (b) Weeds will increase.
      (c) Cotton growth slows.
c) Keeping the weeds out of cotton - especially important just before harvesting
      (a) Keep weed seeds and other weed parts out of harvested cotton.
      (b) Avoid reducing crop value.

4. Controlling weeds in cotton is a complicated process involving a number of production decisions. Ask students how weeds are controlled in their garden. If they respond by saying they pull weeds or use a hoe, ask them why chemicals are not used.

   What weed control options are available?

   a) Different strategies and techniques
      1) Preplanting application of herbicide
         (a) Reduces weeds that would be a problem as the seedling begins to grow.
         (b) Application prior to planting will not impact the cotton.
      2) Burn-down
         (a) Using herbicides to kill growing plants before planting
         (b) Kills plants very quickly, leaving field barren
      3) Just after planting, before the seedling emerges
         (a) Weeds generally emerge from the soil first.
         (b) Applying herbicide after planting will reduce or kill the weed.
   b) After the cotton plant grows
      1) Weed control becomes more difficult.
      2) Grass-type weed herbicide can be sprayed on the cotton plant without any effect.
      3) If broadleaf weed herbicide is used, care must be exercised to avoid spraying the cotton plant.
         (a) May cause injury or death to cotton plant
         (b) Hooded sprayer used to spray between rows
   c) During growing season
      1) Scout the field for weeds.
         (a) Walk through the crop, looking for growing weeds.
         (b) Mark on a map where the weed infestations are found.
         (c) Monitor these areas.
         (d) Spray area when weed infestation becomes serious.
      2) Check between-row cultivation.
         (a) Killing weeds growing between the growing rows of cotton
         (b) Does not remove weeds growing close to the plant rows
   d) Use of transgenic varieties - Use of herbicides developed for transgenic varieties more effectively controls weeds without concern of damage to cotton plant.

F. *Other Activity*

Invite a local crop chemical expert to speak to the class and outline a weed control program for a cotton crop.

G. *Conclusion*

Weeds can be a severe problem in cotton production. Developing a control program is crucial to maximize production and profit. A number of factors should be considered when selecting a weed control program. Applying chemicals to control the weeds is commonly done before planting, post-planting, and between rows. Transgenic varieties are capable of being sprayed with specific weed control chemicals without damaging the crop.

H. *Answers to Evaluation*

1. c
2. a
3. d
4. a
5. b
6. Preplanting, preemergence (post-planting), and hooded (between rows)

UNIT X - COTTON PRODUCTION

Name________________________________

Lesson 4: Selecting a Weed Control Program

Date________________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Applying herbicides directly to cotton is harmful to the cotton because it is ____________________.

   a. A slow growing plant
   b. Shorter than most weeds
   c. A broadleaf plant
   d. Attracted to the herbicides

2. In relation to weed control, knowing what crops were planted in the field the season before is important because __________________________.

   a. Carryover effect of the herbicides used the previous year might affect the cotton
   b. Fewer weeds will be present if there was another crop
   c. Weeds will not return from previous years
   d. Previous fertilizer applications are needed by the cotton

3. There are fewer cotton herbicides available because ____________________________________.

   a. There are less problems with weeds
   b. There is less usage of chemicals by producers
   c. Chemicals used on other crops work very well
   d. Fewer total acres of cotton are planted compared to corn and soybeans

4. Herbicides designed to kill ____________ will not affect cotton.

   a. Grasses
   b. Forbs
   c. Shrubs
   d. Broadleaf weeds

5. Weeds growing in a cotton field will result in lower cotton yields due to _____________________.

   a. Soil erosion
   b. Competition for nutrients
   c. Increased quality of lint
   d. Lower germination rates of the cotton

6. List the three common methods of applying herbicides.

   a.

   b.

   c.

UNIT X - COTTON 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 if replanting is appropriate?**
3. **What amount of weed pressure justifies a herbicide treatment or mechanical removal?**
4. **What amount of insect pressure justifies a pesticide application?**
5. **Why is a growth regulator applied to cotton, and when is it applied?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit X.
2. *Cotton Plant Development and Plant Mapping* (G4268), University Extension, University of Missouri-Columbia.
3. Activity Sheet

   a) AS 5.1: Scouting a Crop

UNIT X - COTTON PRODUCTION

Lesson 5: Scouting and Maintaining the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons have addressed planning the crop, selecting a crop seed variety, tilling and planting the crop, and selecting a weed control program. This lesson will address managing the growing crop and the decisions that must be made while the crop is growing. More so than many other crops, cotton must be carefully monitored and managed throughout the growing season.

B. ***Motivation***

1. Propose to students the following hypothetical situation: The cotton crop is planted, some weed control has been done, and the crop is now 3 weeks old. By looking at the crop, you notice that plant spacing is uneven, weeds are becoming more frequent, and you notice some insect damage. As a producer, you have two options: do nothing, or do something about your crop. What would you decide, and what would you need to consider before making your decision?

2. Show the video *Mid-Season Crop Management*, Part 4 of the Cotton Crop Monitoring for Optimum Management video series, available for loan from the Missouri Resource Center for Career & Technical Education (MRCCTE, formerly MVRC), Ag Video 227, University of Missouri-Columbia.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Once the crop is planted and growing, it is important to monitor the cotton field carefully. Ask students how often they check their family gardens and what they look for. Refer to *Cotton Plant Development and Plant Mapping*, G4268, for detailed information about plant mapping.

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

   a) Factors that should be monitored
      1) Moisture level
         (a) Wilting plant - more water needed
         (b) Avoid overwatering
            (1) Can limit overall growth of the plant
            (2) Decreases amount of oxygen to the plant roots
      2) Plant spacing/density of the crop
         (a) Too closely spaced - competition for limited water and nutrients
         (b) Too widely spaced apart - replanting required
         (c) Emerging of cotton seedlings
            (1) Should emerge in approximately 5 days
            (2) Emerging in 5 days - better chance of survival than a crop that takes longer
            (3) Emerging in 10 days - will probably only produce about 1/3 of the 5-day crop
      3) Existing weeds and stage of growth and development
         (a) Light weed populations
            (1) Control and treatment are probably not necessary.

(2) Observe for changes throughout the growing season.
(b) Heavy weed populations - implement weed control program
4) Insect population
(a) Light insect populations - keep monitoring the crop
(b) Heavy insect populations - consider implementing an insect control program
5) Overall plant health condition - soil fertility issues
(a) Green and healthy plants - soil fertility probably not a concern
(b) Decreasing overall plant health - consider soil testing to determine what plants are lacking
6) Vegetative growth versus reproductive growth
(a) Too much vegetative growth - limit production of cotton lint
(b) Too little vegetative growth - indication of plant stress
b) Scouting program
1) Systematic and regular inspection of the cotton field for insects and their damage
2) Determining various levels of weeds, plant vigor, and water needs
c) Plant mapping
1) Effective technique to keep crop on schedule
2) Quantifies several growth parameters of the cotton plant
3) Measures five plants from four areas of a field
4) Sampling periods - prebloom, bloom, and postbloom

2. Once the plant begins to emerge from the ground, the main concern of producers is the quality of the stand. Ask students what a field should look like as plants begin to emerge. Tell students when answering the question to keep in mind cotton's expected germination percentage.

How does one determine if replanting is appropriate?

a) Quality of stand
1) Not all seeds will grow.
2) Field will still appear uneven due to irregular germination.
b) Determining replanting
1) Ideal seeding for cotton - 3 to 4 plants growing per foot
2) Field average slightly less - replanting probably not appropriate
3) Less than 3 to 4 plants per foot
(a) Consider replanting
(b) Added cost of reseeding
(1) May exceed added income from new plants
(2) Lack new plant growth
(3) Minor damage to existing plants
(4) Plant recovery
c) Replanting decisions - based on economic factors
d) Timing of replant - most important
1) Replant made too late - Crop will not have enough growing days.
2) Second seeding will be a waste of seed, time, and money.
e) Seeding time density
1) Field looks better later in the season when plants produce vegetative growth.
2) Thin spots in the field will not look as thin later.

3. Weeds compete with the cotton plant for nutrients and water. Ask students how they would determine when the weed pressure is out of control and removal by herbicide application or mechanical means is necessary. How would they justify their decision?

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

a) Competition for nutrients and water
1) Competition is particularly harmful during the reproductive stage when the cotton bolls begin filling.

2) When the bolls begin to open - Amount of nutrients needed by the plant diminishes.

b) Factors to consider when eliminating weeds
   1) Weed height in relation to cotton plant height
      (a) Will the herbicide make more contact with the cotton than the weed?
      (b) Will the cotton plant be damaged?
   2) Weed density in relation to cotton density
   3) Impact on cotton plant if mechanically removed
   4) Stunted or diminished vegetative growth

4. As a crop, cotton can be damaged by a number of insects, reducing overall yield or production from 25 to 85%. Ask students what harmful insects they would expect to find around a cotton field and how they would determine when to take action in controlling the insects.

What amount of insect pressure justifies a pesticide application?

a) Determine amount of pest damage in a crop.
   1) Scout fields at least once a week.
   2) Scout more often during flowering stage of the plant.
      (a) Get an accurate estimate of the types and numbers of insects in the field by checking a limited number of the total plants.
      (b) Learn the type, number, and location of insects and damage within a field.

b) Follow field scouting guidelines
   1) At planting
      (a) Place boll weevil traps.
      (b) Set minimum number - 1 trap per 50 acres.
   2) Emergence until the plant makes the third true leaf
      (a) Check for thrips, cutworms, mites, and aphids.
      (b) Make initial stand counts.
      (c) Check boll weevil traps weekly.
   3) Third true leaf until the fifth node stage
      (a) Check terminals (end of plant stems) for eggs, larvae, and weevils.
      (b) Check for damage on plants by plant bugs and weevils.
      (c) Sweep borders of the field for plant bugs.
      (d) Record node height and position of pinhead squares.
   4) Fifth node to first bloom
      (a) Remove and store boll weevil traps.
      (b) Check terminals for eggs and larvae - minimum of 25 plants per field.
      (c) Calculate percent square set - minimum of 25 plants per field.
      (d) Begin sampling 100 green squares per field when 15% of squares reach one-third grown or larger. Check these squares for boll weevil, bollworm, or plant bug damage.
      (e) Assess weekly mean node height and mean number of squares per acre.
      (f) Count number of plant bugs and beneficials per 100 sweeps per field using sweep nets.
   5) Post first bloom
      (a) Pull one-third grown or larger squares for worm and weevil damage counts -100 per field minimum.
      (b) Check top 6 inches of plant for eggs and larvae.
      (c) Check whole plants (10 to 20 per field) for eggs, egg masses, and boll damage.
      (d) Check blooms for weevils, worms, and clouded plant bugs.
      (e) Assess weekly number of squares and bolls per acre.

c) Identify insects that can cause damage to the cotton plant.

d) Identify threshold level for each insect.
   1) Cutworms - cotton plant stand reduced to fewer than three plants per row foot
   2) Thrips
      (a) One or more thrips per plant found on seedling cotton

(b) Extremely hard to find due to size and mobility
(c) Large number of damaged plants

3) Fleahoppers - one plant bug found per 10 feet of row (not usually a problem in cotton in Missouri)
4) Boll weevils
    (a) With traps
        (1) One trap per 10 acres, clustered with other traps (four traps for 40 acres clustered together)
        (2) Threshold - two per trap per week prior to emergence
    (b) Without traps
        (1) 10% of squares damaged the first 2 weeks in July
        (2) 15% of squares damaged in the last 2 weeks of July
        (3) 20% of the squares damaged in August
5) Bollworms - 10% of bolls damaged by moth flight
6) Aphids - low populations start to increase
7) Spider mites - 50% of leaves are infested
8) Clouded plant bugs and Lygus Plant Bug
    (a) 1st week of squaring, 6 to 8 plant bugs per hundred squares
    (b) 2nd week of squaring, 8 to 10 plant bugs per hundred squares
    (c) 3rd week of squaring, 10 to 12 plant bugs per hundred squares
    (d) 4th week of squaring, 15 to 18 plant bugs per hundred squares
    (e) After 4th week squaring, not usually a problem
9) Armyworms - 5 egg masses and live larvae per 100 plants, or 4 or more worms in 100 blooms and bolls
10) Whiteflies - 50% or more of the plants are infested (usually not a problem in Missouri)
11) Root worm nematodes - found in the soil, retesting the soil is necessary

e) Integrated pest management (IPM*)* - use of natural predators of harmful insects to control pests
    1) IMP can reduce the cost of pesticides to the producer.
    2) Beneficial insects tend to be specific to a particular pest insect.
    3) Multiple beneficial insects may be needed and can be purchased (not practical in most cases).
    4) Insects are specifically targeted.
    5) If chemical control is also used, many of the beneficial insects are killed.

5. Cotton's growth is managed using growth regulators. Ask students why cotton's growth is not allowed to progress naturally.

Why is a growth regulator applied to cotton, and when is it applied?

a) Growth regulators
    1) Needed if plant is under stress
    2) Generally necessary because cotton is a semi-tropical plant, not preferring the climates found in cotton producing areas
    3) Speed up the flowering process
    4) Produce a more uniform flowering process
    5) Allow for a more uniform harvesting of the crop
    6) Generally used during early bloom
b) Common growth regulators used in cotton production
    1) PIX (Mepiquat Chloride) - used to shorten plants
    2) Used to help roots develop and bolls set
        (a) PGR IV
        (b) Maxxon
        (c) Cytokin

F. ***Other Activities***

1. Have students participate in scouting a cotton field with a crop consultant or the field's producer.

2. Show the video *Nitrogen and PIX Management*, Part 3 of the Cotton Crop Monitoring for Optimum Management video series, available for loan from the Missouri Resource Center for Career & Technical Education (MRCCTE), Ag Video 226, University of Missouri-Columbia.

G. ***Conclusion***

Cotton is a crop that requires intense management during the growing season. The crop must be regularly evaluated for many different factors, including moisture, plant spacing and stand, insects, and weeds. This can be done through scouting. Careful management of these factors will result in a quality crop, while mismanagement will result in disastrously low yields and crop quality. Finally, cotton growth regulators are used to force the plant to emphasize reproductive development over vegetative development, speeding up the flowering process and making the cotton blooms more uniform.

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

Answers on both sets of questions will vary.

I. ***Answers to Evaluation***

1. b
2. a
3. b
4. c
5. d
6. Four of the following - cutworms, thrips, fleahoppers, boll weevils, bollworms, aphids, spider mites, clouded plant bugs, armyworms, whiteflies, nematodes
7. The use of natural predators of harmful insects to control pests
8. To speed up the flowering process, generally used during early bloom

UNIT X - COTTON PRODUCTION	Name______________________________

Lesson 5: Scouting and Maintaining the Crop	Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Cotton seedlings should emerge from the ground in about ________________ days.

   a. 3
   b. 5
   c. 7
   d. 14

2. What should the producer consider first when deciding to replant the crop?

   a. The economic and financial factors
   b. The crop looks thin
   c. There are only three to four plants per foot
   d. Too many weeds are present

3. Weed pressure on a cotton plant is least desirable when ________________________________.

   a. Bolls are opening
   b. Bolls are filling
   c. Seedlings are beginning to emerge
   d. Bolls are filled

4. The most effective method of determining insect levels in a field is ______________________.

   a. Spraying
   b. Observing plants at the perimeter of the field
   c. Scouting
   d. Plant sampling

5. If using boll weevil traps, there should be at least one trap per _____ acres.

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

Complete the following short answer questions.

6. List four common insect problems in cotton.

   a.

   b.

   c.

   d.

7. What is integrated pest management (IPM)?

8. When and why are growth regulators used on cotton?

Lesson 5: Scouting and Maintaining the Crop Name________________________________

Scouting a Crop

Objective: Students will be able to identify insect problems in a cotton crop.

Materials needed:

Sweep nets
Clipboards
Insect identification resources

Procedure:

In this activity, you will be scouting a growing cotton crop with a local producer. Before actually scouting the crop, ask the producer the following questions and record your answers.

1. What insects have you had problems with in the past?

2. What do you expect to find in today's scouting?

3. How often do you scout your fields?

4. What control program do you use on insects?

After obtaining these answers, go into the field with the producer and scout the field. Using your sweep nets, collect insects from the field. With the producer and your instructor's assistance, identify and count the number of insects you collected. Once identified and collected, answer the following questions.

1. What insects were found and how many?

2. Are these levels high enough to warrant insect control (producer input!!)?

3. Are these conditions normal for this part of the growing season?

UNIT X - COTTON 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 is the most common method of harvesting cotton?**

3. **What are the major reasons for crop loss during harvest?**

4. **What is a short-term storage method before ginning?**

References

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

2. Activity Sheet

    a) AS 6.1 Evaluating Harvested Cotton

UNIT X - COTTON PRODUCTION

Lesson 6: Harvesting the Crop

TEACHING PROCEDURES

A. ***Review***

Previous lessons have addressed scouting and maintaining the crop, weed control programs, tilling and planting the crop, selecting a variety, and planning the crop. This lesson will focus on those issues relevant to harvesting the cotton crop and management decisions made at harvest time during the growing season.

B. ***Motivation***

1. Once again, compare the cotton crop to a garden crop. Ask students how they determine when to pick or harvest crops from a garden. Then ask students if they harvest the garden on the same date each year, and if not, what causes the variations from year to year.

2. Show the video *Late Season Crop Management*, Part 5 of the Cotton Crop Monitoring for Optimum Management video series, available for loan from the Missouri Resource Center for Career & Technical Education (MRCCTE, formerly MVRC), Ag Video 228, University of Missouri-Columbia.

3. Show the video *Crop Management for Defoliation*, Part 6 of the Cotton Crop Monitoring for Optimum Management video series, available for loan from MRCCTE, Ag Video 229, University of Missouri-Columbia.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Knowing when to harvest the cotton crop is an important management decision. Ask students what factors they think will determine when cotton is harvested. Then ask students if all plants are at the same level of maturity when harvested.

What factors determine harvest timing?

a) Cool weather and frost
   1) Speeds up cotton harvesting
   2) Causes leaves to fall off the plant - defoliation
   3) Reduces the amount of trash and green leaf stain in the harvested lint
      (a) Chopped-up leaves
      (b) Vegetative parts of the plant
b) Chemicals
   1) Defoliate plants
   2) Called crop harvest aids
   3) Suppress further growth
   4) Help open the cotton bolls
c) Defoliation timing
   1) Crucial to ensure ideal lint quality and optimum yield
   2) Applications timed so harvesting keeps up with defoliation
   3) Defoliating too early

(a) Reduces the oil content of the seed
(b) Reduces seed viability
(c) Reduces total yield
4) Defoliating too late
(a) May result in diminished results
(b) Defoliating compounds - more effective in warmer temperatures
5) Typically done when at least 60% of the bolls are open
(a) Sprayed directly onto the plants
(b) Correct timing of defoliation
(1) Plant mapping techniques
a. Analyze and record the growth of the plant.
b. Apply defoliant when plant has at least four nodes above the lowest cracked boll or boll starting to show visible lint.
c. Number of nodes decreases to three in fields where there are less than two plants per foot per row.
(2) Number of nodes above the white flower (NAWF)
a. NAWF occurs at or near the eighth or ninth node.
b. NAWF of five occurs around August 10 to 12 and indicates correct timing for defoliation.
6) Generally takes the boll approximately 4 to 6 weeks or 750 to 850 heat units to mature
7) Other factors determining defoliation timing
(a) Firmness of the boll
(b) Percent of open bolls
(c) Seed coat coloration
(d) Heat unit accumulation
(e) Visual assessment
d) Harvesting of the cotton crop
1) Once-over method
(a) All cotton bolls are harvested at the same time.
(b) This method results in reduced cost in time, fuel, labor.
2) Two-harvest method
(a) Early harvest of ready bolls
(b) Later harvest of the rest of the bolls
(c) More expensive but potential return may justify cost

2. There are several methods of harvesting cotton. Ask students to list historical methods of harvesting cotton in our country and how that has changed in today's cotton production.

What is the most common method of harvesting cotton?

a) Machines to harvest cotton
1) Mechanical cotton picker
(a) It is used in most areas of the United States.
(1) Pulls the fiber from the boll
(2) Removes the trash and lint
(3) Cuts the fibers away from the seeds
(4) Ginning process - removes and processes seeds
(b) Row-crop harvester harvests each row separately.
(c) Picker is limited in width.
(d) Two row pickers are usually used together.
2) Cotton stripper
(a) Used in areas of Oklahoma and Texas where stalks do not grow very tall
(b) Plucks the entire boll
(c) All bolls - open
(d) Stem destroyed - unopened bolls lost
b) Issues of harvesting cotton

1) Moisture
   (a) Harvest when dew leaves field.
   (b) Stop when dew returns in evening.
   (c) Moisture content lower than 12% can be harvested and stored without mold damage.
2) Measuring moisture
   (a) Moisture monitor on machine
   (b) Biting cotton seed - if seed cracks, moisture low enough to harvest

3. As with harvesting any crop, reducing crop loss is an important consideration. Ask students where crop loss could occur in the harvesting process.

   What are the major reasons for crop loss during harvest?

   a) Improper cotton picker condition
      1) Worn or damaged spindles
      2) Misalignment and misadjustment of the spindles to moisture pads and doffers
         (a) Reduces the efficiency of the picker
         (b) Results in crop loss
      3) Improperly adjusted spindles
         (a) Leaves some of the cotton on the spindle
         (b) Twists and damages the fibers
   b) Excessive trash
      1) Incomplete defoliation resulting in leaves taken into the picker with the lint
      2) Picking units and basket grates should be cleaned regularly of trash

4. Once the cotton is harvested, the lint is usually stored for a short time before ginning. Discuss with the students how the lint is commonly stored.

   What is a short-term storage method before ginning?

   a) Modules
      1) Storage for short periods of time before ginning
      2) Bundled lint, covered with water-resistant tarps
      3) Stored in the field
   b) Monitoring moisture content
      1) If too high, internal temperature will begin to rise.
      2) Rapid and continuous rise indicates too much moisture.
         (a) Rise of 15 to 20 degrees - gin as soon as possible
         (b) Internal temperature of module exceeds 110°F - gin immediately
   c) Storage location
      1) In a field relatively free of gravel, stalks, and other debris
      2) On well-drained sites accessible during wet weather

F. ***Other Activity***

Arrange for students to observe a local producer harvesting cotton. In addition to the harvesting process, observe modules and their placement.

G. ***Conclusion***

After spending a growing season managing the cotton, the final step in the production of cotton is harvesting. Carefully plan defoliation and harvesting. Observe the bolls to determine the proper time to harvest. If careful management is practiced, an optimal quality crop is harvested, resulting in optimal income for the producer.

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

Answers will vary.

I. ***Answers to Evaluation***

1. a
2. c
3. d
4. Cotton picker and cotton stripper
5. Biting the cotton seed - if the seed cracks, the moisture is probably low enough for the crop to be harvested

6. a. Worn or damaged spindles
   b. Misalignment and misadjustment of the spindles to moisture pads and doffers
   c. Excessive trash in the lint

7. Modules are bundled lint, covered with water-resistant tarps, stored in the field.

8. Monitor moisture levels in modules during the first 5 to 7 days.

UNIT X - COTTON PRODUCTION

Name______________________________

Lesson 6: Harvesting the Crop

Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. The removal of leaves from the plant is called ____________________.

   a. Defoliation
   b. Deleafing
   c. Delimbing
   d. Harvesting

2. Defoliation is typically done when _________% of the bolls are open.

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

3. Once defoliation occurs, the bolls need another _________________ weeks to mature and fully open.

   a. 2 to 4
   b. 4 to 6
   c. 5 to 7
   d. 6 to 8

Complete the following short answer questions.

4. Name two common types of mechanical cotton harvesters used today.

   a.

   b.

5. Describe how to determine correct moisture content of the crop without a moisture monitor.

6. List three major causes of crop losses during harvest.

   a.

   b.

   c.

7. Explain what modules are.

8. In what time period should moisture content levels be monitored in harvested cotton?

Lesson 6: Harvesting the Crop Name______________________________

Evaluating Harvested Cotton

Objective: Students will evaluate harvested cotton and identify possible corrective measures to improve the quality of the cotton.

Directions: Examine cotton from a module that has been recently harvested.

Procedure:

1. From the module, select a small sample of cotton to evaluate.
2. Examine your sample of cotton. Look for uniformity, trash, gravel, and any other foreign material.
3. Compare your sample with several of your classmates' samples.
4. After evaluating the samples, answer the following questions.

Questions to consider:

1. What faults or defects (if any) did you find in the cotton samples?

2. What are possible causes of these faults?

3. What management recommendations would you make to the producer?

UNIT X - COTTON PRODUCTION

Lesson 7: Marketing the Crop

Competency/Objective: Describe marketing opportunities.

Study Questions

1. **What procedures are used in marketing cotton?**

2. **How does cotton quality affect price?**

3. **What are cotton checkoff dollars and how are these funds collected and used?**

References

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

2. Activity Sheet

   a) AS 7.1: Cotton Quality and Effect on Price

UNIT X - COTTON PRODUCTION

Lesson 7: Marketing the Crop

TEACHING PROCEDURES

A. ***Review***

This lesson will address the common methods used to market cotton. Previous lessons have discussed cotton harvesting, scouting and maintenance, weed control, tilling and planting, selecting a variety, and planning the crop.

B. ***Motivation***

Compare raw cotton with cotton that has been processed. Ask students to compare the quality of each sample. Ask the students to list possible factors affecting the quality of the cotton and the price received.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Agricultural crops are sold in many different ways. Ask students to list the major methods other crops are sold and compare with how cotton is sold.

What procedures are used in marketing cotton?

a) Schedule a gin
   1) Call the local processor
   2) Negotiate
      (a) Transportation of the modules
      (b) Schedule time
      (c) Price
   3) Deliver and process cotton
b) Pricing
   1) Cash market pricing
      (a) Relies strictly on the current market price
      (b) Cotton prices generally lowest during harvest due to the excess supply
   2) Forward pricing
      (a) Contracting crop
         (1) Contracted before the actual processing and delivery
         (2) Sale price firmly established, does not reflect fluctuations in the cash market at harvest time
         (3) Disadvantages
            a. Market moves upward to higher prices - only negotiated price received
            b. Crop disasters or failures - purchase cotton to meet the contract
      (b) Hedging (futures market)
         (1) Sells contracts, or a set quality and quantity of cotton
         (2) Buys the same number of contracts back later, hopefully at a lower price, to get out of the futures market
         (3) Allows the producer to use basis (difference between futures and cash price)
         (4) Involves great risks

2. The price established at the point of sale on any agricultural product is dependent upon the quality of the crop. Cotton price is particularly dependent upon quality. Ask students to identify factors that would determine cotton quality. Complete AS 7.1 to expand the students' knowledge of the importance of cotton quality. If a field trip is not possible, obtain samples of cotton that has been graded and have the students compare the differences.

How does cotton quality affect price?

a) Standards are established by the USDA.
    1) Ensure uniformity in grade
    2) Resulting in standard quality and pricing
b) Cotton quality is measured in a variety of ways.
    1) Color grade - the degree of whiteness and yellow in the lint
        (a) White
        (b) Light-spotted
        (c) Spotted
        (d) Tinged
        (e) Yellow-stained
    2) Fiber length - measured by computerized machines
        (a) Given in thirty-seconds and hundredths of an inch
        (b) Longer fibers - more desirable
            (1) More efficient in spinning
            (2) Stronger
            (3) More uniform yarn
    3) Cotton fiber diameter or fineness - determined by using micronaire measurements
        (a) Yarn appearance
        (b) Yarn uniformity
        (c) Yarn strength
        (d) Finer diameters - preferable
    4) Fiber strength
        (a) Relative to the variety of cotton raised
        (b) Reported in grams per tex - equal to the weight in grams of 1,000 meters of fiber
        (c) Relates to yarn and fabric strength
        (d) Affects spinning efficiency
    5) Length uniformity - uniformity of the length of the fibers in a sample
        (a) Related to uniformity of the yarn
        (b) Affects spinning efficiency
        (c) Involved overall yarn strength
    6) Trash - amount of debris on the surface of the cotton
        (a) Measurement taken with a video trashmeter
        (b) Highly undesirable

3. Like other crops, cotton is supported by money from the federal farm bill. Ask students if they know what checkoff dollars are and how they are used.

What are cotton checkoff dollars and how are these funds collected and used?

a) Origins
    1) U.S. Farm Bill
    2) First inclusion in the Farm Bill of 1967
b) What they are
    1) Funds raised from sale of cotton in the United States
    2) Set amount of money charged against the sale each time cotton is sold
    3) Funds collected by a controlling agency
    4) Funds administered by U.S. Cotton Board

c) Funds used
   1) Advertise and market cotton
      (a) Help cotton compete with artificial fibers
      (b) Maintain and expand domestic and foreign markets
   2) Research
      (a) Develop seed varieties
      (b) Develop herbicides and pesticides
      (c) Develop methods of processing

F. ***Other Activity***

While conducting the student activity sheet, also tour the gin to provide students with additional information about cotton processing.

G. ***Conclusion***

Once the cotton crop has been harvested, the final step in completing the year's crop cycle is marketing. Marketing determines the income for the producer and directly impacts his or her profit. Raw cotton is scheduled for a gin and processed according to schedule. The price received for the cotton depends upon the cotton quality that is measured by color, length, diameter or micronaire, strength, amount of trash in the lint, and uniformity of the cotton fiber. The cotton checkoff program strives to develop and maintain cotton markets domestically and internationally with a small amount of money taken out from each individual sale.

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

Answers will vary.

I. ***Answers to Evaluation***

1. a
2. b
3. c
4. c
5. b
6. Affects yarn appearance, uniformity, strength
7. At the time of sale, as a percentage of the value of the crop sold
8. Promotion of the cotton industry, enhance and maintain cotton markets, research

UNIT X - COTTON PRODUCTION | Name______________________________

Lesson 7: Marketing the Crop | Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What type of market relies strictly on the current market price?

   a. Cash market
   b. Futures market
   c. Forward pricing
   d. Hedging

2. What type of market allows the producer to agree to a price before the actual sale?

   a. Cash market
   b. Forward pricing
   c. Futures market
   d. Hedging

3. What market relies on the buying and selling of contracts?

   a. Cash market
   b. Forward pricing
   c. Futures market
   d. Contract market

4. What do micronaire measurements on cotton determine?

   a. Color
   b. Trash content
   c. Fiber diameter
   d. Fiber length

5. When evaluating cotton quality, one tex is equal to the weight in grams of ________ meters of fiber.

   a. 500
   b. 1000
   c. 1500
   d. 2000

Complete the following short answer questions.

6. Give three reasons cotton fiber diameter is important.

   a.

   b.

   c.

7. How are cotton checkoff dollars assessed?

8. What is the purpose of the cotton checkoff program?

Lesson 7: Marketing the Crop Name______________________________

Cotton Quality and Effect on Price

Objective: Students will determine the quality of cotton from procedures performed by the cotton grader.

Directions: As a field trip, go to a cotton gin and observe the cotton being graded. Fill in the following blanks with information gained from observing and asking the cotton grader questions about cotton samples.

Procedure:

In the spaces provided, determine the following cotton quality factors by asking the cotton grader to describe grading results associated with the following factors. How do those factors impact the cash price for the particular cotton module or lot?

Factor	**Grader's comments**
Color	
Fiber length	
Micronaire/diameter of fiber	
Strength of fiber	
Length uniformity	
Trash	

Questions to consider:

1. Of the factors listed, which most negatively affected the price of that sample?

2. Which factors were very good on the sample?

3. What impact did these factors have on the overall price of the cotton?

UNIT X - COTTON PRODUCTION

Lesson 8: Figuring Crop Costs

Competency/Objective: Calculate cost per acre.

Study Questions

1. **What variable costs are associated with cotton production?**
2. **What fixed costs are associated with cotton production?**
3. **How is cost per acre calculated?**
4. **What factors determine an acceptable return on an investment?**
5. **How do government programs affect return?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia. Instructional Materials Laboratory, 2000, Unit X.
2. Activity Sheet
   a) AS 8.1: Figuring Cost per Acre for Cotton

UNIT X - COTTON PRODUCTION

Lesson 8: Figuring Crop Costs

TEACHING PROCEDURES

A. ***Review***

Previous lessons have addressed planning the crop, selecting a variety, tilling and planting the crop, selecting a weed control program, scouting and maintaining the crop, harvesting the crop, and marketing the crop. This lesson will address the financial aspects of producing a cotton crop.

B. ***Motivation***

Review with students the grading and processing steps discussed in the previous lesson. From these factors, students should recognize the impact on price due to the various quality factors. Then ask students how they can determine if a profit was made from that price.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. A good manager of any crop should have accurate and detailed records of all income and expenses concerning the whole farm and each individual crop. Ask students to list costs they would pay <u>only</u> if the crop was actually produced.

   What variable costs are associated with cotton production?

   a) Variable costs
      1) Inputs necessary to produce a specific crop yield
      2) Calculated on a cost-per-acre basis
         (a) Allows producers to realize a profit or loss from a particular field
         (b) Helps producers to decide if another crop should be considered for a particular field
   b) Cotton variable costs
      1) Seed costs
         (a) Seeding rate
         (b) Number of times the field was seeded
         (c) Seed variety purchased
            (1) "Older" varieties are less expensive.
            (2) Newer, transgenic varieties are more expensive.
         (d) Quality of cotton produced by the particular variety
      2) Fertilizer costs
         (a) Costs vary depending on field conditions.
         (b) Soil tests should be taken to determine need.
         (c) Use test recommendations to estimate costs.
      3) Crop chemicals costs recorded separately to realize exact expenses for each
         (a) Insecticides
            (1) Significant insect problems dramatically add to the total variable costs.
            (2) Thorough scouting program and timely applications reduce costs.
         (b) Herbicides
            (1) Costs vary from field to field.
            (2) Weed problems are determined at the same time as insect scouting.
            (3) Applications are timed to gain production value and control costs.

(c) Fungicides
  (1) Generally only applied before or at seeding time
  (2) Occasionally warrant another application to growing crop
(d) Growth regulators
  (1) Used to control the vegetative growth
  (2) Speed up plant blooming
  (3) Helps retain bolls
  (4) Number of applications
    a. Depends on crop management plans and the weather
    b. Costs figured into variable costs of crop
(e) Harvest aids
  (1) Defoliants - used to chemically remove the leaves from the plant
  (2) Boll openers - force uniform opening of the bolls
  (3) Usually applied once
  (4) Critical to short-season production
  (5) Combination use can save $30/acre using once-over harvest

4) Fuel and oil costs
  (a) Keep records of all fuel and oil used in crop operations.
  (b) Divide costs by the number of acres determines the cost per acre.
  (c) Other regular maintenance of machinery should also be figured.

5) Cost of labor
  (a) Include costs of hired labor.
    (1) Crop consultants or scouting services
    (2) Other hired services
  (b) Include producer's own time into the costs.
  (c) Recognize producer's time is worth as much, or more, than hired services.

6) Harvesting cost
  (a) Cost should be included whether using the producer's machinery or hiring someone else's.
  (b) Include wear and tear and any needed repairs on producer's machinery.

7) Ginning the cotton
  (a) Ginning costs are generally charged to the producer by weight, not acreage.
  (b) An average yield should be determined.
  (c) Divide the total cost of ginning by the number of acres. Method does not allow them to know the costs per field.
  (d) Transporting the cotton from the field to the gin is included in the ginning fee.

8) Storing cotton
  (a) Raw or ginned cotton is stored until later dates to maximize profits.
  (b) Crop may diminish in value due to storage.

9) Operating loan expenses
  (a) Crop income - only once or a few times a year
  (b) Interest on borrowed money - considered a variable cost

10) Other costs incurred due to producing the crop - also variable costs

2. Variable costs are what first come to mind when people consider the costs of an agricultural operation, but there are also fixed costs. Ask students what costs a producer would have to pay even if a crop was not produced.

What fixed costs are associated with cotton production?

a) Fixed costs
  1) Does not vary with the level of production
  2) Generally regarded as whole farm, or whole enterprise costs
  3) Not normally charged on a per-acre basis
  4) Divided by the number of acres
  5) Can amount to more cost per acre than variable costs
b) Examples of fixed costs

1) Taxes
   (a) Must be paid regardless of production
   (b) Most obvious type - property taxes
2) Insurance
   (a) Carried on the entire operation
   (b) Liability insurance
   (c) Fire insurance
   (d) Hail/disaster insurance
   (e) Earthquake or hurricane insurance
3) Loan payments
   (a) Money borrowed to purchase land or machinery
   (b) Must be made regardless of production
4) Rental fees
   (a) Equipment or land
   (b) Rental charges - still paid even if crop not produced
5) Farmstead utilities
   (a) Electricity
   (b) Sewer
   (c) Water
   (d) Other services used on the farmstead
   (e) At times utilities are a variable expense
6) Depreciation expense
   (a) Depreciation is the decline in value of a piece of machinery or other equipment due to wear, tear, usage, or aging.
   (b) Money should be set aside in a bank account yearly so the machine can eventually be replaced with a new model.
   (c) Provide for later equipment replacement.

3. After figuring fixed and variable costs, calculating total costs is relatively simple. Ask students how the information regarding total costs is used.

How is cost per acre calculated?

a) Total cost value
   1) Total fixed plus variable costs
   2) Gives total amount of money spent on the crop
   3) Not useful to determine break-even price for crop
b) Cost per acre
   1) Divide the total cost by the number of acres planted.
   2) Determine the break-even price.
      (a) Divide cost per acre by total pounds produced per acre.
      (b) Determine an acceptable return on investment.

4. Once the income and expenses are known, the producer can calculate a profit or loss from the crop or the whole farm. With agricultural prices lower than most producers would like, a determination must be made as to an acceptable level of profit. Ask students how they would determine an acceptable level of return.

What factors determine an acceptable return on an investment?

a) Return on investment
   1) Money received above costs and used for farmstead improvements or investments
   2) Commonly used as profit - supports the farm family through the coming year
   3) Overall return on investment - support the family and its lifestyle
b) Several factors to consider
   1) Money borrowed to produce the crop - return on investment needs to cover the cost
   2) Consider alternative uses for the money compared to investing in a growing crop

3) Alternative crop - raise return on investment
   (a) If another crop has lower costs and a higher income, producer may need to switch.
   (b) If a switch is being considered, the producer must reconfigure expenses.
4) Exceptions
   (a) First cotton crop
      (1) One season may not be enough to evaluate the return on investment accurately.
      (2) Succeeding years may result in higher returns on investment.
   (b) Abnormal weather conditions
      (1) Drought year
      (2) Following years - closer to normal
      (3) Return on investment higher

5. Cotton is impacted by governmental regulations and subsidies. Discuss with the students how governmental policy and programs affects a crop.

   How do government programs affect return?

   a) Cotton production in the Farm Bill
      1) Designed to increase production and competition with foreign markets
      2) Addresses increased production and paying producers to raise more cotton to compete with foreign markets
   b) Producers enrolled in the cotton program
      1) Receive an incentive payment from the government
      2) Increases overall crop income

F. ***Other Activity***

Obtain sample financial information from a cotton producer (keep his or her identity anonymous). Review the information with the students, calculate fixed and variable costs, income, and return on investment. Determine the financial status of that operation's cotton enterprise.

G. ***Conclusion***

Once the crop has been harvested, some financial analysis is important to determine the success or failure of that year's crop. Determining the acceptable return on the investment will compare the return to interest rates, return from other possible crops, and other factors. Government programs increase the income of the cotton enterprise, with payments made to encourage producers to grow cotton.

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

Answers will vary according to local data.

I. ***Answers to Evaluation***

1. a
2. a
3. d
4. b
5. d
6. Dividing total cost by the number of acres
7. Money received by the producer above costs, which can be used for farmstead improvements or investments

8. Three of the following: sufficient to cover cost of borrowing money, alternative investments giving higher return, alternative crop, first crop, abnormal weather conditions

UNIT X - COTTON PRODUCTION

Name_______________________________

Lesson 8: Figuring Crop Costs

Date_______________________________

Evaluation

Circle the letter that corresponds to the best answer.

1. What are costs that are associated with inputs used to produce a specific yield of crop?

   a. Variable
   b. Fixed
   c. Long term
   d. Growing

2. What are seed costs considered?

   a. Variable cost
   b. Fixed cost
   c. Long term cost
   d. Growing

3. What is the most commonly overlooked cost when calculating costs of a crop?

   a. Fertilizer
   b. Growth regulators
   c. Crop chemicals
   d. Labor

4. What type of cost are taxes, insurance, rent payments, and depreciation?

   a. Variable
   b. Fixed
   c. Long term
   d. Growing

5. What is the term for a decline in value of an asset due to wear, tear, usage, and becoming out-of-date?

   a. Amortization
   b. Aging
   c. Declination
   d. Depreciation

Complete the following short answer questions.

6. How would cost per acre be calculated?

7. What is return on investment?

8. List three factors to consider when determining acceptable return on investment.

   a.

   b.

   c.

Lesson 8: Figuring Crop Costs Name______________________________

Figuring Cost per Acre for Cotton

Objective: Students will calculate the cost per acre from a sample set of data collected on a cotton crop.

Directions: Determine variable, fixed, and total costs for a cotton crop, using data provided by your instructor. This data represents a typical crop in your community, using local prices. This problem will be calculated using a field that has _____ acres.

Variable Costs	Price per Unit	Total Cost
Seed		
Fertilizer		
Insecticides		
Herbicides		
Fungicides		
Growth regulator		
Defoliant		
Fuel and oil		
Labor - total hours		
Harvesting cost		
Ginning		
Grading		
Storage		
Interest on borrowed money		
Amount Borrowed	__________	
Length of Loan	__________	
Interest Rate	__________	
Total Variable Cost		__________ **Total Cost**

Fixed Costs

Taxes

Insurance

Loan payments

Land rental

Equipment rental

Utilities

Depreciation expense

Total Fixed Costs ___________

Total Costs (total variable costs + total fixed costs) ___________

Cost per Acre (total costs / number of acres) ___________

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 <u>different</u> 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 <u>unsuccessful</u> 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.

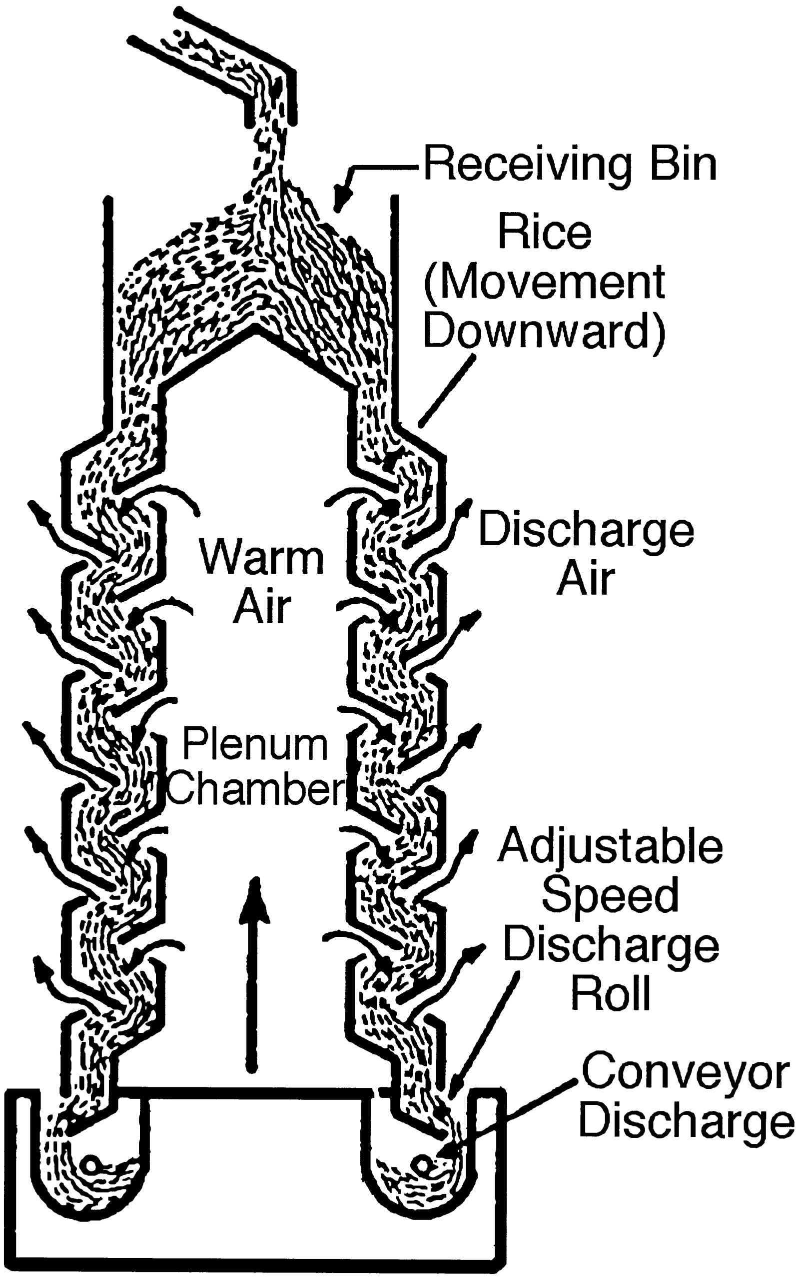
   a.

   b.

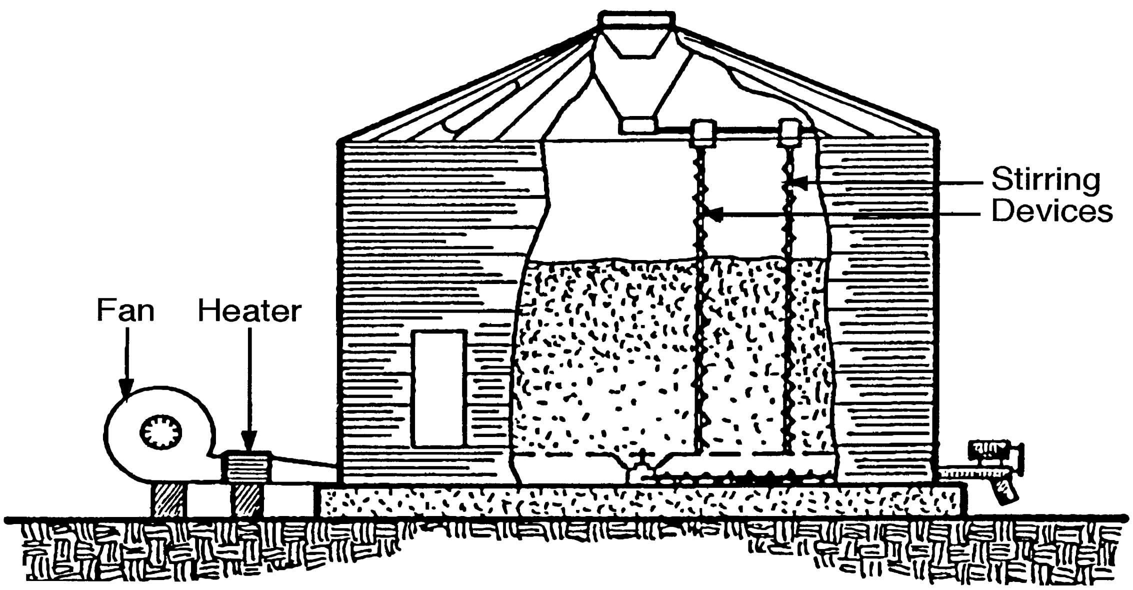
   c.

   d.

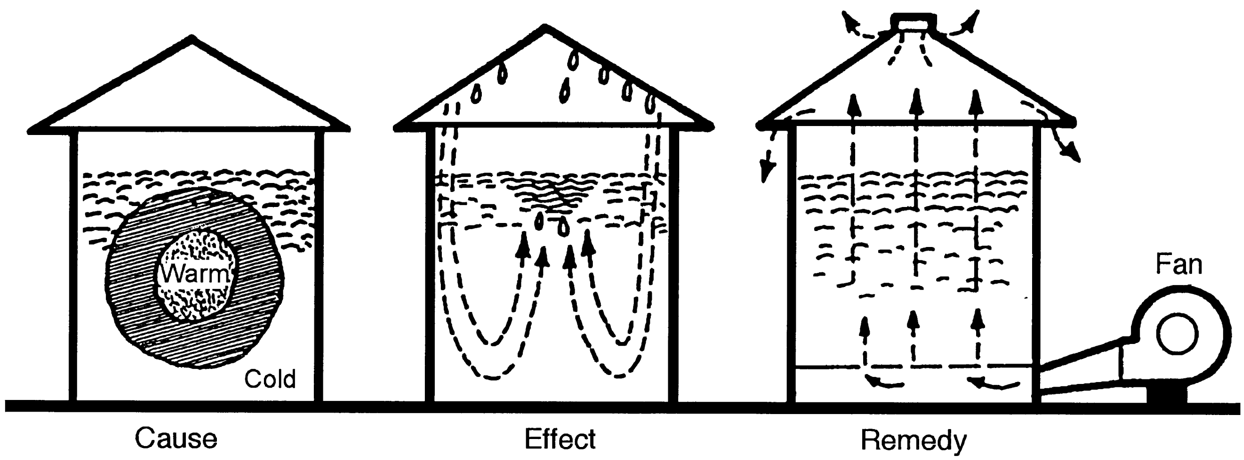
Continuous Flow Commercial Dryer



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				