

Unit A: General Agricultural Machinery

Lesson 3: Recognizing the Impact of Technology Advances in Agricultural Mechanics

Student Learning Objectives:

Instruction in this lesson should result in students achieving the following objectives:

1. Explain the early development of mechanical technology in agriculture.
2. Explain the importance of the internal combustion engine to agriculture.
3. Discuss the advances in the design and use of agricultural structures and farm electrification.
4. Explain the concepts of precision farming and site specific crop management.

Recommended Teaching Time: 1 hour

Recommended Resources: The following resources may be useful in teaching this lesson:

- Johnson, Donald M., et.al. *Mechanical Technology in Agriculture*. Danville, Illinois: Interstate Publishers, Inc., 1998. (Textbook, Chapter 1)
- Burke, Stanley R., and T.J. Wakeman. *Modern Agricultural Mechanics*. Danville, Illinois: Interstate Publishers, inc., 1992. (Textbook)
- Cooper, Elmer L. *Agricultural Mechanics Fundamentals & Applications*. Albany, New York: Delmar Publishers, 1997. (Textbook)
- Lee, Jasper S., and Diana L. Turner. *AgriScience*, Third Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook)
- Phipps, Lloyd J., et al. *Introduction to Agricultural Mechanics*, Second Edition. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2004. (Textbook)

List of Equipment, Tools, Supplies, and Facilities:

- Writing surface
- PowerPoint projector
- PowerPoint Slides
- Transparency Masters
- Copies of student worksheets

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slides 2, 3, 4, and 5):

- Leonard Andrus
- J.I. Case
- Combine
- Cradle scythe
- John Deere
- Design function
- Geographic Information Systems (GIS)
- Global Positioning Systems (GPS)
- Internal combustion engine
- Landsat
- Cyrus McCormick

- Mechanical reaper
- Charles Newbold
- Precision farming
- Plow
- Remote sensing
- Scoured
- Sickle
- Site specific crop management (SSCM)
- Variable Rate Technology (VRT)

Interest Approach:

Ask your students “What are some major inventions of the past 200 years?” “Which are related to agriculture?” List the suggestion on the chalkboard. Tie in the suggestions with the lesson’s objectives.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Explain the early development of mechanical technology in agriculture.

Anticipated Problem: What effect did the early developments of mechanical technology have on agriculture?

(PowerPoint Slides 6, 7, 8, 9, and 10)

- I. Getting enough land to farm was not normally a problem for farmers in the early 1800s. The limiting factor was the lack of available labor. The farmer could barely produce enough food for himself and his family. To become more productive, farmers had to find ways to extend their capacity to do work. In the beginning of the 19th century with the development of machines, the farmer was able to increase production with the reduction of human energy. These early machines used animal power to replace human power. Later in that century, steam and the development of the internal combustion engine replaced animal power. The evolution of two machine types, the plow and grain harvesting equipment, can be traced as examples of technological innovations and advancements that revolutionized production agriculture.

(PowerPoint Slides 11, 12, 13, and 14)

- A. The plow was first patented by **Charles Newbold** in 1797. A **moldboard plow** is an implement used to break or turn soil in preparation for planting. This first plow was one-piece and made of cast iron. The plow faced several problems. Many farmers of the time thought the cast iron would contaminate the soil. Also, it did not perform well in breaking the soil. Many people tried to improve the design. In 1837, a blacksmith began making steel plows from saw steel and wrought iron. This man’s name was **John Deere**. Deere’s plow worked very well on tough soil. One of the plow’s greatest characteristics was that it **scoured** (self-cleaned) very well. Deere formed a partnership with **Leonard Andrus** and began producing steel plows.

(PowerPoint Slides 15, 16, 17, 18, 19, 20, and 21)

B. The technological advancements in the equipment to harvest grain were much more dramatic than those in the development of the plow. Until the 1800s, the traditional tools for harvesting were the sickle and the cradle scythes. The **sickle** is a sharp, curved metal blade fitted with a short handle. While the **cradle scythe** is a hand-held implement with a long curved blade attached to a long, bent handle. The mechanical reaper was not developed until the 1830s. It was one of the most significant farming inventions of the 19th century. The **mechanical reaper** was an implement that was used for cutting and gathering a crop. This machine reduced the amount of time and labor needed to harvest by more than one-half. **Cyrus McCormick** patented the first horse-drawn reaper. In the 1850s, **J.I. Case** began to manufacture and sell a "**combine**"—combination thresher-separator-winner—that threshed the grain, separated it from the straw, and removed the chaff. Again, this machine greatly reduced the time a labor needed as well as crops lost during harvest.

Use the information from previous lessons on history to tie the information of the objective to other events in history. Use TM: 3-1 and TM: 3-2 to discuss the average labor requirements for growing wheat and corn.

Objective 2: Explain the importance of the internal combustion engine to agriculture.

Anticipated Problem: How has the internal combustion engine been important to agriculture?

(PowerPoint Slides 22, 23, 24, 25, 26, and 27)

II. In the late 19th century, a tractor powered by an internal combustion engine was developed. An **internal combustion engine** converts the chemical energy from fuel into heat energy, which is converted into mechanical power. The first tractors were simply an engine bolted to a wheeled, steel frame. The tractor quickly became the preferred power source of the farmer. Tractors, trucks, and self-propelled machinery powered by the internal combustion engine revolutionized agriculture. Almost all aspects of today's agricultural production utilize the internal combustion engine in some way. The main reason for the success of the internal combustion engine was that it provided a reliable, efficient and mobile source of power.

Use TM: 3-3 to discuss how the use of internal combustion engines has changed over the years. Relate other inventions to the times shown in the table.

Objective 3: Discuss the advances in the design and use of agricultural structures and farm electrification.

Anticipated Problem: What are some of the advances in the design and use of agricultural structures and farm electrification?

(PowerPoint Slides 28, 29, and 30)

III. Early farm structures were constructed for only one purpose. They were made to shelter livestock and equipment. The only building materials were those available locally. Structures were all of similar design. There was also no way for the farmer to control the internal environment of the structure. Today's modern structures differ in many ways.

(PowerPoint Slides 31, 32, and 33)

A. Modern structures have become specialized. Very seldom are general-purpose structures built. When designing a structure, the producer first determines what the design function of the building will be. A **design function** is the purpose for which a structure has been created. Internal environments can now be controlled. This give the producer added control over the quality of the goods and products he/she sells.

(PowerPoint Slides 34 and 35)

B. Electricity has had an impact on agriculture equal to or greater than that of the internal combustion engine. Electric power has replaced much of the labor required. Although electricity has been a relatively recent addition to agriculture, the expansion of electrical technologies has been quite rapid.

Discuss how buildings built for use in livestock production and those for crop production differ. Also discuss how electricity is used and what the benefits of using electrification in agricultural structures are.

Objective 4: Explain the concepts of precision farming and site specific crop management.

Anticipated Problem: What is precision farming and site specific crop management?

(PowerPoint Slides 36, 37, and 38)

IV. **Site Specific Crop Management (SSCM)** involves using technology to apply the correct amount of appropriate inputs to crops, to apply that amount to a specific field location, and to apply inputs to cost-effectively produce a crop. The many advances in agricultural mechanics have allowed such operations to occur. There are many separate components that all work together to allow a producer to use SSCM. They are:

(PowerPoint Slides 39, 40, 41, 42, and 43)

A. Precision farming—Precision farming is using cropping practices that improve yield based on the needs of the land. As part of this system, fields are subdivided into small areas based on the information gathered by harvest results, soil testing, and satellite systems. This

information is then used to determine the kinds and amount of inputs to be applied to the subdivision of land. The goal of precision farming is to apply seed, fertilizer, and agricultural chemicals only where they are needed and only in the amounts needed. It has been said that precision farming is farming by the foot rather than by the field.

(PowerPoint Slides 44, 45, and 46)

B. Remote sensing—**Remote sensing** involves gathering and recording data from a great distance. Most remote sensors are on satellites some 800 kilometers above the earth. **Landsat** is the term used to describe the United States satellite system that makes photographs of the earth and plots the earth's resources. These photos are used to make maps. Remote sensing is beneficial in forecasting the weather, locating natural resources, detecting crop disease, and protecting the environment.

(PowerPoint Slides 47, 48, 49, 50, 51, and 52)

C. Geographic Information Systems (GIS)—The **Geographic Information System (GIS)** partitions fields into grids and then maps them for physical attributes per grid segment. Individual maps can be made for fertility, pesticide residues, soil type and texture, drainability, and water holding capacity, and the previous year's yield data. These maps are then used by the producer to make management decisions regarding application rates of fertilizers and other agricultural inputs. The satellite system used to gather this information is called the **Global Positioning System (GPS)**. GPS was first developed as a defense system. The basic concept behind it is satellite ranging or triangulation. Positions on the earth are determined by measuring the distance from a group of satellites in space.

(PowerPoint Slides 53 and 54)

D. Variable Rate Technology (VRT)—Using the information gathered with the Geographic Information Systems, the producer is able to vary the rate of application of all production inputs. This capability is called **Variable Rate Technology**. VRT allows for the rate of these inputs to be varied as the application equipment is traveling across the field. The ability to do this is key to gaining the full benefits of site specific crop management systems.

Ask students “What other normal day technology exist?” “How do we use GPS everyday?” Discuss with students the agricultural implications of this technology as well as nonagricultural implications.

Review/Summary: Use the student learning objectives to summarize the lesson. (PowerPoint Slides 55 and 56) Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the end of the chapters in the textbook may also be used in the review/summary.

Application: Application can involve the following student activity:

Invite an employee from a local fertilizer and chemical dealership to speak to your students on how they use site specific crop management. If available, allow students to use the global positioning system to create a map of the school grounds.

Evaluation: Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1. G
2. F
3. A
4. E
5. D
6. C
7. B
8. H

Part Two: Completion

1. Tractors
2. Landsat
3. Animal
4. Scoured

Part Three: Short Answer

1. It provided a reliable, efficient, and mobile source of power.
2. Precision farming, remote sensing, geographic information systems, and variable rate technology

Recognizing the Impact of Technological Advances in Agricultural Mechanics

Name: _____

Matching: Match each word with the correct definition.

- | | |
|-------------------------------|-----------------------------|
| a. Charles Newbold | e. design function |
| b. Leonard Andrus | f. precision farming |
| c. cradle scythe | g. remote sensing |
| d. internal combustion engine | h. variable rate technology |

- _____ 1. Involves gathering and recording data from a great distance.
- _____ 2. Is using cropping practices that improve yield based on the needs of the land.
- _____ 3. Earned the first patent for the plow.
- _____ 4. The purpose from which a structure has been created.
- _____ 5. Converts the chemical energy from fuel into heat energy, which is converted into mechanical power.
- _____ 6. Hand-held implement with a long curved blade attached to a long, bent handle.
- _____ 7. Formed a partnership with John Deere to produce steel plows.
- _____ 8. Allows for the rate of these inputs to be varied as the application equipment is traveling across the field.

Fill-in-the-blank: Complete the following statements.

1. The first _____ were simply an engine bolted to a wheeled, steel frame.
2. _____ is the term used to describe the United States satellite system that makes photographs of the earth and plots the earth's resources.
3. Early machines used _____ power to replace human power.

4. One of John Deere's plow's greatest characteristics was that is _____ well.

Short Answer: Answer the following questions.

1. What was the main reason for the success of the internal combustion engine?

2. List the key components of the site specific crop management system.

LABOR REQUIREMENTS TO PRODUCE WHEAT USING TYPICAL PRODUCTION SYSTEM OF THE PERIOD

Date	Man-Hours/ hectare	Man-hour/ bushel	Average yield (bushel/ hectare)	Production System
1830	50-60	2.5-3	20	Walking plow, brush for harrow, hand broadcast of seed, side and flail
1895	80-10	0.4-0.5	20	Gang plow, seeder, harrow, binder, thresher, wagons and horses
1932	3-4	0.15-0.2	20	3-bottom gang plow, tractor, 3-meter tandem disc, harrow, 3.7-meter combine, trucks
1968	1.5	0.05	30	Tractor, 3.7-meter one way plow, 4.3-meter drill, 4.3-meter self-propelled combine, trucks
1990	0.25	0.007	35	4-wheel drive tractor, 15-meter field cultivator, 11-meter drill, 7.3-meter self-propelled combine, trucks

LABOR REQUIREMENTS TO PRODUCE CORN USING TYPICAL PRODUCTION SYSTEMS OF THE PERIOD

Date	Man-Hour/ hectare	Man-Hour/ bushel	Average Yield (bushel/ hectare)	Production System
1750	60-70	3-3.5	20	Till with hoe, cultivate with hoe, hand plant, hand harvest
1894	14-16	0.35-0.4	40	Horse-drawn 2-bottom gang plow, disc, peg-tooth harrow, 2-row planter, hand harvest
1932	6-8	0.15-0.2	40	Horse-drawn 2-bottom gang plow, 2-meter tandem disc, 4-section harrow, 2-row planter, cultivator, 2-row picker
1965	1-2	0.0125-0.025	80	5-bottom plow, 4.6-meter tandem disc, 8-row cultivator, 8-row planter, 4-row combine
1990	0.5-1	0.005-0.01	100	4-wheel drive tractor, 10-bottom plow, 7.3-meter tandem disc, 16-row planter, 8-row corn combine

ADOPTION OF INTERNAL COMBUSTION ENGINE POWERED TRACTORS AND TRUCKS ON FARMS IN THE UNITED STATES; 1910-1988

Date	Tractors (thousands)	Horsepower (millions)	Trucks (thousands)
1910	1	Na	0
1920	246	10	139
1930	920	25	900
1940	1567	42	1045
1950	3394	93	2207
1960	4688	153	2834
1970	4619	203	2984
1980	4780	304	3377
1988	4609	Na	3437