Lesson

Recognizing the Impact of Technological Advances in Agricultural Mechanics

Interest Approach

"What are some major inventions of the past 200 years?"

"Which are related to agriculture?"

Student Learning Objectives

- 1. Explain the early development of mechanical technology in agriculture.
- 2. Explain the importance of the internal combustion engine to agriculture.

Student Learning Objectives

- 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.

Terms

- 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

Terms

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

Objective: 1

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

Agricultural Technology

- Getting enough land to farm was not normally a problem for farmers in the early 1800's.
- The limiting factor was the lack of available labor.
- The farmer could barely produce enough food for himself and his family.

Agricultural Technology

- 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 a reduction of human energy.

Agricultural Technology

- 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.

Labor Requirements to Produce Wheat Using Typical United States Production Systems of the Period

Date	Man-Hr/ac	Man-Hr/bu	Average Yield (bu/ac)	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, 10-foot tandem disc, harrow, 12-foot combine, trucks.
1968	1.5	0.05	30	Tractor, 12-foot one way plow, 14-foot drill, 14-foot self-propelled combine, trucks.
1990	0.25	0.007	35	4-wheel drive tractor, 50-foot field cultivator, 36-foot drill, 24-foot self-propelled combine, trucks.

Source: USDA

Labor Requirements to Produce Corn Using Typical United States Production Systems of the Period

Date	Man-Hr/ac	Man-Hr/bu	Average Yield (bu/ac)	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, 7-foot tandem disc, 4-section harrow, 2-row planter, cultivator, 2-row picker.
1965	1–2	0.0125–0.025	80	5-bottom plow, 15-foot 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, 24-foot tandem disc, 16-row planter, 8-row corn combine.

Source: USDA

Agricultural Technology

- 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.

The Plow

- First patented by Charles Newbold in 1797.
- A 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

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 on the design.

- In 1837, a blacksmith in Illinois began making steel plows from saw steel and wrought iron.
- This man's name was John Deere.
- Deere's plow worked very well on the tough Midwestern soil.

John Deere's Plow

- 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 his steel plows.

Harvesting Equipment

- The technological advancements in 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.

Harvesting Equipment

- The sickle is a sharp, curved metal blade fitted with a short handle.
- The cradle scythe is a hand-held implement with a long curved blade attached to a long, bent handle.
- The mechanical reaper was an implement that was used for cutting and gathering a crop.

Harvesting Equipment

- The mechanical reaper was not developed until the 1830s.
- It was one of the most significant farming inventions of the 19th century.

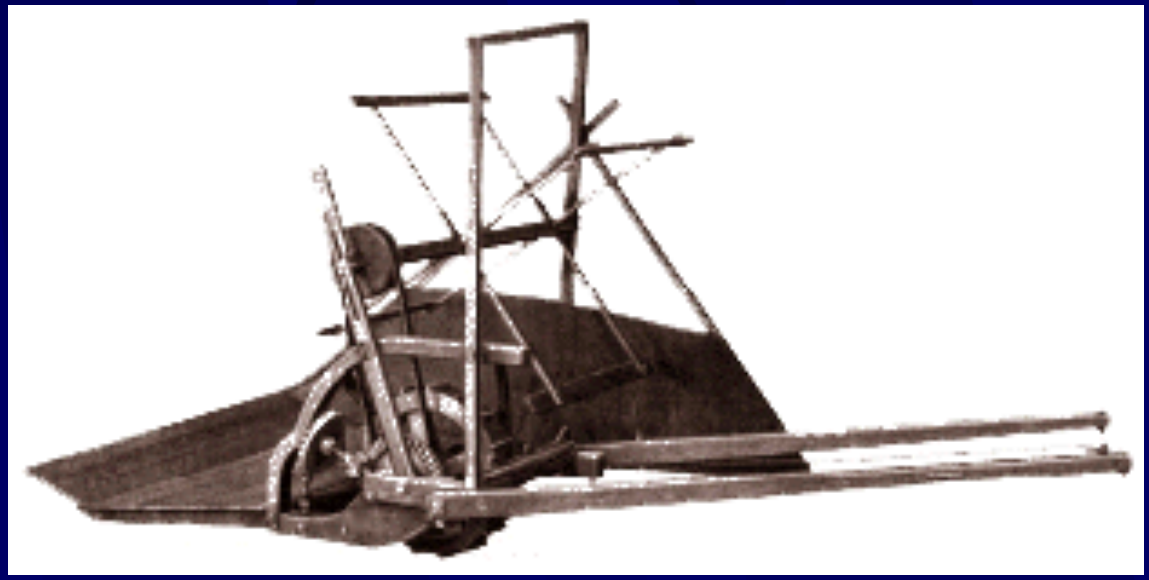
Harvesting Equipment

- 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.

Harvesting Equipment

- Cyrus McCormick patented the first horse-drawn reaper.



Harvesting Equipment

- In the 1850s, J.I. Case began to manufacture and sell a “combine” – combination thresher-separator-winnower – that threshed the grain, separated it from the straw, and removed that chaff.

Harvesting Equipment

- Again, this machine greatly reduced the time and labor needed as well as crops lost during harvest.

Objective: 2

How has the internal combustion engine been important to agriculture?

Internal Combustion Engine

- 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.

Internal Combustion Engine

- The first tractors were simply an engine bolted to a wheeled, steel frame.
- The tractor quickly became the preferred power source of the farmer.

Early Tractor

Internal Combustion Engine

- Tractors, trucks, and self-propelled machinery powered by the internal combustion engine revolutionized American agriculture.

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

Internal Combustion Engine

- Almost all aspects of today's agricultural production utilize the internal combustion engine in some way.

Internal Combustion Engine

- The main reason for the success of the internal combustion engine was that it provided a reliable, efficient and mobile source of power.

Objective: 3

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

Agriculture Structures

- 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.

Agriculture Structures

- 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.

Agriculture Structures

- Modern structures have become specialized.
- Very seldom are general-purpose structures built.

Agriculture Structures

- When designing a structure, the producer first determines what the design function of the building will be.

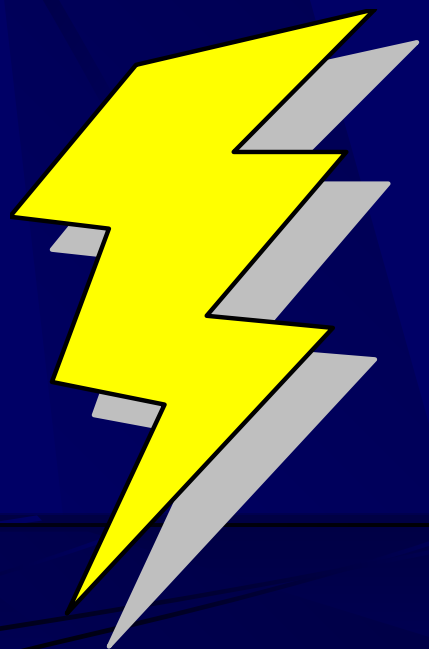
- A design function is the purpose for which a structure has been created.

Agriculture Structures

- Internal environments can now be controlled.
- This gives the producer added control over the quality of the goods and products he/she sells.

Electricity

- Although electricity has been a relatively recent addition to agriculture, the expansion of electrical technologies has been quite rapid.



Electricity

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Objective: 4

What is precision farming and site specific crop management?

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.

Site Specific Crop Management (SSCM)

- 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

Precision Farming

- Precision farming is using cropping practices that improve yield based on the needs of the land.

Precision Farming

- As part of this system, fields are subdivided into small areas based on the information gathered by harvest results, soil testing, and satellite systems.

Precision Farming

- This information is then used to determine the kinds and amount of inputs to be applied to the subdivisions of land.

Precision Farming

- The goal of precision farming is to apply seed, fertilizer, and agricultural chemicals only where they are needed and only in the amounts needed.

Precision Farming

- It has been said that precision farming is farming by the foot rather than by the field.

Remote Sensing

- Remote sensing involves gathering and recording data from a great distance.
- Most remote sensors are on satellites some 500 miles above the earth.

Remote Sensing

- 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

- Remote sensing is beneficial in forecasting the weather, locating natural resources, detecting crop disease, and protecting the environment.

Geographic Information Systems (GIS)

- The Geographic Information System (GIS) partitions fields into grids and then maps them for physical attributes per grid segment.

Geographic Information Systems (GIS)

- 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.

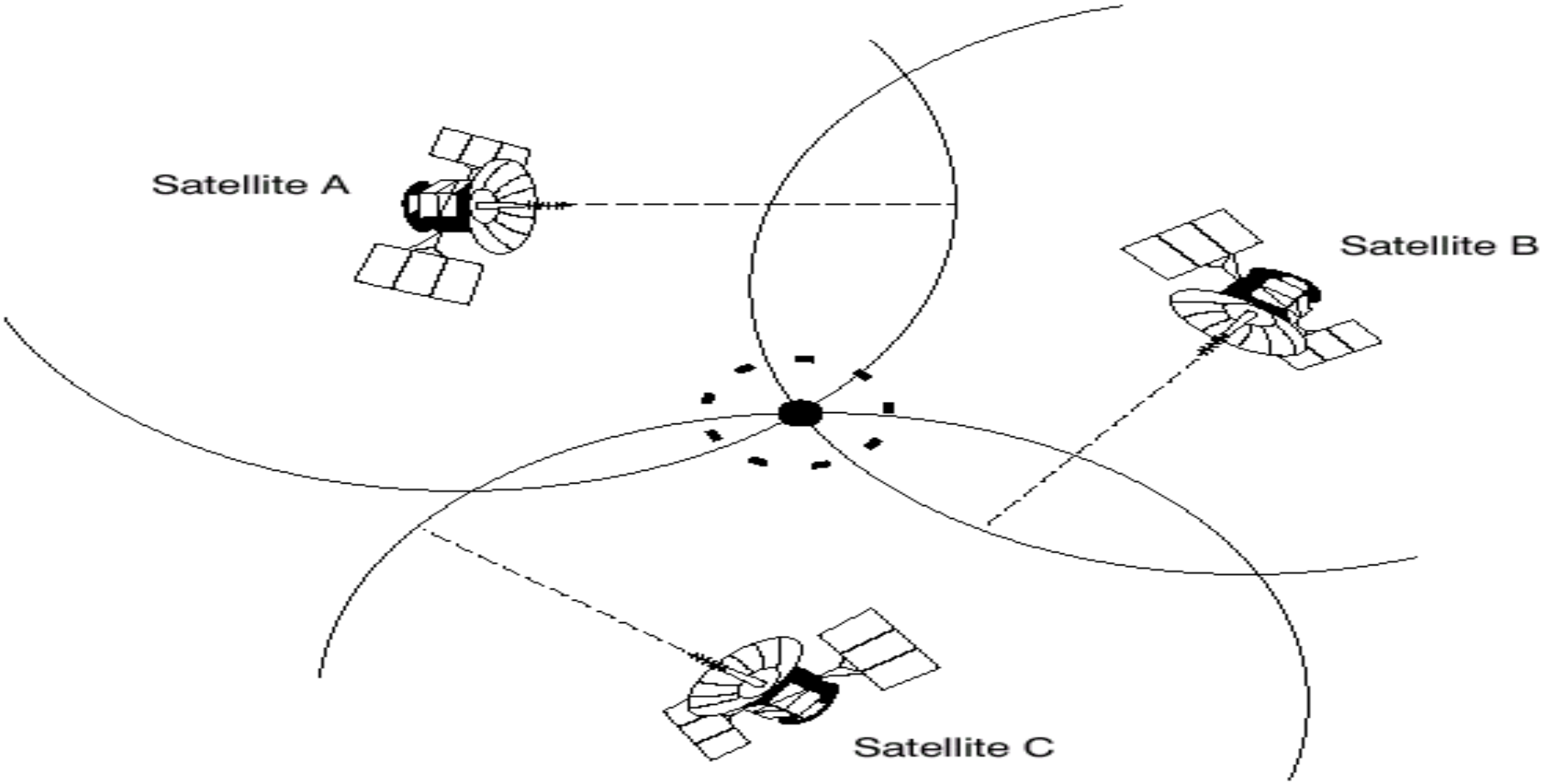
Geographic Information Systems (GIS)

- These maps are then used by the producer to make management decisions regarding application rates of fertilizers and other agricultural inputs.

Geographic Information Systems (GIS)

- 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.

Triangulation



Geographic Information Systems (GIS)

- Positions on the earth are determined by measuring the distance from a group of satellites in space.

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.

Variable Rate Technology (VRT)

- 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.

Review

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- 2. Explain the importance of the internal combustion engine to agriculture.

Review

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