Lecture 32
Agricultural Scientific Revolution: Mechanical

An enormous number of mechanical advances are inherent in the development of agriculture. In addition, the power driving these mechanical advances have shifted from humans, to animals, to water, to steam, and to oil-derived fuels.

Development of Hand Weeders

Two primitive Egyptian hoes form the Middle Kingdom

Soil preparation by hoeing; from a Tomb at Ti at Saqqara, ca. 2400 BCE

January

Wielding primitive hoes, a couple cultivates its fields in the rain. Another farmer sits before a fire and keeps a sharp eye out for crop robbers.
In a symbolic ceremony, the Inca emperor and noblemen turn over the first earth in a sacred field, while three women bow and the empress offers corn beer.

Plowing and hoeing; from a tomb at Beni Hasan, ca. 1900 BCE.

Note that the plow is essentially a large hoe dragged through the soil.

Two handled Egyptian plow

The symbol above the plow is the ancient pictorial word symbol for the plow.
History of Horticulture: Lecture 32

Mesopotamian Plows

Plow from Assyrian bas-relief, 670 BCE. Note the funnel which allowed seed to be added to the furrow during plowing.

Babylonian scratch plow with seed drill.

Greek Plows

Cretan plow

Scratch plow, a sharp pointed hard-wood pulled by oxen.
A = draught pole, B = draught beam, C = stock, D = stilt, E = handle.

Medieval Plows

Light plow with mould-board from an English 14th century bible. Note the donkey in the plow team of oxen.
Woodcut of an early English heavy plow with mould-board from the 14th century

Plough with iron ploughshare and coulter, in a 14th Century Flemish miniature

De Limbourg Brothers: The Month of March (detail) from Les Très Riches Heures du Duc de Berry

Farming in France, 1735
Plowing, broadcast sowing by hand, and harrowing in the seed
Symmetrical wooden plough with an iron ploughshare in use in 1787

Ilja Repin: *The Ploughman Tolstoy in the Fields*

Note how closely the 19th century Russian plows resemble the plows of antiquity.

Horse-drawn plow 1933

Tractor drawn three-bottom Oliver plow, 1918

Egyptian Irrigation Technology
Hand watering of cabbage seedlings in Sumatra 1973

Assyrian Dam of rough masonry and mortared rubble, curved to withstand the flow of the river Khosr about Nineveh

Raising water from the river with shaduf by Assyrians. Three men operate a double lift. The shadufs, on mud uprights, stand at two levels on the river bank, and in front of each a brick platform is built out into the river for the men who fill and empty the buckets. From the palace of Sennacherib at Nineveh, Mesopotamia 7th century BCE.
An Egyptian terracotta figurine from about 30 BCE showing a man driving an Archimedes screw as a treadmill.

A fresco recovered from a villa in Pompeii showing a man driving an Archimedes screw as a treadmill.

An Egyptian farmer turning an Archimedes screw by hand to irrigate a field.
Archimedes screws pump wastewater in a treatment plant in Memphis, Tennessee, USA. Each of these screws is 96 inches (2.44 m) in diameter and can lift 19,900 gallons per minute.

A Persian water wheel powered by a man’s legs.

Three water-lifting technologies, water-wheel, Archimedes screw, and shaduf in a park in Düsseldorf, Germany.
The hydraulic ram is an interesting pump that uses water power to move water to a greater height.

Roman Aqueducts

Caesarea, Israel  Acco

Furrow Irrigation

Furrow irrigation from an Inca garden  Furrow irrigation from a Renaissance garden
Furrow irrigation, Persian miniature

Furrow irrigation using a pump, 1571

Pinto beans furrow-irrigated with water from a feeder canal lined with concrete. Note siphons

Contour furrows (potato) can be used if slopes are carefully controlled
Sprinkler irrigation is practical as a result of portable, lightweight, aluminum pipe. The sprinkler pattern must be overlapped by about 40% in order to achieve uniform application of water.
Concept of drip irrigation from Louis XI garden of 1470

The Chapin System of trickle irrigation for greenhouse watering uses weighted valves (left) to deliver water to individual pots (right)

Trickle irrigation systems used in the field
The wet zone around the roots of a tree or a plant irrigated by the drip method.

Emitters have been designed to equalize water distribution under different water pressures.

Harvesting Technology

Gathering

Paleolithic representation of honey gathering

Women gathering grain 5000-6000 BCE, Tassili n’ Ajjer, Algeria

Modern reconstruction of a Neolithic sickle.
Harvesting in Ancient Egypt

1. Tending vines, from a XIII century miniature
2. Hand Harvest
   - Cutting grain with scythes
   - Harvesting wheat with a cradle
   - The woman binds the sheaves, twisting the stalks of wheat like twine
The 1851 reaper

The twine binder (1881) reaped and tied sheaves of grain in one operation

Wheat harvest in El Centro, California

Hand picking cotton. A family of 11 harvests a bale of cotton (500 lb) in a day. With a modern four-row, mechanical cotton picker, one person can now harvest 80 bales a day.
The mechanical cotton picker is the most sophisticated present day farm machine.

Mechanical Harvesting of Tomatoes

Over the Row Harvesters
History of Horticulture: Lecture 32

Milling

Saddle quern and rubbing stone
Basalt and limestone, 7000 BCE

Mortar and pestle
Basalt, 1500 BCE

Circular millstones
Basalt, 1500 BCE

Using a grindstone in a Bedouin village
in the Syrian Jezireh

Presses

Egyptian Wine Presses
Ancient olive press, Israel

Medieval olive press, Portugal
Guercino, Allegory of winemaking, ca 1626
Cider press, 1900s

Rack and cloth press, late 20th century

Continuous cider press, 1990s

Packing Fruit

Packing Figs, 1900 BCE

Packing apples in a barrel, ca 1900
Spraying Orchards

Orchard speed sprayers use a blast of air as the carrier for highly concentrated sprays.


**History of Horticulture: Lecture 32**

**Controlled Environment Horticulture**

Specularium of The Roman Emperor Tiberius


**Orangery**

Orangery, 17th century Dutch “stove” for protecting oranges

Moving pot plants from orangery, 1730
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<th><strong>Cold Frames and Greenhouses</strong></th>
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<td>Cold frame for protecting plants, Gohelin tapestry 18th century</td>
<td>Humphrey Reptan’s forcing garden for Woburn Abbey, 18th century</td>
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<td>The Wardian case made transport of live plants by ship safer and easier</td>
<td>Climatron, Shaw Botanical garden, St. Louis, Missouri</td>
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<td>Inside plastic greenhouse 1980s</td>
<td>Muskmelons grown under plastic tunnels, Lower Galilee, Israel</td>
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Abu Dhabians and their camels stroll by controlled environment greenhouses, which use seawater for heating, cooling, and irrigation.

Growing lettuce in a phytotron researching the growth of plants in space.

Moving Plants

Tree spade, 1960s

Turf Cutting

Colonial lawn mower

First lawn mower, 1830
### 1920s

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<th>Description</th>
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<td>1920s</td>
<td>Conventional home gasoline lawn mower</td>
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<td>Greens mower</td>
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### Rolling Turf

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<td>1757</td>
<td>Rolling Turf 1757</td>
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### Rolling Turf

- Image 1: Rolling Turf 1757
- Image 2: Person using a roller to flatten the grass
Cutting Sod

Newly developed liquid mulch sod planter (LMSP), 2000

Robotics

Transplanter

Grafting