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.

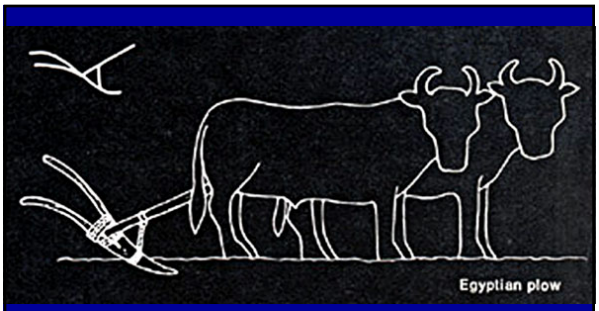
August

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

Egyptian Plows

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

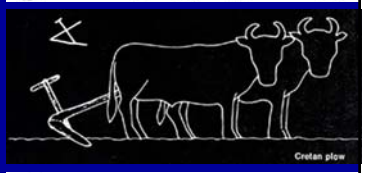
Mesopotamian Plows

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

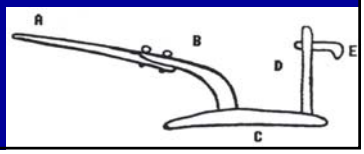
Babylonian scratch plow with seed drill

Greek Plows

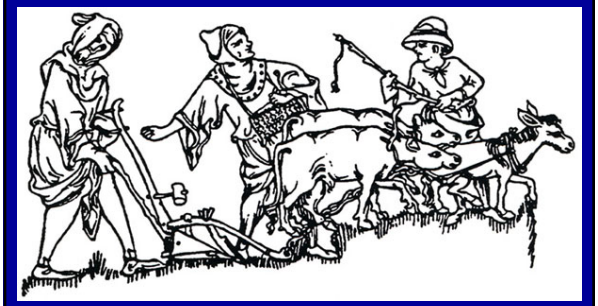
Cretan plow



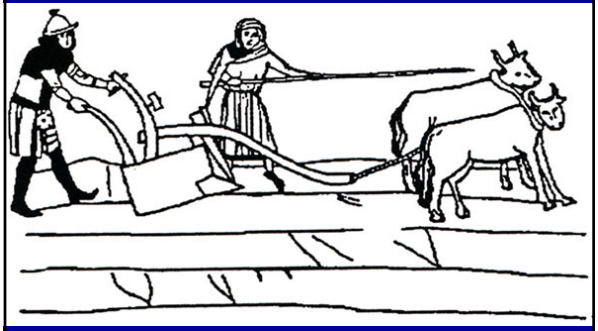
Scratch plow, a sharp pointed hard-wood pulled by oxen
A = draught pole, B = draught beam, C = stock, D = stilt, E = handle



Medieval Plows

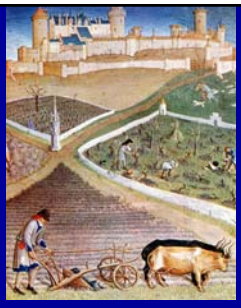


Light plow with mould-board from an English 14th century bible. Note the donkey in the plow team of oxen



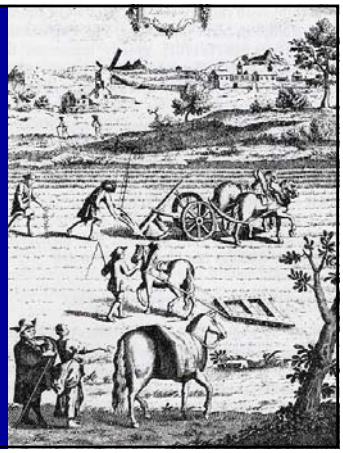
Woodcut of an early English heavy plow withmould-board from the 14th century

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



18th and 19th Century Plows

Symmetrical wooden plough with an iron ploughshare in use in 1787

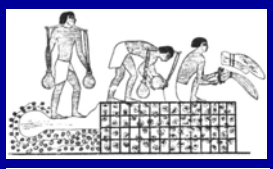
Iljà Repin: *The Ploughman Tolstoy in the Fields*
Note how closely the 19th century Russian plows resemble the plows of antiquity

20th Century Plows

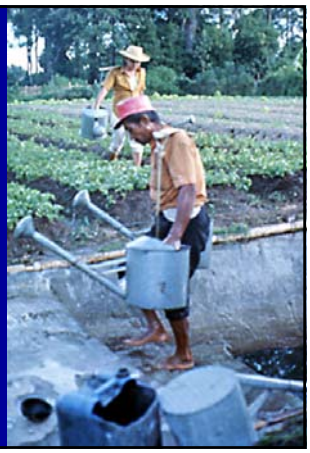
Horse-drawn plow 1933

Tractor drawn three-bottom Oliver plow, 1918

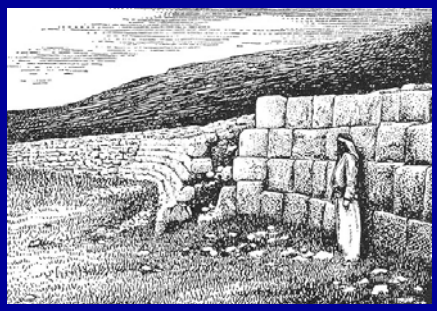
Irrigation Technology Egyptian



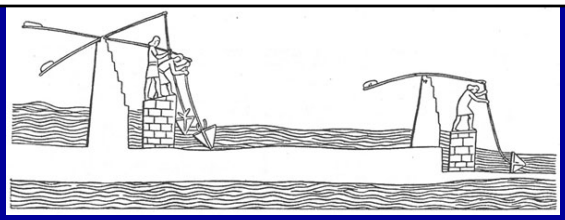
Hand watering of cabbage seedlings in Sumatra 1973



Assyrian



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.

Archimedes Screw

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

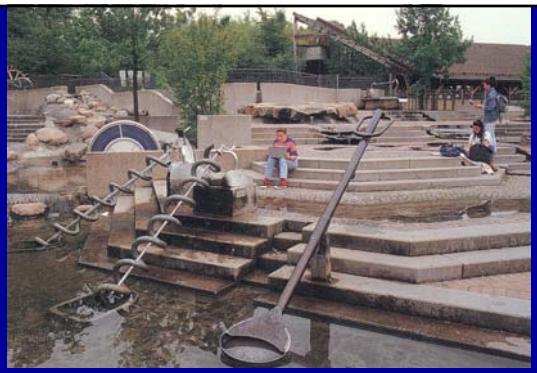
National Museum in Naples, Italy

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

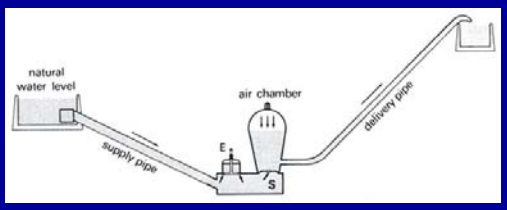
Sakeih (Wheel of Pots)

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

Hydro Ram



The hydraulic ram is an interesting pump that uses water power to move water to a greater height

Roman Aqueducts

Caesaria, Israel

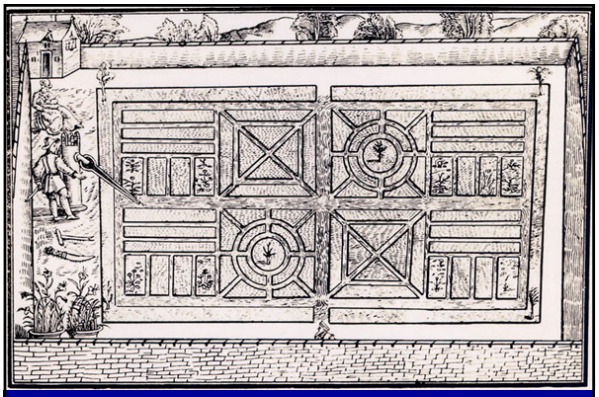
Acco

Furrow Irrigation

Furrow irrigation from an Inca garden

Furrow irrigation from a Renaissance garden

Furrow Irrigation, Persian miniature

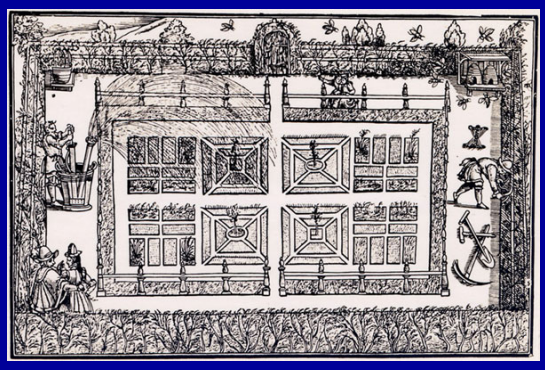


Furrow irrigation using a pump, 1571

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



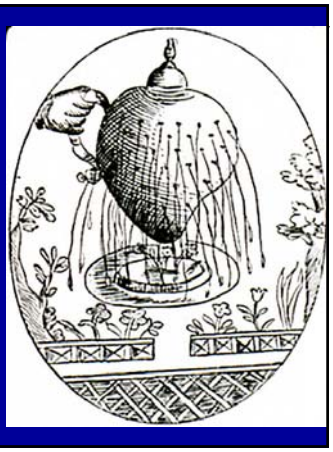
Watering with pump and sprinkler, 1571

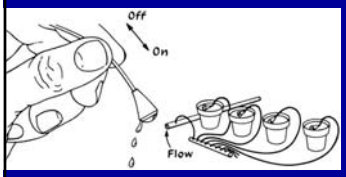
Sprinkler irrigation is practical as a result of portable, lightweight, aluminum pipe.
The sprinkler pattern must be overlapped by about 40% in order to achieve uniform application of water.

Pivot irrigation of cotton in Mississippi

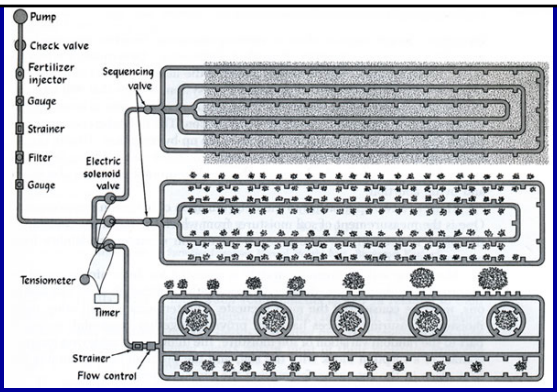
Trickle Irrigation

Concept of drip irrigation from Louis XI garden of 1470



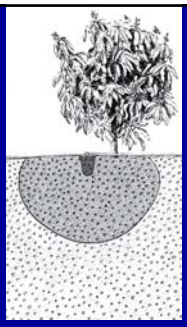


The Chapin System of trickle irrigation for greenhouse watering uses weighted valves (left) to deliver water to individual pots (right)

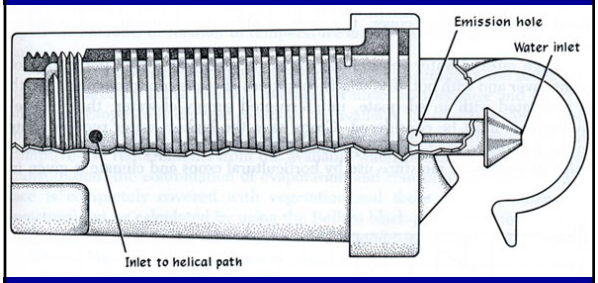


Trickle irrigation systems used in the field

Trickle irrigation in Israel, 1975



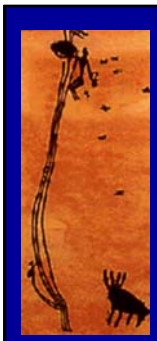
The wet zone around the roots of a tree or a plant irrigated by the drip method



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

Harvesting Technology

Gathering

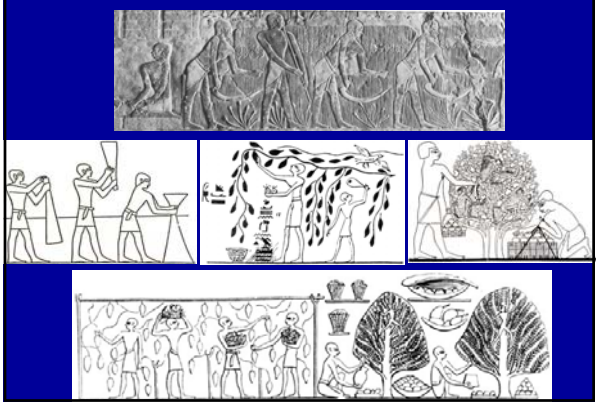


Paleolithic representation of honey gathering

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

Modern reconstruction of a Neolithic sickle

Harvesting in Ancient Egypt



Hand Harvest

Tending vines, from a XIII century miniature

Cutting grain with scythes

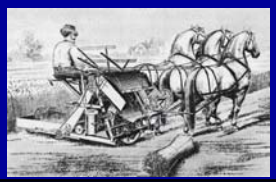
Harvesting wheat with a cradle

The woman binds the sheaves, twisting the stalks of wheat like twine

Development of the Reaper

Cyrus McCormick's first reaper, 1831

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

Milling

Saddle quern and rubbing stone
Basalt and limestone, 7000 BCE

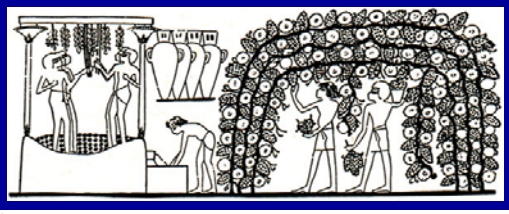
Mortar and pestle
Basalt, 1500 BCE

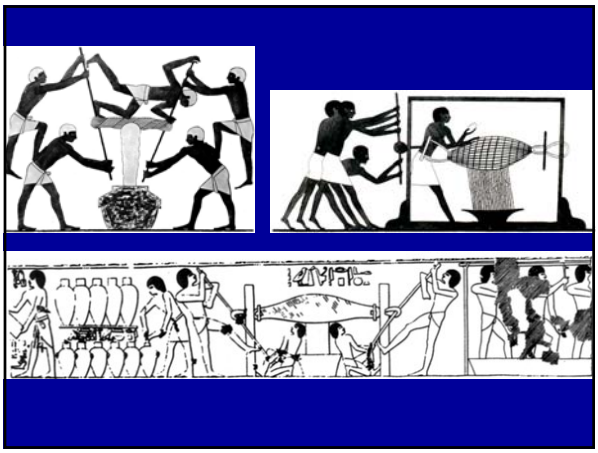
Circular millstones
Basalt, 1500 BCE

Using a grindstone in a Bedouin village
in the Syrian Jezireh

Presses

Egyptian Wine Presses





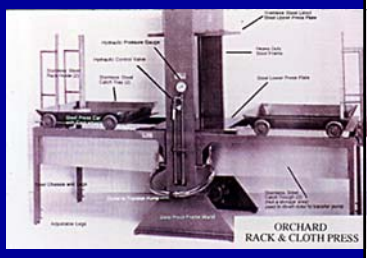
Ancient Presses

Ancient olive press, Israel

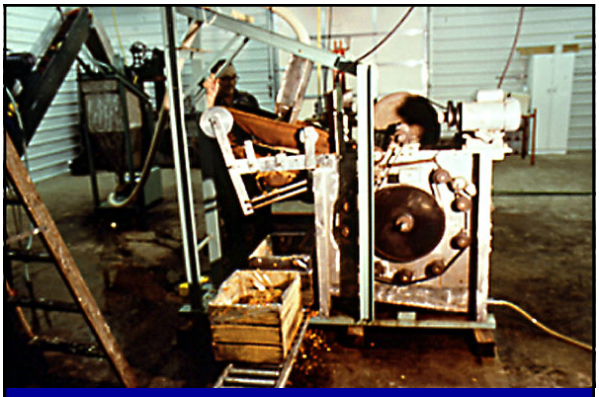
Medieval olive press, Portugal

Guercino, Allegory of winemaking, ca 1626

Cider press, 1900s

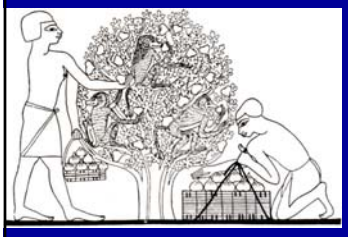


Rack and cloth press, late 20th century



Continuous cider press, 1990s

Packing Fruit



Packing Figs, 1900 BCE

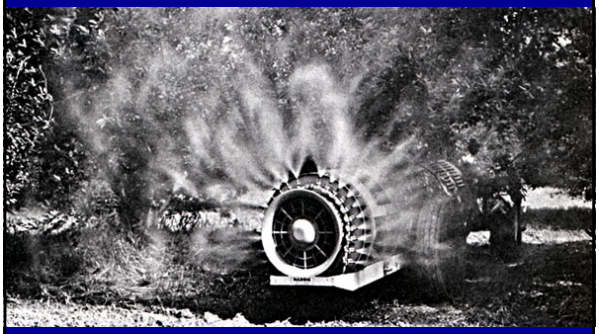
Packing apples in a barrel, ca 1900

Grading and packing oranges, California

Automatic box filler

Spraying Orchards

1900s



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

Controlled Environment Horticulture

Specularium of The Roman Emperor Tiberius

Glass cloche 1718

Growing peach on wall, John Innes, Hertford England 1962

Orangery

Orangery, 17th century Dutch "stove" for protecting oranges

Moving pot plants from orangery, 1730

Cold frames and Greenhouses

Cold frame for protecting plants, Gohelin tapestry 18th century

Humphrey Reptan's forcing garden for Woburn Abbey, 18th century

Greenhouses

The Wardian case made transport of live plants by ship safer and easier

Climatron, Shaw Botanical garden, St. Louis, Missouri

Plastic Greenhouses and Tunnels

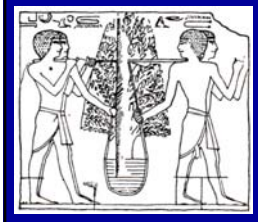
Inside plastic greenhouse 1980s

Muskmelons grown under plastic tunnels, Lower Galilee, Israel

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

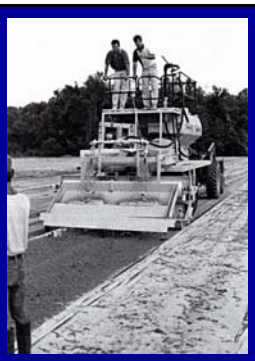
Conventional home gasoline lawn mower

Greens mower

Rolling Turf

Rolling Turf 1757

Cutting Sod



Newly developed liquid mulch sod planter (LMSP), 2000

Robotics

Transplanter

Grafting