

How a Few Simple Things Changed History

Class 2

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What We Will Cover Today

- Finish up on wheat
- Make some remarks about the related impact of rice and corn
- Discuss the impact of spices

Mechanization of Production

- The latter half of the 19th century saw the introduction or widespread adoption of several new technologies:
 - The iron plow,
 - The gang plow (which could plow more than one row at a time)
 - The spring-toothed harrow
 - The harvester (pulled by a horse or mule)
 - The binder (which automatically tied up bunches of grain)

Mechanization's Effects

- When used together, the new technologies saved enormous amounts of time
 - Reduced the amount of labor for a bushel of wheat from 61 hours to 3 hours
- Led farms to become larger and farmers to shift to mono-cropping
- Led to large-scale economic misery and political unrest in rural areas

Guano, Nitrates, & Phosphate - 1

- As noted earlier, the history of agriculture in general and wheat production in particular is a struggle against the fact that nutrient depletion, especially of nitrogen and phosphorus, limits plant growth and crop yields
- In the 1820s, Peruvian and Chilean guano (bird droppings) began to be imported into Europe and North America for fertilizer

Guano, Nitrates & Phosphate - 2

- In 1842, John Lawes applied sulfuric acid to phosphate rock, producing a concentrated phosphate that could be spread upon the soil
- Phosphate production was greatly increased as a result of the new Gilchrist-Thomas steel making process in which the resulting slag byproduct served as the source for phosphate-based fertilizer

Guano, Nitrates & Phosphate - 3

- The creation of phosphate fertilizers along with guano and Chilean nitrates lessened a bottleneck to increased wheat production but
 - Chilean nitrates and guano could not meet the ever-increasing demand for fertilizer
 - Nitrates were not only a fertilizer but also a key component of explosives
 - The two above facts meant that when World War I broke out, European farm production was to suffer greatly
 - This had profound effects on the course and outcome of World War I

20th Century Innovations

- Full de-localization of the world food supply system
- Chemically-produced nitrate fertilizers
 - Synthetically-produced ammonia
 - Hydrogenation
 - Used to produce margarine and oils that remained solid at room temperature
- The Green Revolution

Delocalization of Food Systems

- Changes in transportation – railroads and steamships in the 19th century and trucks and airplanes in the 20th – aided by bottling, canning, and freezing, delocalized the world food supply. This had several effects:
 - It severed the links between territory and food supply and lessened seasonal variations
 - It overcame the perennial hunger of the European population
 - It imposed a greater uniformity on the diet of the industrialized world while exposing people to foreign cuisines

Nitrate Fertilizers - 1

- The Haber-Bosch process made it possible to produce synthetic ammonia from which nitrate fertilizers, explosives, and synthetic gasoline could be manufactured
 - It prolonged both world wars
 - It laid the groundwork for the Green Revolution in the latter half of the 20th Century

Nitrate Fertilizers - 2

World Use of Artificial Fertilizer

1940	1965	1990
4 Million Tons	40 Million Tons	150 Million Tons

Number of Tractors (in Millions)

Year	1930	1940	1950	1960	1970	1990
USA	1.0	1.6	3.4	4.7	4.6	4.6
World	1.1	3.0	6.0	10.0	16.0	26.0

Nitrate Fertilizers - 3

- Effects of Nitrogen Fertilizers -1
 - It allowed farmers to supply much more nitrogen to their crops
 - For wheat, corn, & rice, it meant larger seed heads which in turn meant higher yields
 - It allowed an additional 3 Billion people to eat
 - It widened the gap between rich farmers who could afford fertilizer (and tractors and other mechanized equipment) and those who couldn't

Nitrate Fertilizers -4

- Since more than half of all fertilizer applied to the soil ends up in rivers and lakes, fertilizer contributed greatly to both water pollution and the eutrophication of rivers, lakes, and estuaries
- It made food production dependent on the natural gas used to produce the hydrogen used in the Haber-Bosch process
 - Since natural gas prices are pegged to oil prices, this made fertilizer prices hostage to oil.

Farm Mechanization - 1

- Effects of tractors and other farm machinery
 - Tractors, harvesting combines, and related equipment made better sense on big fields growing single crops
 - This meant larger farms
 - This meant single crops (monoculture)
 - Monoculture meant that insects and other pests had to be controlled with chemical pesticides (since predators on pests did not find monocultures an appealing habitat)

Farm Mechanization - 2

- Monocultures depleted soil nutrients faster, so that more chemical fertilizer was required
- Mechanization virtually ended the need for working farm animals (which in 1920 had taken up about ¼th of all cropland)
 - This led to the slaughter or abandonment of hundreds of thousands of horses, mules, and oxen
 - The removal of the demand for animal feed caused wheat, corn, and oat prices to decline during the 1920s
 - This caused hard times for American and European farmers, leading to political realignment in the U.S. and right wing radicalism in Europe

Farm Mechanization - 3

- Mechanization greatly reduced the demand for farm labor, leading to both an extensive internal migration of rural farm laborers to cities and large-scale emigration to foreign countries
 - Rural Southern Blacks and Appalachian Whites to Northern cities
 - Rural Mexican farm laborers to the American Southwest
 - Emigration of Turkish, Yugoslav, Southern Italian, and Algerian peasants to Western Europe

Farm Mechanization - 4

- Mechanization made food production dependent on fossil fuels
- Mechanization favored the big grain producing countries
 - It shattered production bottlenecks in lands (such as the U.S., Canada, & Australia) where farm labor was scarce
 - It favored locales with big fields, flat farmland, and climates suitable for wheat and corn growing

The Green Revolution

- The Green Revolution had three major components
 - Extensive Use of Nitrogen fertilizers
 - Farm Mechanization
 - The development of new wheat and rice varieties with both increased yields and resistance to major plant diseases
 - This included dwarf varieties of wheat that had large, heavy seed heads and short stalks that could support the seed head

The Green Revolution - 2

- In the 19th century, the Japanese developed a dwarf variety of wheat which they crossed with American wheat strains to produce a strain by WWII (Norin 10) that had a short 2' stalk and responded well to fertilizer but was susceptible to disease
- In 1944, Norman Borlaug developed a Mexican wheat with yields 20%-40% higher than traditional varieties and was resistant to stem rust
 - It could also be planted in lowland deserts in the Winter and highlands in the Summer

The Green Revolution - 3

- In 1952, Borlaug crossed his Mexican varieties with Norin 10 and other varieties
 - In a few years, he developed wheat strains that were insensitive to day length, disease resistant, and, with nitrogen fertilizer, could double the yield of traditional Mexican varieties
 - In 1962, he released his new seeds to Mexican farmers
 - In 1963, the Mexican wheat harvest was six times what it had been in 1944 when Borlaug arrived in Mexico
 - Following his Mexican success, Borlaug took his wheat to India and Pakistan
 - Result: yields five times that of traditional Indian varieties so that India by the 1980s was a wheat exporter

The Green Revolution - 4

- The Green Revolution for a time exorcized the ghost of Thomas Malthus
 - In 1967, Peter and Paul Paddock wrote *Famine – 1975*, which predicted that hundreds of millions would starve to death in the 1970s-1980s. India would be an extreme famine basket case
 - This did not happen. In the 1980s, India was a wheat exporter
- Problems, however, developed which were to surface late in the 20th century

Green Revolution Problems - 1

- The high-yield seed varieties required artificial fertilizers, other agricultural chemicals, and large amounts of water
 - Nitrogen-laden agricultural runoff created 'dead zones' in some coastal areas, adversely affecting fish and shellfish populations
- High-yield crops attracted new pests, thus requiring extensive use of pesticides
 - Pesticides harmed wildlife, contaminated the soil, polluted the runoff water, and poisoned farm laborers

Green Revolution Problems - 3

- The dependence of Green Revolution crops on fossil fuels and large amounts of water makes Green Revolution agriculture vulnerable to
 - Disruption or decline of Middle Eastern oil production
 - Climate change-induced drought in grain-growing areas
 - Declining water tables in Pakistan-India
 - Depletion of the ogalalla aquifer in the Great Plains
 - Declining water flow in many of the world's rivers

Green Revolution Problems - 4

- Signs that the Green Revolution has run its course
 - A decline in the rate of growth of the food supply
 - Since the mid-1990s, the rate of growth declined to 1%-2% a year, falling behind the 2% growth in annual demand
 - India started importing wheat again in 2006
 - After years of stable grain prices, from January 2007 to April 2008, wheat prices doubled, rice prices tripled, and corn prices increased 50%
 - This reflected the growing demand of Chinese consumers for meat, rising oil prices, diversion of corn to ethanol, and drought and floods in key growing areas
 - This precipitated food riots in 14 countries

The Impact of Rice

Rice



What is Rice?

- Rice = the starchy seed of an annual southeast Asian cereal grass (*Oryza sativa*) that is cooked and used for food. It is cultivated as a cereal grain for a large part of the world's human population and is second only to corn in worldwide grain production

Some Notes About Rice - 1

- Rice was first domesticated in the Yangtze River valley around 10,000 to 8,000 years ago
- Soon afterward, the two major varieties of *indica* rice (a long-grain rice largely grown in tropical climates) and *Japonica* rice (a round-grain variety largely grown in temperate climates) were developed

Some Notes About Rice - 2

- Rice is a water-intensive crop that is traditionally grown in flooded fields or paddies of slowly-moving water after planting
 - This mode provided extra nutrients in two ways
 - It encouraged the growth of algae which fixed nitrogen from the atmosphere
 - It allowed large amounts of organic matter – vegetable waste and human and animal manure – to rot in the water and to seep via the continued trampling involved into the soil
 - This also facilitated weed and pest control
 - Rice can be grown on hills or mountains without flooding, but more weed and pest control is required

Some Notes About Rice - 3

- Like wheat, domesticated rice has a tough rachis that prevents seed dispersal
- In the 11th Century, a new variety of rice from Vietnam enabled either two crops of rice to be grown in a year in India, Southeast Asia, and favored areas of China or both a rice crop and a wheat crop further north.
- Wet rice production produced large increases in crop yields but required intensive labor to cultivate the crop, construct and maintain the necessary water control systems, and maintain the fields

Some Notes About Rice – 4

Millions of Calories per Acre

Crop	Potatoes	Corn	Wheat	Rice
Yield	9.2 Million	7.5 Million	3.0 Million	7.1 Million

Some Notes About Rice - 5

- As noted in the previous table, a crop of rice provides many more calories per acre than a crop of wheat
- In contrast to the river basins of the Middle East (with the exception of the Nile) and Europe, the major river basins of Asia were major depositors of silt
 - This meant that crops could be continually grown without the necessity of leaving land to fallow

Consequences - 1

- Rice as the major cereal crop combined with the following factors meant that China, India, and Southeast Asia could support much larger populations than could Europe or the Middle East
 - Multiple crops in a year,
 - large-scale silting (which removed the necessity of fallowing), and
 - Rice paddies
- The large-scale irrigation works that characterized Chinese, Indian, and Middle Eastern riverine cultures required the creation of bureaucratic and authoritarian states

Consequences - 2

- The large populations of China, India, & Southeast Asia together with the close proximity of pigs, cows, water buffalo, and chickens made these areas breeding grounds of epidemic diseases
 - When trade links between Rome, the Middle East, India & China via ship and the Silk Road were established (in the 1st & 2nd centuries AD), epidemic diseases from Asia spread into the Roman world with devastating consequences
 - Greatly weakened the Roman Empire and facilitated the rise of Christianity

Consequences - 3

- The fact of large populations meant that there was always enough labor to perform the labor intensive work of growing rice and maintaining the irrigation network
 - Thus there was no need to incorporate foreign slaves into the work force in contrast to other areas of the world
 - There was also, in contrast to medieval Europe, less of an inclination to develop labor-saving technologies, such as windmills and waterwheels.

Consequences - 4

- The combination of a large population and large-scale handicraft industries which could meet Indian and Chinese demand led to Asian technology being caught in a *high-level equilibrium trap*
 - Asian producers had no incentive to massively expand output since this would have glutted the market
 - Asian producers had no incentive to mechanize production since this meant expending scarce capital to save on cheap labor
 - Many of the handicraft workers consisted of landless peasants or members of their families who supplemented family income by making handicraft items and textiles for sale to city dwellers and rural landlords

Consequences - 5

- The importation of Western-made manufactured goods and textiles ruined the Chinese handicraft goods and the Indian textile industry
 - This resulted in the “de-industrialization” of India
 - This impoverished landless Chinese peasants and turned them into a sector of the population ripe for rebellion and revolution
 - This led to the Taiping Rebellion in the 19th Century
 - It provided a social basis of support for the Chinese Communist Party in the 20th Century

Rice in the Western World

- Rice spread to the Middle East during Hellenistic times and to southern Europe via the Arabs in the Middle Ages.
- In the 1520s, the Spanish introduced rice into Mexico and the Portuguese introduced it into Brazil.
- In 1694, rice cultivation was introduced into South Carolina and later into Georgia, using the labor of slaves from the Senegambia area of West Africa where rice was grown.

Rice in the Western World - 2

- In the mid-1880s, rice cultivation spread to southern Arkansas, Louisiana, and East Texas.
 - Cajun farmers grew rice in wet marshlands and lowland prairies where they also farmed crayfish when the fields were flooded
- Chinese laborers attracted by the Gold Rush and the construction of the transcontinental RR brought rice cultivation to California
 - By 2006, California was the second largest rice-producing state

Consequences for the U.S.

- Rice cultivation in colonial South Carolina and Georgia ensured that these colonies would develop an economy based on slavery
- Chinese laborers in the U.S. invented rice dishes such as chow mein and chop suey that defined what Americans considered to be Chinese cuisine even though such dishes were not common in China

The Impact of Corn

Corn



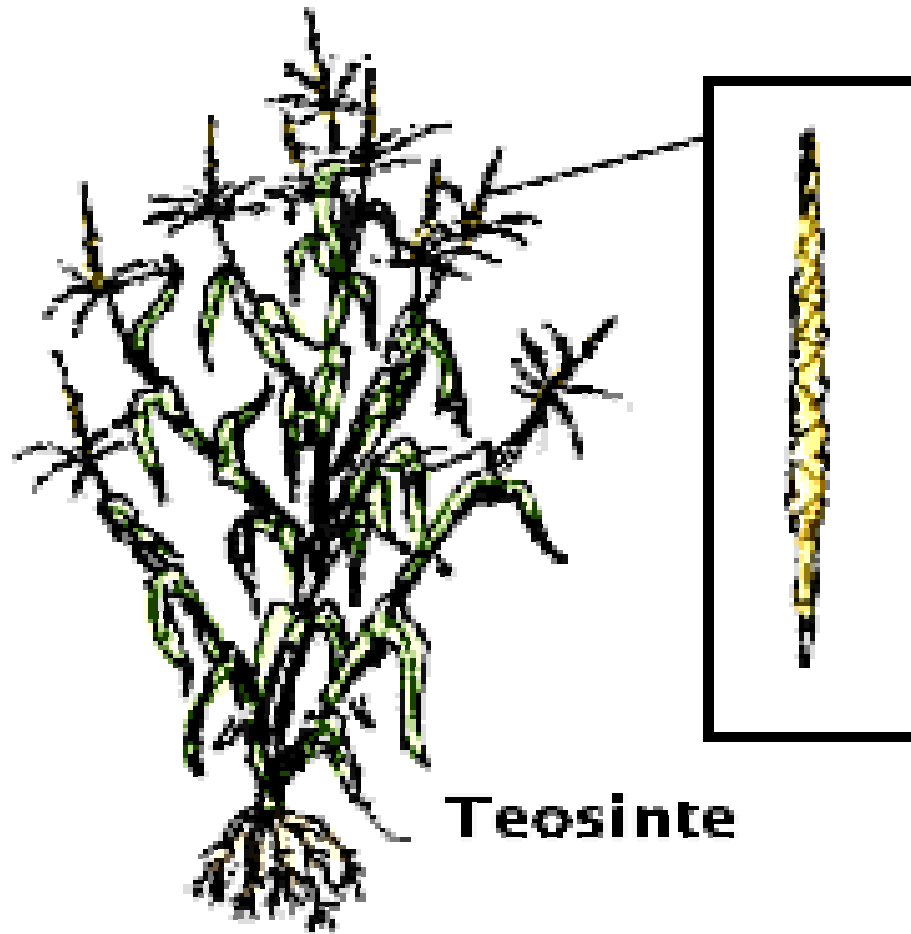
What Is Corn?

- Corn = a : the seeds of a cereal grass and especially of the important cereal crop of a particular region (as wheat in Britain, oats in Scotland and Ireland, and Indian corn in the New World and Australia) b : the kernels of sweet corn served as a vegetable while still soft and milky
 - From the Old Norse word *korn* (grain)
- Maize = Indian corn
 - From the Taino Indian word *mahiz* (corn)

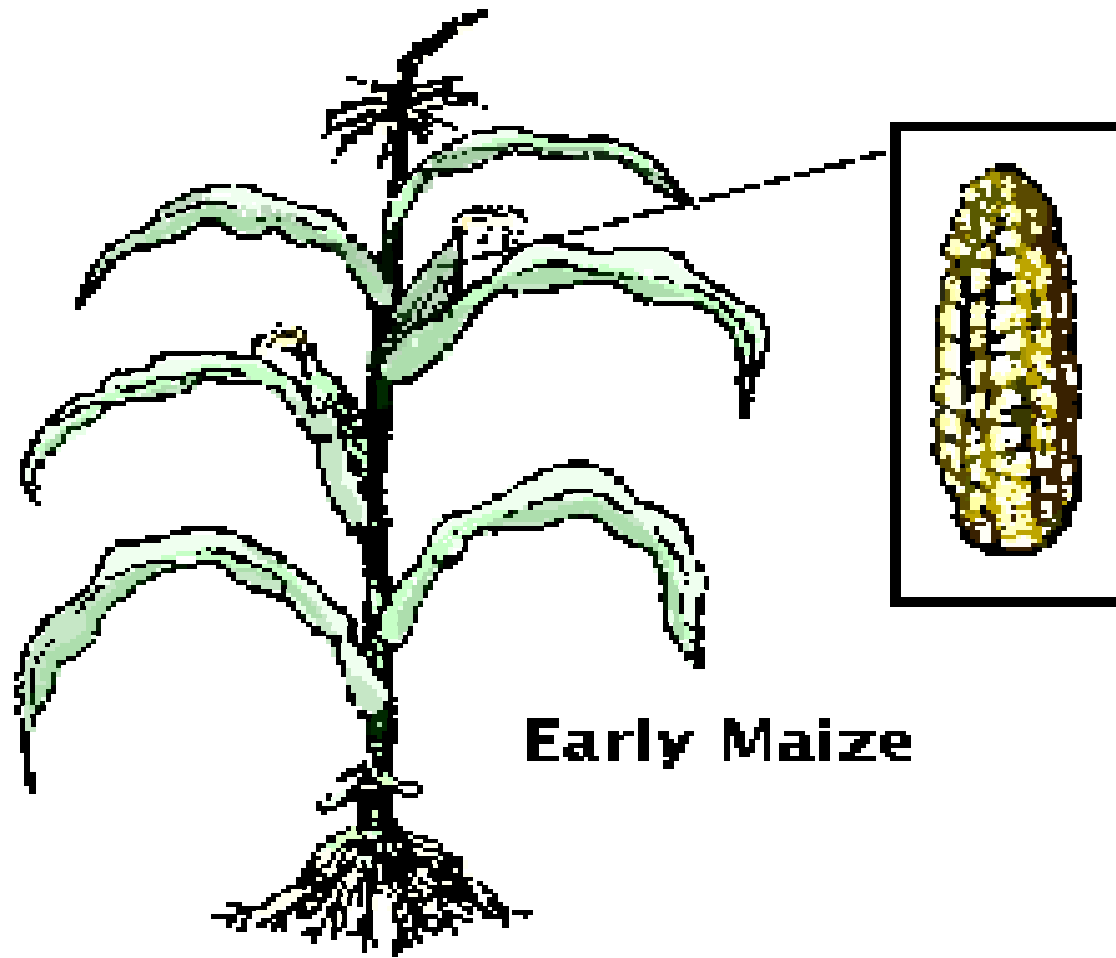
Some Notes About Corn - 1

- Corn seems to have evolved from *teosinte* (a tall annual grass from the central highlands of Mexico that is closely related to and is considered ancestral to Indian corn), aided by the introduction of genes from other grasses
- In comparison with wheat, the domestication of maize was a long and complicated process since several genetic mutations (along with subsequent propagation) were required

Teosinte



Early corn



Early Maize

Teosinte & Early Corn



Teosinte & Modern Corn



Some Notes About Corn - 2

- Ancestral Corn was being cultivated in Mexico by 5000 BC, but it was not until 2000 BC that Corn assumed the capability of supporting village populations.
- After 1100 BC, corn began to slowly spread from Mexico to North and South America
 - Corn spread to the Andean highlands by 1000 BC and the Pacific coast lowlands by 850 BC

Some Notes About Corn - 3

- Corn arrived In North America c200 AD but was a minor crop until a new variety adapted to North America's shorter summers appeared c900 AD
- By the time of Columbus, corn had spread to South America and to southern Canada

Notes About Corn - 4

- In arid Mexico & South America, corn fields required irrigation which
 - Required construction and maintenance of irrigation ponds, dams, and ditches
 - Permitted growth of large populations
- In humid Central & Eastern North America,
 - Corn arrived relatively late and required less labor
 - Became a supplement to hunter-gathering with cultivation a female responsibility

Some Notes About Corn - 5

Millions of Calories per Acre

Crop	Potatoes	Corn	Wheat	Oats	Barley
Yield	7.5 Million	7.3 Million	4.2 Million	5.5 Million	5.1 Million

Consequences of Corn - 1

- Corn could grow at higher altitudes than wheat and also, unlike wheat, grow on hillsides
 - This enabled new communities of farmers to develop and grow in the Balkans in the 18th century at altitudes out of the reach of Turkish Muslim authorities
 - Along with the sweet potato, it allowed expansion of Chinese farmers into the uplands of the Yangtze basin, and Fukien, Szechuan, and Hunan provinces

Consequences of Corn - 2

- Catches of stored corn in Indian villages abandoned or wiped out by epidemics in 1617 just prior to the arrival of the Pilgrims helped them survive the first winter
 - Also provided the seed corn with which to plant in the following spring

The Impact of Spices

What is a Spice?

- Spice = a dried vegetable seed, fruit, root, bark, or substance used in nutritionally insignificant quantities as a food additive for flavor, color, or as a preservative that kills harmful bacteria or prevents their growth. Many spices are also used as medicines, in religious rituals, as cosmetics, or as perfumes

What is a Herb?

- Herbs = leafy green plant parts used as a food additive for flavor, color, or scent. They are also used for medicinal purposes. Culinary herbs are distinguished from vegetables in that, like spices, they are used in small amounts and provide flavor rather than substance to food. Like spices, herbs were used in medicinal and religious rituals

Notes About Spices - 1

- There is evidence that spices have been used for thousands of years. By 2000 BC, there was a spice trade throughout the Middle East for cinnamon, pepper, and various herbs
- By the 1st Century AD, there was a thriving trade in spices, with over half the imports to the Mediterranean from Asia and the east coast of Africa consisting of spices (mostly pepper)

Notes About Spices - 2

- Spices were used to make foods taste better and increase consumption of nutritious but not necessarily appealing foods
- Spices were also used as natural preservatives since many of them contained anti-microbial chemicals that killed or suppressed bacteria and fungi that commonly contaminate and spoil foods

Notes About Spices - 3

- Traditional dishes from tropical and subtropical regions tend to be much spicier than traditional dishes from colder climates
 - Many of the spices that appear most often and most abundantly in recipes from hot climates – especially garlic, onions, and hot peppers – can inhibit 75% to 100% of many bacterial species

Notes About Spices - 4

- Spices were generally added to meat after cooking to flavor it, not before to preserve it.
- Spices were generally not used to disguise tainted meat and fish
 - The wealthy elites that alone could afford spices generally had access to fresh food or to food that was preserved by salting, pickling, curing, or drying

Notes About Spices - 5

- Spices and herbs were often used as medicines
 - Many spices fit into the prevailing system of Galenic medicine with its four humours
 - Pepper, for example, was used to treat ‘cold diseases’ accompanied by excess phlegm, such as rheumatism
 - Ginger was used to heat the stomach and aid digestion
 - Nutmeg was used to benefit the spleen and relieve any bad cold