

Smil Discussion

Understanding Food Production

Eating Fossil Fuels

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Transition from foraging to sedentary

- Hominins ancestors: erect posture, bipedalism, large brains
- Used simple tools: hammerstones useful for butchering but not hunting
- Most large meat came from scavenging
- Eg. Mammoth hunters became 12000 years ago mastered large beasts and coastal dwellers became fishers
- Early agriculture and domestication: Increased population densities but not average nutrition
- E.g foraging in arid landscapes would require 100 sq km to support a single family
- Productive regions: pop density 2-3 people per 100 hectares (140 soccer fields)
- Coastal societies, eg. Pacific northwest reliable fish migration, high protein and time to carve totem poles
- Early agro soc 2-3 times pop den than foraging soc. Eg. Egypt density rose from 1.3 people per hectare of cultivated land to 2.5 people per hectare 3500 years later. Almost 6 tennis courts to feed an extra human

Transition from Preindustrial production

- Rates grew to 3 people per hectare in 16th century in Ming dynasty whereas in Europe 2 p/h until 18th century
- Until recent only small share of elites didn't have to worry about feeding
- Malnutrition and undernutrition were common, famine was a regular occurrence due to wars.
- Ability to produce a surfeit of food is fundamentally important, don't worry about eat to survive
- E.g. Undernourished 65% in 1950 to 25% in 1970 to 15% in 2000 to 8.9% in 2019 (FAO)
- Malnutrition rates fell from 2-3 in 1950 to 1 in 11 in 2019 (pop changed from 890 million in 1950 to 7.7 billion in 2019)

What factors led to this?

- Crop yield -> fertilization, irrigation, crop protection
- Two kinds of energy: Sun and Electricity
- Existential dependence on fossil fuels is direct and indir use in food production
- High intensity with high predicitability while dec the time and area of cropland needed to feed one person

Genesee Valley in western New York: 1801

- Practice not diff from Egypt 2 millenia ago
- Land is ploughed using ox attached to iron plate
- Seed from prev crop, sown by hand, brush harrows to cover it up
- 27 hours of human effort per seeded hectare
- Crop is harvested with sickles, stalks are tied in sheaves, left to dry, sheaves taken to barn, and threshed by flailing on hard floor, grain is winnowed (separated from chaff), put in sacks
- 150 hours of human effort/hectare and 70 ox hours for yield of 1 ton of grain /hectare of which 10% is set aside for next year
- 10 min of human effort to produce 1 kg of wheat (2 loaves of bread)
- Primary energy is Sun: wood for cooking, wood for charcoal and smelting: no non renewable energy inputs almost for farming

Red river valley eastern North Dakota 1901

- Industrialization high mechanization
- Horses pull plows, mechanical seed drills, mechanical harvesters put stalks, only stooking done manually
- 22 hours per hect, $1/7^{\text{th}}$ the time in 1801
- Large areas but low yield still 1 ton per hectare
- HE reduced to 1.5 min per kg of grain and 37 hours for animals

Arkansas River Valley Kansas: 2021

- Farms 3-4 times larger, 1-2 people op large machinery
- Dominated by tractors, seed from growers, inorganic fertilizers, insecticides
- Large combines for harvesting, trucks for transport
- 2 hours per hectare from 150 hours in 1801
- Yield is 3.3 ton per hectare: 2 sec per kg of grain

What goes in?

- Fertilizers: Potassium (least costly to produce KCl), Nitrogen, Phosphorus
- Nitrogen (limiting factor tho abundant) to Ammonia which converts to nitrates
- Natural ways: lightening, leguminous plants (soyabeans, peas) convert to soluble nitrates
- No staple crops wheat, oil crops are legumes: Rotate with legumes is one way
- Natural wastes was common but human effort was immense for low nitrogen yield
- Export of Chilean nitrates in 19th century and synthesis of Ammonia by Fritz Haber in 1909 broke barrier to Nitrogen production

Energy costs of Bread, Chicken, Tomatoes

- 800 grams of wheat gives 580 grams after milling
- Standard baguette (250 grams of wheat): 2 tablespoons of diesel fuel
- 200-250mL/kg of bread
- Real cost higher due to transportation
- Broilers have high feeding efficiency (units of feed per live weight). 3 for broiler and 1.82 for cattle
- 1 American chicken requires 3 kg of corn
- 300-350 mL/kg of diesel fuel per edible meat
- Costs could be higher due to transport of feeds such as Brazilian soybeans
- Tomatoes grown in plastic covered green houses in Mexico, China (largest producer), Spain and Italy
- Plastics less expensive than multi story greenhouses. Need clips, plastic sheets
- Heavily fertilized crop: 10 times more than grain corn
- Packaging of 1 kg of fert req 1.5 litres of diesel
- Study in Almeria region of Spain (largest covered commercial cultivation 20 km sq) found heated GH 500mL of diesel and unheated 150mL/kg
- 650mL/kg of diesel fuel per edible food (more than 5 table spoons of diesel fuel)