

## The origins of agriculture

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- Archaeologists think agriculture is a big deal. Why?
  - It is a recent change in the way humans have lived for most of their existence
    - As we saw before, even if you include only anatomically modern *Homo sapiens*, 98% of our duration as a species has been as foragers.
  - so: farming and civilization are both very recent aberrations for the human race.
    - That can't be a coincidence: they must be connected somehow
  - All the “pristine civilizations” we know of got their subsistence at least in part through agriculture
    - So again, agriculture and civilization must be connected
    - Agriculture seems to be a necessary prerequisite for civilization
- **Agriculture** = Activities to artificially increase plant food yields (sowing seeds, clearing forest, weeding, diverting water, fertilizing, etc.)
  - Agriculture provides more food per unit area of land than does foraging
  - That is, you get more food per acre by farming it than by collecting the wild foods on it
    - This allows more people to live in a given area
    - That is, it allows a higher density of people
  - Of course, it takes more labor to farm an acre of land than to collect the wild foods that are naturally there
  - This process of putting more labor per acre *in* to get more product per acre *out* is called **intensification**
    - agriculture is more “intensive” than foraging
      - in that it produces food more per acre, but requires more labor per acre to do so
    - agricultural practices themselves can be more or less “intensive”
      - a “low intensity” form of agriculture might involve just scattering seeds or diverting floodwaters to wet some land
      - fertilizing, irrigating with canals, etc. are “more intensive” forms of agriculture
        - because they get more crops per acre
        - at the cost of collecting, hauling, and applying the fertilizer, building and cleaning the canals, etc.
  - Is farming a good deal, compared to foraging?
    - that is, if you double the labor input, do you at least double the food output?
    - the surprising, empirical answer is, in most cases: no!
    - In fact, agriculture usually requires more labor per unit of food produced than does foraging
      - That is, a farming family has to work more hours per year to provide its own food than a foraging family does
  - The !Kung recognize this as a matter of common sense
    - That is why when Lee (author of the reading on the !Kung) asked the !Kung why they don't farm, one famous reply was "Why should we farm when there are so many mongongo nuts?"

- They know that they can get the food they need with less work by foraging
- The tradeoff of agriculture is clear if we consider the difference between the yield of food *per acre* and the yield of food *per hour worked*
  - agriculture produces more food per acre
  - but agriculture produces less food per hour worked
  - In a given area, agriculture can produce more food than foraging can, so agriculture can feed more people
    - But each one has to work harder than before to survive
- Foraging is a good deal if there is a lot of land per person, that is, a very low density of people
  - But if there are too many people for the available land, foraging just can't provide enough food
  - so if population gets too high, farming or herding become the only alternatives to hunger
- You often hear the idea that when people switched from foraging to farming, they escaped the pressures of a precarious existence and suddenly had the time to develop “civilized” practices like art, literature, science, and technology
  - but in fact it was the reverse
  - farmers have *less* free time than foragers
  - so we need some more sophisticated explanation for the development of civilization
  - instead of looking at the total or average amount of "free time", maybe we should think about how the free time is distributed in the society
    - *who* has less free time free from subsistence tasks
    - and who has more
- **Sedentism** = living more or less permanently in one place
  - in some particularly good environments, foragers can settle in one place (become sedentary)
    - or have just a few semi-permanent settlements (be semi-sedentary)
      - sometimes seasonal settlements
    - this requires either enough wild food available year-round, or some kind of food that can be collected in great quantities and stored for the off-season
    - sedentary foragers are usually highly specialized on one or a few very productive wild resources in specially favored places
    - like acorns in some parts of California
    - salmon on the Pacific northwest coast
  - in less-ideal environments, agriculture allows people to become sedentary, and creates reasons for them to do so
    - farmers *can* settle because
      - agriculture can provide enough food in a limited area that the food is not exhausted before the next season replenishes it
        - so people don't have to move in order to get food
    - farmers are *encouraged* to settle because
      - fields must be tilled, weeded, irrigated, harvested, etc., which requires people to be there at many different times during the year
      - harvests produce a lot of food at once, which has to be stored for eating later

- staying near the stored food is easier than carrying it around
- stored food, fields, canals, etc. may need to be defended
- Effects of agriculture and sedentism
  - Agriculture and sedentism tend to lead to population growth
    - Both tend to increase fertility for biological reasons
      - Increased carbohydrate consumption from agricultural crops may keep women's body fat levels high enough year-round that they do not go through periods of infertility
        - foragers often get very lean during the season of scarcity (it varies in different regions), which reduces female fertility
        - this is an effect familiar to female runners and dancers
      - Less mobile mothers don't have to carry their small children constantly, encouraging them to stop breast feeding sooner
        - Fertility is reduced while nursing
        - So shortening the period of breast feeding shortens the period of reduced fertility
        - Making the mother more likely to get pregnant again sooner and have more children over the course of her lifetime
      - Since the mother does not have to carry her infant around while foraging, farming makes it practical for a woman to have more than one infant at a time, allowing larger families
        - mothers are not forced to take measures to prevent having another infant while a previous one is still small
        - such as abstinence rules, contraceptive measures, induced abortions, or infanticide, all of which were practiced by at least some foragers
    - Agriculture also provides economic incentives to want more children
      - Farming creates a greater demand for labor, that is, kids to help with the work
      - So farmers generally want to have large families, and the population tends to grow
  - This population growth may push people further into agriculture
    - if they are intensive foragers, the population may outgrow what the wild resources can support
      - in order to avoid shortages, they may start encouraging the wild plants they specialize in to grow, through burning, planting, diverting water, weeding, etc.
    - if they are farmers, population growth may push them into more intensive farming
      - in order to produce enough for the rising population, they focus more and more on farming, less and less on foraging
  - Eventually they are locked in
    - population rises above what wild resources can support
    - people can't give up farming without causing hardship
    - So the shift to farming may become a one-way change
    - there is no going back without unacceptable disaster
- Agriculture and sedentism have surprising effects on nutrition and health
  - early agriculture often focuses on one or a few of the most productive crops
    - so most early farmers had less varied diets than foragers
    - and often poorer nutrition overall

- more carbohydrates lead to more dental caries (cavities), abscesses, etc.
  - these were serious matters before modern dentistry
- more labor leads to more arthritis, back and knee problems, etc.
- living in permanent villages creates new problems of sanitation (waste disposal, insect infestation, etc.) that encourage disease
- living in larger, denser groups aids the spread of epidemic diseases
- overall, settled agricultural lifestyles typically increased biological stress on people
  - and often decreased lifespan
  - more children were produced, but they had more ailments and tended to die younger
  - in theory, these two trends could cancel each other out
    - but the observed pattern is that in most cases, the increased birth rate outweighed the reduced survivorship, and the net effect was a population increase
- Agriculture and sedentism have cultural effects, too:
  - Sedentism allows accumulation of material goods: storage of goods and food
    - thus the origins of rich and poor people and classes
    - so sedentism makes economic stratification possible
    - accumulation is not limited to a single generation, either; land and goods can be inherited
      - mobile foragers also inherit, but the goods involved are minimal and mobility limits accumulation
      - more fortunate families may accumulate wealth over generations
        - allowing greater economic stratification
        - and the formation of economic classes and aristocratic families
- Agriculture and sedentism allow the production and storage of **surplus**: food or other goods beyond the needs of the producer
  - surplus production is possible for at least some foragers, but since mobile foragers generally cannot store or transport much surplus, they don't generally produce it
  - surplus production makes it possible to support craftspeople and other specialists who do not produce all (or any) of their own food
    - Harvey Weiss called this "the beginning of the big rip-off"
  - the existence of surplus and people who don't produce all their own food creates a whole new arena for social arrangements that may become very complex. Consider:
    - Successful farmers might use their surplus to support servants
    - Farming families might want to pool some of their surplus as insurance for bad times or to support work on community projects, defense, etc.
      - There will have to be ways to keep track, distribute, decide who gets what, etc.
    - If some people trade surplus for goods or services, how will the inevitable disagreements, debts, etc. be handled?
    - Some people might try to encourage or coerce others to produce surplus to support them, like chiefs, priests, warriors...
- Agriculture allows larger groups to live together
  - because farming produces more food in a given area, more people can live there permanently
  - people have to interact with a larger number of others

- the kinship system becomes inadequate to structure interactions
  - since you can't keep track of so many relationships
- so people start using other criteria to determine how to interact with people they encounter
  - such as social status, class, rank
  - this is the beginning of more complex social organization
- greater likelihood of conflicts
  - because more people are interacting with each other
  - and because people can't defuse problems by simply moving away
  - encourages the development of institutions for conflict resolution (chiefs, religious authorities, courts, etc.)
- Settled people with goods are easier to raid, threaten, conquer, control, tax
  - unlike mobile foragers, settled people have stored food, goods, and improved fields that people may want to take by force
    - so raids or warfare become possible
    - so sedentary people may need to defend themselves
  - because they are stuck in one place, settled farmers are easier to coerce and extract production from (taxes)
  - this vulnerability, surplus, and accumulation of wealth help make power hierarchies possible
- Agriculture and sedentism made these changes, many of which are steps towards “civilization”, possible.
  - But they did not necessarily *cause* civilization to arise
    - they just made civilization possible, while among mobile foragers it was not.
  - Some foragers specializing in unusually rich resources (like salmon on the northwest coast of the US, or acorns in California) were sedentary and lived in relatively large villages, even without agriculture
    - Yet none of these developed states or “civilizations”
  - even settled farmers were around for thousands of years before “civilizations” emerged
  - So sedentism, and even agriculture, are apparently necessary steps, but not sufficient ones, for the appearance of civilization
  - Something else must be needed, too
- What we want to know about the origins of agriculture
  - Basic facts
    - Where and when agriculture began
    - With what crops
  - Explanation: How and why did people start farming?
    - Why did agriculture seem like a good deal at the time?
    - That is, what processes, pressures, etc. led people to start farming and eventually to depend on it in any given case?
- This means we will be looking at the beginning and spread of the **Neolithic** period
  - **Neolithic**: two meanings
    - 1. A stone tool technology that emphasizes grinding, rather than flaking

- This results in a more durable cutting edge (although not as sharp)
- good for axes needed to cut trees to clear farmland in forested places like Europe
- 2. More importantly for us, the period in which agriculture came into use and was the main source of food
  - so called because in many places, ground-stone tools came into use at about the same time as agriculture became important
  - so they serve as a convenient marker and term for early agricultural periods
- There are several ways we can recognize the advent of agriculture in the archaeological record
  - **Domestication** = genetic modification of a wild plant or animal due to human involvement with its reproduction
    - Not necessarily intentional - but a plant or animal is not domesticated unless it has evolved under human influence
    - If we can identify remains of domesticated plants or animals (ones that differ from wild forms), we have direct evidence of agriculture or pastoralism
  - Canals or fields (indicated by furrows, ditches, regularly placed small mounds, etc)
    - Rarely preserved, but occasionally we get lucky
  - Lots of tools used for agricultural tasks (smaller quantities might just have been used for specialized foraging)
    - Hoes or digging tools (identifiable by form and rounded wear)
    - Sickles used for harvesting grain (identifiable by sickle gloss)
    - Grinding stones used for grinding grain
  - Large, permanent settlements are a strong hint that people were supported by agriculture, but not proof in themselves
  - Storage structures for crops
    - again, specialized foragers might have these to a lesser extent
- How could domestication and the practice of agriculture happen?
  - Example: a possible process of domestication of wheat (other grains may have been similar)
    - wild wheat
      - seeds have brittle rachis [RAY-kis] (attachment to the stem), so they fall off easily
      - seeds are narrow and have a rounded point that lets them penetrate cracks in the ground
    - people start collecting wild wheat, probably by pushing a basket up to the heads of wheat and giving them a tap to make the ripe seeds fall into the basket
      - those seeds that happen to have a more brittle rachis fall off the stems more easily.
      - Plants that happen to have a slightly tougher rachis lose fewer seeds to the harvesters.
      - These seeds that are NOT harvested are the ones that remain to naturally sow the next generation of plants
    - this process selects for plants with a tough rachis, gradually producing a kind of wheat more like the domesticated form, in which the seeds stay on the head and have to be removed by threshing
      - this evolution of the plants is caused unintentionally by people
    - an increasing fraction of the seeds do not fall off easily when ripe, and are less successful at working their way into the soil because they were less pointed
      - so the wheat becomes less effective at sowing itself naturally

- as the seeds stick more tightly to the head, people shift their harvesting method
  - they used sickles to cut off and collect the whole head, and then later thresh (beat) the heads to knock the seeds off
  - this allows more effective harvesting of most of the wheat
- between the reduced effectiveness of the wheat at sowing itself, and the efficient harvesting of most of the seeds, the wild stands do not replenish themselves well
- so people start “helping” the wheat by sowing part of the harvest
  - the seeds are those that stayed on the heads long enough to be collected by threshing
  - so the wheat is still growing from seeds with a tough rachis
- eventually people start intentionally selecting seeds to sow that have the desired qualities: fat, large grains
  - now the evolution of the plants is intentionally guided by people
  - the result is domesticated wheat, with large grains that tend to stay on the head
- the details are still being evaluated, but something like this is probably right
- similar processes of unintentional selection followed by intentional breeding are thought to have happened with other domesticates, both plants and animals
- So, what is the archaeological evidence about the adoption of agriculture? What actually happened?
  - People adopted agriculture independently in many places, at different times, with different crops
    - (these are current estimates; a lot of research is going on to better define these cases)
    - 9,000 - 8,000 BC: the Levant (Jordan valley of Palestine and Israel, nearby areas)
      - wheat, barley, lentils, peas, etc.
      - sheep, goats, pigs, cattle
    - 8,500 - 7,700 BC: the rest of southwest Asia (Anatolia, Egypt, the Fertile Crescent, reaching out towards India)
      - wheat, barley, lentils, peas, etc.
      - sheep, goats, pigs, cattle
    - 10,000? - 6,500 BC: southern China, southeast Asia
      - yams maybe earliest; rice
      - water buffalo, pigs
    - 6,500 - 5,000 BC: north-central China
      - millet, etc.
      - pigs
    - 9,000 - 3,000 BC: Peru
      - beans, peppers, squash, quinoa, potatoes, gourds (very gradual adoption)
      - guinea pigs, llamas
    - 7,000 - 4,000 BC: Papua New Guinea
      - tubers such as yams or taro
    - 5,000 - 3000 BC: Mexico
      - maize, beans, squash, peppers, gourds
      - turkeys, dogs
    - after 2000 BC: Sub-Saharan Africa

- rice, sorghum, millet
- by 1000 BC: Midwest North America
  - marsh elder, sunflower, goosefoot
- The processes leading to farming were probably different in different cases
  - The transition was often a gradual increase in dependence on plants that were encouraged by sowing, simple irrigation, burning off competing grasses, etc.
    - making it hard to pick a specific date when farming “started” or became important
  - Depending on where you draw the lines, most of the world’s major independent agricultural traditions began between about 10,000 BC and 3,000 BC
    - many people continued to forage during this time, and on almost to the present
    - others developed hybrid arrangements where they herded animals, traded, etc. but depended in part on food they got through relationships with farmers near them
    - others adopted agriculture later, picking up crops, animals, and practices developed earlier by other groups, responding to other circumstances
  - On a gross scale, all of these independent inventions of agriculture happened at about the same time in human existence.
    - that is, humans existed for several hundred thousand years, then independently developed agriculture in many different places in “just” a few thousand years
- What was special about this time that many different cultures began farming then?
  - *Homo sapiens* evolved mostly during the Pleistocene (ice ages)
  - The Pleistocene tapered off and the climate warmed, ice retreated, sea level rose, wild plant and animal communities changed...
  - within a few thousand years, humans were farming in many places around the world
    - in the broad scheme of things, these independent inventions of agriculture all happened in the same post-Pleistocene time frame, reflecting the same general processes
      - they presumably had something to do with the climate changes
      - and possibly with the gradually rising populations of humans around the world
    - at a more detailed level, thousands of years separated the adoption of agriculture in different regions
      - and each case happened in ways specific to the environment and cultures of the area
- The case of the classic “western” agricultural complex
  - crops and animals:
    - Wheat and barley
      - plus rye, lentils, peas, and other minor crops
      - the term “pulses” in the reading refers to legume seeds (beans, peas, lentils, etc.)
    - Sheep and goats
      - plus cattle and pigs
  - Spread throughout Southwest Asia (Mesopotamia, the Levant, Anatolia [modern Turkey]); Egypt; Europe; and the Indus region
  - The earliest well-documented transition to a significant dependence on agriculture was in the Levant, lapping into the upper Euphrates valley
    - this is the western side of the "fertile crescent"
    - Prior to about 11,000 BC, the Levant was occupied by small, mobile bands of foragers

- around 11,000 BC, some of these settled down in a very rich region
  - mixed oak and pistachio woodland
    - and grassland with wild cereals and legumes
  - These people are called Natufians
  - they were highly specialized foragers
    - intensively harvested wild grains
      - as shown by abundant grinding stones
      - sickles with sickle gloss
      - lots of wild wheat, barley, lentils, vetch (a legume), peas, chickpeas found in cooking pits at various sites, carbonized accidentally
    - also collected nuts such as almond, pistachio, acorn
    - also hunted herds of gazelles that migrated through the region seasonally
  - The region was so favorable that they could be semi-sedentary or even fully sedentary
    - as indicated by hamlets of circular houses with stone foundations
  - they stored the cereals and nuts in pits
    - storage is a necessary part of this specialization
    - since the cereal seeds and nuts are only available seasonally
    - so they had to collect large quantities and store them for the rest of the year
  - these storage pits were associated with individual houses
    - rather than serving multiple houses or the whole settlement
    - and each house also had its own grinding stones and other tools
    - suggesting that each family harvested, stored, and processed its own grain and looked after its own needs
    - rather than working together in larger groups where more people would depend on each other for a variety of different tasks
    - so economically, these sedentary Natufians were organized similarly to mobile foragers
  - they began accumulating wealth, as settled people are prone to do
    - elaborately carved sickle handles
    - beads and figurines made from bone, shell, stone
- The Levant experienced increasing rainfall from about 12,500 to 9,000 BC
  - this expanded the area of good patchy woodland
  - allowing the Natufian adaptation of specialized sedentary foragers highly focused on wild grains to become widespread
- around 10,000 BC, the climate began to turn cooler and drier
  - the area of rich woodland contracted
    - for example, the Natufian site of Tell Abu Hureyra was gradually stranded as the woodlands pulled back some 60 miles away
    - this kind of change probably happened at other sites, too
  - the plant foods found in hearths and garbage gradually shifted, with the ones that need the most water fading away first
  - but wild wheat continued to be stored and consumed in great quantities
    - even though it would not naturally have grown nearby anymore

- Natufians evidently encouraged it to grow nearby, by planting, watering, tending, etc.
- this was not a major change for them
  - instead, it was a way of maintaining the way of life that they already had
  - they already knew how to harvest, store, and use the grains and were accustomed to doing that
  - in this sense, they were "pre-adapted" to become farmers
- at about the same time, an apparently domesticated form of rye appeared
  - apparently the earliest detectable case of plant evolution due to humans meddling with the plant's reproduction
- later, lentils and other legumes reappeared in the garbage
  - the climate was still unfavorable for them to grow wild nearby
  - so they were presumably starting to farm these plants, too
- the change was gradual, but by 8500 BC at Abu Hureyra, cultivated cereals and legumes were a major part of the diet: they were farming
  - although wild foods also remained important for 2500 years
  - sheep and goats were being domesticated by 8500 BC, but hunted wild gazelle still comprised much more of the meat in the diet
- Chronology break!
  - the term Natufian is used for people up to about 9000 BC
  - after that, there was a transitional period
  - followed by the Pre-Pottery Neolithic "A" period, or PPNA, from about 8500-7000 BC
    - "Neolithic" means that they were early farmers
    - "Pre-pottery" means that they did not make ceramics yet
    - "A" labels this early part of the pre-pottery Neolithic, versus a later part, called "B"
  - the PPNB was about 7000-6000 BC
- so the transition to farming was made gradually by the last Natufians and the first Neolithic cultures of the Levant (PPNA), often found at the same sites
- Back to Abu Hureyra...
- reliance on domesticated animals came later at Abu Hureyra, around 7500-7000 BC
  - by then a PPNA farming village
  - there was a fairly rapid drop in bones of hunted gazelles
  - replaced by more sheep and goats, which had been domesticated considerably earlier
- Abu Hureyra eventually grew to over 11 ha (hectares, 1 ha=100 x 100 m)
  - with 2000 to 3000 people
  - probably one of the biggest settlements of its time
    - most villages between 7000 and 6000 BC were less than half this size
  - Abu Hureyra was eventually abandoned around 6000 BC
- Abu Hureyra is just one particularly well-known site
  - others probably went through roughly the same process
  - with local variations, and not at exactly the same time
  - some cases may have been like Abu Hureyra, where the changing environment seems to have been a key factor pushing them into farming
  - others may have been pushed more by population growth

- the effect is the same: people have to produce more food from the land around them
- another example of a large early Neolithic village: 'Ain Ghazal
  - 7000-6000 BC (Pre-pottery Neolithic B, or PPNB)
  - about 12 ha (similar to Abu Hureyra at its peak)
  - rectangular houses, plastered floors, central hearth
  - more evidence of accumulation of wealth
    - a cache of 84 flint blades in a hole below the floor of a house
      - implies that someone had accumulated more blades than they or their family was likely to need themselves
      - suggests that someone was storing goods for later use or exchange
    - beads made from shells that came from the Red Sea (150 miles away) and the Mediterranean Sea (70 miles away)
  - ideas about the supernatural
    - small ceramic figurines, usually female
    - large standing figurines, mostly male, of plaster on a bundled twig and straw core
    - four human skulls with faces modeled in plaster, buried in a pit, all facing southwest
    - the large standing figurines resemble the plaster-coated skulls; is this all part of some form of ancestor worship?
      - if so, could ancestor worship suggest the rise of more and less important lineages, maybe chiefly families?
      - does this imply ritual specialists? More so than among the !Kung?
  - From roughly 8500 BC to 3500 BC, and even later in many places, most people in Southwest Asia lived in farming villages generally like Tell Abu Hureyra or 'Ain Ghazal
    - Most villages ranged from several extended families to a few hundred people; a few probably reached into the 2000s.
    - A tremendously stable, successful lifestyle of small-scale, traditional farmers
    - Lasted at least 5000 years with only relatively minor changes in most places
    - That is, agriculture did *not* lead directly to cities or civilization
    - instead, it led to a village farming lifestyle that worked fine for thousands of years, and in some places still does
- this example of the Levant region is just one of many; we will look at other places where agriculture was adopted throughout the rest of the course
- This kind of transition from foraging to farming made it possible for people to live in villages not only in a few of the most favored places, but also in much of the rest of the world
  - the Neolithic made settled village life possible almost everywhere
  - and paved the way for some villages to eventually grow into larger towns.
- We will move quickly on to more complex societies, but don't forget that this relatively simple Neolithic village lifestyle lasted in most regions for several thousand years before cities and "civilizations" began to appear
- Next time, we will look at some examples of the earliest large towns on earth, especially the famous Neolithic site of Çatal Hüyük. Do the reading (and visit the Çatal Hüyük web sites on the course web page if you can); this is very cool stuff.