

Lecture 3

Neolithic Revolution and the Discovery of Agriculture

The Great Technological Discoveries of Pre-history

1. **The discovery of tools.** Although there are examples of “tools” being used by animals, from ants to apes, the development of tools is one of the distinguishing characteristics of humans. The development of tools such as flint points, axes (Fig. 3-1), weapons such as the spear and the bow and arrow, snares, and hooks is a reflection of the change from gathering and scavenging to hunting. The development of hunting societies leads to social organization.
2. **The discovery and control of fire.** Fire provides heat and light and expands the food supply. A great many foods are inedible, unpalatable, or unsanitary without the cooking process. In the Greek legend, Prometheus stole fire from the Gods and was punished by being chained to a rock with an eagle continually pecking away at his liver. The discovery of techniques to preserve fire and to make fire through combustion is a key discovery of humankind; techniques include percussion (iron pyrites and flint), wood friction, and fire piston (Asia).
3. **The invention of agriculture.** Agriculture refers to a series of discoveries involving the domestication, culture, and management of plants and animals. It is one of the most far reaching discoveries of early humans leading to profound social changes. It is clearly the basis for civilizations. Agriculture was adopted repeatedly and independently in various parts of the world after the retreat of the Pleistocene ice around 12,000 years ago. This warming trend affected the Middle East, northern China, and Mesoamerican where agriculture began.
4. **The invention of the wheel.** The wheel is not only the basis for the mechanical and transportation revolution but is involved with the technologies of ceramics and spinning.

The Neolithic Age.

The Neolithic or New Stone Age (7 to 10,000 years ago) pertains to a stage of culture following the Paleolithic and is characterized by the use of polished stone implements, development of permanent dwellings, cultural advances such as pottery making, domestication of animals and plants, the cultivation of grain and fruit trees, and weaving (Fig. 3-2). The change from hunting/gathering to primitive farming appears so abrupt that this technological change is often characterized as the **Neolithic Revolution**. The discovery of smelting and the creation of bronze tools has given the name **Bronze Age** to the Late Neolithic period.

Origins of Agriculture

Agriculture must be thought of as a series of discoveries involving the domestication of plants and animals and their management (Fig. 3-3). The precise origin of the first center of agriculture is obscure. Carl O. Sauer (1952) has proposed that the beginnings may be southeast Asia. Its candidacy is proposed as a result of:

- Different ecological types

- A mild climate

- Ability to support a population by hunting and fishing

- A naturally rich flora—especially asexually propagated plants. It is likely that planting of vegetative plants preceded the planting of seed.

The spread of early agricultural techniques led to new advances as new plant forms were carried to new environments. Archeological evidence is the “literature” of the beginnings of agriculture. The evidence places contemporary agriculture 7000 to 9000 years ago in the river valleys in three locations;



Fig. 3-1. Adze and axe 7000 BCE. Earliest tools were made from flaked flint. Later certain tools began to be shaped from hard stone that was polished with an even harder stone, like emery, which could take 4–8 weeks. These tools had to be fitted into a shank made of antler before they could be fixed to a handle. Source: Syria.



Fig. 3-2. Terra cotta spindle whorls 5000 BCE. These objects were used as weights in the process of spinning threads. In Syria, flax was the first fibre to be spun (into linen), predating the use of sheep's wool. Source: Syria.

A



B



Fig. 3-3. Reconstruction of Paleolithic landscape (A) and Neolithic village at Abu Hureyra (B). Source: Syria.

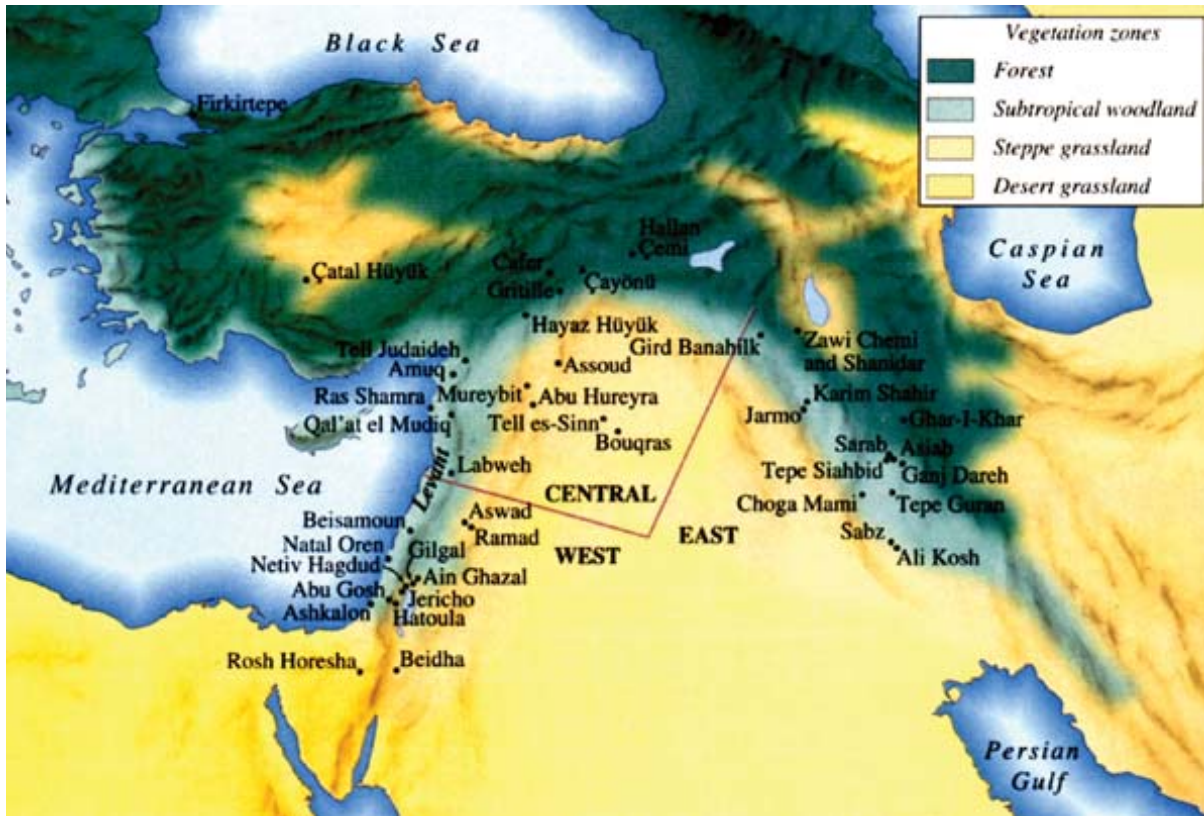


Fig. 3-4. The fertile crescent.

Tigris-Euphrates Rivers (Mesopotamia—present day Iraq)
 Indus River
 Nile River

The earliest evidence of agricultural development occurs in the area known as the Fertile Crescent (present-day Iraq, Syria, Lebanon, Israel) (Fig. 3-4, 3-5). Jarmo is one of the earliest villages. Agriculture also developed in other areas such as China and MesoAmerica but at a later date. The precise push to develop agriculture is not clear but a number of reasons have been speculated.

Domestication for Religious Reasons. These include rituals, ceremonies, and magical spells, many of which are related to healing. In early societies, agriculture is thought of as a Divine Gift. Present-day evidence for the relation between agriculture and religion is found in the sanctity of cows, bullfights, use of sheep in sacrificial ceremonies, sacred oils, incense, religious use of bread (the “Eucharist” is the consecration of bread and wine in Christian theology).

Population Pressure. Climatic changes reduced range and led to “oasis” agriculture. Population pressures may have initiated plant domestication. In agricultural societies children are assets, so once the decision is made to depend on agriculture, populations inevitably increase and the economy becomes locked into agriculture. A high value is placed on prolific women; barren ones are cast out. Subsistence agricultural populations are unlikely to reach equilibria without disease epidemics, famine, and war.

Nomadism. Nomadism refers to a primitive type of animal agriculture in which there is no fixed location but the herder and the flock or herd rotates in a search for suitable pasture. Nomadism is the link between hunting and farming.

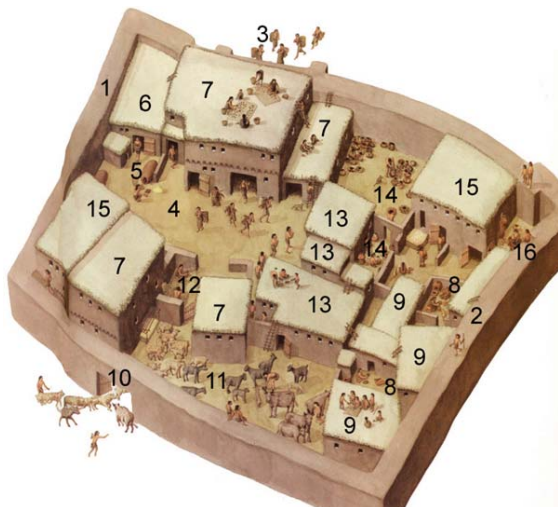
Fig. 3-5. Images from the Ancient Near East

A. Female figurines - Terra cotta 5000 BCE. Sites from this period yield an abundance of terra cotta representations of women with exaggerated hips and breasts, convincing evidence that the agro-pastoral communities at the time were very much concerned about fertility as a fundamental principle of survival. This type of fertility symbol—called a mother goddess by some—appeared in the Near East at the end of the 9th millennium and continued in various related styles of representation for several more millennia.



B. Terra cotta wagons 2500 BCE. Carts were developed towards the end of the 4th millennium. At first, they were drawn by asses or oxen, which were preferable for transporting heavy loads. The two-wheeled model is called a cart. Since wagons were slow going no more than 15 km per day, and could be used only on fairly flat land. It was more profitable to transport goods on the backs of asses, since these animals could travel over uneven terrain and cover a distance of 20 km per day.

C. The first houses that prehistoric Syrians lived in were round; later houses became rectangular, with rounded corners. However, by around 6000 BCE, at least on the site of el-Kowm, near Palmyra, people were living in three-part rectangular houses like this one (reconstructed). Their houses had plaster floors and were equipped with storerooms for keeping food and hearths for cooking it.



D. Model of a fortified Turkish village of Hacilon, about 5400 BCE. Source: First Farmers.

1) West wall, 2) East wall, 3) Northwest gate, 4) North courtyard, 5) Parching oven, 6) Grainery, 7) House, 8) Small courtyard, 9) Kitchen, 10) South gate, 11) South courtyard, 12) Basket weaving area, 13) Pottery workshop, 14) Pottery courtyard, 15) Shrine, 16) Well

Agriculture and Social Surplus: Conventional Theory

The creation of a **social surplus** brought about by agriculture—a series of related technologies involving plant and animals—gave rise to high populations and, when successful, to sedentary life for some, and the release of men and women to other occupations and leisure. In primitive societies based on food gathering, each individual is totally involved with the urgencies of securing sustenance. Abundance is temporary and exceptional. The “social surplus” releases from food production those individuals with skill in other specialties. This development of new specialties is only possible as agriculture increases in efficiency to allow the exploitation of a new leisure. This is still true. This led to a new class of specialists: artisans, clerks, and priests.

Primitive humans became organized into hunting, fishing, and gathering societies. When populations are significantly below the carrying capacity of the land and wants are simple, life is easier than in agricultural societies. Gatherers in temperate and tropical climates do have leisure time and usually become wise in plant lore. Hunting supplements the food supply. However these societies are based on low populations. Farming requires more work but feeds more people dependably.

The interaction of hunters and farmers has traditionally led to conflicts.

The conflict between hunters, nomads, and farmers is historic and traditional and is based on land claims. **J. R. Harlan** in *Crops and Man* (1992) points out that present-day hunter gatherers know how to cultivate crops but do not because it is too much work. Probably women, not involved in the hunt, were the first farmers. See **Reading 3-1**. p. 51-65.

Agriculturists view hunters as savage, backward, primitive, ignorant, indolent, lazy, wild, lacking in intelligence.

The legend of Abel and Cain. Offering to God by Abel (nomad) was acceptable but Cain (farmer) was not! Clearly the author of the book of genesis was a nomad.

The dispute between cowboys vs. farmers in US. Western lore is an extension of this dispute.

Domestication of Crop Plants

The development of cultivated plants is one of the fundamental processes that led to the development of agriculture. Practically every one of our present day crop plants and domestic animals was developed before recorded history. Thus our crop plants and animals represent our greatest heritage from the past. **The greatest horticulturists were undoubtedly Neolithic farmers.**

Crops—refers to any plant that is harvested systematically.

Cultivated crop—any plant which is grown through human interference; it may be a wild plant.

Domesticated crops—The word, domesticate, refers to bringing a plant or animal into the household. It usually involves interference in the reproductive process, and long time plant and animal domestication leads to fundamental genetic change. Thus, domesticated crops are altered genetically from the wild state, not merely tamed. Examples: domesticated cats vs. bobcats; wild wheat (shatters) vs. bread wheat (nonshattering) (Fig. 3-6).

Domestication is a two step process:

1. Cultivation: choosing and bringing a wild plant (or animal) into management.

2. Selection: the differential reproduction of variants of these plants to better suit the needs of humans. This may be an unconscious action, e.g. selection for non shattering in grains because this character will be increased with hand harvesting. Similarly, selection for extension of juvenile state in animals is achieved naturally by selecting for nonaggressive animals.

As a result of changes wrought by selection, many crop plants have been so changed that for many of them their origins are obscure with no extant close wild relatives. Some no longer appear outside of cultivation, and have become new types called **cultigens**. Maize and cabbage are two examples.

Changes from Wild Species to Domesticated Crops

(Source: Franz Schwanitz 1906)

Gathered plants are the first form of wild plants. Present-day examples of species that are still gathered in various parts of the world include:

Blueberry (*Vaccinium* spp.)

Brazil nut (*Bertholletia excelsa*)

Chickpea (*Cicer arietinum*)

Indian rice (*Zizania aquatica*)

Rubber (*Hevea brasiliensis*)

Sugar maple (*Acer saccharum*)

However, wild plants become distinctly different from cultivated plants. The change from wild to cultivated crops is characterized by a number of gross genetic changes. These involve:

1. *Gigas characteristics*

Cultivated plants appear larger, more robust, larger thicker leaves, fleshier roots, larger flowers, fruits, and seeds. Due to a number of factors.

- a. Polyploidy. (Examples: strawberry is an octoploid, bread wheat is a hexaploid.)
- b. Possibility of internal changes in the chromosomes which are often larger and thicker in cultivated plants
- c. Mutation

2. *Reduction in fertility*

- a. Decrease in fertility through reduction in seed number, accompanied by an increase in seed size.
- b. Loss of fertility, particularly true for crops in which economic portion is not the seed. Many cultivated sweet potatoes no longer flower. Many cultivated crops are seedless, such as banana, orange. Thus, crops are often dependent on humans for survival.

3. *Loss of survival characters*

Shattering ability in grains

Potatoes- tubers borne close to plant in domestic types, spread in wild types

Thin vs. thick shells in nuts

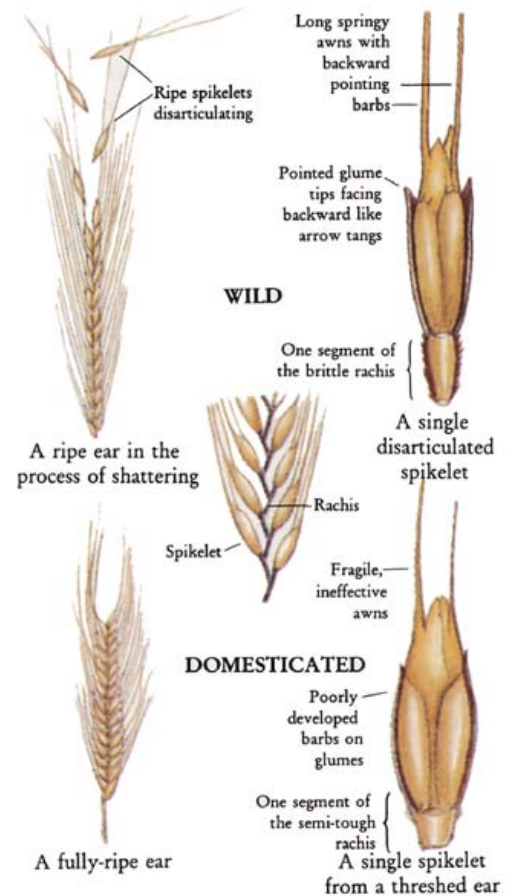


Fig. 3-6. Wild and domesticated forms of einkorn wheat. Wild forms need to disperse seeds effectively and has thus evolved easily shattered ears with brittle rachises and thin, arrow-shaped spikelets designed to penetrate surface litter and embed themselves in cracks in the ground. In domesticated form, plumper spikelets have lost some of the key structures necessary for self-implantation, seed dispersal, and success in the soil. Source: Smith 1994, p. 73.

4. *Loss of bitter and toxic substances*

Hydrocyanic acid in cassava
Tannins in apples
Bitter principles (cucurbitacins) in cucurbits
Bitterness in lettuce

5. *Loss of protective, defensive structures*

Spines (citrus, apples, locust)
Prickly fruits and seeds (cactus)

6. *Loss of delayed germination*

Loss of dormancy separates weeds from many annual crop plants.
Typically, ornamentals (closer to wild plants) have seed dormancy while vegetables do not.

7. *Early and simultaneous ripening*

This change is occurring in tomato.

8. *Change in life span*

Seed crops- shortened
Vegetative crops – lengthened

9. *Changes in organ shape and size*

roots - carrots, parsnips, beets
flowers - doubleness
buds – cauliflower
fruits - increasing apple fruit size

10. *Increase in self pollination*

Cultivated types are often highly self pollinated. Self-pollination is rarer in wild species.

References

- Ames, Oakes. 1939. Economic annuals and human cultures. Botanical Museum of Harvard University, Cambridge, Massachusetts.
- Anderson, E. 1969. Plants, Man, and Life. University of California, Berkeley.
- Baker, H.G. 1970. Plants and Civilization. Wadsworth Publishing Co., Belmont, California.
- Bender, B. 1975. Farming in Prehistory: From Hunter-gatherer to Food Producer. John Baker, London.
- Camp, W.H., V.R. Boswell, and J.R. Magness. 1957. The World in your Garden. National Geographic Society, Washington, DC.
- De Candolle, Alphonse. 1890. Origin of Cultivated Plants. D. Appleton & Co., New York.
- Diamond, J. 1997. Guns, Germs, and Steel. W.W. Norton & Co., New York.
- Diamond, J. 2002. Evolution, consequences and future of plant and animal domestication. *Nature* 418: 700-707.
- Fortin, Michel. 1999. Syria: Land of Civilization. Musee de la ovilesation de Quebec.
- Frankel, O.H. and E. Bennett (ed.). 1970. Genetic Resources in Plants: Their Exploitation and Conservation. IBP Handbook No. 11. F.A. Davis Company, Philadelphia, Pennsylvania.
- Frankel, O.H. and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. International Biological Programme 2. Cambridge University Press, Cambridge, Massachusetts.
- Harlan, J.R. 1971. Agricultural origins: centers and non-centers. *Science* 174:468-474.
- Harlan, J.R. 1992. Crops and Man. 2nd ed. ASA, CSA, Madison, Wisconsin.
- Hedrick, U.P. (ed.). 1919. Sturtevant's Notes on Edible Plants. Report of the New York Agricultural Experiment Station for 1919. J.B. Lyon
- Hutchinson, J.B. (ed.). 1965. Crop Plant Evolution. Cambridge University Press, New York.
- Isaac, Erick. 1970. Geography of Domestication. Prentice-Hall, Englewood Cliffs, New Jersey.
- Reed, C.A. 1977. Origins of Agriculture. Mouton Publ., The Hague, Paris.
- Sauer, Carl O. 1952. Agricultural Origins and Dispersals. American Geographic Society, New York.
- Schwanitz, Franz. 1966. The Origin of Cultivated Plants. Harvard University Press, Cambridge, Massachusetts.
- Singer, C., E.J. Holmyard, and A.R. Hall (eds.). 1954-1958. A History of Technology. (5 volumes), Oxford University Press, London.
- Smartt, J. and Simmonds, N.W. 1995. Evolution of Crop Plants. Longman Scientific Technical, Burmt Mill, Harlow, Essex, UK.
- Smith, B.D. 1994. The Emergence of Agriculture. Scientific American Library of New York (Div. of HPHLP).
- Solbrig, O.T. and D.J. Solbrig. 1994. So Shall You Reap. Island Press, Washington, DC.
- Ucko, P.J. and A.W. Dimbleby. 1969. Domestication and Exploitation of Plants and Animals. Duckworth & Co.
- Vavilov, N.I. 1949-1950. The Origin of Variation, Immunity, and Breeding of Cultivated Plants. Chronica Botanica Co., Waltham, Massachusetts.