2.3 TECHNOLOGICAL CHANGE IN WARRING STATES CHINA

Texts such as the *Shiji* provide us with a considerable body of data concerning changes in technology and material culture during the Classical era. This brief section describes some of the most basic of these changes, which accommodated the transformation of China during the Warring States period. The principal focus of these pages is on agriculture, which was – and remains to this day – the foundation of the Chinese economy and of China's social institutions. We will also describe the technology that brought China into the Iron Age during this period, and the rapid development of China's waterway system, which permitted the commercial growth of the last years of the Zhou.

The Revolution in Agricultural Technology in Ancient China

Many of the political and social changes that can be observed over the course of the Spring and Autumn and Warring States periods are closely related to changes in agricultural practices and technologies. Just as the industrial revolution changed the structure of European life during the nineteenth century, the more gradual revolution of the Iron Age in China changed the most basic limiting constraints of society and political organization, and the resulting changes were enormous.

Marxist historians and our current understanding

Marxist historians (of whom there have been not a few in the People's Republic of China) view all phenomena of human culture as indirect reflections of the underlying economic structures governing production. For Karl Marx, who lived during the time of the Industrial Revolution's greatest impact, the nature of production methods and the way in which the means of production (land, tools, liquid capital) were distributed in a given society determined all other phenomena: laws, literature, imagination. Marx's theories have not only influenced the way ancient history has been studied in China, but also studies of ancient China in Japan.

Even if we do not follow Marx's ideas, we benefit greatly from the types of economic history that Marxist-oriented East Asian scholars have pursued (and not just East Asians – the late Joseph Needham, a British biologist-turned-sinologist who spent forty years compiling an encyclopedic account of Chinese science was likewise influenced by Marxism in his choice of specialization). In many respects, it is they who have uncovered the truly revolutionary nature of social change in ancient China. We may not agree that the means of production and their ownership are the ultimate determinants of all social phenomena, but it is unquestionably true that they are critically important, and that no historical account can afford to ignore them.

The importance of agricultural history

It is a principle of this course that what was important to the ancient Chinese peasant must be important to anyone who studies ancient Chinese history. Whether we are discussing the location of farm dwellings inside or outside city walls, the system of taxation that made farm life bitter, or

the intellectual categorization of social classes, which gave farmers an illusory high status, when we explore the condition of the peasantry, we are looking at key **limiting factors** that constrain the enterprises upon which other sectors of society can choose to embark.

In this section, we will explore briefly certain basic facts of Chinese agricultural life, and then discuss the ways in which agriculture was dramatically changed during the period of Classical China.

Dominant crops and the menu of ancient China

The most pervasively cultivated crop in ancient China was **millet**, a short-grained cereal that is not attractive enough for modern supermarket shelves. The key role of millet is reflected in the fact that the Zhou royal clan traced its roots to a lineage founder known as "Prince Millet," and that the mythology of the rise of civilization that was probably most current in Zhou times, before an earlier culture-hero known as the "Spirit Farmer" became popular in legend, probably pictured this Zhou founder as the inventor of agriculture. Millet was the essence of farming, and we find traces of millet in virtually all archaeological sites, dating back to the Neolithic period.

Apart from millet, of which there were several main varieties, the other two most widely planted grains were **wheat** and **rice** (barley was also cultivated). Two types of wheat were planted: from an early date, "spring wheat" was an important crop, planted in spring and harvested in the fall. But during the Classical period, another type, "winter wheat" came to be more widely planted. It was planted in the fall and harvested in late spring, allowing the field to be devoted to another crop after the initial harvest.

Wheat, like millet, was not generally ground. Only late in the Warring States period did the practice of grinding wheat into flour and producing "cake" arise. Instead, wheat, like millet, was generally eaten boiled, or seared and then boiled, in a kind of gruel to which flavoring, vegetables, and meat could be added. (This is not far removed from much Chinese cooking today). Grains were also in demand in the manufacture of alcoholic drinks, which were used in many rituals of the patrician lineage cults, and were also considered essential for the drunken orgies which many members of the elite found an important form of relaxation after a busy day examining the state treasuries.

Rice, which grows in nearly-stagnant water, required land rich in irrigation resources, and could not be planted far north. Nevertheless, it was a highly prized grain, as it is in China today, and much in demand.

In addition to these grains, soybeans were a very important crop. Although the techniques for using soybeans to create tofu, imitation hamburgers, cameras, and Toyotas had not yet been invented, soybeans themselves actually taste very good, and were the most common vegetable supplement to the Chinese diet (soy sauce probably was devised during the Classical period as well).

The Classical diet was overwhelmingly vegetable. Although the records of huge ritual slaughters of livestock indicate that the ancestors had an insatiable taste for meat, the ordinary person tasted very little or none. Only in wealthier districts and among the patrician class were domesticated animals raised for food. The most common of these were pigs and dogs (sorry); cattle, sheep, and goats were also husbanded, along with fowl, such as chicken, goose, pheasant, and quail. Hunting yielded a variety of prized foods for the high elite, particularly several varieties of deer; fish were a delicacy in inland areas.

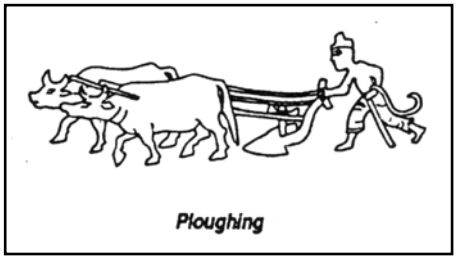
Other cultivated crops

Classical Chinese ate a variety of fruits and vegetables, but it is unclear to what degree these were cultivated; many were simply gathered from the borders of settled areas. Among the vegetables that may have been grown in garden plots were turnips, leeks, and lettuces. Melons and cucumbers were also raised. Lotus roots, water chestnuts, ginger, cinnamon, and in some areas bamboo shoots were probably gathered wild.

Among the fruits that were gathered from trees were oranges, pomelos, dates, and chestnuts. The most important tree, however, was the mulberry. The leaves of the mulberry are the principal food of the silkworm, and it was a remarkable invention of ancient Chinese culture to domesticate the silkworm and bring to it leaves plucked from the mulberry. Silk, with meat, was the most basic of all luxury goods in China, and the reward of the common man or woman for living to the age of sixty (no easy chore) was that one then qualified to demand of one's family a bit of meat at meals and silk clothing.

For the less fortunate or the younger, clothing was produced through the growing of hemp, which produced a fiber basic to everyday wear. The leaves of the hemp plant were also sometimes eaten in congee, if nothing tastier was available (or, perhaps, if the days were dull).

The revolution in Classical agriculture

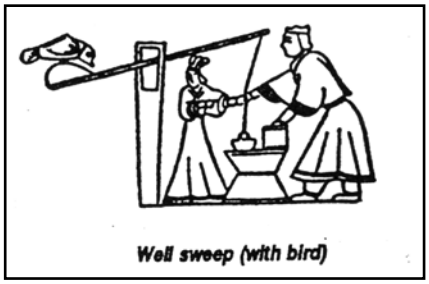

Ploughing

All of the possibilities of social organization in ancient China were dramatically altered by the innovation of iron technology and the production of the iron plough, which began to appear late in the Spring and Autumn period. Prior to this time, plowshares had principally been made from wood. Wood ploughs could cut only looser types of soil and severely limited the area of land that qualified as arable. Moreover, wooden ploughs required a great deal of pressure to cut the soil to the degree they could. The farmer would need to grip the plough handle and use his foot to press the plough down as he pushed forward a step at a time, using the motion of his arms to clear a furrow as he went hopping along.

The advent of the iron plough led directly to a second innovation: the ox-drawn plough. With the weight and sharpness of the iron plough, it was no longer necessary to exert more downward pressure to cut a furrow than could be provided by the arms as they gripped the plough

handle. This meant that the farmer's feet could be freed for walking. Of course, the iron of the plough was heavy and difficult to push. Over time, oxen, individually or in yoked teams, were increasingly employed to pull the plough. With the iron plough and ox power, lands that had once been too poor to be worked suddenly became worth opening up. Wastelands began to vanish, and in their stead settlements and walled towns sprang up. Many patrimonial estates of modest influence suddenly found themselves with a vastly increased tax base, anxious to attract the people of neighboring lands to their territories to provide labor for newly reclaimed fields. In some cases, buffer zones between states disappeared and became fertile country worth seizing. All of this contributed directly to the proliferation of armed struggle over the principal "means of production": land and labor.

Other innovations in this period contributed to these changes. In the past, farmers who wished to irrigate their crops had not had any method better than carrying jugs to and from water sources. During the Classical period, a device called a well sweep, which suspended a bucket at the end of a long pivoting lever, greatly eased small scale irrigation. In addition, the beginnings of a dense network of irrigation canals boosted yields, and allowed the cultivation of rice in areas where it had not been previously possible. A growing understanding of the importance of manure allowed the reduction in the amount of land that had to lie fallow, recovering nutrients, and also encouraged a burst in the planting of winter wheat, which made the double crop schedule feasible through a large portion of China.



Well sweep (with bird)

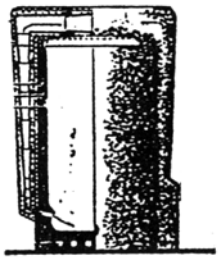
Finally, as the many possibilities for vastly increased yields came to be understood, a science of agriculture came into existence, and men whose technological skills in farming were of practical value came to enjoy privileged status as teachers, not unlike the status accorded Confucian masters of ritual techniques and Mohist masters of the arts of defensive warfare. The promise of status and students with gifts of tuition attracted a significant number of people to the study of agriculture as an art. The long term result was that by the end of the first millennium A.D., China possessed a sophistication in the technology of traditional agriculture that has never been surpassed (an excellence which may, in fact, have inhibited the stimulation of further scientific inquiry). The basic contours of this spectacular agricultural system were laid during the Classical period, and as they were, they gradually transformed the political and cultural possibilities available to all members of society.

Metallurgy: China's Transition from the Bronze Age to the Iron Age

While bronze was the most advanced mode of technology throughout the late Shang and early Zhou, sometime during the sixth century B.C., China developed iron technology. The spread of iron technology improved agricultural techniques and yields, thus making greater populations possible, and also improved technologies of war. It is possible to trace many of the differences between Chinese social patterns of the Spring and Autumn period and those of the Warring States era to the entrance of China into the Iron Age. For example, the abandonment of chariot warfare

and the mobilization of huge infantry forces grew in part from the availability of iron weaponry, and in fact this type of transition in warfare is linked to the advent of the Iron Age in societies other than China.

Ancient China developed both wrought (hammered) and cast iron processes. From an early date, perhaps about 500 B.C., the bellows-driven smelter became common. Large forges equipped with a line of bellows could drive temperatures extremely high, allowing advances in iron technology which placed China from one to two millennia in advance of European technologies, which employed relatively brittle wrought iron until a much later date. Sophisticated experimentation resulted in an ability to forge steel, which was used in the highest quality weaponry, such as famous swords from the states of Han and Chu, the colorful names of which appear periodically in contemporary accounts.



Smelting furnace

Iron mine technology was also very advanced. Likely sites were identified by land configurations and iron-related surface minerals. Perpendicular shafts were driven up to 150 feet down, with horizontal shafts, supported by wood-beam frameworks, dug at various levels. Systems of ropes and pulleys allowed the ore to be raised to the surface, and other debris was lifted to higher, exhausted shafts, where it was deposited as fill to stabilize the mine and to facilitate proper air flow.

During the Warring States period, virtually every state possessed domestic mines and ironworks, where weaponry and agricultural tools, such as spades, adzes, hoes, and so forth, were manufactured.

The Development of Water Conservancy

From the sixth century on, the governments of the various states began to devote increased attention to massive public works. Among these were large-scale dams and canals, which improved agricultural productivity, transportation for commerce, and the ability to move troops in times of war.

The earliest of these projects that can be dated with certainty is the construction in stages of a massive canal, undertaken by the government of Wu, a southeastern state on the north bank of the lower Yangzi, whose population was considered non-Chinese until midway through the Spring and Autumn period. As we saw earlier, in the early years of the fifth century, the ruling house of Wu capped a rapid rise to power by seizing the hegemonic leadership of the patrician lords. As part of this political process, Wu began work, in 486, on a massive canal, designed to link the waters of the Yangzi with those of the Huai River, which lay north, midway between the Yangzi and the Yellow River. Four years later, this canal was extended further north to reach waterways in the smaller states of Song and Lu, at which point a navigable route existed linking the Yangzi to the Yellow River. While the motive for this canal system was chiefly military, its benefits for agriculture and commerce were far greater. The artificial waterways it created provided irrigation

that improved existing fields in some places, and allowed new lands to be opened to cultivation in others. Its military success was limited – as we have seen, the state of Wu was annihilated by its neighbor to the south, Yue, in 473, less than ten years after the completion of the system.

The construction of canals, which involved sophisticated technologies, was somewhat more complex than that required for dams. Dams had been a feature of the Chinese landscape for centuries, particularly in the flood plain of the Yellow River, where catastrophic floods periodically laid waste to vast regions of farming. From the late Spring and Autumn period on, the increases in corvée labor available for massive public works projects led states to address this sort of problem more comprehensively than in the past – not, for the most part, cooperatively, but rather as one aspect of increasing political competition. Along the lower reaches of the Yellow River, the state of Qi, which extended east from the geographically lower southeast bank, constructed a great dike about eight miles to the east, greatly reducing flood damage. The states of Zhao and Wei, which shared the northwest bank and which had not been much troubled by floods, suddenly found themselves awash in the backwaters created by the dike in Qi, and the constructed their own dikes at a similar distance from the river channel. As a result, flood damage was constrained to a strip about fifteen miles wide. The rich silt deposited there by floods actually made this land highly fertile, and farmers exploited the land very actively, only slightly discouraged by the fact that every decade or two, catastrophic floods destroyed their crops and drowned them in great numbers.

The development of a canal system was also a major spur to the growth of commerce. Not only were goods more easily shipped in barges along waterways than overland by ox carts, but these "high speed" routes made possible the sort of inter-regional trade that creates a market for rare items and exotica. In particular, goods from the sub-tropical south found a ready welcome in the more barren north once it became feasible for merchants to undertake their transport. Commerce in such objects was an extremely high-profit trade which contributed significantly to the growth of the merchant class, and also began a thousand-year process that saw the balance of wealth and population shift dramatically from the north to the south.

The most famous of all these waterway projects provides an illustration of how these improvements were critically linked to political intrigue. The following tale from the *History of the Former Han* is an account of events in the mid-third century, when Qin's imminent conquest of the other patrician states was becoming increasingly evident.

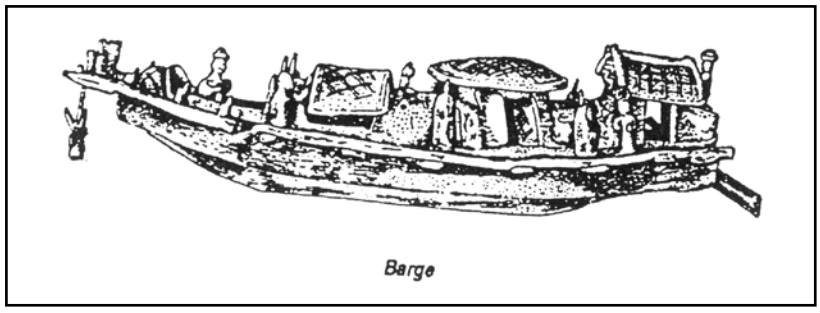
The state of Han, learning that Qin was eager to undertake profitable enterprises, desired to exhaust Qin's resources thereby, in order that Qin should not begin expanding towards the east. The ruler of Han therefore sent to Qin a hydraulic engineer named Zheng Guo, to persuade deceitfully the ruler of Qin to open a canal from the Jing River, flowing eastwards from Zhongshan and Hukou, and extending along the foot of the northern mountains, carrying water to fall into the River Luo in the east. The proposed canal was to be more than 300 *li* in length and was to be used for irrigating agricultural lands.

..... Route of the Zheng Guo Canal

Before the construction work was even half finished, however, the people of Qin became aware that the project was a trick, and the ruler of Qin wanted to kill Zheng Guo. Zheng Guo addressed him as follows: "It is true that initially I deceived you. Nevertheless, when completed, this canal will be of great benefit to Qin. This ruse has prolonged the state of Han by a few years, but I am accomplishing a work that will sustain the state of Qin for ten thousand generations."

The king of Qin agreed with him and approved his words. He gave firm orders that the canal was to be completed. When it was finished, rich silt-bearing water flowed through it to irrigate more than forty thousand *jing* (about 650,000 acres) of alkaline fields. Subsequently, the harvests from these fields yielded an abundance of up to one *zhong* per *mu* (about 70 bushels per acre). Thus the Lands Within the Passes became a fertile country, and famine years were unknown. Qin became rich and powerful, and in the end was able to conquer all the other feudal states. The canal was known ever after as the Zheng Guo Canal.

(adapted from Joseph Needham, *Science and Civilization in China* [Cambridge] IV.3, 285)



Barge

KEY TERMS

Iron Age the iron plough

Sources and Further Readings

One of the most significant scholarly enterprises in the field of Chinese studies has been the series, *Science and Civilization in China*, which was begun in the early 1950s by the British biologist and sinologist Joseph Needham. The series was written or supervised by Needham until his death in 1995, and volumes continue to be published as of this writing. Aiming at completeness rather than brevity and often very technical, the works in this series are the most authoritative sources for issues of Chinese science and technology in all traditional periods. However, for the Warring States era, Cho-yun Hsu's *Ancient China in Transition* provides essential information.