

## Traditional Chinese Plows and the Transfer of Their Technology

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### Introduction

To date, very little systematic research on Chinese traditional plows has been conducted. To the best of my knowledge, Amano Motonosuke, who has devoted his life to the study of agricultural history in China, Zhou Xin, who works at the Research Institute for Agricultural Tools in Jining City, Shandong, and Professor Yin Shaoting of Yunnan University, who is also the commentator for this session, have published acclaimed works incorporating research results from their fieldwork and archaeological and documentary studies. As a result, the types and geographical distribution of plows traditionally used in China have so far been made clear. However, there are still unresolved issues concerning the significance of the origin and development process of traditional Chinese plows. Based on recent trends in the study of agricultural history and on my own research, I would like to state my opinions on some of these issues.

### 1. The issue of the stone plow of the Neolithic Age and the bronze plow of the Shang Dynasty

First, let us consider the issue of when the plow first appeared in China. There are currently two theories regarding the origin of the plow in China. The first is that the plow was invented in China; the second is that it was imported. Many Chinese researchers support the first theory, and one basis for their belief is the presence of the stone plow of the Neolithic Age.

Stone plows have mainly been unearthed from sites belonging to the Songze and Liangzhu cultures of the Taihu (Great Lake) area (in Zhejiang, Jiangsu, and Shanghai). Like the plowshare, the stone plow is triangular, with two or three perforations in its center, and both its sides sharpened into blades. Most stone plows have sides about 20 centimeters in length, sometimes as long as 50 centimeters. The stone plow is believed to have been attached to a wooden body when used, but since such wooden bodies decay, their restored shapes and forms vary according to the researchers who draw them. In the early stages of research, these stone plows were restored in the form of cultivation tools similar to man-powered frame plows, and this shape was believed to have been the archetype for the current plow. Recent archaeological findings, however, have shown that two wing-like stone parts were attached to a type of stone plow, and that these were used together. In addition, a stone plow still attached to a wooden body that was luckily found at the site dating back to the Liangzhu Culture in Pinghu City, Zhejiang, was quite possibly a treadle plow used for cultivation. Yoshiki Koyanagi, who has excavated Neolithic sites in the Zhejiang region, has publicized his opinion that this particular stone plow should not be compared to the frame plows of Northern China that appear later, based on his observations of countless stone plows. I share his opinion on this matter.

In relation to the origin of the plow used in China, the one agricultural tool other than the previously mentioned stone plow that I must refer to is the bronze plowshare. Very few examples of this type of plowshare have been found so far. Some major examples include the two recently found at the large tomb dating back to the Shang

Dynasty found in Xingan Prefecture, Jiangxi, and another unearthed in the area between Henan and Shanxi (and introduced by Amano in his work) dating back to around the Western Zhou Dynasty. As they all have designs of *taotie* (mythical ferocious animals) inscribed on their surfaces, they are believed to have been farming tools made for ceremonial use. They are all quite small ; approximately 10 centimeters long and 13 centimeters wide. As other bronze farming tools such as the *lei*, *si*, *chan*, *cha* and *jue* have been unearthed from the Xingan site, the function of the plowshare must have been different from those of the other tools. It is therefore impossible to reach a definitive conclusion as to whether this tool was actually used as the tip of the plow pulled by animals simply because it looks as if it was used in this way. Looking into the *jiaguwen* (inscriptions on bones or tortoise shells dating back to the Shang Dynasty), which are the earliest forms of Chinese characters, the primordial form for the character 犁 (noted as “犁” in *Shuowen*, a book of characters dating back to the Eastern Han Dynasty) is believed to have been “𠂔”(𠂔), which is a pictograph describing the cultivation of earth using the *lei* or other such treadle plows. The element 牛 (cow) was later added to this character, after the Spring and Autumn Period and the Warring States Period. It is symbolically significant that there were actually two followers of Kongzi (Confucius) (551-479 B.C.) who had names related to plowing : Rangeng (also known as Boniu), and Sima Geng (aka Sima Li, aka Ziniu). Such names were probably given to the followers since the cow-pulled plow was an innovative technology at the time. Therefore, I hesitate to agree that the bronze plowshare of the Shang Dynasty should be deemed direct proof of animal-powered plowing.

## 2. The innovation of iron-making technology and the dissemination of iron agricultural tools

In documents from the Warring States Period, such as *Guoyu*, *Zhanguoce*, *Hanfeizi* and *Shangjunshu*, the Zhongyuan States' policies for increasing wealth and military power are described vividly. Often mentioned in such historical literature is the presence of people called *gengzhan zhi shi*. Literally translated, these are people who hold farming tools and are engaged in farming in times of peace, but take up weapons and fight once wars start. Society during the Spring and Autumn Period was greatly different from that of the Shang and Western Zhou periods in that it was the law, and not the divine, that ruled citizens' daily lives. Also, it was commoners devoted to farming who were the major forces in national defense, rather than the aristocrats who fought on chariots. Everything from census registrations to military service systems, the organization and distribution of farmland, agricultural law, tax systems and forms of settlement worked together smoothly under the law. The sources of power and wealth of the rulers of the states during the Warring States Period were politics and foreign diplomacy by bureaucrats and the development of uncultivated frontiers by the *gengzhan zhi shi*. Of particular note is how in Qin State, as part of its Constitutional Reform of Shangyang during the reign of Xiaogong (361-338 BC), a large-scale basic provision system of farmlands called the *qianmo* (crisscross footpaths between fields) system was introduced and clearly worked hand in hand with plowing. In *Zhanguoce* it is recorded that “in the state of Qin, plows pulled by cows cultivate the land, and food is transported with river traffic.”

What supported the dissemination of plowing at the time was the innovation of iron-making technology during the Spring and Autumn Period. Man-made ironware first appeared in the Zhongyuan (Central Plain) region in the late Western Zhou Period (around 800 B.C.), and the technology for manufacturing steel by putting cast iron through the process of direct decarburization was invented during the transitional period between the Spring and

Autumn Period and the Warring States Period (mid-fifth century B.C.). This was a phenomenal invention in the history of iron making that promoted the large-scale production of iron weapons, farming tools and various production tools later in the mid- and late Warring States Period. Of the Zhongyuan states, Han, Wei and Zhao of the Shanxi and Henan regions, and Yan of the Hebei region had the most innovative iron-making technology during the Warring States Period. The institutions for producing iron weaponry and farming tools in the later Qin and Han empires had merely succeeded the legacy of these warring states.

The iron-making technology of the warring states had a large influence on the surrounding areas as well. For example, iron-farming tools of the Yan State were taken to the Korean peninsula via the Liaodong peninsula. As the traditional treadle plow in Korea called *ttabi* is reminiscent of the *lei* and *ba* of ancient China, it is my assumption that the former is linked to the latter. I also believe that the *jaenggi*, the plow traditionally found in Korea, closely resembles the frame plow of the Han Period because the Han people brought this type of plow when they settled in the area at the time Wudi (Emperor Wu) (108 B.C.) established the four commanderies (including the famous Lelang Commandery) in Korea. When the Qin State conquered the states in the Zhongyuan (Central Plain), it forced local residents to relocate to the frontiers for farming and cultivation. Among those relocated were adventurous iron-making technicians such as Zhuo Shi and Cheng Zheng, who are mentioned in the *Huozhi Liezhan (Treatise on Economy) of Shiji* and worked hard at refining and casting iron by actively employing workers from different ethnic groups, and made a great success in the back regions of Sichuan. However, in Southwest China, where many ethnic minorities lived together, such adventurous iron makers probably played a larger role in weapons innovation rather than dissemination of farming tools. The full-scale dissemination of iron farming tools began only after the establishment of the state-operated workshops called *tieguan* (Offices of Iron) during the Western Han Period.

### 3. Frame plows seen in pictorial resources from the Han Period and dry farming in Northern China

What were the plows of ancient China shaped like? The best materials for providing concrete answers to this question are the carved stones and wall paintings that adorn the tombs of the Eastern Han Period (first to second century A.D.). At the time, powerful native families invested vast amounts of money on tombs to show off their wealth. As a result, the walls of carved stone chambered tombs and wall-painting tombs depicted scenes of the families' manors and farms. As far as I know, fifteen such plowing scenes have been discovered to date. Upon detailed investigations of these scenes, I have discovered that there are two distinct types of ancient plows, which can be clearly differentiated in terms of geographical distribution. They are the quadrangular-frame plow used in the Shanxi, Gansu and Nei Monggol districts, and the triangular-frame plow used in Shandong and north Jiangsu (northern area of Jiangsu Province, north of the Huai River). In other words, the ancient plow of China is basically the frame plow, and this tradition has been handed down continuously to this day.

The frame plow, or more specifically the quadrangular-frame plow with a long sole, is not suited for cultivating deep soil, and was mostly used for shallow surface cultivation. The use of this type of plow is greatly related to dry farming, which was designed to suit the quality of soil, climate and natural features characteristic of Northern China.

Northern China is widely covered with loess, and local farmers have long conducted non-irrigation farming that

is dependant on rainwater. The average annual rainfall is 400 to 600 mm, most of which falls during the summer and autumn, when crops are in their growing stage. Therefore, farmers are often hit by drought damage in spring, when crops are in the seeding stage. A farmer's proverb in Northern China states that "nine years out of ten, there's a drought in spring." To counter the problem, farmers devised a way to store the precious little amount of rainfall that permeates the ground. The *li* (plow) is used to cultivate the thin top layer of soil, the *ba* (harrow) to crush the clods of earth, and the *lao* (flat harrow) (or *mo* (compacting soil board)) to compress the soil. Great pains are taken in treating the surface soil in this way to control the evaporation of moisture in the soil with capillary action. Such processes were especially important after the autumn harvest season, as the water preserved in the ground makes seeding in spring possible. The first academic in the field of agriculture to systematically describe this method of dry farming is Jia Sixie of the Northern Wei Dynasty (386-534 AD), who explains the significance of autumn farming procedures in his work *Qimin Yaoshu*: "If no harrowing is to be done after plowing, it is much better to do nothing at all" and "harrowing should be done over and over." I myself have been taught, during my research conducted in a farm village in Shanxi Province, about the number of times the soil needs to be tended after harvest, with phrases such as "two *lis* are followed by two *bas*" or "one *li* is followed by one *ba*."

So far, such systems of dry farming have been believed to have been completed around the end of the fifth century and the beginning of the sixth century, when the aforementioned Jia Sixie was active. But recently, numerous farming scenes depicting dry farming have been discovered in Jiayuguan, Gansu Province and the colored brick-chambered tombs of the Wei and Jin Dynasty Period and the Wuhu Shiliuguo Period in Jinguan. This shows that the method of dry farming was established earlier than originally believed, and that the *li* (plowing) – *ba* (harrowing) – *lao* or *mo* (rubbing) system was already established by the Han Period.

The tractive method for the frame plow most often employed during the Han Period was the *erniu taigang* method (the tractive method using a long yoke with two cattle). I have noticed in my research on farming tools in Southwest China that this method is quite inconvenient for turning in a different direction, due to the straight long-beam. The quadrangular-frame plow, with its long sole, requires more dexterity compared to the triangular-frame plow without the sole. Also, there was the short-beam swing plow, which could be pulled by one cow. Along with cattle, horses were used as draft animals, an example of which is mentioned in *Yantie Lun* (*Treatise on Salt and Iron*), written during the Han Period. What I found most interesting was the fact that there was a tractive method using a set of cattle and horses together, as can be seen in the carved stone of the Eastern Han Period depicting plowing, located in Teng Prefecture and Zaozhuang City, Shandong. I have heard that such methods are still in use today in Northern China, but I have yet to see any examples with my own eyes.

There are two points worthy of particular attention in regard to the functions of the plow used during the Han Period. One is the fact that the moldboard, which is used to turn over the soil, had already been devised at the time. Two types of moldboards have been unearthed to date – one that turns over the soil to both sides, and one that turns over the soil to only one side – and plows with moldboard attachments can actually be found in plowing scenes. Francesca Bray, who wrote the volume on agriculture in Joseph Needham's great work *Science and Civilization in China*, places the Chinese invention of the moldboard as one of the most significant incidents in the history of plowing technology. Zhao Guo's *daitian fa* (rotation of the ridge and furrow system) of the Western Han

Period, which is a system that alternately uses the ridge and the furrow, would not have been possible without the invention of the moldboard. The second fact of significance is that devices for adjusting the depth of cultivation (*jian* (bolt) and *ping* (adjuster)) had also been already devised at the time. These devices were first recorded in *Leisi Jing* by Lu Guimeng (? – 881), but had actually been invented much earlier than was believed. Pictorial resources from the Han Period have provided many new insights into the history of agricultural technology in China.

#### 4. Technology transfer of dry farming in the Jiangnan and Lingnan regions

China's climate can roughly be divided into two by the line that connects Qinling (the Qinling Mountain Range) and Huaihe (the Huai River). Northern China, which is the area north of this line, is a farming area where millet and wheat are raised, whereas the Jiangnan and Lingnan regions, which lie south of the line, have irrigated wet paddy fields used for growing rice. This is an approximate classification, but it is convenient for viewing China's overall climate. Since ancient times, the development of plowing and the improvement of plows in China mainly took place in areas north of the Qinling- Huaihe line. During the Warring States Period and the Han Dynasty, the Jiangnan and Lingnan regions were undeveloped and sparsely populated, and rice was grown in wet paddies with a farming method called *huogeng shuinou*. Little is known about this farming method, however, except that it was probably a method of direct seeding cultivation in which the plows were not used.

In records that date back to the Han Period, there are some rare examples of attempts made by the administrators of the times to disseminate plowing in Southwest China and the Jiangnan region. These attempts, however, should not be overrated; a full-scale introduction of plowing technology to areas south of the Qinling and Huaihe line was brought about later by the outbreak of refugees and immigrants who arrived in massive numbers at around the end of the Eastern Han Dynasty to the Six Dynasties Period. This era between the early third century to the mid-sixth century saw an unprecedented mobility in population due to a rapid succession of social unrest, such as the Yellow Turbans Uprising, the co-existence of the Three Kingdoms (Wei, Wu and Shu), the discord between the Northern and Southern Dynasties caused by the invasion of Northern China by the Wuhu (five different ethnic groups), and the fight for power among the dynasties. During this period, a large part of the population moved south from Northern China to Jiangnan and Lingnan. For example, when the Western Jin Dynasty was overthrown by the Yongjia Rebellion (early fourth century A.D.) and the Eastern Jin Dynasty was established in Jiangnan, it is recorded in *Jinshu* vol. 65, *Biography of Wang Dao*, that “60 to 70% of the people of Zhongyang sought refuge in Jiangnan.” These refugees formed new residential districts according to their areas of origin, and the commanderies and prefectures thus formed were called *qiaojun* and *qiaoxian*. The character 僑 (*qiao*) means “a person living temporarily in a strange land,” and these people were discriminated against by the natives, as their domiciles of origin were listed on the family register.

Since many ethnic minorities resided in Southwest China and the Lingnan area at the time, the Han people who settled in the area are believed to have separated their habitats to some extent in order to avoid conflict. According to my experience in research conducted in Yunnan, the state-operated farms worked by the newly settled Han people (mostly poor peasants from Hunan and Hubei) were set up in the neutral zone situated between the ethnic minority that conducted slash-and-burn cultivation in the mountains and the ethnic minority that conducted wet

rice farming in the basin. Institutions such as schools, hospitals and repair shops for farming tools were established, and the political and cultural awareness of the residents, who formed a unit of civilization of their own, was quite high.

Actually, a similar awareness existed among the Han people who settled during the previously mentioned times of social unrest. The models of irrigation pond and paddy field in Southwest China and models of plowing and harrowing paddy field in the Lingnan region are concrete examples that symbolize the identity of the Han settlers. These are all funeral objects buried with bodies in burial sites, and most of those found in Southwest China were buried during the Eastern Han Period (first century to early third century), depicting a union of water supply and irrigation facilities (doubled with fish breeding ponds) with wet paddy farming. Most of those found in the Lingnan region, on the other hand, date back to the Western and Eastern Jin periods (late third century to fifth century), and depict the land improvement works of wet rice paddies that use the *li* and *ba* before seeding. In some rare cases, figurines holding the *cha* (treadle plow) are included in the former group of models, but there are no items that indicate the practice of plowing. This is because the use of plows did not spread in Southwest China, and farmers depended on hand tools such as hoes and treadle plows, which is proved from the fact that the iron *cha* manufactured at the *tieguan* (Offices of Iron) in the Shu Commandery, Sichuan, was widely circulated in Southwest China. On the other hand, the *li* and *ba* appear in the latter group of models as they relate to the settlement of farmers with experience in dry farming during the period of social disturbance.

To this day, seven models of plowing and harrowing paddy fields have been discovered. They are concentrated in the Canton Delta region, and all except one have been unearthed in the Guangxi area excluding Guangdong. As mentioned before, these models all date back to after the Western Jin Period, but aside from these, one model of a wet paddy field that dates back to the Eastern Han Period (second century) has been found at Lanshi, Fongshan City, Guangdong. As this model depicts a plowshare on the surface of the fields, it has attracted researchers' attention as one proof of how plowing was disseminated in the Canton Delta region. But I came to doubt this depiction of plowing, as the positional relationship of the plowshare and the person handling the tool seemed to lack validity. When I visited the Panyu Museum of Canton Province in the spring of 2005, I found a model of a wet paddy field similar to that unearthed from the brick-chambered tomb of the Eastern Han Period. Depicted in this model was the process of wet paddy farming, which showed the use of treadle plows but not the plow. Panyu and Lanshi, where these models were discovered, are only 30 kilometers apart. These models show the standards of wet paddy farming by the settlers (or their descendants) in the Canton Delta before the period of social unrest, and indicate that the main agricultural tool used at the time was the treadle plow, not the plow. Through these findings, I became more convinced that the dissemination of plowing in the Canton Delta was brought about by settlers who came to the area after the late third century.

Models of plowing and harrowing paddy fields clearly indicate the transfer of dry farming from the upland farming area in Northern China. The farming tools that appear in the models are the *li* (plow), *ba* (harrow) and *liuzhou* (roller). All these tools are pulled by animals (cattle or water buffalo), and the plow cultivates the surface, the *ba* (*chaoba* (vertical harrow)) crushes the clods of soil, and the *liuzhou* (roller) compresses the bottom of the wet paddy. This is an applied version of the plowing-harrowing (by flat harrow)-compacting (by bush harrow or soil board) process used in dry farming. Farming tools similar to the *liuzhou* (roller) can be found in the upland

farming areas of Northern China as well, and are used for compressing the soil. The great development made upon the transfer of this technology is that improvement of the *caiba* (flat harrow) used in upland farming to become the *chaoba* (vertical harrow) used in wet paddies. Amano Motonosuke assumed the invention of the *chaoba* (vertical harrow) to have taken place sometime in the twelfth century, based on the *Genzhitu* (*Picture Album on Farming and Weaving*) drawn by Lou Shou (190 – 1162 A.D.) of the Southern Song Dynasty, but this assumption was corrected substantially later on. It is also believed that the type of plow introduced to the Lingnan region was the frame plow (sometimes with a long sole). Another significant discovery was made in relation to this type of plow: a farming scene depicting the use of a typical frame plow with a curved beam was found on the surface of the bronze drum dating back to the Six Dynasties Period (fourth to sixth century) that was unearthed in Xilin Prefecture, Guangxi. This is the oldest pictorial resource on this type of plow. The frame plow with the curved beam may have been invented during the transfer process of dry farming technology.

### Conclusion

By looking into pictorial resources from the Han Period and the models of plowing and harrowing paddy fields made after the Jin Dynasty Period, I made an overview of the various issues regarding the forms of traditional Chinese plows, plowing techniques and the transfer of dry farming to the wet paddy region of Northern China. Through these processes of validation, I believe that I have been able to complement the gaps in the history of Chinese agriculture that previous studies of documents were unable to fill. In this report, however, I deliberately did not touch on the theory that the Chinese traditional plow came from abroad. If the plow did in fact come from the west, the issue must be discussed in a comprehensive manner, taking into consideration not only the form of the plow but also the crops, displacement of settlers, tractive methods, and the training methods of animals as well. From this standpoint, the hypothesis set forth by O uji Toshiaki is quite attractive in that he assumed the presence of “the Road of the Frame-Plow with the Long Sole” that crossed the Asian continent from the west (Mediterranean coast) to the east (reaching as far as China and Japan), and lists Western Asia and Eastern India, which show a variety of types of plows as candidates for the origin of the plow. There is still a long way to go in unraveling the mystery of the origin of the traditional Chinese plow.

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#### <Figures>

Fig. 1 Pair of carved stones of the Eastern Han Dynasty depicting a plowing scene (Unearthed from the tomb of Wang Deyuan in Suide County, Shaanxi Province)

(From *Suide Handai Huaxiangshi (Carved Stones of the Han Dynasty Discovered in Suide)* edited by Li Guilong and published by Shanxi Renmin Meishu Chubanshe)

Fig. 2 Carved stone of the Eastern Han Dynasty depicting a plowing scene (Unearthed in Sihong County, Jiangsu Province)

Fig. 3 Carved stone of the Eastern Han Dynasty depicting a plowing scene (Unearthed in Baijiashan, Suide County, Shaanxi Province)

(From *Suide Handai Huaxiangshi (Carved Stones of the Han Dynasty Discovered in Suide)* edited by Li Guilong and published by Shanxi Renmin Meishu Chubanshe)

Fig. 4 Carved stone depicting a plowing scene (Unearthed from a tomb of the Han Dynasty in Jinxiang County, Shandong Province)



- Fig. 5 Carved stone of the Eastern Han Dynasty depicting a plowing scene (Unearthed in Suining County, Jiangsu Province)  
(From *Jiangsu Xuzhou Han Huaxiangshi (Carved Stones of the Han Dynasty Discovered in Xuzhou, Jiangsu Province)* published by Science Press)
- Fig. 6 Plowing and sowing scenes painted on colored bricks of Tomb No. 1 in Xincheng, Jiayuguan City, Gansu Province. They are important records of dry farming in a frontier region in the Wei and Jin Dynasties.
- Fig. 7 Model showing paddy-field plowing and harrowing unearthed in Lian County, Guangdong Province (Western Jin Dynasty)
- Fig. 8 Model showing paddy-field cultivation unearthed in Wuzhou City, Guangxi region (Southern Dynasties)
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- Fig. 13 Model showing paddy-field cultivation unearthed in Huanggang, Zhaoqing City, Guangdong Province (Eastern Jin Dynasty)