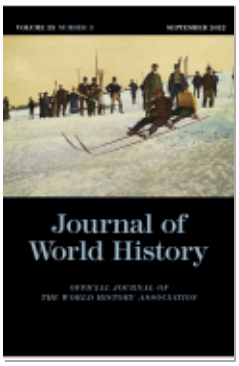
The Spread and Regional Development of Wheat Farming in the Yellow River Valley under the Han Empire



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The Spread and Regional Development of Wheat Farming in the Yellow River Valley under the Han Empire*

CHENG LI AND YIJIE ZHUANG

We synthesize recent archaeological discoveries on the spread of Han wheat farming, including archaeobotanical evidence, artefacts related to wheat farming and wheat flour processing, and discovered texts such as wooden slips. We cross-examine the archaeological data with transmitted historical records within the wider social and cultural contexts of the Yellow River valley and adjacent regions. We conclude that the spread of wheat farming in the Middle Yellow River region was slower than that of the Lower Yellow River region due to environmental and social reasons. After Emperor Wu's era, wheat farming began to take off in both regions, which was characterized by its expanding geographic distributions, its increasing importance in the imperial agricultural economies and its growing recognition by the society. The beneficial factors, including favorable climate-environmental conditions, accumulating agronomic knowledge, technological innovations and other factors, and changing dietary traditions played diverse roles in the regional development of wheat farming in these regions.

KEYWORDS: Wheat farming, Yellow River valley, Han Empire, Agricultural technologies, Flour-processing technologies.

THE late first millennium B.C. saw the establishment of agricultural primacy in the economic life of the Han Empire (202 B.C.–220 A.D.). The prominent role of agriculture in not only the

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economic activities but the political and cultural affairs of the Han Empire is attested in rich historic documents of Han and later historical periods. For instance, planting crops by Han emperors outside ceremonious places in Chang'an and Luoyang city became a state ritual ceremony during important farming seasons. This was to symbolize the superior position of agriculture in the state over other economic sectors, which was in accordance with the so-called '*zhongnong yishang* (emphasizing agriculture and restraining commerce)' state policy.[1] Increased agricultural yields sustained imperial expansion, construction of large-scale infrastructures, and other imperial projects. However, the establishment of agricultural primacy is narrated mainly through the lens of the state in these historical documents. Such a top-down perspective tends to homogenize the process of agricultural development, giving very little account to distinctive characteristics in cultural preferences, technological traditions, and environmental conditions in different regions of the empire. Very rarely is the establishment of agricultural primacy scrutinized with archaeological evidence. It remains unclear whether the regional divergence of agricultural economies reflects deliberate imperial agricultural strategies or an outcome of gradual development of regional economies under diverse social-environmental conditions. It is also hard to assess how this regionalization would in turn impact the imperial socioeconomic policies.

The establishment of Han agricultural primacy was characterized by two prominent developments: first, the agricultural practices became highly refined and delicate with the increasing application of iron tools and advanced agronomic knowledge[2] (see below); second, along with the pronounced intensification process of agricultural production was the further diversification of crops in the agricultural system. Studies mainly based on historical documents have shown that a wide variety of cereal crops, vegetable, and other economic crops as well as different livestock were cultivated and raised by Han farmers. In addition to traditional crops such as millets, wheat and rice, soybeans also became important, so did vegetables such as melons, ginger, garlic, Chinese

[1] Cho-yun Hsu, *Handai nongye: zaoqi zhongguo nongye jingji de xingcheng* (Han Agriculture: The Formation of Early Chinese Agrarian Economy) (Nanjing: Jiangsu renmin chubanshe, 2012), 37–38.

[2] Zhuang Yijie, Lee Heejin, and Tristram R. Kidder, "The Cradle of Heaven-Human Induction Idealism: Agricultural Intensification, Environmental Consequences and Social Responses in Han China and Three-Kingdoms Korea," *World Archaeology* 48 (2017): 563–585.

chive, and cash crops such as mulberry, sesame, hemp and indigo plant, whilst the six main livestock included horse, cattle, sheep, chicken, dog and pig.[3] The importance of these crops and livestock also fluctuated, and the changing role of wheat in the Han farming system is one of the typical examples.

The varieties of wheat included *Triticum monococcum* (diploid), *T. turgidum* (all tetraploids), and *T. aestivum* (all hexaploids). After its domesticated in at least 8500 B.C. in the Fertile Crescent and Anatolia, wheat began to spread to Europe from around 7000 B.C. onwards, to the Lower Nile between 6000–4000 B.C. and to Southern Turkmenistan in around 6000 B.C. before reaching Eastern Kazakhstan in around 3000–2500 B.C.[4] and Southern India in around 2000 B.C.[5] This multi-directional spreading events involved different wheat varieties and spoke of different stories on the adoption and assimilation process of wheat and wheat farming into local agricultural systems, diets and cultures. In general, glume wheats were most important (e.g., emmer wheat in ancient Egypt and einkorn wheat in Neolithic central Europe).[6] In the eastward spread of free-threshing wheats, mainly hexaploids were prominent in the Indus Valley. Based on the current evidence, hexaploid free-threshing wheat was the only species that was adopted in eastern Asia.[7]

The story of the arrival and adoption of wheat in ancient China is equally fascinating. The earliest wheat remain in China is directly dated to c. 2500 B.C.[8] The introduction of wheat to late Neolithic and Early Bronze Age China coincided with increasing regional interactions between China and the western part of the Eurasian continent, and it is widely regarded that wheat arrived in China alongside barley,

[3] Hsu, *Handai nongye*, 81–90.

[4] Robert N. Spengler, Michael D. Frachetti, and Paula N. Domani, "Late Bronze Age Agriculture at Tasbas in the Dzhungar Mountains of Eastern Kazakhstan," *Quaternary International* 348 (2014): 147–157.

[5] Dorian Q. Fuller and Leilani Lucas, "Wheats: Origins and Development," in *Encyclopedia of Global Archaeology*, ed. Claire Smith (New York: Springer, 2014), 7812–7817.

[6] Sue Colledge and James Conolly, *The Origins and Spread of Domestic Plants in Southwest Asia and Europe* (Walnut Creek: Left Coast Press, 2007).

[7] Nicole Boivin, Dorian Q. Fuller, and Alison Crowther, "Old World Globalization and the Columbian Exchange: Comparison and Contrast," *World Archaeology* 44, no. 3 (2012): 452–469.

[8] Zhao Zhijun, "Xiaomai chuanru zhongguo de yanjiu: zhiwu kaogu ziliao (Introduction of Wheat in China: The Archaeobotanical Data)," *Nanfang wenwu* 3 (2015): 44–52.

sheep, goat, cattle and metallurgy.[9] Mainstream opinions consider the so-called proto-Silk Roads the main route for the spread of wheat into China, via Xinjiang and Hexi corridor to the Middle and Lower Yellow River.[10] Alternatively, based on the relatively earlier ^{14}C dates of wheat remains in the Lower Yellow River, some scholars proposed an eastern transmission route of wheat into China via Shandong Province before it spread westward to other neighboring regions.[11] Despite its early appearance, both archaeobotanical and bioarchaeological evidence has shown that wheat did not become an important crop during the late Neolithic and Bronze Age period and was certainly not widely cultivated.[12] Zhou et al.'s recent reconstruction of Bronze-Age diets in the Central Plains based on isotopic signature of human bones, for instance, suggests that wheat might have been considered an inferior food that was consumed by populations (interestingly in some cases by urban populations) of lower social status. This was in contrast to the elite's C4-based diet (in this case, most likely millets).[13] It took several millennia years before wheat became an important crop in agricultural systems of ancient China. During the Han period in particular, the economic and cultural role of wheat changed drastically as we will illustrate in this article.

Indeed, the Han period represents a unique case to investigate the changing roles of wheat farming in the society and how this could inform the dynamics between technological choice, economic patterns and political structures in different regions of the empire. In the present article, we synthesize recent archaeological discoveries, including archaeobotanical evidence, artefacts related to wheat farming and wheat flour processing, and discovered texts such as wooden slips from Han archaeological contexts. We cross-examine the archaeological data with transmitted historical records in the wider social and cultural contexts of the Yellow River valley and adjacent regions. We then

[9] Li Jaang, "The Landscape of China's Participation in the Bronze Age Eurasian Network," *Journal of World Prehistory* 28 (2015): 179–213.

[10] Rowan Flad, Li Shuicheng, Wu Xiaohong, and Zhao Zhijun, "Early Wheat in China: Results from New Studies at Donghuishan in the Hexi Corridor," *The Holocene* 20, no. 6 (2010): 955–965.

[11] Long Tengwen, Christian Leipe, Jin Guiyun, Mayke Wagner, Guo Rongzhen, Oskar Schröder, and Pavel E. Tarasov, "The Early History of Wheat in China from ^{14}C Dating and Bayesian Chronological Modelling," *Nature Plants* 4 (2018): 272–279.

[12] Li Cheng, "Shilun zhongguo beifang longshan shidai zhi lianghan de xiaomai zaipei (The Planting of Wheat in Northern China from the Longshan Period to Han Dynasties)," *Kaogu yu wenwu* 5 (2016): 100–109.

[13] Zhou Ligang and Sandra J. Garvie-Lok, "Isotopic Evidence for the Expansion of Wheat Consumption in Northern China," *Archaeological Research in Asia* 4 (2015): 25–35.

compare and discuss the spread of wheat farming and the different environmental conditions, cultural preferences and technological traditions that contribute to regional development of wheat farming during the Han period in these regions.

Landscape of Han Wheat Farming

Climatic and Environmental Restrictions for Wheat Farming

The water efficiency of wheat is the lowest amongst many cereal crops, requiring at least 400–600 mm of water in its entire growth cycle (in contrast with foxtail and broomcorn millets which require only 200–300 mm). Influenced by the continental monsoonal climate, 75% of the annual precipitation in the Yellow River valley fall in the summer. Precipitation is scarce in the spring when droughts occurs frequently. Such water stress during early spring to early summer coincides with the critical stage when wheat plant is jointing, flowering and fruiting, significantly affecting the yield.[14]

The Taihang and Qinling mountains also prevent warm moist air coming from southeast, causing distinctive regional differences in precipitation. The Lower Yellow River region belongs to warm temperate monsoonal climate with annual precipitation of around 650–700 mm. The Yellow-Huai River Plain to the south of the Lower Yellow River is in the transition zone from the temperate to sub-tropical climates with a higher annual precipitation between 700–900 mm. Compared to these regions, the Middle Yellow River region receives much less annual precipitation, except for the Guanzhong Plain area which has an annual precipitation of around 500–600 mm.[15]

The wheat farming landscapes along the Yellow River valley were profoundly shaped by the climatic, hydrological and pedological differences across times and space. During early Western Han (c. 202–116 B.C.), without technological innovation and labor investment in irrigation and effective farming polices, wheat farming was restrained in places with optimal hydrological conditions. Indeed,

[14] Zhu Kezhen, "Lun woguo qihou de jige tedian jiqi yu liangshi zuowu shengchan de guanxi (The Characteristics of China's Climate and its Relationship with Crop Production)," *Dili xuebao* 30, no. 1 (1964): 189–199.

[15] http://yrcc.gov.cn/ (Official Website of the Yellow River Conservancy Commission of the Ministry of Water Resources of the People's Republic of China).

the distribution of wheat farming in the Yellow River valley was scattered and wheat farming was less important than millet farming during early Western Han. The middle (c. 116–48 B.C.) to late (c. 48 B.C.–8 A.D.) Western Han saw the construction of large-scale hydraulic infrastructures especially in the heartland and economically developed areas of the empire,[16] which fundamentally changed the developmental trajectories of agriculture in these regions. Below we synthesize archaeological and historical evidence of wheat farming in these regions and demonstrate that the spread of wheat farming followed diverse pathways in different regions.

Spatial-temporal Patterns of Wheat Farming: Chronologies and Distributions

Middle Yellow River — Table 1 summarizes discovered archaeological evidence from various archaeological contexts in the Middle Yellow River region. For the limited discoveries of carbonized wheat seeds and written texts related to wheat farming, those predating Emperor Wu's era (141–87 B.C.) were only found in the ancillary burials at the Changling Mausoleum in the Guanzhong Plain where the Chang'an city was located. Because of the special social status of the tomb occupants, this evidence might not represent the universal situation of wheat farming and contemporary consumption pattern in the society. The chapter *Shihuozhi* (*the Records of Economy*) of *Hanshu* (*the Book of Western Han*) records an important statement by Dong Zhongshu (179–104 B.C.), one of the most important governmental officers during Emperor Wu's era, who reported that the Guanzhong Plain was not accustomed to grow wheat.[17] This important information indicates that wheat farming was not universally accepted by society in the area until Emperor Wu's era.

From 87 B.C. onwards, more archaeological remains regarding wheat farming surrounding Chang'an were found. Wheat became an

[16] Zhuang Yijie, "State and Irrigation: Archaeological and Textual Evidence of Water Management in Late Bronze Age China," *WIREs Water* (2017): https://doi.org/10.1002/WAT2.1217.

[17] Ban Gu, *Hanshu* (Beijing: Zhonghua shuju, 1962), 1137.

TABLE 1. Archaeological wheat remains of the Middle Yellow River

Site	Location	Date	Context	Category
Yangjiawan[18]	Xianyang, Shaanxi	Emperors Wen and Jing (180–141 B.C.)	Ancillary burials of the Changling mausoleum	Carbonized seeds
Yangling[19]	Xianyang, Shaanxi	Emperor Wu (c. 141–117 B.C.)	Ancillary pits of the Yangling mausoleum	Carbonized seeds
Sanzhao (Fig. 1, 1)[20]	Xi'an, Shaanxi	Late Western Han (c. 48 B.C.–8 A.D.)	Low-rank elite burials	Carbonized seeds
Bailuyuan[21]	Xi'an, Shaanxi	Early Western Han (c. 202–116 B.C.)	High-rank elite burials	Written texts on pottery vessels
Shaanxi Juanyan Cailiaochang (Fig. 1, 2)[22]	Xi'an, Shaanxi	Late Eastern Han (c. 146–220 A.D.)	Low-rank elite burials	Written texts on pottery vessels

important crop in both daily life and mortuary practices.[23] Apart from carbonized wheat seeds, the characters for wheat, along with the characters for other cereal crops, were commonly written on the surface of buried pottery jars or ceramic granary models. Historical records, such as *Hanshu*, *Houhanshu* (*the Book of Later/Eastern Han*) and *Jinshu* (*the Book of Jin*), provided important information regarding the wider distribution of wheat farming across the empire. Chapter *Shihuozhi* of *Jinshu* mentioned that the Guanzhong Plain became wealthy because of

[18] Yangjiawan hanmu fajue xiaozu, "Xianyang yangjiawan hanmu fajue jianbao (Brief Report of the Excavation of Han Tombs in Yangjiawan, Xianyang)," *Wenwu* 10 (1977): 10–21.

[19] Wang Xueli, "Hanjingdi yangling lingyuan kaogu huo xinchengguo (New Archaeological Finds in the Yangling Mausoleum of Emperor Jing)," *Zhongguo wenwubao* 1 (1993).

[20] Zhao Zhijun, "Xi'an diqu lianghan muzang chutu taocang nei zhiwu yicun de jianding he fenxi (Identification and Analysis of Plant Remains in Pottery Granary Models Unearthed from Han Tombs in Xi'an)," in *Xi'an donghanmu (Eastern Han Tombs of Xi'an)*, ed. Xi'anshi wenwu baohu kaogusuo (Beijing: Wenwu chubanshe, 2009), 1077–1088.

[21] Shanxisheng kaogu yanjiusuo, *Bailuyuan hanmu* (Han Tombs of Bailuyuan) (Xi'an: Sanqin chubanshe, 2003), 99–124.

[22] Shanxisheng kaogu yanjiusuo, "Shaanxi Juanyan Cailiaochang hanmu fajue jianbao (Brief Report of the Excavation of Han Tombs in Juanyan Cailiaochang, Shaanxi)," *Kaogu yu wenwu* 1 (1997): 3–12.

[23] Li, "Shilun zhongguo beifang longshan shidai zhi lianghan de xiaomai zaipei," 100–109.

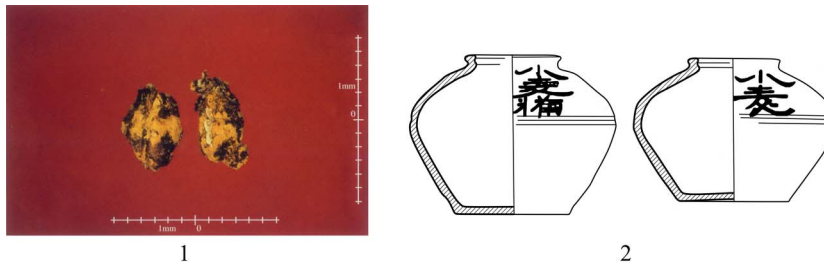

FIGURE 1. Wheat remains from the Middle Yellow River. 1. Sanzhao cemetery; 2. Shaanxi Juanyan Cailiaochang cemetery.

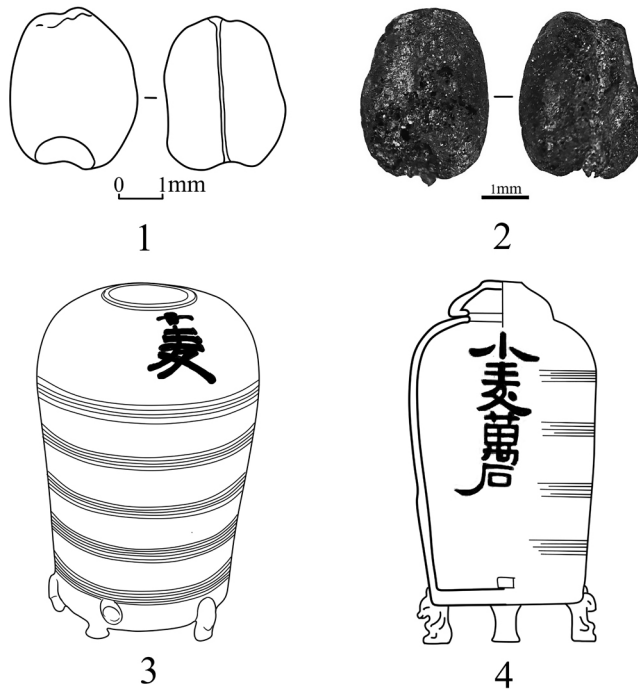

FIGURE 2. Wheat remains from the Lower Yellow River. 1. Xijincheng site; 2. Daxinzhuang site; 3. Jinguyuan cemetery; 4. Wunvzhong cemetery.

wheat farming during late Western Han,[24] indicating that wheat was established as one of the primary cereal crops in this region at that time.

[24] Fang Xuanling et al., *Jinshu* (Beijing: Zhonghua shuju, 1974), 791.

TABLE 2. Distribution of wheat farming in the Middle Yellow River from the middle-to-late Western Han to Eastern Han

Source	Date	Location	Present location
Zhaodiji (*the Biography of Emperor Zhao*) of *Hanshu*[25]	Emperor Zhao (87–74 B.C.)	Sanfu	Central Shaanxi
Shihuozhi of *Jinshu*[26]	Emperor Cheng (33–7 B.C.)	Sanfu	Central Shaanxi
Wangdanzhuan (*the Biography of Wang Dan*) of *Houhanshu*[27]	Emperor Guangwu (25–57 A.D.)	Xiagui	Central Shaanxi
Guangwudiji (*the Biography of Emperor Guangwu*) of *Houhanshu*[28]	Emperor Guangwu (25–57 A.D.)	Sanfu	Central Shaanxi
Lugongzhuan (*the Biography of Lu Gong*) of *Houhanshu*[29]	Emperor He (88–106 A.D.)	Sanfu, Bing State, Liang State	Central and northern Shaanxi, Shanxi, southern Inner Mongolia and eastern Gansu

This fundamentally transformed the agrarian landscape in the Guanzhong Plain and changed the situation of 'not accustomed to wheat farming' stated by Dong Zhongshu. Wheat farming also spread to imperial frontiers such as Bing State and Liang State in present Northern Shaanxi, Southern Inner Mongolia and Eastern Gansu as documented by historical records (Table 2, Fig. 3).

Lower Yellow River — Wheat farming began in late Neolithic period in the Lower Yellow River region.[30] The archaeological remains related to Han period wheat farming (Table 3) were found in small towns and villages and medium-to-small sized tombs. In addition to the direct evidence of carbonized wheat seeds and texts written on pottery vessels and wooden slips from several sites, the chapter *Zhuixingxun* (*the*

[25] Ban, *Hanshu*, 220.
[26] Fang et al., *Jinshu*, 791.
[27] Fan Ye, *Houhanshu* (Beijing: Zhonghua shuju, 1964), 931.
[28] Fan, *Houhanshu*, 39.
[29] Ibid., 877.
[30] Long et al., "The Early History of Wheat in China from ^{14}C Dating and Bayesian Chronological Modelling," 272–279.

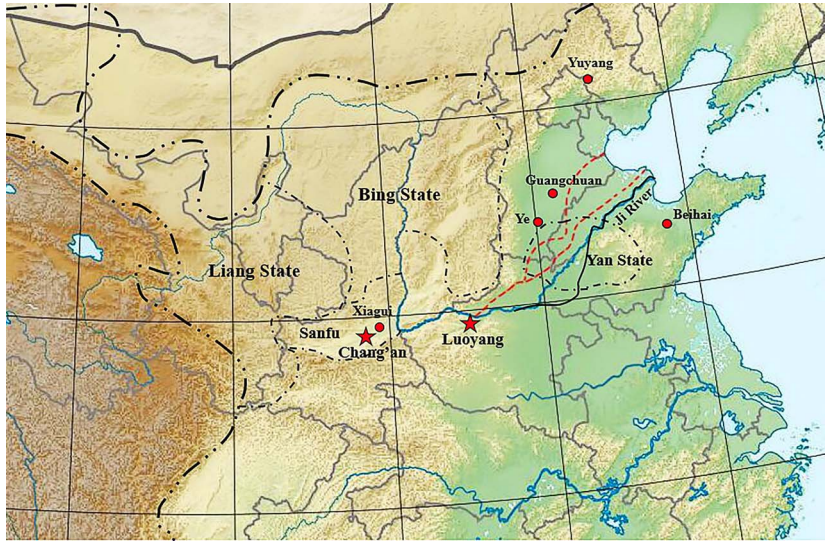

FIGURE 3. The Yellow River valley during Han period. ▪▪—▪▪—▪▪ Border of Han Empire; ▪—▪—▪—▪ Border of administrative districts mentioned in this article; ——— Main channels of Lower Yellow River during Han period; ★ Capitals of Western and Eastern Han Dynasties; ● Ancient cities mentioned in this article.

Records of Natural Environment) of *Huainanzi* (*the Book of Prince Huainan*), commonly believed to be written during Emperor Wu's era, emphasized that the Ji River area, a tributary of the Lower Yellow River was suitable for wheat farming.[31] The Ji River was originated in Henan and flew through Shandong before entering the Bohai Sea. Fostered by its optimal hydrological and pedological condition,[32] the Ji River area became one of the most important wheat-farming regions during Han.

The agricultural foundation for wheat farming in the Lower Yellow River region was further consolidated after a series of promotion activities since Emperor Wu's era. Wheat farming expanded to much wider areas. The ubiquity of wheat grains in the systematically studied archaeobotanical assemblage at the Xijincheng site, Bo'ai county, Henan, reached around 80% ($n = 5$). Similarly, the written characters

[31] Liu An, *Huainanzi* (Beijing: Zhonghua shuju, 1954), 61.
[32] Zhou Zhenhe, *Hanshu dilizhi shihui* (Explanation of Dilizhi of Hanshu) (Hefei: Anhui jiaoyu chubanshe, 2006), 452–454.

TABLE 3. Archaeological wheat remains of the Lower Yellow River

Site	Location	Date	Context	Category
Xijincheng (Fig. 2, 1)[33]	Bo'ai, Henan	Han (202 B.C. –220 A.D.)	Small village	Carbonized seeds
Liulige[34]	Huixian, Henan	Emperor Wu to the Xin Mang era (c. 116 B.C. –25 A.D.)	Medium-to-small sized tombs	Carbonized seeds
Jinguyuan (Fig. 2, 3)[35]	Luoyang, Henan	Emperor Wu to the Xin Mang era (c. 116 B.C. –25 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Tiemen[36]	Xin'an, Henan	Middle to late Western Han (c. 116 B.C. –8 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Shaogou[37]	Luoyang, Henan	Middle Western Han to Eastern Han (c. 116 B.C. –220 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Xijiao[38]	Luoyang, Henan	Middle Western Han to Eastern Han (c. 116 B.C. –220 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Xibeijiao[39]	Luoyang, Henan	Emperor Yuan to the Xin Mang era (c. 48 B.C. –25 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels

(*Continued*)

[33] Chen Xuexiang, Wang Liangzhi, and Wang Qing, "Henan bo'aixian xijincheng yizhi 2006-2007nian fuxuan jieguo fenxi (Analysis of Flotation Finds of Xijincheng Site in Bo'ai County, Henan in 2006–2007)," *Huaxia kaogu* 3 (2010): 67–76.

[34] Zhongguo kexueyuan kaogu yanjiusuo, *Huixian fajue baogao* (Excavation Report of Hui County) (Beijing: Kexue chubanshe, 1956), 56.

[35] Luoyangshi wenwu gongzuodui, "Luoyang Jinguyuan chezhan 11hao hanmu fajue jianbao (Brief Report of the Excavation of Han Tomb No. 11 at Jinguyuan Station, Luoyang)," *Wenwu* 4 (1983): 15–28.

[36] Henansheng wenhuaju wenwu gongzuodui, "Henan xin'an tiemenzhen xihan muzang fajue baogao (Excavation Report of Western Han Tombs in Tiemen, Xin'an, Henan)," *Kaogu xuebao* 2 (1959): 57–73.

[37] Zhongguo kexueyuan kaogu yanjiusuo luoyangqu fajuedui, *Luoyang shaogou hanmu* (Han Tombs of Shaogou, Luoyang) (Beijing: Kexue chubanshe, 1959), 112–115.

[38] Zhongguo kexueyuan kaogu yanjiusuo luoyang fajuedui, "Luoyang xijiao hanmu fajue baogao (Excavations of Western Han Tombs in the Western Suburb of Luoyang)," *Kaogu xuebao* 2 (1963): 1–58.

[39] He Guanbao, "Luoyang laocheng xibeijiao 81hao hanmu (The Han Tomb No. 81 in the Northwestern Suburb, Old Town of Luoyang)," *Kaogu* 8 (1964): 403–406.

TABLE 3. (*Continued*)

Site	Location	Date	Context	Category
Jianbin[40]	Luoyang, Henan	Late Western Han to middle Eastern Han (c. 48 B.C. –145 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Wunvzhong (Fig. 2, 4)[41]	Luoyang, Henan	Xin Mang era (8–25 A.D.)	Medium-to-small sized tombs	Texts on pottery vessels
Daxinzhuang (Fig. 2, 2)[42]	Jinan, Shandong	Han (202 B.C. –220 A.D.)	Small village	Carbonized seeds
Beitaishang[43]	Tengzhou, Shandong	Han (202 B.C. –220 A.D.)	Small village	Carbonized seeds
Kanjiazhai[44]	Linzi, Shandong	Western Han (202 B.C. –8 A.D.)	City remains	Carbonized seeds
Zhucheng[45]	Zoucheng, Shandong	Western Han (202 B.C. –8 A.D.)	City remains	Carbonized seeds
Dongpan[46]	Linshu, Shandong	Eastern Han (25 –220 A.D.)	Small village	Carbonized seeds
Yinwan[47]	Lianyungang, Jiangsu	Emperor Cheng (33–7 B.C.)	Medium-to-small sized tombs	Texts on wooden slips

[40] Zhongguo kexueyuan kaogu yanjiusuo luoyang fajuedui, "Luoyang jianbing guwenhua yizhi ji hanmu (Ancient Cultural Site and Han Tombs of Jianbin, Luoyang)," *Kaogu xuebao* 1 (1956): 11–28.

[41] Luoyangshi dier wenwu gongzuodui, "Luoyang wunvzhong 267hao xinmangmu fajue jianbao (Excavation of a Tomb from the Wangmang Period at Wunvzhong near Luoyang)," *Wenwu* 7 (1996): 42–53.

[42] Chen Xuexiang, *Haidai diqu xinshiqi shidai wanqi zhi qingtong shidai nongye wendingxing kaocha* (Paleoethnobotany and Agriculture Across the Transition from the Late Neolithic to the Bronze Age in Northern China: A Case Study) (Doctoral Thesis, Jinan: Shandong University, 2007), 54–59.

[43] Wang Zhenzhen, *Shandong tengzhou beitaishang yizhi zhiwu dayicun fenxi* (Plant Macrofossil Analysis of Beitaishang Site in Tengzhou of Shandong Province) (Master Thesis, Jinan: Shandong University, 2018), 29–30.

[44] Chen Xuexiang, Ma Fangqing, Xu Longguo, Bai Yunxiang, and Wang Qi, "Shandong linzi qigucheng kanjiazhai yizhi Bqu di1 didian zhiwu yicun fuxuan jieguo ji chubu fenxi (Plant Remains from the Locality I of Area B at Kanjiazhai Site, Linzi City Site of the Qi State, Shandong Province)," *Zhongguo nongshi* 2 (2018): 15–25.

[45] Ma Fangqing, *Shangdong zoucheng zhuguo gucheng (2015) dongzhou zhi xihan zhiwu kaogu guancha* (Archaeological Research at the City Site of the Zhu State from Eastern Zhou to Western Han Periods with the Perspective of Paleoethnobotany: A Case Study Based on Macroremains in 2015) (Master Thesis, Jinan: Shandong University, 2017), 25–28.

[46] Wang Haiyu, Liu Yanchang, and Jin Guiyun, "Shandongsheng linshuxian dongpan yizhi 2009 niandu tanhua zhiwu yicun fenxi (Analysis on the Carbonized Plant Remains from the Dongpan Site, 2009, Linshu County, Shandong)," in *Dongfang kaogu (Oriental Archaeology) (No. 8)*, ed. Shandong daxue dongfang kaogu yanjiu zhongxin (Beijing: Kexue chubanshe, 2012), 357–372.

[47] Lianyungangshi bowuguan, Zhongguo shehui kexueyuan jianbo yanjiu zhongxin, Donghaixian bowuguan, and Zhongguo wenwu yanjiusuo, *Yinwan hanmu jiandu* (Bamboo and Wooden Slips in Han Tombs of Yinwan) (Beijing: Zhonghua shuju, 1997), 13.

TABLE 4. Crops found in cemeteries from the middle-to-late Western Han to Eastern Han

	Cemetery		
	Number		
Crop	Shaogou	Xijiao	Jinguyuan
Foxtail millet	6	10	3
Broomcorn millet	3	3	5
Wheat	5	7	6
Barley	4	10	0
Rice	6	4	2
Soybean	4	10	2
Hemp	3	6	0

of 'wheat' also occurred frequently on ceramic granary models (Table 4).[48] In a few cases, the inscriptions mentioned 'ten thousand *shi* (one Han *shi* equal to around 30 kg) of wheat'. Whilst such inscriptions were an exaggeration of the actual quantity of wheat grains buried in medium-to-small sized tombs, it clearly suggests that wheat was one of the most important crops in the region during the middle-to-late Western Han to Eastern Han.

In addition to the archaeological evidence, there were many historical accounts concerning the distribution of wheat farming in the Lower Yellow River. These accounts described spatial variations of wheat farming in Henan, Shandong and Hebei from the middle-to-late Western Han to Eastern Han (Table 5, Fig. 3).

Summary: Formation of Han Wheat Farming Landscape

Synthesizing the aforementioned archaeological evidence and historical records, we can discern two developmental stages of wheat farming during Western Han (Fig. 4). Wheat farming was unevenly distributed across the empire during the early Western Han to Emperor Wu's era. While wheat became one of the primary crops in the Lower Yellow River region, wheat farming remained less developed in the Middle

[48] Li Cheng, Zhu Gemin, and Ling Xue, "Lun lianghan shiqi zhongguo beifang xiaomai zhongzhi de fazhan (A Discussion on the Development of Wheat Planting in Northern China during the Western and Eastern Han Periods)," *Xibei daxue xuebao (Zhexue shehui kexue ban)* 46, no. 6 (2016): 34–40.

TABLE 5. Distribution of wheat farming in the Lower Yellow River from the middle-to-late Western Han to Eastern Han

Source	Date	Location	Present location
Dongzhongshuzhuan (*the Biography of Dong Zhongshu*) *of Hanshu*[49]	Emperor Wu (141–87 B.C.)	Guangchuan	Central and southern Hebei
Yuandiji (*the Biography of Emperor Yuan*) of *Hanshu*[50]	Emperor Yuan (49–33 B.C.)	Beihai	Eastern Shandong
Fuzhanzhuan (*the Biography of Fu Zhan*) of *Houhanshu*[51]	Emperor Guangwu (25–57 A.D.)	Yuyang	Beijing and northern Hebei
Mingdiji (*the Biography of Emperor Ming*) of *Houhanshu*[52]	Emperor Ming (57–75 A.D.)	Jingshi	Luoyang, western Henan
Xunyuzhuan (*the Biography of Xun Yu*) of *Houhanshu*[53]	Emperor Xian (189–220 A.D.)	Yan State	Western Shandong, eastern Henan and southern Hebei
Yuanshaozhuan (*the Biography of Yuan Shao*) of *Sanguozhi* (*the Book of Three Kingdoms*)[54]	Emperor Xian (189–220 A.D.)	Ye	Linzhang county, southern Hebei

Yellow River centered around the Guanzhong Plain. After Emperor Wu's era, pronounced change of the distribution of wheat farming occurred in the Yellow River valley. Based on governmental documents and imperial edicts,[55] not only did wheat farming rapidly expand in the Lower Yellow River and its surrounding Huai River regions, in the imperial center and frontiers where wheat farming was not as important previously, such as central Shaanxi, southern Inner Mongolia and

[49] Ban, *Hanshu*, 2495.
[50] Ibid., 283.
[51] Fan, *Houhanshu*, 895.
[52] Ibid., 107.
[53] Ibid., 2283.
[54] Chen Shou, *Sanguozhi* (Beijing: Zhonghua shuju, 1959), 202.
[55] Li Cheng, *Huanghe liuyu shiqian zhi lianghan xiaomai zhongzhi yu tuiguang yanjiu* (Researches on Cultivation and Popularization of Wheat in the Yellow River Basin from Prehistory to Han Dynasty) (Doctoral Thesis, Xi'an: Northwest University, 2014), 61–62.

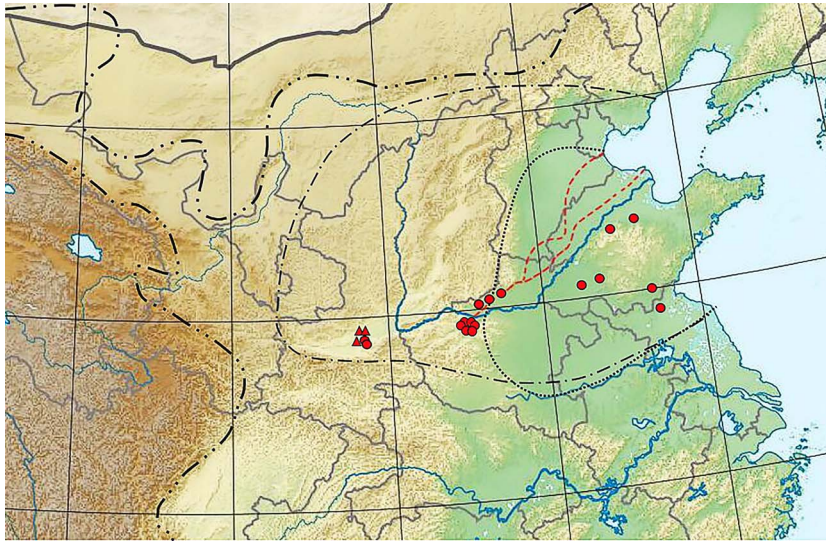

FIGURE 4. The development of wheat farming in the Yellow River valley during Han period. ▪▪—▪▪—▪▪ Border of Han Empire; ——— Main channels of Lower Yellow River during Han period; ▲ Early Western Han sites with archaeological evidence of wheat farming; ● Late Western to Eastern Han sites with archaeological evidence of wheat farming; ▪▪▪▪▪▪▪▪▪ Distribution areas of wheat farming as recorded in historical documents of early Western Han; ▪—▪—▪ Distribution areas of wheat farming as recorded in historical documents of late Western to Eastern Han.

eastern Gansu, its cultivation area and yields saw a significant increase.[56]

The governmental documents entitled *Jibu* (*the Compilation of Documents*) were found in the late Western Han tomb (dating to Emperor Cheng's era, 33–7 B.C.) at Yinwan located in the Donghai Prefecture on the Yellow-Huai River Plain. The records written on wooden slips provided detailed information regarding the administrative structure, numbers of governmental officers, population, arable fields and fiscal incomes of the prefecture. It was also clearly stated that 'winter wheat was planted on 107,3□□ *qing* (one Han *qing* equal to around 4.7 hectare) of land, 1,920 *qing* and 82 *mu* (one Han *mu* equal to around 461 m^2) more than last year'. This was equal to a 1.79% annual increase. Using these valuable records on land and population, some scholars estimate the per capita land for winter wheat farming in the Donghai Prefecture during late Western Han reached around 5.3 *mu* and that of per household reached c. 28 *mu*. This means that almost

[56] Hui Fuping, "Handai maizuo tuiguang yinsu tantao: yi donghaijun yu guanzhong diqu weili (The Discussion on the Promotion Factors of Wheat Farming during Han dynasty: A Case Study of Donghai County and Guanzhong Region)," *Nanjing nongye daxue xuebao (Shehui kexue ban)* 4 (2001): 63–66.

half of the arable land in the region was used for winter wheat farming.[57]

Despite the absence of carbonized wheat remains in the tomb, the Yinwan record suggests that wheat farming was rapidly developing in the Donghai Prefecture which located in the Huang-Huai Plain regions during late Western Han. Wheat farming was so important in the local farming regime and financial system that it was written down in the local government's reportage to the central government according to the Yinwan case. As discussed above, amongst the wheat farming regions during Han, the Lower Yellow River and Huai River regions had the most optimal climate regime for wheat farming. In addition, the relatively flat land, high groundwater level, and sufficient sunlight in these regions were also conducive to the growth of wheat. The agricultural yield in these regions witnessed a remarkable increase from early to late Western Han period, making them the most agriculturally developed regions of the empire.

The First Push Factor: Agricultural Technologies

Innovations of Wheat Farming Technologies

Farming technologies enjoyed pronounced developments from the late Western Han. According to the chapter *Shihuozhi* of *Hanshu*, farming specialist Zhao Guo (c. first century B.C.) was sent to the countryside by Emperor Wu to promote the so-called '*daitianfa*' rotational farming.[58] This innovative farming technique was to divide the field into ridges and furrows. Seeds were sown in the furrow so that the seedlings were protected from wind blowing whilst also receiving sufficient moisture. During the weeding stage, weedy plants were removed from the ridge and soil was ploughed over from the ridge to the furrow to further foster the growth of seedlings. Roots of the wheat plant were able to penetrate deeper into the leveled field. With the *daitianfa*, wheat plants became more drought resistant and protected from wind blowing. The ridge and furrow were rotated in the next farming season.[59] This new farming regime significantly increased agricultural productivity and yields.

[57] Zhao Shuling and Chang Sen, "Lun lianghan shidai dongxiaomai zai woguo beifang de tuiguang puji (The Spread of Winter Wheat in the Northern China in the Han Dynasty)," *Zhongguo lishi dili luncong* 2 (1999): 37–46.
[58] Ban, *Hanshu*, 1138–1139.
[59] Hsu, *Handai nongye*, 111–115.

During the excavation of the well-preserved late Western Han archaeological site of Sanyangzhuang in present Neihuang county, Henan in 2005, fields with ridges and furrows were unearthed to the east, west and north outside the village compounds (Fig. 5, 1). The orderly aligned ridges and furrows (c. 60 cm in width) were the first ever archaeological discovery of Han farming fields[60] and some scholars believe that these were the direct representation of the *daitianfa* farming method (Fig. 5, 2).[61] The fact that the fields were situated on the Yellow River floodplain inside an artificial levee[62] also illustrates that the level of field management was intensified by the late Western Han period.

A number of agronomic books were written during the late Western Han to Eastern Han period. These books systematically summarized the agronomic knowledge accumulated during Han. *Fan Shengzhi shu* (*the Book of Fan Shengzhi*), for instance, documented the contemporary wheat farming technologies during the late Western Han. It conserved knowledge regarding different stages of wheat farming, including seed selection, sowing, drought-resistant methods, ploughing, harvesting and storage. It also discussed the rotation method between winter wheat and spring wheat farming.[63] This earliest record on winter and spring wheat farming stated that, 'if wheat is planted on time, the yield will be guaranteed. 70 days after the summer solstice (early September), winter wheat should be planted. Wheat plants will suffer from insect plagues and damaged by frost if planted too early; but if planted too late, the growth will be affected, and the ear of the wheat will be small and the grains not full . . . after the spring thawing, soils should be ploughed and spring wheat should be planted . . . '. The late Eastern Han agronomic book, *Simin yueling* (*the Monthly Decrees to the Four [Groups of] People*), further articulated the seasonality of winter and

[60] Liu Haiwang and Zhu Rusheng, "Henan neihuang sanyangzhuang handai tianzhai yicun (Fields and Settlement Remain of Sanyangzhuang in Neihuang County, Henan)," in *Zhongguo zhongyao kaogu faxian* (Major Archaeological Discoveries in China), ed. Guojia wenwuju (Beijing: Wenwu chubanshe, 2006), 100–104.

[61] Fu Kui, *Qinhan nongye jvluo de xingtai yu gengzuo jishu: yi sanyangzhuang yizhi wei zhongxin de tantao* (On the Pattern of the Agricultural Settlement and the Agricultural Technology in Qin and Han Dynasties: Taking Sanyangzhuang Site as the Center for Discussion) (Doctoral Thesis, Zhengzhou: Zhengzhou University, 2013), 108–130.

[62] Tristram R. Kidder, Liu Haiwang, Xu Qinghai, and Li Minglin, "The Alluvial Geoarchaeology of the Sanyangzhuang Site on the Yellow River Floodplain, Henan Province, China," *Geoarchaeology: An International Journal* 27 (2012): 324–343.

[63] Jing Feng and Hui Fuping, "Handai huanghe liuyu maizuo fazhan de huanjing yinsu yu jishu yingxiang (Environment Factor and Agricultural Technology Influence of Winter Wheat Planting of the Han Dynasty in the Yellow River valley)," *Zhongguo lishi dili luncong* 22, no. 4 (2007): 21–27.

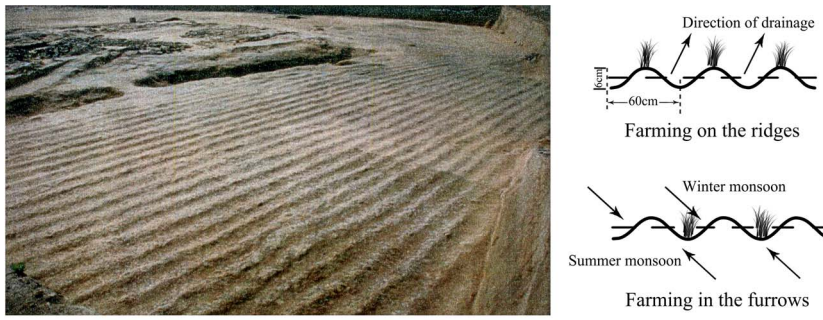

FIGURE 5. The late Western Han farming fields. 1. Fields with ridges and furrows at the Sanyangzhuang site; 2. Reconstruction of the Sanyangzhuang fields.

spring wheat farming.[64] The appearance of such records from the late Western Han to Eastern Han is a clear indication that wheat farming had become a regular practice following a well-established farming system.

Iron Casting Technology and Its Application to the Production of Agricultural Tools

The production of Han agricultural tools benefited greatly from the advanced iron casting technologies. From Emperor Wu's era, iron casting industry became monopolized by the state with centralized management and mass production. According to the chapter *Dilizhi* (*the Records of Geography*) of *Hanshu*, 49 iron offices were established across the country.[65] Each of these offices was responsible for several large-scale iron workshops. Several dozens of such workshops in present Henan and Shandong have been excavated.[66] These excavations confirm the developed Han iron casting industry that was characterized by well-organized specialized production and advanced equipment. The application of spheroidal graphite casting and wrought iron

[64] Shi Shenghan, *Simin yueling jiaozhu* (Collation of Simin Yueling) (Beijing: Zhonghua shuju, 1965), 98–99.
[65] Ban, *Hanshu*, 1523–1674.
[66] Henansheng wenhuaju wenwu gongzuodui, *Gongxian tieshenggou* (Tieshenggou, Gong County) (Beijing: Wenwu chubanshe, 1962), 1–34; Li Jinghua, "Nanyang beiguan wafangzhuang handai yetie yizhi fajue baogao (Excavation Report of Iron Smelting Site of Han Dynasty in Wafangzhuang, Beiguan of Nanyang)," *Huaxia kaogu* 1 (1991): 1–110.

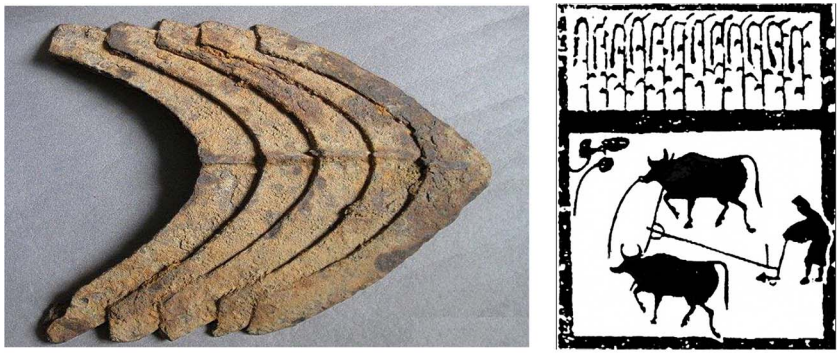

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FIGURE 6. Agricultural technologies during Han. 1. Iron ploughshares from Shaanxi; 2. Stone carving of cattle-draught ploughing from Shaanxi.

technologies were milestone achievements in metallurgical history of China.[67] In particular, the adoption of wrought iron technology significantly improved the quality of iron agricultural tools.

On the one hand, the application of large iron ploughshares was promoted across the empire since the late Western Han period. Many types of iron ploughshares were produced and used, including small, large and super-large iron ploughshares with many different types of fittings. Such typical iron ploughshares and fittings have been discovered at many sites in Henan and Shaanxi (Fig. 6, 1).[68] On the other hand, the intensified field management in wheat farming also demanded a higher adaptability of agricultural tools to different kinds of farming operations. This stimulated the innovation of new farming tools. For instance, the inventions of field-leveling machine (*mo*) and sowing machine (*louche*)[69] significantly increased the productivity in the field. In addition, new cattle-draught ploughing technology represented by the so-called '*erniu taigang*' (two cattle pulling one plough) also became popular in different regions as evidenced by clear

[67] Zhang Gangjie, "Shilun handai Yetieye de fazhan jiqi dui nongye shengchan de yingxiang (Development of Iron Smelting during Han Dynasty and its Influence on Agricultural Production)," *Zhengzhou daxue xuebao (Zhexue shehui kexue ban)* 1 (1987): 58–63.

[68] Liu Xinglin, "Handai nongye de kaogu faxian he yanjiu (On the Archaeological Discoveries and Research-Work Concerning the Agriculture of Han Dynasty)," *Lanzhou daxue xuebao (Shehui kexue ban)* 33, no. 2 (2005): 11–19; Chen Wenhua, *Zhongguo nongye kaogu tulu* (Atlas of China's Agricultural Archaeology) (Nanchang: Jiangxi nongye jishu chubanshe, 1994), 236.

[69] Chen, *Zhongguo nongye kaogu tulu*, 255.

pictorial evidence of such ploughs in Han period tombs in Shandong, Jiangsu and Shaanxi (Fig. 6, 2).[70]

Development of Irrigation Technologies

From Emperor Wu's era, the government started to construct large-scale hydraulic infrastructures in the Guanzhong Plain, including the Cao, Longshou, Chengguo, and Bai canals (Fig. 7, 1). As one of the main functions of these canals was for irrigation, they formed a well-functioning irrigation network surrounding the Chang'an city. The headwater of one of the canals, the Bai Canal, was found during an archaeological survey in 1973. An approximate 300 m long section of the headwater site was preserved. It consisted of seven vertical pits which were aligned in a row from east to west and a horizontal canal. These pits were constructed in every 30–40 m or 70–80 m. The first pit was located on a bank of the Jing River. A hidden ditch was dug underneath it. The water inlet was 3 m above the present water level of the Jing River. 12 m to the east of the seventh pit was connected with the main canal (Fig. 7, 2).[71] The archaeological investigation of the headwater of the Bai Canal proves that sophisticated design and technologies applied to build the canal represented advanced hydraulic engineering during Han. These irrigation systems in the Guanzhong Plain were crucial for both water supply during drought seasons and improvement of soil conditions (e.g., reduced salinity) for farming. There is little doubt that the construction of these hydraulic systems guaranteed water supply for increasingly large-scale wheat farming in the Middle Yellow River during the late Western Han.

The hydraulic facilities in the Lower Yellow River and the Huang-Huai Plain regions took advantage of the high groundwater level and wider distribution of natural water bodies, and were mainly constructed along rivers and lakes. According to the chapter *Gouxuzhi* (*the Records of Rivers and Canals*) of *Hanshu*, from Emperor Wu's era, the government built many large-scale hydraulic infrastructures and numerous small-scale artificial ditches along the Huai River, Wen River, and Judingze River.[72] As documented in the chapter

[70] Cao Yuying, "Zhongguo niugeng de qiyuan he fazhan (Origin and Development of Cattle-Draught Ploughing in China)," *Nongye kaogu* 2 (1982): 96–101; Qian Xiaokang, "Li (The Plough)," *Nongye kaogu* 1 (2002): 170–181.

[71] Qin Zhongxing, "Qin zhengguoqu qushou yizhi diaochaji (Investigation on the Headwater Site of Zhengguo Canal of Qin Dynasty)," *Wenwu* 7 (1974): 33–38.

[72] Ban, *Hanshu*, 1675–1700.

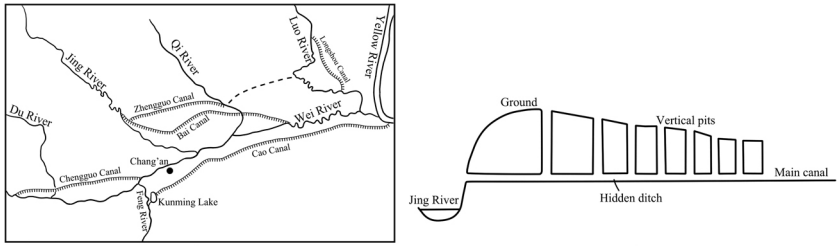

FIGURE 7. The hydraulic infrastructures of Western Han. 1. Distribution of main rivers and canals in the Guanzhong Plain during Emperor Wu's era; 2. Section of headwater of Bai Canal.

Xuyangzhuan (*the Biography of Xu Yang*) of *Houhanshu*, a similar tradition of making most of natural hydrological conditions to construct both state-run and small-scale irrigation and water conservancy facilities was continued and expanded in prefectures such as Runan, Jiujiang, Donghai and Taishan during emperor Guangwu's reign, with the establishment of a new governmental position, the Dushuiyuan office.[73] These facilities irrigated several dozen thousands of arable lands and also effectively prevented floods in the areas.[74]

THE SECOND PUSH FACTOR: WHEAT FLOUR PROCESSING TECHNOLOGIES

Food Processing Technologies before Han

The innovation for food processing technologies was another factor that contributed to the development of wheat farming during Han. The popularity of new cereal processing tools and technologies, especially those for processing wheat flour, became closely intertwined with the formation of new cuisine and pushed the rapid spread of wheat farming in the Yellow River valley.

The main cereal processing tools were grinding slabs, handstones, pestles and mortars from the Neolithic to Qin period.[75] Grinding slabs were relatively large in size, and of tabular, elongated shape. The

[73] Fan, *Houhanshu*, 2710.

[74] Peng Wei, "Guanyu xiaomai zai handai tuiguang de zaitantao (Re-discussion on the Promotion of Wheat During Han Dynasty)," *Zhongguo jingjishi yanjiu* 4 (2010): 63–71.

[75] Song Zhaolin, "Shiqian shiwu de jiagong jishu: lun moju yu chujiu de qiyuan (Prehistoric Food Processing Technologies: The Origins of Grinding Tools, Pestles and Mortars)," *Nongye kaogu* 3 (1997): 187–195.

discovered grinding slabs often have a concave surface in the middle after repeated grinding. The cylindrical or oval-shaped handstone was operated to-and-fro on top of the grinding slab to create friction for dehusking or crushing wheat grains. Pestle and mortar were also used in dehusking and pounding. Supplementary to these cereal processing tools were pottery or bronze vessels for steaming and boiling whole or partially grinded cereal grains. The formation and development of such culinary tradition were determined by the region's agricultural systems that were dominated by millet farming.

The introduction of wheat farming profoundly changed the Han culinary tradition. Compared to millets, the thick coat of wheat grains is hard to dehusk using simple grinding tools. Boiled or steamed wheat grains that were only partially dehusked were hard to chew and digest. The late Western Han historical text, *Jijiupian* (*the Quickly Master Sections*) still complained about the taste of wheat grain, claiming that it was only for the consumption of poor farmers.[76] Similarly, *Houhanshu* also mentioned that eating whole-grain wheat-based foods was regarded by elites and celebrities a sign of poverty or even a humiliation of one's social status.[77] Before the arrival of proper grinding equipment, wheat as a main staple food was not widely accepted. There was a lack of motivation for wheat farming, which limited the development of wheat farming in the Yellow River valley.

Innovations of Wheat Flour Processing Tools

As wheat farming became an important part of Han agricultural economies, it became an increasing social urgency to improve processing technologies for wheat-based foods. From late third century B.C. onwards, rotary mills for fine processing of cereal grains such as wheat appeared in the Yellow River valley. This important change of food processing technologies meant that wheat grain could be now grinded into fine flour, which would further transform the culinary tradition. However, this dietary transformation did not take place overnight; rather, it experienced a gradual, top-down process that was similar to the spread and expansion of wheat farming discussed above.

[76] Zhang Chuanguan, *Jijiupian jiaoli (Collation of Jijiupian)* (Beijing: Zhonghua shuju, 2017), 156–157.

[77] Hu Zhixiang, "Xianqin zhushi jiagong fangfa tanxi (Analysis on Processing Methods of Staple Food in Pre-Qin period)," *Zhongyuan wenwu* 2 (1990): 75–80.

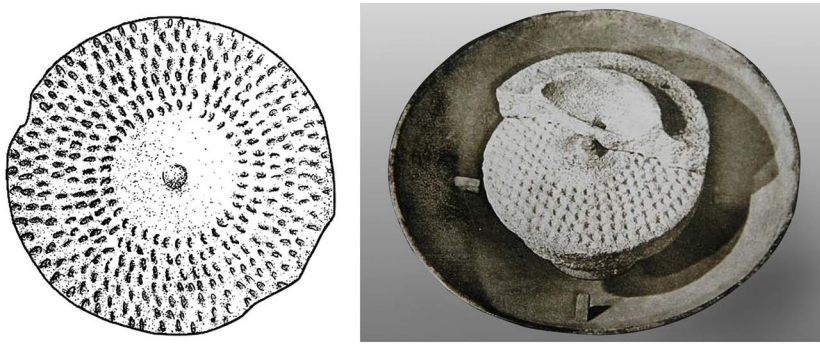

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FIGURE 8. Rotary mills of early Western Han. 1. Yueyang city site; 2. Tomb of Prince Zhongshanjing.

Relatively speaking, archaeological discoveries of rotary mills were fewer in early Western Han. Most mills were found at residential sites and used for practical purposes. The rotary mills unearthed from royal palaces such as the Yueyang city in Lintong (Fig. 8, 1)[78] and the Guigong palace in Chang'an city[79] were made of stones, while both stone and ceramic rotary mills were found from Han tombs such as the tomb of Prince Zhongshanjing in Hebei (Fig. 8, 2).[80] The shape of the early Western Han rotary mills was characterized by their grinding surface with radial concaves. This relatively primitive design was not particularly effective for grinding cereal grains and thus could not be used for mass production of wheat flour. Moreover, majority of the early Western Han rotary mills were found at high-rank sites such as palaces and royal cemeteries. Very rarely did they appear at ordinary sites. This discovery frequency is consistent with related historical records such as *Hanshu* which stated that a special governmental office called '*tangguan* (the Soup Officer)' was established, being responsible for supply of wheat flour foods.[81] The production of wheat flour using rotary mills

[78] Shaanxisheng wenwu guanli weiyuanhui, "Qindu yueyang yizhi chubu kantanji (Preliminary Exploration of Yueyang Site)," *Wenwu* 1 (1966): 10–18.

[79] Zhongguo shehui kexueyuan kaogu yanjiusuo and Riben nailiang guoli wenhuacai yanjiusuo, "Han chang'ancheng guigong sanhao jianzhu yizhi fajue jianbao (Brief Report of the Excavation of No. 3 Construction Site of Guigong Palace in Chang'an City of Han Dynasty)," *Kaogu* 1 (2001): 74–83.

[80] Zhongguo shehui kexueyuan kaogu yanjiusuo and Hebeisheng wenwu guanlichu, *Mancheng hanmu fajue baogao* (Excavation Report of Han Tombs in Mancheng) (Beijing: Wenwu chubanshe, 1980), 143–144.

[81] Ban, *Hanshu*, 731–732.

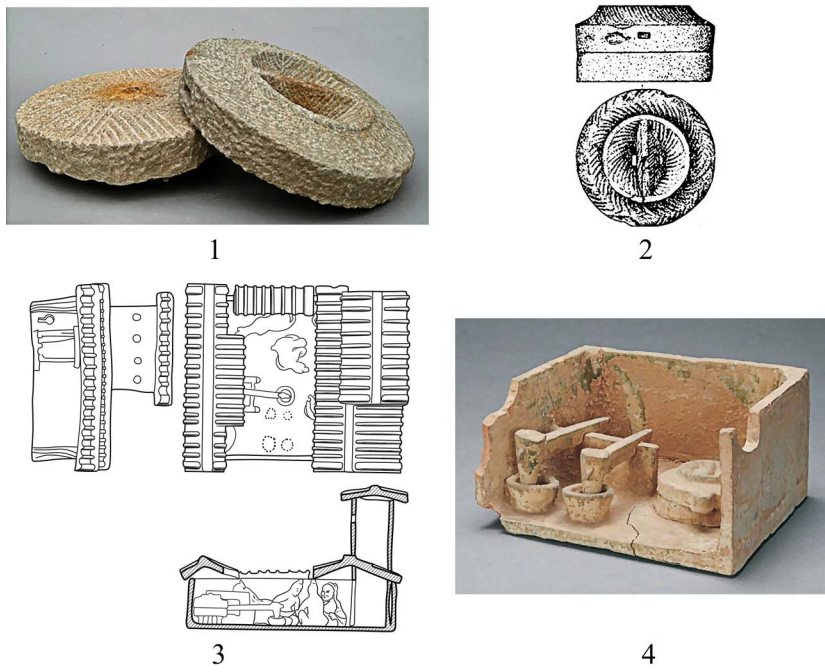

FIGURE 9. Rotary mills and mill models of late Western Han to Eastern Han. 1. Sanyangzhuang site; 2. Shaogou cemetery; 3. Liujiaqu cemetery; 4. Diantoucun cemetery.

and the consumption of wheat flour-based foods were restricted within the high elite circle during this period.

By the late Western Han period, rotary mills were found in much wider geographic areas of the Yellow River valley, commonly appearing at ordinary settlement and cemetery sites. Stone rotary mills for practical use have been unearthed from Han village sites in Henan (Fig. 9, 1)[82] and Shandong.[83] In addition, ceramic and stone models of rotary mills that were made for funerary purposes were commonly found

[82] Henansheng wenwu kaogu yanjiusuo and Neihuangxian wenwu baohu guanlisuo, "Henan neihuang sanyangzhuang handai juluo yizhi dierchu tingyuan fajue jianbao (Brief Report of the Excavation of the Second Courtyard of Han Settlement Site in Sanyangzhuang, Neihuang County, Henan)," *Huaxia kaogu* 3 (2010): 19–31; Fu, *Qinhan nongye jvluo de xingtai yu gengzuo jishu*, 155.

[83] Jia Demin, "Shandong anqiu faxian handai shimo (A Stone Mill of Han Dynasty in Anqiu, Shandong)," *Kaogu* 11 (1995): 1002.

in Han tombs in Henan (Fig. 9, 2)[84] and Hebei.[85] The design and shape of the rotary mills were also improved. Most of the rotary mills had radial grooves neatly carved on the grinding surface of the mills. The concave and convex lines on the upper and lower stones of the mill matched each other to increase its efficiency in producing fine wheat flour.[86] The dramatically increasing number of rotary mills, especially those discovered at ordinary sites in small cities and villages during the late Western Han, clearly suggests their spread from political centers into towns and villages. Their popularity is also indicated by the common presence of mill models in tombs of different social ranks. Particularly noteworthy are the ceramic mill models in late Eastern Han tombs at Liujiaqu (Fig. 9, 3),[87] Diantoucun (Fig. 9, 4)[88] and other cemeteries in Henan. These mill models were equipped with rotary mills, mortars and pestles, windmills and other facilities used for flour processing, with ceramic human figurines operating them.

Although the flour making underwent a qualitative leap after the invention of rotary mills, at the beginning, the processed wheat flour was still coarse and of uneven sizes and often mixed with partially grinded husk fragments. This further drove technological innovations for processing finer wheat flour. A wide variety of tools were invented. The aforementioned *Jijiupian*, for instance, mentioned that bamboo sifters such as '*shai* (the bigger one)' and '*dan* (the smaller one)' were used to refining the quality of wheat flour.[89]

Formation of Wheat Flour-based Culinary Tradition

Relatively speaking, wheat farming had a longer history in Xinjiang and the Hexi corridor on the Silk Roads than in the Central Plains. Influenced by the culinary tradition in Central Asia and further west,

[84] Zhongguo kexueyuan kaogu yanjiusuo luoyangqu fajuedui, *Luoyang shaogou hanmu*, 206–208.

[85] Hebeisheng wenwu yanjiusuo and Xingtai diqu wenwu guanlisuo, "Hebei shahe xinggu hanmu (Han Tombs of Xinggu in Shahe, Hebei)," *Wenwu* 9 (1992): 12–21.

[86] Li Falin, "Gudai xuanzhuanmo shitan (Research of the Ancient Rotary Mills)," *Nongye kaogu* 2 (1986): 146–167.

[87] Huanghe shuiku kaogu gongzuodui, "Henan shaanxian liujiaqu hanmu (Excavations of the Han Tombs at Liujiaqu, Shaan County)," *Kaogu xuebao* 1 (1965): 107–168.

[88] Gu Yongjie and Shi Xiaolei, "Henan bowuyuan cang zaoqi liangshi jiagong qiju yanjiu (Research on Early Grain Processing Tools Collected by Henan Museum)," *Wenwu jianding yu jianshang* 9 (2014): 65–69.

[89] Chen Shaojun, "Mantou ji jiaomian shipin qiyuan wenti de zairenshi (A New Understanding of the Origins of Steamed Bread and Fermented Flour-Based Food)," *Nongye kaogu* 3 (1995): 218–220.

wheat flour bread was baked and consumed here. This processing method was evidently different from the boiling-and-steaming based food processing technologies in the Yellow River valley.[90] Because of its dehydrated condition after baking, bread can be kept for a longer period of time and easy to carry and was therefore liked favorably by merchants and diplomats along the Silk Roads. The mass production of high-quality wheat flour as discussed above and the introduction of bread along the Silk Roads significantly diversified food preparation methods in the Yellow River valley.

'*Bing* (bread)' first appeared in the diet during Western Han and subsequently became the common name for all flour-based foods. According to *Jijiupian*, steamed dough made of wheat flour and water was called *bing*.[91] By Eastern Han, a wide variety of *bing* bread became common staple food in people's diet. The chapter *Shiyinshi* (*the Explanation of Food*) of *Shiming* (*the Explanation of Names*) mentioned many different types of bread, including '*zhengbing* (steamed bread)', '*tangbing* (bread in soup, or noodle)', '*suibing* (bread made with marrow)', '*jinbing* (golden bread)', '*suobing* (bread like long strip)'.[92] *Bing* also became a product being sold on the market. Despite the lack of archaeological evidence, some related historic documents just discussed amply suggest that the '*hubing* (nomadic bread)' was becoming popular in the Yellow River valley. According to the chapter *Yinshibu* (*the Diet*) of *Taiping yulan* (*The Encyclopedia for the Emperor)*, Emperor Ling of late Eastern Han was particularly fond of *hubing*. Eating *hubing* then became fashionable amongst royals and aristocrats in the capital,[93] and adding a new element to the local cuisine, which became a predominant way of food processing in later historical period in the Yellow River valley.

Meanwhile, fermentation technology was also invented for wheat-flour based food preparation. *Simin yueling* documented that boiled bread without fermentation were hard to digest and harmful to the digestive system and were therefore not suitable to be eaten directly. The same book also mentioned a kind of bread, '*jiusoubing*', that was possibly fermented and very easy to digest.[94] Some scholars think that

[90] Zhu Gemin, "Xinjiang diqu gudai mianfen mozhi jishu fazhan tanxi (The Development of Ancient Flour Grinding Technology in Xinjiang region)," *Kaogu yu wenwu* 3 (2019): 122–128.
[91] Peng Wei, "Handai shiyin zakao (An Investigation of the Eating and Drinking in Han Dynasty)," *Shixue yuekan* 1 (2008): 19–33.
[92] Liu Xi, *Shiming* (Beijing: Zhonghua shuju, 1985), 62.
[93] Li Fang, Li Mu, and Xu Xuan, *Taiping yulan* (Beijing: Zhonghua shuju, 1959), 3818.
[94] Shi, *Simin yueling jiaozhu*, 44–46.

this bread was fermented with some alcohol that contained yeast.[95] These records suggest that at least by the late Eastern Han period, fermentation had become a mature technique in the preparation of wheat flour-based foods. These developments further stimulated wheat farming in Han China.

Discussion

Technological Innovation, Governmental Promotion, and Establishment of Wheat Farming

The environmental condition in the Lower Yellow River and its adjacent Huai River regions were suitable for wheat farming since the late Neolithic period. In addition, as the regions were more strongly affected by the Yellow River floods, there was a more urgent need to mitigate food shortage caused by natural disasters, especially during Han when the population reached a colossal figure. These multiple reasons contributed to early and rapid spread of wheat farming in these regions during early Western Han. Compared to this, wheat farming in the Middle Yellow River including the Guanzhong Plain did not witness a rapid development during early Western Han due to a combination of environmental, social and political reasons. First, annual precipitation in these regions was lower and there was not significant threat from summer floods. The relatively dry condition was naturally suitable for growing millets and other drought-resistant crops. The motivation to grow wheat which required higher labor and infrastructural investment had been low. Second, the predominant small-scale peasant agricultural economies during early Western Han[96] meant that many households could not afford costly farming techniques such as *daitianfa* which required more high-quality agricultural tools and cattle-draught ploughing. This to a large extent hindered the promotion of wheat farming. Third, the application of rotary mills was still restricted in the elite circle or rich households and the efficiency of wheat-flour production was still low. To normal households, boiled wheat grain that only underwent very crude processing was not as tasty and easily digestive as millet-based foods. In the central government's decrees related to agricultural production of this period, 'encouraging (people) to grow wheat' often occurred. These

[95] Chen, "Mantou ji jiaomian shipin qiyuan wenti de zairenshi," 218–220.
[96] Hsu, *Handai nongye*, 65–80.

documents hinted the dilemma facing the state: on the one hand the state was keen to promote wheat farming but on the other hand the general public was not enthusiastic about it.

But the situation changed dramatically since the late Western Han. The distribution of wheat farming in the Middle Yellow River centered around the Guanzhong Plain expanded considerably. This expansion of wheat farming benefited from a series of political, social and technological developments. First, the technologies for field management, agricultural tool production and irrigation all witnessed a full-flung development since Emperor Wu's era (see above). These guaranteed optimal resources and growing conditions for wheat farming in the Guanzhong Plain which in turn led to its recognition by farmers, that wheat farming had the advantage of producing significantly more yields. This was an important change as farmers who were sometimes resistant to changes would become more willing to grow wheat in otherwise millet-farming dominant regions. Second, the disintegrating small-scale peasant economy from the end of late Western Han onwards due to land annexation by landlords resulted in the formation of self-sustained manor economy during the transition to the early Eastern Han.[97] Under this new economic circumstance, the manor owners were able to afford advanced technologies such as high-quality iron agricultural tools and cattle-draught ploughing. Indeed, the application of these new farming technologies had far-reaching impact on the expansion of wheat farming. Third, the improvement and popularity of rotary mills from the late Western Han onwards revolutionized wheat flour processing. Wheat flour-based foods were gradually accepted by different classes of the society. Amongst the governmental orders published during late Western to early Eastern Han period, wheat farming was mentioned many times.[98] It suffices to suggest that agricultural production of wheat became an important concern of the government.

Reassessing the Role of Wheat Farming in Han Agricultural Economies

Eastern Zhou (770–221 B.C.) historical records already mentioned wheat was planted in the autumn and harvested in the summer.[99] The

[97] Ibid., 45–56.
[98] Li, *Huanghe liuyu shiqian zhi lianghan xiaomai zhongzhi yu tuiguang yanjiu*, 61–62.
[99] Xia Qimei, "Mailei zuowu qiyuan ji qizai nanbeichao yiqian de zaipei (Origin of Wheat and its Cultivation Before the Northern and Southern Dynasties)," *Zhongguo nongshi* 1 (1989): 90–97.

unambiguous documentation of 'winter wheat' farming came from governmental decrees and official reportages during Emperor Wu's era. The establishment of winter wheat farming was an important agricultural achievement during Han and it had profound social and cultural impacts.

The traditional dryland crops of foxtail and broomcorn millets were planted in the spring and harvested in the autumn. Food shortage frequently occurred under such a monolithic farming system and caused social riots. The growth cycle of winter wheat was an effective supplement to the existing dryland farming. Not only did it increase the productivity of arable land and therefore agricultural yields, it also played a key role in mitigating food shortage.[100] In the Lower Yellow River, the rainy season coincided with the harvesting of foxtail and broomcorn millets. River floods often caused harvestless situation in the field. The growth cycle of winter wheat avoided the flood season and its harvest can often be guaranteed. According to the chapter *Wudiji* (*the Biography of Emperor Wu*) of *Hanshu*, in autumn 120 B.C., Emperor Wu sent officers to areas that were affected by floods to grow winter wheat.[101] Some governors realized the significance of winter wheat to agricultural development and establishment of social welfare system. They praised winter wheat as 'the grain that reverses the deprivation of food shortage and should be particularly valued'.[102]

The above prompted to the change of the cultural role of wheat. In the political centers of Chang'an and Luoyang and their surrounding areas during the late Western Han to Eastern Han, ceramic granary models were a common element in the tombs belonging to people of different social classes. Black, white or red-ink characters of crop names were often written on the surface of the granaries (see above). Wheat, together with other cereals such as foxtail millet, broomcorn millet, soybean and hemp (sometimes rice) occurred in these writings. These granary models were often used in groups (often five a group). It is suggested that these granary models and the crop names written on top of them represented the idea of '*wugu* (Five Cereals)'[103] and that

[100] Han Maoli, "Lun lishi shiqi dongxiaomai zhongzhi kongjian kuozhan de dili jichu yu shehui huanjing (Geographical Basis and Social Circumstance of Spatial Expansion of Winter Wheat Planting in Historical Period)," in *Lishi dili (Historical Geography) (No. 27)*, ed. Zhongguo dili xuehui lishi dili zhuanye weiyuanhui (Shanghai: Shanghai renmin chubanshe, 2013), 178–213.

[101] Ban, *Hanshu*, 177.

[102] Zheng Xuan and Kong Yingda, *Liji zhengyi (Collation of Liji)* (Shanghai: Shanghai guji chubanshe, 2008), 697.

[103] Chen Dingrong, "Gucangguan gaishu (Research of the Pottery Granary Models)," *Nongye kaogu* 2 (1987): 279–285.

such an idea had entered the funerary domain during Han. These granary models symbolized the wealth owned by the deceased. The interpretations of related historical documents regarding what consisting of *wugu* (or '*liugu* [Six Cereals]' or '*jiugu* [Nine Cereals]') have been controversial.[104] However, it is certain that at least by the Han period, wheat was one of the components of *wugu*. It continued to enjoy a high social and cultural status that was closely intertwined with the social and political life throughout the dynastic period of China.

Importantly, it should be noted that despite this unprecedented development of wheat farming, millet farming remained the most important in the Han agricultural system. After many millennia's continuous experiments and successful cultivation, millet farming became significantly sophisticated and mature. As the most important crop in Han agricultural system, foxtail millet was repeatedly mentioned in historical documents for their prestigious status in the agricultural system. The early Western Han politician, Chao Cuo (200–154 B.C.) stated that millet farming was the foundation of politics and suggested that taxation of foxtail millet should be a criterion for obtaining nobility,[105] whilst during Emperor Wu's reign, a special office, '*sousu duwei* (the Military Officer for Foxtail Millet Collection)', was established to collect crops as military provisions, in which foxtail millet was used to refer to all other crops.[106] Supportive evidence for the importance of foxtail millet also comes from recent archaeological studies. Isotopic analysis of human remains from a few late Western Han to Eastern Han tombs in Shanxi and Shaanxi confirms that C4-based plants (foxtail and broomcorn millets) were the main source of food consumption of the deceased individuals; C3-based plants (most likely wheat and barley) accounted for a small proportion.[107] Indeed, until end of Eastern Han, foxtail millet still occupied the most important position in the society.

[104] Song Zhenhao, "Wugu, liugu yu jiugu: tantan jiaguwen zhongde gulei zuowu (Five Cereals, Six Cereals and Nine Cereals: The Grain Crops in Oracle Bones Inscriptions)," *Zhongguo lishi wenwu* 4 (2002): 61–67.

[105] Ban, *Hanshu*, 1133–1135.

[106] Ibid., 1138.

[107] Zhang Guowen, Hu Yaowu, Olaf Nehlich, Yang Wuzhan, Liu Daiyun, Song Guoding, Wang Changsui, and Michael P. Richards, "Guangzhong lianghan xianmin shengye moshi jiyu beifang youmu minzu jian chayi de wending tongweisu fenxi (Stable Isotope Analysis of the Living Pattern of Ancient People in Guanzhong Region of Han Dynasty and the Differences Between it and the Northern Nomadic People)," *Huaxia kaogu* 3 (2013):131–141.

Technological Innovations, Cultural Assimilation, and Wheat Farming in the Roman Empire: A Comparative Perspective

The economic systems of early empires like Han and Rome were largely reliant on agriculture for food production, in which cereal crops and animal products were the staple foods while hemp and flax as well as other crops were grown as cash crops. Agricultural taxation was a vital part of imperial financial systems and the main incentive for the Han and Roman empires to promote agricultural production within and beyond their borders.[108] The promotion of it was often achieved through a top-down process. Large-scale irrigation projects were constructed to increase agricultural yields, technological innovations were made to improve productivity, and economic policies were developed to stimulate production.[109] In this section we briefly discuss the close relationship between economic specialization, technological evolution, and cultural assimilation within and between different regions of the Roman Empire and compare it briefly with that in the Han Empire.

Similar to that in the Han Empire, the selection of crops and the adoption of agricultural practices of the Roman Empire were also profoundly influenced by the environmental conditions. The ecosystem in the core parts of the Roman Empire surrounding the Mediterranean heartland was characterized by its diverse terrains and pronounced seasonality. The regions were partitioned into separate areas with different, fragmentary access to natural resources.[110] This deeply shaped the imperial strategy on the exploitation of natural resources in these areas. During the Roman period, most agricultural practices were aimed at managing and controlling this spatial and temporal fragmentation of natural resources and environmental conditions. It began with the selection of crops that were well adapted to such environmental fragmentation. Crops such as wheat, barley, grape and olive were planted and nurtured within modest-sized plots

[108] Gao Rong, "Handai dui xibei bianjiang de jingying guanli (Management of the Northwest Frontier during the Han Dynasty)," *Zhongguo bianjiang shidi yanjiu* 4 (1994): 58–67; Susanne E. Hakenbeck, Jane Evans, Hazel J. Chapman, and Erzsebet Fóthi, "Practising Pastoralism in an Agricultural Environment: An Isotopic Analysis of the impact of the Hunnic incursions on Pannonian Populations," *PLOS ONE* 12, no. 3 (2017): e0173079.

[109] Hsu, *Handai nongye*, 13–14; Alan Bowman and Andrew Wilson, *Quantifying the Roman Economy: Methods and Problems* (Oxford: Oxford University Press, 2013).

[110] Peregrine Horden and Nicholas Purcell, *The Corrupting Sea: A Study of Mediterranean History* (Oxford: Blackwell, 2000).

with irrigation facilities,[111] and food processing technologies were invented to process these different crops. Through their continuous agricultural experiments and technological interactions with neighboring regions, the Roman developed an agricultural package that was suitable not only for the Mediterranean areas but also for the cooler and wetter environments in the imperial north and the hotter, more arid environments in its south and east. The main crops in this package included grapes that were cultivated for wine production, olives for pressing oil, and cereals such as wheat and barley for making bread and other staple foods.[112] Amongst these crops, wheat was cultivated in wider areas. As wheat farming was more labor intensive than other crops and required more careful management of the Mediterranean ecology, the impetus behind the expanding wheat farming is thought to be more associated with cultural than ecological reasons.[113]

Furthermore, innovations in crop processing tools also greatly stimulated the development of Roman agricultural economies. Wheat flour was mainly produced using rotary mill.[114] There was a smaller version of the mill, with rounded-disc-shaped upper and lower grinding stones and a handle. As it can be easily operated by manual labor, it was also named 'rotary hand mill' (Fig. 10). Another type was of lager volume with an hourglass-shaped upper grinding stone (*catillus*) and a cylinder-shaped lower grinding stone (*meta*), mainly drawn by animal power. It was also called 'Pompeian mill' because those discovered in Pompeii were most typical (Fig. 11). Thanks to the rotating power and sophisticated design, the stone rotary mill was used to produce fine-quality wheat flour. Because of this advantage, the design and operational methods of stone rotary mills were continuously improved and the function of the mills also evolved. The Pompeian mill became very popular with the developing bakery industry during the Roman period. For instance, amongst the 35 Roman period bakery shop sites discovered at Pompeii, each of them was equipped with at least one to several Pompeian mills.[115] It can be surmised that the Pompeian mill

[111] Richard Duncan-Jones, *The Economy of the Roman Empire* (Cambridge: Cambridge University Press, 1982).

[112] Moses I. Finley, *The Ancient Economy* (Berkeley: University of California Press, 1973).

[113] Evi Margaritis and Martin K. Jones, "Greek and Roman Agriculture," in *Engineering and Technology in the Classical World*, ed. John Oleson (Oxford: Oxford University Press, 2008), 158–174.

[114] Natàlia Alonso and Rafael Frankel, "A Survey of Ancient Grain Milling Systems in the Mediterranean," *Revue Archéologique de l'Est* 43 (2017): 461–478.

[115] August Mau, *Pompeii: Its Life and Art* (London: The Macmillan Company, 1899), 377–384.

FIGURE 10. Rotary hand mill of Roman Empire (author 1 has photographed in Museum of London).

FIGURE 11. Pompeian mills and bakery of Roman Empire (author 1 has photographed in Pompeii).

was mainly used in large-scale grinding and specialized bakery shops in cities and manors. In other words, this mill was a product of the highly developed Roman urban economies. However, the Pompeian mill was not as popular as small rotary hand mill at ordinary households and rural areas of the Roman Empire. Lastly, with the imperial expansion, different kinds of mills were brought into different regions of the empire by Roman armies. Rotary mills therefore spread across the Mediterranean and even to the Near East,[116] and played a key role in the agricultural lives of these regions.

From first century B.C. onwards, severe land annexation by landlord occurred in both Han (see above) and Roman empires. Whilst the similar process of small-scale peasant economy giving way to manor-house economy also stimulated agricultural development in the Roman Empire,[117] the Roman imperial policies on agricultural economies differed significantly from those of Han Empire. Both agriculture and commerce were vital to the Roman Empire. Manors that specialized in economic production could sell their agricultural products for profits.[118] The discoveries of aforementioned Pompeiian mills, for instance, suggest that manor owners were concerned for the efficiency of flour production and bread making. With the growing demand for bread, bakeries (*pistrina*) appeared in the cities. Many manor owners became specialized bakers and traders (*pistor*), leading to the formation of a new social class.[119] Compared to this, under the 'emphasizing agriculture and restraining commerce' state policy, private commercial activities of Han Empire were under strict governmental control and salt, iron and wine production was monopolized by the government.[120] Agricultural production remained primarily as a means for self-sustainment, providing food for the consumption of farmers or royals, aristocrats and landowners. As discussed above, stone rotary mills in Han Empire were mainly used for small-scale production of wheat flour. In addition, technological changes on wheat-flour processing mainly focused on improving the design of grinding grooves of the stone rotary mills.[121] This technological characteristic coincided

[116] Curtis Runnels, "Rotary Querns in Greece," *Journal of Roman Archaeology* 3 (1990): 147–154.
[117] John Wacher, *The Roman World, Vol. 1* (London: Routledge and Kegan Paul Ltd., 1987), 556–557; Hsu, *Handai nongye*, 45–56.
[118] Marcus P. Cato, *De Agri Cultura, Vol. I* (Boston: Harvard University Press, 1928), 4–6.
[119] Ludwig A. Moritz, *Grain-Mills and Flour in Classical Antiquity* (Oxford: Clarendon Press, 1958), 136–140.
[120] Hsu, *Handai nongye*, 37–38.
[121] Li, *Huanghe liuyu shiqian zhi lianghan xiaomai zhongzhi yu tuiguang yanjiu*, 132–134.

with a tendency of food processing procedure which emphasized quality in ancient China especially promoted by the royals and aristocrats.

To sum up, we illustrate distinctive regional patterns and temporal variations in wheat farming and flour-processing technologies in Roman Empire and compare them with those of Han Empire. Albeit a brief comparison, it provides insightful perspectives to understand food production, culinary traditions, and their relationship with the changing environmental, social and cultural circumstances of the Han Empire.

Conclusion

To conclude, our synthesis of archaeological and historical evidence clearly shows distinctive spatial and temporal changes of wheat farming in the Yellow River valley during Han. The beneficial factors, including favorable climate-environmental conditions, accumulating agronomic knowledge, technological innovations and other factors, played diverse roles in the spread of wheat farming in these regions. Similar to the Roman case, the spread of wheat farming in Han Empire was also closely related to dietary roles of wheat and food processing technologies. However, it was perhaps different to Roman Empire that state, royals and aristocrats played a decisive role in the top-down promotion of wheat farming and wheat-flour based diet. And importantly, wheat farming overall was still subordinate to millet farming in Han agricultural economies.

Future studies should aim to obtain more bioarchaeological evidence related to millet and wheat consumption patterns from more diverse archaeological contexts in the Yellow River valley. Comparison of these results will help to further illustrate the diverse social and cultural roles of wheat farming and wheat-flour based foods in these regions, and more importantly, to cross-examine the importance of historical, archaeological and bioarchaeological evidence to understanding ancient farming systems in Han Empire.

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