

Morphological Characteristics and Tool Assemblage of Rice-Cultivation Tillage Tools in the Hemudu Culture

Yajun Duan, Na Qi*

School of Fine Arts and Design, Xihua University, Chengdu 610039, Sichuan, China

*Corresponding author: Na Qi, happyli8183@163.com

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Abstract: A large number of bone spades, wooden spades, wooden shovels, and a small number of stone spades related to rice-cultivation tillage have been unearthed from sites of the Hemudu Culture. Existing studies have mainly focused on the forms, hafting methods, and functions of individual bone spades, while less attention has been paid to how different tools participated in continuous tillage processes and formed assemblage relationships. This paper examines Hemudu tillage tools under low-lying, waterside, and shallow muddy surface conditions, focusing on their material properties, working-end forms, hafting structures, and possible operational functions. The study argues that these tools were not scattered artifacts, but formed a basic tool assemblage through land opening, soil turning and lifting, and preliminary field-surface treatment. This assemblage was characterized by the dominance of bone spades, the supplementary role of wooden tools, and the transitional appearance of stone spades, showing preliminary division of labor and limited coordination. This perspective helps shift the study of Hemudu agricultural tools from artifact classification toward tool relationships within tillage processes.

Keywords: Hemudu Culture; Rice agriculture; Rice-cultivation tillage tools; Bone spade; Operational process; Tool assemblage

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1. Introduction

The Hemudu Culture is an important representative of early rice agriculture in the lower reaches of the Yangtze River. The large number of rice remains, together with tools such as bone spades, wooden spades, and wooden shovels unearthed from Hemudu sites, indicates that continuous rice-cultivation activities had already been carried out in a low-lying and waterside environment. Compared with the more mature paddy-field engineering and stone-tool system of the later Liangzhu Culture, rice production in the Hemudu Culture relied more heavily on natural wetland conditions, and its tools mainly served shallow land working and the

establishment of basic tillage surfaces ^[1-3].

Previous studies have mainly discussed the forms, hafting methods, and functional properties of bone spades, thereby providing an important basis for understanding agricultural production in the Hemudu Culture. However, most of these discussions still focus on individual artifacts. Relatively insufficient attention has been paid to how bone spades, wooden spades, wooden shovels, and early stone spades jointly participated in continuous operations such as land opening, soil turning and lifting, and preliminary field-surface treatment. In fact, the forms of agricultural tools are closely related to the objects of work, modes of force application, and land conditions. Only by placing these tools within specific tillage activities can their functional differences and assemblage characteristics be more clearly understood ^[4-7].

This paper examines the rice-cultivation tillage tools of the Hemudu Culture by focusing on environmental conditions, tool forms, operational requirements, and assemblage relationships. It argues that these tools had not yet developed into a mature system of staged division of labor, but had already formed an early assemblage characterized by bone spades as dominant tools, wooden tools as supplements, and stone spades as transitional forms.

2. Environmental context of rice-cultivation tillage activities in the Hemudu culture

The formation of rice-cultivation tillage tools in the Hemudu Culture was closely related to its wetland environment and early rice-farming conditions. The Hemudu site was located in a low-lying area with abundant water resources, surrounded by rivers, swamps, wet depressions, and waterside muddy surfaces. These conditions provided a favorable natural setting for early rice cultivation. Unlike the more regularized paddy fields under stronger artificial control in later periods, the farming space of Hemudu was closer to an early wetland-based rice-cultivation setting, characterized by waterside location, high moisture, shallow soil working, and preliminary land management.

Such environmental conditions directly shaped the working objects and tool requirements of Hemudu tillage activities. The Hemudu people mainly worked on wet, soft, shallow, and slightly sticky muddy surfaces rather than dry and compact soils requiring deep plowing or forceful soil breaking. Therefore, their tillage activities focused on surface opening, shallow soil turning, soil lifting, and preliminary surface treatment in order to gradually form a relatively stable, workable surface ^[8-10].

From the perspective of spatial organization, Hemudu settlements and wetland environments had not yet formed a clear separation between residential areas and farmland areas. Rice cultivation, gathering, fishing, and hunting were all embedded in the wetland ecosystem. In this context, agricultural tools first needed to respond to basic tillage needs on waterside muddy surfaces, rather than to the fine maintenance of mature paddy fields.

Hemudu tillage activities mainly involved land opening, shallow soil turning and lifting, and preliminary field-surface treatment. These overlapping operations required tools capable of cutting into wet soil, moving muddy soil, and adjusting local surfaces. Therefore, Hemudu tools are better understood through functional tendencies and assemblage relationships rather than fixed single uses ^[11-13].

3. Material, structural, and functional characteristics of Hemudu tillage tools

Rice-cultivation tillage tools in the Hemudu Culture were mainly represented by bone and wooden tools, with a small number of stone tools appearing in later layers. Material differences were not merely differences in

artifact categories, but were closely related to different working methods and land conditions. Bone materials had a certain degree of hardness and toughness, and the natural forms of scapulae and hip bones could be processed into working ends and hafting parts. On wet, soft, and shallow muddy surfaces, bone spades were well suited to basic operations such as cutting, prying, soil turning, and soil lifting, and therefore became the most representative tools in Hemudu tillage activities.

Table 1 shows that Hemudu tools had already developed differentiated functional tendencies ^[1-3]. Bone spades varied in front-end form and blade treatment, indicating different modes of soil penetration, disturbance, and surface treatment. Wooden spades and wooden shovels, with larger working surfaces and more complete bodies, were better suited to wide-surface pushing and preliminary leveling. Stone spades, though limited in number and relatively rough in production, suggest a transitional tendency toward more regularized stone tools. These tendencies should not be understood as a mature specialized division of labor, but as flexible responses to continuous and overlapping tillage operations.

Table 1. Types, structural features, and functional tendencies of Hemudu tillage tools

Type	Material / Layer	Main Morphological and Structural Features	Operational and Functional Tendencies
Long-front/short-front bone spades	Bone; typical of the fourth layer	The front end is narrow or elongated; the body is mostly processed according to the natural form of the bone. Grooves, holes, or binding traces can be seen in the hafting area, and the working end is suited to concentrated force.	Surface opening, shallow cutting, and local prying
Willow-leaf-shaped and conical-front bone spades	Bone; typical of the fourth layer	The body is relatively contracted or the front end is relatively pointed; the overall form is more regular. The tool is shaped according to the natural bone form and manually trimmed.	Soil penetration, disturbance, and local soil turning
Bone spades with double-toothed, flat, and oblique blades	Bone; typical of the third layer	Double-toothed, flat-blade, and oblique-blade forms show clear differences. Blade treatment and hafting structure are relatively clear.	Local soil turning, mud lifting, side cutting, and trimming
Wooden spade	Wood; found in the second layer	The plane is nearly rectangular; one side is relatively flat, the blade is wide, with a shallow groove in the middle and long holes on both sides. The complete wooden body forms a larger working surface and facilitates continuous force transmission.	Shallow pushing, moving surface soil, and larger-area treatment
Wooden shovel	Wood; found in the fourth layer	The sides and blade are thin, the middle is thick, and the rear end has a handle-like part. The working surface is relatively wide and the overall structure is strong.	Soil lifting, pushing, and preliminary surface leveling
Stone spade	Stone; found in the first(upper) layer	The body is flat, with a straight top, curved front blade, central perforation, and relatively rough grinding. It combines a plate-like body, perforation, and curved blade.	Transitional tendency toward more regularized stone spades

4. Basic tool assemblage of Hemudu rice-cultivation tillage tools

In Hemudu rice-cultivation tillage activities, bone spades, wooden spades, wooden shovels, and early stone spades formed a basic tool assemblage rather than isolated artifact categories. Bone spades occupied the dominant position because they could cover multiple operations, including land opening, soil turning and lifting, and surface treatment. Wooden tools supplemented bone tools through larger working surfaces suitable for wide-surface pushing and preliminary leveling, while stone spades indicated a transitional

tendency toward more regularized tool forms.

This assemblage may be summarized as “bone spades as dominant tools, wooden tools as supplements, stone spades as transitional forms, and limited coordination.” It differed from both a loose coexistence of scattered artifacts and the clearer grouped division of labor found in the Liangzhu Culture, representing a basic stage from single-tool dominance toward tool relationships.

5. Conclusion

The rice-cultivation tillage tools of the Hemudu Culture should not be understood only as evidence for the existence of early agricultural implements or as isolated objects for typological and functional interpretation. When bone spades, wooden spades, wooden shovels, and early stone spades are placed within the low-lying, waterside, and shallow muddy conditions of Hemudu, they can be seen as tools jointly responding to basic operations such as land opening, soil turning and lifting, and preliminary field-surface treatment.

Overall, Hemudu rice-cultivation tillage tools formed a basic tool assemblage characterized by bone spades as the core, wooden tools as supplements, and stone spades as transitional forms. Although these tools had not yet developed into a mature system of specialized division of labor, their morphological differences already reflected clear functional tendencies. This assemblage reveals an early stage in which prehistoric rice-cultivation tools developed from single-tool dominance toward preliminary division of labor and limited coordination.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Yajun Duan conceived the study, collected and analyzed the materials, and wrote the manuscript. Na Qi supervised the research and reviewed the manuscript. Both authors approved the final version of the manuscript.

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