6 Conclusions

Summary 6.1 3,000 Years of Agriculture in Yunnan from the First Villages to the Han Conquest. – 6.2 Agriculture Beyond Yunnan.

6.1 3,000 Years of Agriculture in Yunnan from the First Villages to the Han Conquest

The recent accumulation of archaeobotanical studies coupled with direct radiocarbon dating of charred plant remains has greatly improved our understanding of the timings and geographies relating to the emergence of productive economies in China, including in Southwest China. Yunnan, at the geographical periphery of the early Chinese States, has often been at the margins of archaeological research, despite earlier claims of being the homeland of rice domesticators and the origin point of agricultural dispersal to mainland Southeast Asia, based on linguistics reconstructions (see § 2.2.1.1). After 15 years of systematic archaeobotanical research in China, the beginning of millet agriculture has been individuated in northern China starting by the sixth millennium BCE, while rice systems emerged along the middle and lower Yangzi by the end of the sixth/early fifth millennium BCE, with paddy-like rice fields documented in these areas from the fourth millennium BCE onward (see § 2.3.1.2). The collection of wild millet and wild rice is presumed to have started a few millennia earlier than this. In Yunnan, the first productive economies are mixed farming systems based on the cultivation of domesticated rice and millet. These are attested since the third millennium BCE in northwest Yunnan (as evidenced at least from ca. 2650 BCE at Baiyangcun, in the Jinsha Basin; Dal Martello 2020).

The apparent delay of a few millennia in the arrival of domesticated crops to Yunnan has often been attributed to the plants biological need to evolve

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suitable varieties to local environments.[1] This hypothesis was related to a potential rice farmers dispersal as main driver of agricultural spread into the region, and supported by the low attested presence of hunter-gatherer groups in Southwest China (although this may be biased by the limited available data). Within Southwest China, Yunnan's rugged topography creates a vertical zonation characterised by deep, water rich river basins surrounded by high mountains, which create mild weather valley conditions conducive to agricultural production. This allows for the existence of successive environmental niches that provide suitable growing conditions for the cultivation of plants with diverging requirements, including dryland and wetland crops such as millet and rice. As such, the rugged topography of Yunnan would not have created a barrier to crops spread, instead, the reason for this delay may be individuated in the fact that rice communities are less expansive than millet agriculturalists and major demographic expansions (and thus the spread of agriculture) were possibly linked to the establishment of millet systems (Qin, Fuller 2019; Stevens, Zhuang, Fuller 2024). Mixed farming systems based on the cultivation of rice and millet have been documented along the Yellow River Basin and northern Yangzi tributaries by the late fifth/fourth millennium BCE (see § 5.1). These are considered the result of millet farmers expansions that took up rice cultivation. Such expansions were at the basis of the first agricultural systems in Northwest and broader Southwest China, where mixed millet-rice systems are found in southern Sichuan only a few centuries earlier than in Yunnan, at Guijiabao (3000-2800 BCE; Hao et al. 2022) along the Jinsha Basin, after an earlier phase of millet only agriculture (from ca. 3300 BCE).

While genetic data regarding the origins of farmers at Baiyangcun and Xingyi is not available, data from later periods confirms migrations of millet farmers into Yunnan in the late second millennium BCE (attested at Haimenkou; Tao et al. 2023), which brought with them technological innovations (see below). Whether earlier demographic spreads or cultural connections played a role for the initial emergence of agriculture in Yunnan remains unclarified. At present, an introduction from Sichuan along the Jinsha Basin, driven by demographic expansion after the establishment of mixed farming systems in the area, is the most likely hypothesis. Early rice systems in northwest Yunnan were based on the wetland cultivation of the crop, as demonstrated by the examination of the weedy flora associated to rice at Baiyangcun. In the third millennium BCE, agricultural production in Yunnan continued to be complemented by the collection of local wild resources, albeit these are less well represented in the archaeobotanical assemblages, possibly hinting to diversified consumption patterns of wild resources compared to cereals. The preference of farmers to settle close to water reservoirs, such as along river basins, may have pushed pre-existing

1 It has also been noted that in addition to crop evolution, agricultural adaptation can take the form of cultural innovation with the development of new cultivation technologies and techniques (e.g., Fuller, Lucas 2017). Stevens and Fuller (2017) suggest a three-stage model for the spread of agriculture outside a domestication centre: Stage 1) cultivators moving within the natural distribution range of a wild species cause the replacement of collecting practices with cultivation activities; Stage 2) within the limit of the wild progenitor distribution, not yet fully domesticated plants expand and gradually replace wild ones; in this phase populations grow, and language families may spread with the spread of agriculturalist groups; Stage 3) agriculturalists move outside the natural ecologic limits of the wild progenitor and only in this case the species adapt to new ecosystems.

hunter-gatherer groups higher in the mountains. However, the extent and nature of interactions between hypothesised migrant farmers with local hunter-gatherers in Yunnan is unknown, due to the current limited archaeological research conducted in the province.

A wave of migrations is attested in the mid-second millennium BCE, when wheat and barley become incorporated into the already mixed agricultural systems of Yunnan (attested at Haimenkou by 1450 BCE; Xue et al. 2022). Agricultural change is accompanied by the emergence of metallurgy as attested by the local production of small bronze tools through bivalve stone moulding (Min 2009a; 2009b). Strong cultural affinities in ceramics traditions and now genetic data confirm that this spread derives from interactions and diffusions from Northwest China (Qinghai/Gansu regions). Recent finds of barley, alongside possible pea in southeastern Tibet by the end of the second millennium BCE (such as at Changguogou at 1500-1200 BCE and Qugong at ca. 1400 BCE)[2] may indicate a southern Himalayas connection from India to China by this period, but the lack of data from Northeast India makes it difficult to investigate this issue. However, since wheat and barley enter Yunnan together (and finds from the two regions are roughly contemporaneous), the question of whether barley may have also spread to China separately than wheat via the southern Himalayas remains unclarified (see also § 2.5.2). Barley also never becomes predominant in the early agricultural systems of Yunnan (and neither does in Central China). This may indicate different flavour preferences or that at this time cultural connections between Yunnan and India were not as strong, but further research is needed to clarify the time depth of the southern Himalayas cultural connection routes.

At Haimenkou, the agricultural assemblage evolves to include legumes, fruits, and other economic species, which points to an intensification of the productive strategy. At the same time, *Chenopodium album* may have been cultivated alongside millet and rice in response to a drying environment and uncertain harvests in the early first millennium BCE (Xue et al. 2022). However, drying climatic conditions did not push for the specialisation of the agricultural systems, instead, all species available became incorporated into a highly mixed system that took advantage of the peculiar vertical landscape of Yunnan. Such a system was at the basis of the agricultural production during the Dian Kingdom, when farming intensified through seasonal crop rotation of winter wheat and summer rice/millet cultivation. Sites associated with the Dian Basin show that wheat complemented the production of rice and millet, rather than substituting it (see § 4.5). Rice fields may have been established in the lowlands, close to water reservoirs, while wheat and millet fields may have been planted ascending into the surrounding hills. The fluctuating climate in the first millennium BCE may have had a role in the creation and persistence of this highly mixed regime. Preliminary data from Hebosuo after the Han conquest of the Dian in 109 BCE show continuity in agricultural systems, and an intensification of crop production, possibly through irrigation and the development of fruit trees management (Yang et al. 2023). At present, irrigation is inferred from historical data rather than archaeobotanical data. The continuity in the productive system composition attested at Hebosuo shows that political change did not alter pre-existing

2 Fu 2001; d'Alpoim Guedes et al. 2013a; Gao et al. 2020b; 2021.

farming systems, rather these were intensified to satisfy the larger demand of food derived from a growing population. Some scholars suggested that this was a strategy to prevent social uprising (Yang et al. 2023).

6.2 Agriculture Beyond Yunnan

The current archaeobotanical evidence does not support previous theories indicating a primary role of Yunnan Austroasiatic speakers in the domestication of rice and its dispersal to mainland Southeast Asia (see § 2.2.1.1). The first documented agricultural systems in mainland Southeast Asia differed from those in Yunnan. In mainland Southeast Asia, the first documented farming systems were based on the dryland cultivation of foxtail millet (attested at Non Pa Wai at ca. 2470 BCE; Weber et al. 2010), followed by the dryland cultivation of rice, attested a few centuries later than the millet-based agricultural systems (e.g., Castillo et al. 2018a, 2016; Castillo 2013; see § 5.3). Foxtail millet may have been introduced to central Thailand via riverine routes from Yunnan through the Mekong; however, a route from coastal southern China (via Guangdong/Guangxi) has also been hypothesised. Here, mixed rice-millet farming systems have been reported from Gantuoyan, possibly from the second phase of occupation of the site (2000-800 BCE; Guangxi 2003). Securely dated evidence for mixed farming systems derives from Gancaoling, in Guangdong, from 2600 BCE (Deng et al. 2022a). However, in northern Vietnam (via which millet farming could have spread into central Thailand), rice systems are documented only from the second millennium BCE (e.g., domesticated rice has been identified with microCT scanning of spikelet bases at An Son and Loc Giang, 2000 BCE; Barron et al. 2017), and so far, millet presence there is lacking.

Similarities in incised/impressed ceramic production between Yunnan and mainland Southeast Asia in the third-second millennium BCE, along with the presence of mixed millet-rice systems in the Jinsha Basin from the early third millennium BCE provide a slightly stronger support to a terrestrial route of agricultural spread via Yunnan into mainland Southeast Asia. However, data from mainland Southeast Asia is extremely patchy, and data for farming systems from southern China, be it Yunnan or the southern coast, only date to a few centuries earlier than the first farming systems documented in mainland Southeast Asia. No conclusive evidence has been found so far in either Yunnan or the southern Chinese coast about the possible development of dryland rice cultivation before its appearance in mainland Southeast Asia. The many geographical gaps and the lack of reliable radiocarbon dating and systematic archaeobotanical investigation hinders our understanding of this specific rice cultivation adaptation. The introduction of bronze technology into mainland Southeast Asia at the end of the second millennium BCE was distinct from the earlier dispersal of agricultural crops, but it was possibly facilitated by the network of connections established between southern China and mainland Southeast Asia (Ciarla 2013).This further suggests that the history of cultural contacts and interactions between the two regions was a complex and stratified history of overlays, with multiple geographical and chronological routes of exchange and interactions. Much of this history still needs to be unearthed.