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4 The origins and spread of cereal agriculture in Mainland Southeast Asia

4.1 Introduction

Cereal agriculture was established through much of mainland Southeast Asia around 4,000 years ago, but underwent important subsequent transformations. The first evidence for cereal-based agriculture in the southern parts of China and Taiwan dates to ca. 2500 BC or a few centuries earlier. While there are a few sites in mainland Southeast Asia that might have involved cereal farming between 2500 and 2000 BC, including millet cultivation in Non Pa Wai, Thailand, most evidence is after 2000 BC. Current evidence suggests that lower yielding, and lower input, dry rice and millet cultivation are what first became established in mainland Southeast Asia. Wet rice, which is so common in the landscapes today, represents a later development, involving labour intensification and probably new varietal diversity in rice. The earliest evidence for this at present comes from ca. 100 BC at Ban Non Wat (Castillo et al. 2018b). Some of that new diversity included *indica* rice introduced from India (perhaps by the 3rd century AD), which dominate much of lowland irrigated rice in the plains of mainland Southeast Asia today. Additional diversity involved several pulse crops introduced from India, such as mungbean and pigeon pea, as well as cotton, all of which were established by Iron Age times (Castillo et al. 2016; D'Alpoim Guedes et al. 2020). Another strand of new diversity included glutinous rice, that spread as new *japonica* rice varieties from China, perhaps also in the last 2000 years. There is much less evidence for cereal agriculture in Island Southeast Asia and that is mostly within the past 3500 years – for example rice phytoliths of this age have recently been reported from Sulawesi (Deng et al. 2020a).

The shift from hunter-gather economies to those based on agriculture was a fundamental change in how human societies affected their environments and it created a fundamental demographic transition, with the potential to support ever greater populations. As such the transition to agriculture has been seen as fundamental to the distribution of language families, as farmers have tended to expand geographically through migration at the expense of foraging populations (e. g. Bellwood 2005). Nevertheless, not all agricultural systems are equivalent, with some supporting much higher population densities and therefore packing the landscape, whereas other farming systems have lower carrying capacities and are prone to more frequent community fission and migration. Therefore, in terms of understanding early agriculturalist migrations it is not enough to establish the presence of agriculture. Instead, what is important is to establish the basis of that agricultural system and its potential productivity – the details of which crops and cropping systems really does matter. It

https://doi.org/10.1515/9783110558142-004

has recently been demonstrated, for example, that the lower productivity of African savannah millets meant that African agriculture spread faster than the more productive Eurasian wheat and barley (Fuller et al. 2019), and that early wet rice in China was less prone to support migrations than rainfed rice and millets (Qin and Fuller 2019), a key insight we return to below.

Mainland Southeast Asia is generally regarded as a recipient region of agriculturalist migrations (Higham 2003; Bellwood 2005), which seems clearly the case for major cereal farming traditions, such as millets and rice. Recent archaeological synthesis suggests that there were as many as 20–24 separate regional foci of plant domestication (Purugganan and Fuller 2009; Larson et al. 2014), and of these, probably a dozen involved the domestication of a cereal. This means that the other half of the centres of origin were likely to have focused on various vegetatively reproduced crops, the tubers and arboricultural crops that have often been prominent in the tropics. While mainland Southeast Asia may well have had earlier Holocene traditions of tuber cultivation or even palm starch use (sago), which has been better documented for Island Southeast Asia, the archaeobotanical evidence for documenting this remains scarce (see Fuller et al. 2014; Denham et al. 2020). We therefore focus on the transition to grain-based agriculture, the origins of staple cereals, which would have displaced prior hunter-gatherer or vegeculturalist traditions over the long-term. From the perspective of early Southeast Asia, the most important centres of cereal domestication were doubtless those from China, where a distinct northern macro-region provided domesticated millets (*Panicum miliaceum* and *Setaria italica*), and further south in the Yangtze basin rice (*Oryza sativa*) was domesticated. It is fundamental, however, not to treat rice as a single monotypic crop, as its forms and its agricultural systems vary greatly from highly intensive irrigated flooded paddy fields, to lower productivity rainfed systems with very different ecological and demographic implications (Fuller et al. 2011; Qin and Fuller 2019), as well as significant cultural variants, such as sticky rices. So we treat three major rice culture types in turn. Nevertheless, other Old World regions contributed to the cereal diversity in Southeast Asia. India–in its broad modern sense – was the source of new forms of rice (*Oryza sativa* subsp *indica*, and cultivars grouped as "*circum-aus*"), as well as some minor millets and a stepping stone for African cereals. Cereals of Near Eastern origin found niches in some of the mountain regions of Southeast Asia, and even a few secondary cereal crops of potential local origin, perhaps focused in particular on the mountainous region of the Indo-Burma borderlands (Fuller and Castillo in press).

4.2 Chinese domestication processes: millets and early rice

China is recognised as having at least two and probably more centres of independent, initial crop domestication (Zhao 2011; Stevens and Fuller 2017). These include a northern Chinese millet centre of origin. Soybeans (*Glycine max*) also come from this region but were added later (domesticated around ca. 2500 BC). This is also one of the regions where pigs were domesticated, also by ca. 5000 BC (Cucchi et al. 2016; Dong and Yuan 2020). A second region is the Yangtze valley, where rice was domesticated (*Oryza sativa*), but modern genetic inferences suggest this was subspecies *japonica* only, with subspecies *indica* and the separate groups of "*circum-aus*" having different regional origins, which we return to below (Choi et al. 2017; Civan and Brown 2018; Gutaker et al. 2020). A possible third region is the far south of China (including Guangdong, Guangxi), and the Pearl River Basin, which has long been suggested to have been a region of vegecultural origins of some tuber crops, although clear archaeological evidence remains limited (e. g. Li 1970; Yang et al. 2013; Denham et al. 2018).

In northern China, two millet species (*Panicum miliaceum* and *Setaria italica*) were domesticated and were the initial focus of cereal agriculture. It is unclear whether more than one cultural area was involved in domestication, and there are at least five cultures that are generally regarded as likely early millet cultivators which stretch throughout the Yellow River basin and the upper Liao River basin in eastern Inner Mongolia; these cultures are dated from 6500–5000 BC, and include the Dadiwan, Peiligang, Cishan, Houli and Xinglongwa cultural complexes (Cohen 2011; Ren et al. 2016; Stevens and Fuller 2017). Foxtail millet was the dominant cereal in the middle Yellow river basin through the Yangshao and Longshan cultures and into the Shang Dynasty (Stevens and Fuller 2017; Li et al. 2020; Deng et al. 2020b), making it central to the rise of the first Chinese states, presumably related to population growth in Sinitic speaking groups.

The Yangtze River basin, including its middle and lower reaches (east of the Three Gorges region), and its tributaries (such as the Han and Huai Rivers) is broadly accepted as a region of rice domestication at roughly the same time as millet domestication, i. e. 7000–5000 BC (Cohen 2011; Stevens and Fuller 2017). However, the Yangtze basin is certainly not culturally unified in this period, with distinctive Neolithic traditions in the middle Yangtze (Hunan province), the Lower Yangtze (the regions around Taihu lake, Zhengzhou bay), and along tributary rivers. It has been argued that Middle and Lower Yangtze rice domestication processes were separate (Fuller and Qin 2009; Zhao 2011; Makibayashi 2014; Silva et al. 2015). What is clear for rice is the evolution of morphological features of rice domestication, including non-shattering panicles, larger grain sizes, change in plant habit, that were evolving rapidly between 6500 and 4500 BC, with domesticated rice spreading thereafter (Fuller et al. 2016; Stevens and Fuller 2017; Ishikawa et al. 2020). Early exploitation (>6500 BC) and low-level pre-domestication cultivation is likely, but remains partially documented.

Two millet crop species that need to be considered in terms of early Chinese agriculture and its potential spread to Southeast Asia are foxtail and broomcorn millet, although only foxtail millet became the most widespread throughout Southeast Asia. Broomcorn millet (*Panicum miliaceum)* is traditionally grown in Taiwan, the southern parts of China and parts of Myanmar, where a Burmese name is recorded from at least the 12th century (Bradley 2011), but otherwise has had little penetration in Southeast Asia as a crop. Nevertheless, *P. miliaceum* is present among the earliest archaeological cereal remains in Yunnan, in near coastal Fujian and in Taiwan, all by ca. 2500 BC (Dal Martello et al. 2018; Tsang et al. 2017; Deng et al. 2018a). Foxtail millet (*Setaria italica)*, is widespread through Southeast Asia, which is readily attested by vernacular names across the major language families, from Tai-Kadai (e.g. Lao *kʰăo fāːŋ,* Vidal 1962), Tibeto-Burman (e.g. Old Burmese *tɕʰap,* Proto-Burmic **tsap,* Bradley 2011), Munda languages (Proto-Munda **hoxy,* Zide and Zide 1976), Austronesian languages (Proto-Malayo Polynesian **beteŋ*), with plausible correspondence to an Old Chinese term, **tsek (*Sagart et al. 2017). Archaeologically it is more widespread than *Panicum miliaceum:* while it co-occurs with *Panicum* in Yunnan (Baiyangcun, ca. 2600 BC: Dal Martello et al. 2018), Fujian (Pingfengshan and Huangguashan, 2200–1600 BC: Deng et al. 2018), and Taiwan (Nuankuanli East, ca. 2500 BC: Tsang et al. 2017). Foxtail millet and rice both spread early to Southeast Asia. Foxtail millet on its own, without rice, is reported from central Thailand with a direct date of ca. 2200 BC, from Non Pa Wai (Weber et al. 2010), whereas at later phases in this valley rice appeared (c. 1500 BC) and increased through time (D'Alpoim Guedes et al. 2020). Foxtail millet and rice co-occur, such as at Rach Nui in Vietnam, ca. 1500 BC and Khao Sam Kaeo in Thailand, ca. 200 BC (Castillo et al. 2016; Castillo et al. 2018a). Both *Panicum* and *Setaria* and these sticky varieties spread secondarily through much of eastern Asia and parts of Southeast Asia.

Rice is the best known, and most widely spread, of the cereals that originated in China. Although the origins of Asian rice (*Oryza sativa*) was not restricted to China, its Neolithic origins in China are the source for the initial spread to Southeast Asia. Later rice dispersals from India, including subspecies *indica* and the *circum-aus* rices, are dealt with below. In addition, we address the origins and spread of glutinous rice varieties, which are important in many Southeast Asia regions. Like rice, the millets also later evolved "glutinous" or waxy varieties through post-domestication mutations (Araki et al. 2012; Hachinken et al. 2013). A secondary dispersal of new sticky millet varieties is parallel to the spread of glutinous rice to Southeast Asia (Fuller and Castillo 2016).

After being domesticated, rice spread to other regions (Fuller et al. 2010; Silva et al. 2015; Stevens and Fuller 2017). The first direction of dispersal was northwards to the Yellow River (by 3800 BC at the latest, based on direct AMS dates from Nanjiaokou, Henan). Rice was slower to spread southwards or westwards, but reached northern Yunnan, Guangdong near the Pearl River Delta, and the Island of Taiwain by ca. 2600

BC (Dal Martello et al. 2018; Qin and Fuller 2019; Gao et al. 2020). As already noted, the spread of rice was usually accompanied by the Chinese millets, especially into Southwest and Southeast China.

The earliest evidence for domesticated rice in Southeast Asia is from Khok Phanom Di, on the eastern margin of the lower Chao Phraya Plain in Thailand (Thompson 1996). The site was occupied between 2000 and 1500 BC and yielded twenty-seven domesticated-type rice spikelet bases. The absence of millets here should be noted, a contrast to the presence of millet but not rice at the near contemporary Non Pa Wai (2200–1500 BC) in central Thailand (Weber et al. 2010; D'Alpoim Guedes et al. 2020). Since then, numerous other sites have been found with the presence of domesticated rice across Southeast Asia spanning the Neolithic to the Historic periods. The evidence so far points to multiple dispersal routes at different times. However, it remains clear that rice was adopted widely in Southeast Asia by the Neolithic starting in the period of 2000–1500 BC (Castillo 2017; D'Alpoim Guedes et al. 2020).

4.3 The problem of *indica* rice origins

It has long been recognised that there are at least two distinct subspecies, *indica* and *japonica*, which have long been attributed to separate geographical origins – with *japonica* associated with origins in China and *indica*, plausibly from South Asia (e. g. Vitte et al. 2004). This is important because both *indica* and *japonica* rices have long been cultivated in Southeast Asia. In mainland Southeast Asia much upland rainfed rice is *japonica*, while *indica* dominates lowland irrigated rice. As noted above the first rices to spread from China to Southeast Asia appear to have been subspecies *japonica* (Gutaker et al. 2020). Rices of the *indica* subspecies were later adopted in Southeast Asia alongside the established *japonica* rices. This likely involved multiple dispersal events (Gutaker et al. 2020). Evidence from grain metrics in Thailand suggests that the earliest *indica* may have been present in the early centuries AD (Castillo et al. 2018b) and became more widespread before Angkorian times (Castillo 2017; Castillo et al. 2018c). Interestingly, other crops of Indian origin, including pulses (*Vigna radiata, Macrotyloma uniflorum, Cajanus cajan*) and cotton (*Gossypium arboreum*) were adopted earlier in Mainland Southeast Asia, certainly by ca. 300–200 BC (Castillo et al. 2016). One find of *Cajanus cajan* may even be older than 1000 BC (D'Alpoim Guedes et al. 2020), hinting at very early interactions across the Bay of Bengal (Fuller et al. 2011).

Archaeological evidence indicates early rice cultivation in the Ganges plains of India by ca. 2500 BC, which have been argued to represent the origins of *indica* (Fuller 2006). After 1000 BC rice cultivation became widespread in India spreading to the far south and Sri Lanka, including differentiation into wet and dry cultivation ecologies (Fuller and Qin 2009; Kingwell-Banham 2019).

However, more recent advances in the genomics of rice diversity, the genetics underlying domestication features in rice, and archaeology has complicated the picture further. Genomic evidence also indicates that a distinct group of "*circum-aus*" rices should be segregated from *indica,* as they are as distant as *indica* from *japonica* (McNally et al. 2009; Choi et al. 2017; Civan et al. 2018; Gutaker et al. 2020). The *circum-aus* rices are particularly diverse in northeast India and Bangladesh, where they perhaps originated. These *circum-aus* rices also came into Southeast Asia, represented by the so-called "Champa rices", which had a short growing season and were introduced from Vietnam to China in the 10th century and set off something of a demographic and agricultural revolution (Barker 2011).

4.4 Dry rice and secondary transitions to irrigated rice

Another fundamental axis of variation in rice is that between rainfed (dry) and wet (flooded or irrigated) cultivation systems. Historically, major states in mainland Southeast Asia have been supported by wet rice which provides both large surpluses and supported the large populations from which state armies were drawn (Scott 2009). In the uplands of Southeast Asia the highest diversity of ethnolinguistic groups is associated with dry rice and other rainfed crops. Thus, understanding the nature of rice cultivation systems is fundamental to assessing its potential to support population density as well as its impact on the environment. In order to distinguish wet from dry rice systems it is necessary to document the companion species of rice, namely the weeds that grew with rice, which have increasingly been documented in recent years (Fuller and Qin 2009; Weisskopf et al. 2014, 2015; Castillo et al. 2018b; Kingwell-Banham 2019). Currently we infer that the first form of cultivation in mainland Southeast Asia was dry rice (Fuller et al. 2016; Castillo 2017; Qin and Fuller 2019; D'Alpoim Guedes et al. 2020). The transition to wet rice and irrigation took place in some regions during the Iron Age. This has been documented in Northeast Thailand by archaeobotanical evidence taking place between 100 BC and AD 400 (Castillo et al. 2018b). Wet and dry ecologies occur across each of the rice subspecies.

A key reason why this matters is the issue of potential yield, which impacts carrying capacity and in turn the frequency with which we can expect outward migration due to community fission. While ancient yields cannot be directly recovered we can make reasonable inferences from ethnographic and historic parallels (Qin and Fuller 2019). Over the long-term we might expect yields to tend to increase, but nevertheless the contrast in productivity between dry and wet rice should remain. An average taken from pre-modern wet rice yields is 1,897 kg/ha, while 1300 kg/ha was achieved in 10th century Japan, and 1,000 kg/ha in the Han Dynasty at Hangzhou nearly 2000 years ago (Qin and Fuller 2019). In contrast, the average of recent dry rice yields is 1,062 kg/ha

(Qin and Fuller 2019), although data from Palawan and Borneo swiddens average just 578 kg/ha, with as low as 229 kg/ha being reported (Barton 2012). Millet yields tend to be closer to those of dry rice, with 500–650 kg/ha being reasonable historical estimates for Chinese millets, and ca. 400 kg/ha being typical of several Indian millets (Qin and Fuller 2019). Taken together with the needs of fallowing some land when growing rainfed rice or millet, it is possible to estimate the reasonable agricultural carrying capacity of self-sufficient villages, with population growth above this level expected to lead to group fission and outward migration (Fuller et al. 2019). Based on such estimates the potential carrying capacity of early rice farming, in Neolithic Yangtze is up to seven times that of dry rice or millet farming, which means that migrations of dry rice or millet farmers would have been more likely and more frequent. Wet rice farmers tended to pack into a landscape, urbanize and invest labour in further agricultural intensification – represented in the Lower Yangtze by the emergence of the urban centre of Liangzhu at ca. 3000 BC (Zhuang et al. 2014; Qin and Fuller 2019; Liu et al. 2020), and Shijiahe in the Middle Yangtze at a similar timeframe, and contrary to the Bellwood (2005) hypothesis, the wet rice farmers of the Yangtze basin tend to grow in population density, urbanise and intensify their agriculture, already by 3000 BC, whereas the dry rice and millet farmers who emerged on their more mountainous peripheries, in the era 3000–2500 BC, are more likely to be the cultural groups who expanded through migration into southeast Asia, due to maintaining much lower population densities and a recurrent quest for new agricultural lands. (cf. Deng et al. 2018b)

4.5 The creation and spread of sticky rice

An important cultural pattern in much of eastern Asia and Southeast Asia is the cultivation of sticky varieties of the major cereals, especially rice and millet. These cereals have become an important component of cuisines and alcohol brewing to varying degrees throughout the region, but are conspicuously little known in agriculture further west (in the Indian subcontinent or Central Asia) – this highlights that the "sticky cereal zone" represents a geographical region defined by a cultural frontier that operated against the westward dispersal of sticky cereals (Sakamoto 1996; Fuller and Castillo 2016; Fuller and Lucas 2017). This zone includes much of China, mainland Southeast Asia, Malaysia and the Philippines, where sticky and non-sticky varieties of cereals are both grown. Two things are striking about this pattern. First, there is no ecological advantage or disadvantage that explains the presence of absence of sticky cereals. Second, the sticky forms of cereals do not exist among wild populations, and therefore evolved after domestication as a result of cultural selection on several cereal taxa. Beyond rice and the major Chinese millets, sticky mutant varieties have been selected in some populations of barley, sorghum, job's tears and maize (Sakamoto 1996; Fuller and Castillo 2016). The resulting characteristic texture in parallel mutations arise from recessive genes and affect starch synthesis, so-called *waxy* mutations. Such grains when cooked are extremely sticky, and taste sweeter as a result of the increased starch molecule branch endings interacting with salivary amylase and different cooking properties (see Wani et al. 2012; Bertoft 2017). From the point of view of early agricultural history, this is significant as these sticky forms are likely to have evolved later, after the Neolithic in China, and dispersed into Southeast Asia. When is still unknown, but they could have evolved in China by 1500 BC and started reaching Southeast Asia after that (Fuller and Castillo 2016). As with the displacement of *japonica* rices by subspecies *indica* (and *circum-aus*), sticky rices (which are mainly *japonica*), represent a significant agricultural transformation. Rice agriculture was not of a single form, but experienced several major waves of dispersal and processes of historical transformation.

4.6 Additional cereals, later or localized

Beyond the several strands of rice, and the earliest Chinese millets there are numerous other cereals that can be found in cultivation in parts of Southeast Asia, mostly with a patchy distribution. In broad terms we can divide these other cereals into three categories in terms of where they came from. First, there are those cereals that derive ultimately from the Mediterranean or temperate Eurasian world, but have found themselves useful in mountainous regions, spread from higher elevation cultivation traditions around the Tibetan Plateau and through the Himalayas in the mountain ranges of southern China, northern Myanmar or adjacent countries – forms of wheats (*Triticum aestivum* mainly), barley (mainly *Hordeum vulgare*) and oats (*Avena sativa, A. byzantina* and *A. chinensis,* the latter plausibly natively domesticated in northwest China). Second, there are additional tropical millets of African origin, especially finger millet (*Eleusine coracana*) and sorghum (*Sorghum bicolor*). The spread of these two cereals from African origins through India is well-reviewed (Fuller 2014; Blench 2016; Fuller and Stevens 2018), but their incorporation into agriculture in parts of China or Southeast Asia remains poorly understood. In Southeast Asia, a single early occurrence of finger millet is at Phu Khao Thong dating to around the first century BC (Castillo et al. 2016). Written sources suggest that sorghum spread into the Sichuan basin, Southwest China by the mid first millennium AD (Hagerty 1941), while it is recorded from Burmese texts by the 12th century (Bradley 2011). Third, there are a few endemic cereals that are minor or highly localised in some parts of Southeast Asia (*Digitaria cruciata, Spodiopogon formosanus, Coix lachryma-jobi*), and some Indian millets that have made minor inroads into Southeast Asia (*Panicum sumatrense, Echinochloa frumentacea*).

The origins of agriculture in the eastern Mediterranean and middle East was based on wheat and barley, of which several forms were domesticated by 7500 BC (Zohary et al. 2012; Fuller et al. 2018). But it was only a few of these wheat and barley forms that made it to the East. It was hexaploid bread wheats (*Triticum aestivum sensu lato*), which had emerged as a hybrid weed in the early Neolithic, that became the dominant wheat in India (from the third millennium BC) and the only wheat to spread through central Asia into China, also arriving as a very minor crop in the Yellow River before 2000 BC (Deng et al. 2020b). Similarly, the derived six-row barleys (which are more productive), including the naked form, that are widely grown in the Himalayas, the Tibetan plateau, into the mountains of northern Southeast Asia, especially in Yunnan and Myanmar arrived from the west. Barley and wheat also appear in wordlists reconstructed for the Proto-Burmic languages (Bradley 2011); these terms appear borrowed from Indic terms which fits with an eastwards dispersal from India, where wheat and barley were well established in the Ganges plains by 2000 BC (Pokharia et al. 2017). They were established crops in Bangladesh ca. 400–200 BC (Rahman et al. 2020). An earlier dispersal from northwest China into central Yunnan by ca. 1500 BC is indicated by the wheat and barley finds at Haimenkou, but these did not penetrate further south at that time (D'Alpoim Guedes and Butler 2014; cf. Liu et al. 2017).

A locally domesticated cereal in Southeast Asia may be job's tears (*Coix lachryma-jobi*), a cereal of minor importance currently cultivated throughout the tropics and subtropics, including China, India, the Philippines, Myanmar, Thailand and Malaysia, and also on a small scale in Korea, Japan and Taiwan (Arora 1977; Simoons 1991; Jiang et al. 2008). Despite speculation that its cultivation in Southeast Asia might have preceded rice (Li 1970: 12; Simoons 1991: 81), this is not borne out by the available archaeobotanical evidence. Job's tears is a staple food amongst some tribal groups on the hills of the Assam region (Arora 1977). Bradley (2011) infers domestication in the Tibeto-Burman region, with diffusion into China during the Han Dynasty. As this species may occur as a weed around wet rice fields, its few archaeological finds remain ambiguous in inferring its cultivation history. Recently, starch grains attributed to this species have been reported from many hunter-gatherer and Neolithic sites across northern China (Liu et al. 2019), but given its morphological similarity to maize – a universal modern starch contaminant (Crowther et al. 2014) – and the lack of any evidence for this species in verified archaeological seed/husk assemblages across northern China during the later Neolithic, its ancient presence as an early cultivar must be considered suspect.

4.7 Concluding remarks

It remains the case that we have a poor understanding of pre-cereal subsistence throughout Southeast Asia, and whether or not there were major developments in terms of vegetative agriculture that could have had major impacts on demography and the dispersal of human populations. Vegecultural systems – based on tuber crops

(*Colocasia esculenta, Dioscorea* sp.), bananas (*Musa* spp.), and sago (*Metroxylon* and other species) – could have preceded cereal agriculture in many regions, but remains undocumented. Domestication processes of tuber crops are harder to document archaeologically than cereal cultivation systems (Denham et al. 2020). It therefore remains speculative as to whether or not the presence of these taxa in regions, such as around the Pearl River region in Guangdong prior to the earliest rice finds (Yang et al. 2013; Denham et al. 2018), represent cultivation or forms of wild gathering. Forms of vegeculture and exploitation of vegetative food plants by hunter-gatherers form a spectrum of behavioural orientations (Barton and Denham 2018); it is less clear-cut than the transition from gathering to cultivation in cereals.

Nevertheless, the spread of cereals, especially rice, involved several dispersal episodes, several varieties, and alternative cultivation systems. It was this diversity of rice cultivation traditions that helped to support both high ethnolinguistic diversity in parts of the hilly tracts of Southeast Asia, and denser populations of lowland rice states.

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