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How rice failed to unify Asia: Globalization and regionalism of early farming traditions in the monsoon world

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Processes of globalization were ultimately driven by migration, of farmers with their crops, or the adoption of new diversity through contact. However, despite such processes, agricultural systems and foodways remain diverse and often regionally distinctive. These distinctions are not easily explained either by ecological differences, or entirely by broad cultural traditions. Instead patterns of regionalism persisted despite globalization in part due to disjunctions of cultural traditions and ecological constraints and the complex mosaic of these boundaries.

Introduction

Much of the Old World already shared a great deal of its agricultural biodiversity long before Columbus reached the Caribbean or Vasco de Gama crossed the Indian Ocean. Instead, earlier globalization processes had already linked agricultural developments across wide regions. Sorghum was grown throughout much of Africa, the Indian subcontinent, parts of Southeast Asia, China and Mediterranean Europe; wheat could be found right across Eurasia and south of the Sahara in Ethiopia and Mali; Asian rice (*Oryza sativa*) was well established in Swahili east Africa, the Mediterranean through the Middle East, India, Southeast Asia, China, Korea and Japan. The intercontinental pattern of these crops for the Medieval World was mapped by Chaudhuri when he defined *Asia before Europe* (1991). This was not just true of such major staple crops, but also many more subsidiary species, from sesame to mungbean, from drumstick trees to coconuts. While in some cases this can be accounted for by widespread wild species, and sister species that were domesticated more than once in far-flung places, such as African and Asian rices (Callaway 2014), most domestications appear to have been quite rare and localized within the overall range of wild progenitor populations (see, e.g. Larson *et al.* 2014; Zohary *et al.* 2012, for some Near Eastern taxa; Fuller *et al.* 2010, for Asian rice). Thus in early periods, mostly "prehistoric" (depending on the part of the world's chronology one prefers), many crops had spread more widely and globalized. Recently historians and archaeologists have called increasing attention to the antiquity of "food globalization" (Boivin *et al.* 2012; 2014; Fuller *et al.* 2011b; Jones *et al*. 2011; Van der Veen 2011).

These processes of globalization were ultimately driven by migration, of farmers with their crops, or the adoption of new diversity through contact. Such adoptions are part and parcel of increasing connectivities, and arguably at the leading edge of the complex connectivities theorized as representing ancient globalizations (as defined by Robertson, this volume; Knappett, this volume). However, despite such processes, agricultural systems and foodways remain diverse and often regionally distinctive. These distinctions are not easily explained either by ecological differences, although these clearly play an important constraining role in crop distribution, nor entirely by broad cultural traditions (judged for example by language family affiliation of ethnolinguistic groups). Instead patterns of regionalism persisted despite globalization in part due to disjunctions of cultural traditions and ecological constraints and the complex mosaic of these boundaries, but also connected to traditions of "taste" and regional identity. Feinman (this volume) advocates "a multiscalar and deep time perspective on the long history of human connections," and food crops, we will argue provide an essential window on connections. Food is both intimate—consumed and prepared at the household level—and regional, transforming landscapes for agricultural production to feed the needs and desires of communities. Indeed, we would contend that food crops, their adoption and spread, may often be among the first evidence for emergence of the connectivities and networks that come to represent globalization (as is the case for the earliest maritime links between Africa and India: see Fuller and Boivin 2009). Food, after all is often shared in situations of hospitality even when languages are not shared. At the same time to know that a foreign plant is edible and cultivatable requires some transmission of knowledge that can only come through human connections.

The present chapter explores these patterns across Monsoon Asia, of both selective crop dispersals geographically and of inter-regional differences in agricultural and food practices, including South Asia, Southeast Asia and China. We will explore earlier globalization processes, which interconnected different agricultural worlds. As emphasized by Knappet (this volume) globalization implies increasing connectivity over both space and through time that resulted in significant social change. We will argue that the adoption of food crops certainly has links to major social changes and marked periods of increasing connectivities between different cultural areas, but without leading to cultural same-ness. We also demonstrate how globalization in Asia is more akin to Wolters' (1999) concept of localization or "global localization" defined as "how the homogenising elements of global culture (from institutions and commodities to social practices and ideas) are differentially incorporated into local cultures, which are in turn altered in the process (Pitts & Versluys 2014)."

Initial crop domestications in Monsoon Asia

The origins of agriculture was transformative. This led to new engagements with other species that changed them (domestication), that transformed landscapes to produce a few key species (environmental anthropogenesis), and that led to a major demographic transition in human populations and those of favoured species, domesticates and commensals. In Southeast Asia, the adoption of cereal cultivation, especially rice, and the management of pigs and cattle is considered the primary force behind social change during the prehistoric period, which formed 'distinctive regional groups of people in a period of rapid population growth' (Gignoux *et al.* 2011; Higham 2014). In China and India agricultural production supported dense populations and the development of urbanism, from about 4000 years ago in central China (Liu and Chen 2012) and 2500 years ago in the Ganges valley (Allchin 1995).

In monsoon Asia, east of the Indus, through South Asia, mainland Southeast Asia and in China east of the Tibetan Plateau, a mosaic of several different pathways to agriculture was followed based on summer rainfall (monsoons) and cultivation of a diversity of small-grain grasses (poorly represented by the English term "millets"), or rice (Figure 8.2.1). Northern Chinese millet domestication probably preceded rice domestication (Zhao 2011). It is believed that domestication took place in the loess plateau region of northern China where the wild progenitor green foxtail (*Setaria italica* ssp. *viridis*) is found. The wild populations of broomcorn millet (*Panicum miliaceum*) are poorly characterized but presumably occurred in the Inner Mongolia steppic region. One or both of these millets are found in widely dispersed cultures across northern China, from Gansu in the west through Shandong in the east and northwards to eastern Inner Mongolia, all at ca. 6000 BC (Bettinger *et al.* 2010; Liu *et al.* 2009; Zhao 2011). Even earlier exploitation, dating back to 8000-9000 BC is suggested by phytoliths and starch grains (Yang *et al.* 2012), although the extent of cultivation or domestication remains unclear.

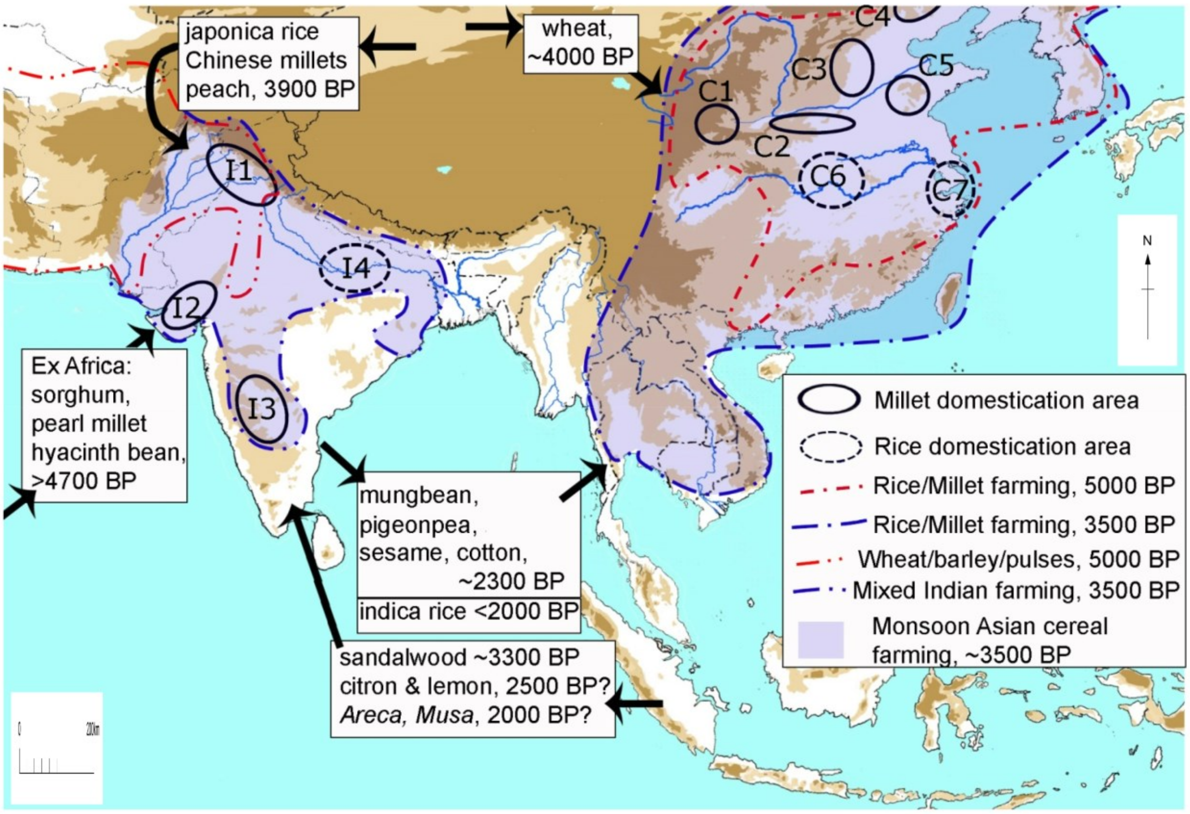

Figure 8.2.1: Map summarizing the centres of cereal domestication early cultivation in Monsoon Asia. Isochrons for the dispersal of farming based on Chinese millets/rice and on wheat/barley or mixed India systems (including wheat/barley and local millets or rice) indicated. Selected later crop translocations between regions are indicates in boxes. Areas of plausible domestication indicates as follows: I1. Upper Indus tributaries and Himalayan flanks (millets and pulses); I2. Suarashtra/ Thar fringe (millets and pulses); I3. South Deccan (millets and pulses); I4. Middle Ganges (proto-indica rice); C1. Dadiwan culture (broomcorn millet); C2. Peiligang culture (foxtail millet, pig(?)); C3. Cishan culture (broomcorn/foxtail millet); C4. Xinglongwa culture (broomcorn/foxtail millet); C5. Houli culture (broomcorn/foxtail millet); C6. Middle Yangtze & tributaries (japonica rice); C7. Lower Yangtze (japonica rice).

Interestingly, other domesticates of north or central China are only added over the course of the middle Neolithic (4500-2500 BC), including pigs, soybeans and hemp. The earliest use of soybeans (*Glycine max*) is to be found in Central China, south of the Yellow river, with finds from Jiahu, dating to the later seventh millennium BC (Zhao 2010). Seed size change suggests soybean domestication is evident between 3650 and 1450 BC (Fuller *et al.* 2014; Lee *et al.* 2011), although a separate domestication in Jomon Japan seems clear (Lee *et al.* 2011). Hemp (*Cannabis sativa*) was traditionally an oilseed as well as a fibre crop in early China. It was well-established as an edible seed crop and drug by the time of early Chinese written sources (Li 1974a; 1974b), but well identified archaeological finds are few, and date from the later Yangshao through the Bronze Age (Zhao 2011).

Pig is the only early indigenous animal domesticate of central China; although dog would have been around much longer, since their domestication(s) in western Eurasia happened in the Upper Palaeolithic (Larson and Fuller 2014; Skoglund *et al.* 2015). Recent assessments suggest that the pig may have been domesticated already alongside pre-domestication cultivation of rice at Jiahu before 6000 BC (Cucchi *et al*. 2011), and might have been present in at least small quantities at Kuahuqiao in the Lower Yangtze by 5500 BC (Yuan *et al.* 2008). Genetic data suggest a single major domestication of pig in central China, but distinct lineages were brought into domestication in mainland Southeast Asia (or southwest China), on the Indian subcontinent, and plausibly separately on Taiwan (Larson *et al*. 2010; Larson 2012), although zooarchaeological evidence for placing these in cultural space or time remain lacking.

While a classic set of farmyard animals was domesticated in western Asia (sheep, goat, cattle) which dispersed eastwards into this zone, especially in China and India, various alternative livestock species became important across Monsoon Asia, including water buffalo (*Bubalus bubalis*) domesticated in the Indus region (the river type) and probably somewhere in northern Southeast Asia (the swamp type) (Larson and Fuller 2014). Humped zebu cattle (*Bos indicus*) hail from the Indus region, either from a distinct domestication, as suggested by the bone assemblages of Mehrgarh (Meadow 1993) or by early hybridization of introduced domesticated cattle with local wild populations (Larson and Berger 2013). Within zebu there are two major genetic groupings suggesting that further introgression of local wild populations was important as zebu spread east from the Indus into inner India (Chen *et al.* 2010). In Southeast Asia banteng cattle in Assam (*Bos frontalis*) and Bali cattle (*Bos javanicus*) in Indonesia remain enigmatic in terms of when and where they were domesticated, as does the role of introduced zebu cattle in promoting these processes (Larson and Fuller 2014). It is likely that by the first millennium AD all of these bovines were under domestication, but the earlier processes of their taming and anthropogenic dispersal, especially in Southeast Asia and southern China, are poorly documented.

Systematically collected archaeobotanical samples in the past few years has begun to make possible the documentation of rice domestication in terms of the evolution of morphological domestication traits, the development of arable habitats, and the shift in reliance from wild gathered foods to cultivated rice (Fuller and Qin 2009; Fuller *et al.* 2010; 2011a; 2014). Recent work documenting preserved rice spikelet bases characterize the dominance of non-shattering panicles reliant on human harvesters for seed dispersal over a period of ca. 3000 years, comparable to well-documented cereal domestications elsewhere such as the Near East (Fuller *et al.* 2014).

The genetic evidence of rice points to two centres of early cultivation, with subsequent prehistoric hybridization between the two. China's Yangtze basin was the hearth for *japonica* rice and South Asian wild populations were ancestral *indica* (Fuller *et al.* 2010). Data indicate that domestication of *japonica* rice in China took place by 4500-4000 BC in the Lower Yangtze valley, while a separate domestication in the middle Yangtze region may have been earlier, even before 6000 BC (Fuller and Qin 2009; Zhang and Hung 2013; Deng *et al.* 2015). These were protracted evolutionary processes, taking millennia (Fuller *et al.* 2014), and it is easier to document the final stages as plant morphology was changed across the population, rather than the leading edge when human behaviours started to shift to cultivation. Sites dating to as early as 10000-7000 BC (e.g. Shangshan, Pengtoushan) show evidence of rice use, and might lie early in the cultivation trajectory (e.g. Wu *et al.* 2014) but better archaeobotanical data are needed to prove this.

On the other hand, domesticated *indica* only appears around 2000 BC in South Asia, with the earliest unambiguous evidence of non-shattering spikelet bases from 1800-1600 BC (Fuller 2011). In India, one finds early evidence of rice use in the middle Ganges at Lahuradewa with a direct date of ca. 6400 cal. BC. However, this is most logically early management, or non-domestication cultivation, since the genetics of domestication traits appear to have been hybridized into *indica* rice from early east Asian *japonica* (Fuller *et al.* 2010; Fuller 2011; Gross and Zhao 2014). Rather than a direct dispersal of rice from the Yangtze to the Ganges, archaeological data point to early trade via intermediaries in central Asia that transferred western crops to China (such as wheat) and various Chinese crops, including *japonica* rice, into Pakistan and Northwest India during the Late Harappan era after 2000 BC (Fuller and Qin 2009; Fuller and Boivin 2009; Boivin *et al.* 2012).

Just as Indian rice is younger than Chinese rice, but evolves by a distinct process, several millets in India are indigenous domestications that were later than Chinese millets. Several distinct regions in India appear to have domesticated millets in the fourth or third millennium BC (Fuller 2014; Fuller and Murphy 2014). In the southern peninsula cultivation of browntop millet (*Brachiaria ramosa*) accompanied by bristley foxtail (*Setaria verticillata*), and the pulses mungbean (*Vigna radiata*) and horsegram (*Macrotyloma uniflorum*), supported the development of agricultural villages in the Ashmound cultural tradition that flourished from 3000-1200 BC, with increasing sedentism and population despite drying climatic conditions (Boivin *et al.* 2008; Ponton *et al.* 2012). On the Saurashtra peninsula in western India, little millet (*Panicum sumatrense*) was the staple grain accompanied by several *Setaria* spp. and/or *Brachiaria*, and the urd bean (*Vigna mungo*). While these probably supported villages of the Padri-Anarta tradition from ca. 3500 BC, they are clearly in evidence from later Harappan influenced sites after 2600 BC (Weber 1991; Fuller 2011). It may be in this broader region where sesame (*Sesamum indicum*) was first cultivated, which spread as a crop throughout the Indus region and then onto Mesopotamia, as well as eggplant (*Solanum melongena*) (Kashyap 2006)—eggplants in Southeast Asia are inferred to be a separate domestication (Meyer *et al.* 2014). The subsistence economies here were ultimately based on adaptations to the tropical savannahs, with importance for both pastoralism and drought-tolerant monsoon season cultivation.

Another likely region of millet domestication was in northwest India near the upper Punjab plains of the Ganges, Yamuna and Ravi rivers, where an unrecognized Neolithic is postulated to precede the Early Harappan sites (from ca. 3200 BC), with evidence for little millet, horsegram, mungbean, and probably domesticated sawa millet (*Echinochloa colonum*), prior to evidence of contact with other Indian millet centres and alongside introduced western crops like wheat, barley and lentil (Weber *et al.* 2013; Fuller 2014; Fuller and Murphy 2014). While perhaps three distinct regions transitioned independently to millet cultivation in South Asia, these areas ultimately shared the same diverse range of crop species both native to the subcontinent and introduced from outside, including millets and *japonica* rice from China.

Farmer dispersals and early crop diffusion: China to Southeast Asia

The oldest domesticated cereals in the archaeological record of Southeast Asia came from China: rice (*Oryza sativa*) and foxtail millet (*Setaria italica*). On current evidence foxtail millet could be older, as it is documented from Non Pa Wai, Thailand with a direct date of 2470-2200 cal. BC (Weber *et al.* 2010), predating the earliest rice from the same valley (i.e. Khao Wong Prachan Valley) by at least a thousand years. Elsewhere in Southeast Asia earlier reports of rice grains or phytoliths could derive from wild populations (Yen 1982; Fuller *et al.* 2010). This, indeed, highlights one of the challenges in Southeast Asian archaeobotany: wild rices are extensively distributed throughout the region, so systematic collection of morphological indicators of domestication, such as spikelet bases is necessary.

The spread of rice farmers from China into mainland Southeast Asia probably took several routes; from the middle Yangtze via Guangdong (Fuller *et al.* 2010); via Yunnan (Higham 2005; also Higham *et al.* 2011) and via both Yunnan and Guangxi (Higham 2013) along the coasts, lower mountain slope zones and down major rivers. For insular Southeast Asia, the Austronesian dispersal route proposed by Bellwood (2007) from Taiwan into the Philippines currently does not have enough rice evidence to support it; nor is there evidence for millets south of Taiwan. Early pigs in Taiwan and the Philippines are plausibly the Lanyu genetic lineage of pigs of local derivation, rather than either the "Pacific Clade" or Chinese mainland pigs (see Larson *et al.* 2010; Larson 2012).

We also find different systems of cultivation throughout the prehistoric sites studied. The evidence so far available suggests that wetland systems of agriculture were used in the lower and middle Yangtze ca. 4000 BC from where they spread (Fuller and Qin 2009; Nasu *et al.* 2011; Weisskopf *et al.* 2014; 2015). However, wetland cultivation was probably not adopted in Southeast Asia when rice was first introduced. Instead early rice cultivation systems in the interior of mainland Southeast Asia were dryland (rainfed), whilst those in lower or coastal areas could have been décrue cultivation, on seasonally flooded land. Dryland systems of rice cultivation are indicated by the study of weed flora associated with rice cultivation spanning the Bronze to Iron Age (Castillo 2011; Castillo 2013; Fuller *et al.* 2011a). This is supported by some local geoarchaeological studies (Allen 1991, 2009).

The appearance of domesticated pig in SE Asia coincides with the period when domesticated cereals are introduced, although disentangling introduced Chinese pigs from genetically distinct indigenous mainland Southeast Asian pigs remains a challenge. Local pig domestication processes remain undocumented, but are implied by modern pig genetics (Larson *et al.* 2010). Whilst there is not enough evidence to suggest that early farmers from Taiwan took rice to the Philippines during the Neolithic, the evidence for pigs at the site of Nagsabaran shows a plausible introduction ca. 2500-2000 cal BC from Taiwan (Amano *et al*. 2013; Piper *et al.* 2009), but these are likely to be an endemic Taiwanese ("Lanyu") pig rather than Chinese Neolithic pigs (see Larson 2012). More evidence for the introduction of domesticated pig southwards is found in the Uattamdi sites, Kayoa Island, Indonesia dating to 3300 BP (Bellwood 1998), although modern genetic geography might suggest that these pigs came from the mainland and not from Taiwan or the Philippines, since Indonesian, New Guinean and Pacific pigs originate from the mainland SE Asian boar not Chinese boar (Larson *et al.* 2010). In mainland SEA, domesticated pig is found at Man Bac in northern Vietnam dating to ca. 1800-1500 BC (Piper *et al.* 2014; Sawada *et al*., 2011). Domesticated or managed pig is difficult to differentiate from the wild stock and most studies use morphometric analyses and age profiling of pigs to reflect human management (Piper and Amano 2013; Larson *et al*. 2010). Using these methods, pig remains in southern Vietnamese sites An Son (1800-1600 BC) and Rach Nui (1500-1200 BC) are said to represent managed/domesticated pig (Oxenham *et al.* 2015; Piper *et al*. 2014; Piper and Amano 2013). Ban Non Wat also reports domesticated pig from the Neolithic Period ca. 1650-1050 BC (Higham and Higham 2009; Higham and Rispoli 2014). Although the Chinese origins for domesticated pig have been established, genetic evidence shows that local SE Asian wild boars introgressed with Chinese domesticated pigs and therefore, took part in the domestication process of pigs in SE Asia (Larson *et al*. 2010).

The situation for bovine livestock in SE Asia is more complicated than for pig. Although cattle remains are reported in SE Asian sites, their status as hunted or domesticated stock remains unclear (Amano *et al.* 2013; Fuller *et al.* 2011a). The *Bos* faunal remains at Non Nok Tha ca. 2000 BC were demonstrably smaller than wild cattle, prompting Higham and Leach (1971) to propose a centre for domestication in northeastern Thailand. At Ban Non Wat, both domesticated and local wild cattle (*Bos gaurus, B. javanicus* or *Novibos sauveli*) were identified (Kijngam 2010; Piper *et al.* 2014). On the other hand, water buffalo (*Bubalus bubalis*) at Ban Non Wat was wild. An early introduction of water buffalo in northern Philippines dates to 500 BC (Amano *et al*. 2013). The earliest reported bovine find (possibly of tamaraw [*Bubalus mindorensis*]) in SE Asia is from Callao Cave, Philippines dated to ca. 65,000 BC via U-series ablation of associated bones (Amano *et al*. 2013; Mijares *et al*. 2010),

Farmer dispersals and early crop diffusion: India

South Asia was characterized by a mosaic of local domestications and the diffusion of domesticated species through interaction between regions. At least 3 or 4 regions had transitions from hunting and gathering to independent cultivation of locally available species (see above). Most of India was transformed to landscapes of agriculture by diffusion, probably including both the migration of farmers to earlier established cultivation centres on the subcontinent and by the transfer of crops and livestock between cultural traditions. This lead to an increasing diversity of crops in India—indeed there is a much greater diversity of grain crops documented in prehistoric India than in any other world region. This diverse range of crops came to be increasingly shared across different regions of India.

In western India, in Gujarat and parts of Rajasthan, evidence for local plant domestication is entwined with the introduction of livestock (sheep, goat and zebu cattle) from the Indus valley, west of the Desert from the middle of the fourth millennium BC, leading to established agro-pastoral village cultures, such as the Ahar tradition in Rajasthan or the Sorath Harappan of Saurasthra by 2500 BC. While the Gujarat region was incorporated in the expanding influence of the Indus Valley civilization from about 2500 BC, evidence for a local transition to food production dates to about a millennium earlier (Ajithprasad 2004). It is likely that this part of India was the first in Asia to bring into local cultivation African crops such as pearl millet and sorghum adopted by 2000-1700 BC, with debated evidence for finger millet (Fuller and Boivin 2009). The first rice to be grown in this region is of similar age (Fuller *et al.* 2010), although whether it was early *indica* forms introduced from the Ganges or *japonica*, introduced down the Indus from a northwestern entry to the subcontinent is unclear.

The centre of the Southern Indian peninsula is a savannah habitat corridor. Through this region the same livestock species (sheep, goat, cattle) dispersed by ca. 3000 BC, but were combined with millet and pulse crops domesticated from local flora, by at least 2000 BC, and plausibly earlier (Fuller 2011). The appearance of wheat and barley by 1900 BC, and later still after 1500 BC some crops of African origin, indicates translocations of crops over the course of the Neolithic. Chinese millets, *Panicum miliaceum* and *Setaria italica* also probably spread through India over the course of the second millennium BC, although their presence is problematic due to difficulties with reliably identifying these from some of the indigenous millets (Fuller and Boivin 2009). The presence of cotton (*Gossypium*) on some Southern Neolithic sites, directly dated at Hallur to 900 BC suggests local traditions of textile production (Boivin *et al*. 2008, 189). While a non-subsistence crop like cotton, suggests production of commodities for trade, the techniques of spinning and weaving as well as cotton and flax likely diffused from the Indus region starting from the middle of the second millennium BC (Fuller 2008).

This same period, in the second half of the second millennium BC, also saw the first clear evidence for the cultivation of tree crops, like mango, jackfruit or *Citrus*, not just in South India but on the plains of the Ganges (Kingwell-Banham and Fuller 2012), highlighting long distance connections in the diffusion and development of orchard arboriculture. The Iron Age in the first millennium BC then saw the widespread adoption of additional staple crops, notably rice, but also another Indian millet, kodo millet (*Paspalum scrobiculatum*). The earliest rice on peninsular India consists of just a few grains in the latest levels of the site of Inamgaon (Vishnu-Mittre 1976) at ca. 1000 BC, but later sites see the widespread adoption of rice (e.g. Kajale 1989; Fuller *et al*. 2010). Kodo millet may have begun as weed of rice, known from the Ganges plains, but in Iron Age and peninsular Early Historic sites it is often the predominant staple grain, perhaps due to it suitability for drier and marginal soils (e.g. Kajale 1984; Fuller in press). Thus, taken together we have at least 4 waves of diffusion of domesticates into South India, livestock at ca. 3000 BC, winter cereals after 2000 BC, commodity crops, textile techniques, fruit trees, and some African domesticates from 1500 BC, and finally rice and kodo millet in the first millennium BC. These new crops from the Gangetic north were accompanied by new high status serving traditions, notably the *thali* plate, widespread and characteristically Indian today, but initially associated with the spread of products (like Northern Black Polish Ware) and influence from northern India (Allchin 1959; Fuller 2005).

The Ganges plains of northern India have already been discussed as a plausible center for an independent start of rice cultivation, even if full morphological domestication has to wait until hybridization was possible with introduced rices from China (Fuller *et al.* 2010; Fuller 2011). By 2000 BC sedentary villages, preserved as mounds, were widespread indicating an agricultural base with new introductions, especially western crops like wheat, barley and lentil, and livestock (sheep, goat and zebu cattle), as well as some pulses from peninsular India, especially *Vigna* spp., like mungbean. Most of these introduced crops and animals spread from the west, under the influence of the Indus civilization, and were accompanied by adopted ceramic types that relate to serving traditions, such as dish-on-stand pedestalled plates in the Ganges (Tewari *et al.* 2008) and necked jars in southern India (Fuller 2005). In southern India, crops and vessels from the northwest have been hypothesized to relate in the first instance to liquid consumption, such as beers (Fuller 2005). The ceramic connection between the Ganges and the Indus, by contrast point to the serving of products like loaves or cakes. This highlights that despite growing similarities in terms of the range of crop plants available and the evidence for interregional trade and cultural flows within South Asia, some cultural differences were localized, maintained or even intensified.

Increased crop diversity across the Indian subcontinent in the second and first millennia BC led to shared trends towards population growth, state formation and urbanization. This brought with it trade and an increased sharing of cultural traditions, including what historians of India referred to as “Aryanization” of southern India, mainly in the first millennium AD (e.g. Stein 1998: 100), but beginning with the spread of Buddhism and the expansion of the Mauryan empire in the final centuries BC. Despite this, food traditions remained distinctively different in north and south India.

The frontier of sticky cereals and milk

While differences in cooking tradition may have separated north and south India, even more pronounced are the long-term divisions in cooking and taste between the Indian subcontinent and Eastern Asia. This was explored recently in terms of a long-lasting difference between a boiling and steaming cultural niche in Eastern Asia and a bread and roasting niche in western Asia, with India tending to have more in common with western Asia (Fuller and Rowlands 2009; 2011). The archaeology of western Asia at least as far east as the Indus valley indicates the presence of clay ovens (*tandur*) was typical in settlements before the development of ceramics. Together with the prominence of querns, this suggests the baking (e.g. bread) and the dry cooking (roasting) of meat were likely widespread in the Neolithic if not earlier. By contrast in early China, even before clear evidence for domesticated crops, ceramic assemblages for boiling (of grains, nuts, tubers, fish) were widespread. Accompanying the rise of agriculture was the development of compound steaming vessels. This suggests that rice and millets were adopted into a cultural system of cooking and taste, and became increasing adapted to better fit this system.

Despite sharing the same crops, between China or Southeast Asia and India, such as rice, foxtail millet, broomcorn millet, and sorghum, the varieties that are sticky, or technically have waxy starch, rarely cross this South Asia- Southeast/ East Asia divide. Instead only non-sticky forms are widespread outside Southeast/East Asia. This division in terms of the texture of the cooked cereal has little adaptive meaning in terms of ecology of the cultivated environment, but instead represents adaptations to human taste preferences. As a current map of the distribution of sticky cereals reveals, these are diverse in Eastern Asia and rare west of Assam, except for some more westerly occurrences of sticky rice in the Himalayas, which we suggest correlated with Tibeto-Burman speakers, who originated further east, or their influence (Figure 8.2.2).

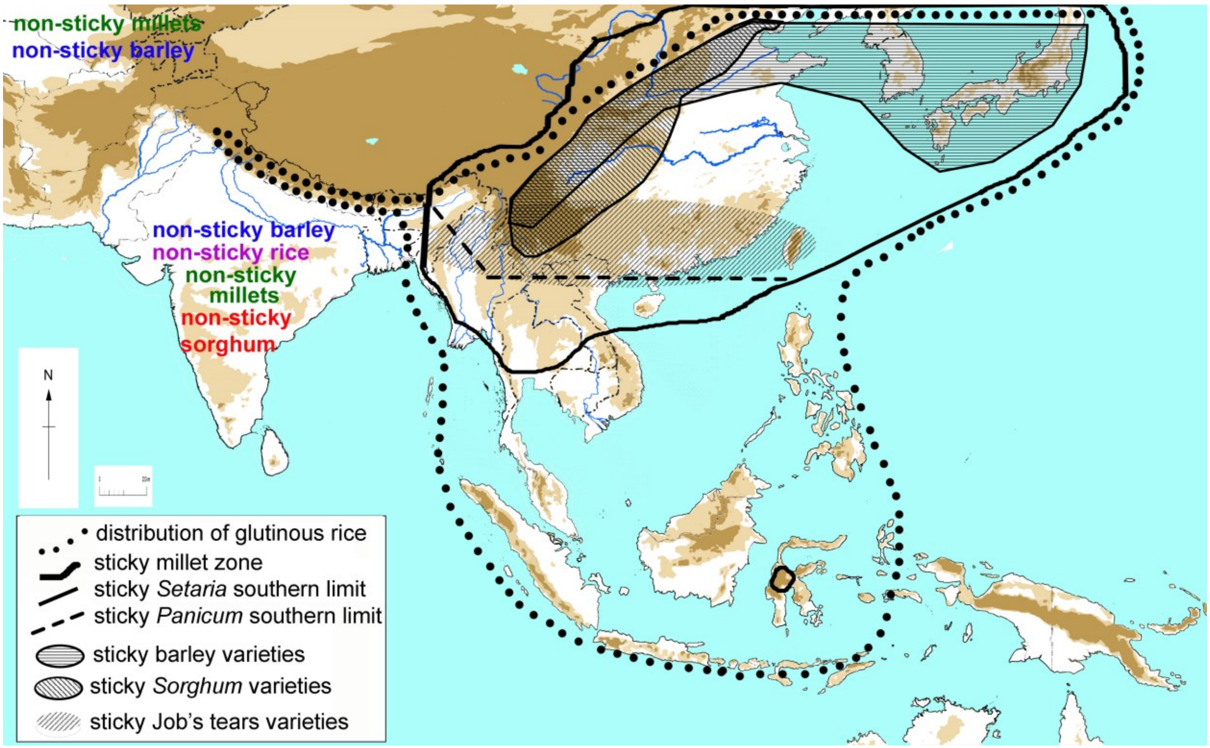

Figure 8.2.2: *Map summarizing the geographical distribution of sticky (low amylose) and non-sticky forms of cereals in Asia in comparison to the frontier between western milk use and eastern non-milk use (after Simoons*

1970). The limits of sticky cereals are approximate and have yet to accurately mapped (revised from Sakamoto 1996; Fuller and Castillo, in press).

We suggest that the origins of this difference started with cooking traditions that necessarily made foods that were different in character. With food boiled or steamed in China, where ceramics developed already in the Pleistocene, consumed foods were sticky and more cohesive in texture compared to most those of South Asia—from the Indus to South India, where grinding stones and grain cultivation likely preceded ceramics, which came to be made from ca. 6000 BC in the Indus and 3500-3000 BC in most other parts of India. Here flours could be baked, griddle cooked or stone boiled but resulting in drier, doughier products. The Ganges valley is a potential exception where ceramics develop early (by 7000 BC), perhaps also associated with the boiling of wild rice, fish and other aquatic resources, but not elaborated to the extent of early to middle Holocene China. The differences in textures created by cooking traditions, such as the stickier, more cohesive cereal products from boiling or steaming in China created a taste preference that snowballed through subsequent genetic changes in the crops. This would have been further reinforced by rituals and belief systems about the relationships between kin lineages, transmitted bodily substances, and ritual interactions with ancestors (Fuller and Rowlands 2009; 2011).

The stickiness of rice or millet is partly due to cooking but mostly due to the structure of the starch in the grain, which in turn comes from a genetic change. Wild rices and non-sticky rices have 75-80% of the waxy starch, amylopectin. As amylose levels decrease and amylopectin increases rice becomes stickier (Chang 2000). True glutinous rice has no amylose at all. Changes in starch composition are caused by post-domestication mutations, initially in temperate japonica rice, which in turn spread by hybridization into many rice varieties (Mikami *et al.* 2008). The occurrence of parallel mutations in many other cereals, especially the Chinese millets and East Asian varieties of sorghum, barley, jobs-tears, and even Chinese, Korean and Japanese maize, only introduced from America in the past 500 years (e.g. Erikson 1969; Sakamoto 1996; Ma *et al.* 2010; Araki *et al* .2013), points to an epicentre for selection of this trait in northern China. Also, sticky rice and millets are sweeter when boiled in water and have often been favoured as the base for alcohol production, as in the rice and millet "wines" of China and its neighbouring countries, with sticky millets known to be used from the earliest Chinese writings on wine production (Bray 1984). Although hard evidence is lacking, one can infer from geographical patterns in modern genetics and later historical documents that it was millets, and probably *Panicum*, that first evolved to be sticky, somewhere in northern China (Fuller and Castillo, in press). In this case evolution of rice toward increasing stickiness took place after rice had spread northwards and after the first wave of rice, which was non-sticky, had spread to Southeast Asia. The spread of sticky rice in Southeast Asia, probably took place in the first millennium BC. The valuing of sticky rice, from China through Southeast Asia, starting 2000 or more years ago, can be conceived as a case standardization (in the sense outlined by Jennings, this volume).

Sticky forms have failed to spread westward, even though non-sticky forms of these species have spread. The case of Chinese millets, *Panicum miliaceum* and *Setaria italica* is particularly clear, since it seems likely that sticky forms had evolved before these species diffused westwards from China (starting ca. 2500 BC), but the sticky forms did not spread to Central Asia, Europe or India despite their availability in the east. In addition, cereals originating elsewhere which have spread into East Asia have had sticky varieties evolve and persist there, including taxa such as sorghum and barley, which do not have waxy forms in their region of origin nor in India. Even more recently maize, introduced to China in the 16th century AD (Ho 1955), has evolved sticky forms (*Zea mays* var. *ceratina*) via waxy starch mutations at least twice within China to better fit regional tastes (Zheng *et al.* 2013). Thus, as cereals dispersed out of China there was a selection against stickiness, while dispersal into China favoured stickiness.

Another key culinary frontier that divides South from East Asia is the non-milking frontier (Figure 8.2.2), first defined by Simmons (1970; 1978). The use of dairy products is widespread in Europe, western Asia and South Asia, but has had minimal importance or even avoidance in central China and Southeast Asia. This is partly correlated with lactose tolerance genes in human populations, since many lactose-intolerant populations in India process milk by fermentation into curds. To the north and west of central China, Mongolian and Tibetan pastoralists also make important economic use of milk. What remains unresolved is the extent to which the non-milking frontier which can be traced through the Assam region of northeast India correlated with the division between use of sticky and non-sticky rice and cereals—do these in fact reflect the same deep time culinary and cultural frontier as hypothesized by Fuller and Rowlands (2009; 2011)?

The selectiveness of secondary exchanges between India and Southeast Asia

While the origins and dispersal of agriculture in Eastern and Southern Asia show many parallels, including sharing closely related crops and ecologies, subsequent transfer of crops between these regions was protracted and selective. Traditional food systems in Southeast Asia include cultivation of *indica* rice, the keeping of zebu cattle and beans such as mungbean and hyacinth bean that had come from India to Southeast Asia. These same taxa are also important in Chinese agriculture, although at present details of the timing and process by which crops were transferred from India is better documented from mainland Southeast Asia.

The beginnings of economic and cultural integration in Southeast Asia started in the fourth and third centuries BC, and it was in this period when we have the first unambiguous evidence for regional trade networks that linked westwards also to India (Bellina *et al*. 2014). This period also known as 'Indianization' is a term that signals the presence of macro-scale networks, emergence of distinctive new social forms in Southeast Asia and implies a directionality of cultural flows in the network (see chapter by Knappett, this volume, on '-ization'). Sites dating ca. 400 BC to 200 AD, such as Ban Don Ta Phet in central Thailand, Phu Khao Thong and Khao Sam Kaeo in peninsular Thailand, and the Sa Hyunh sites in central Vietnam provide evidence for early interactions with India, China and other Southeast Asian groups (Chaisuwan 2011; Dzung 2011; Glover and Bellina 2011). These links with India, China and other Southeast Asian groups are well documented at Khao Sam Kaeo as illustrated by the material culture found at the site such as rouletted ware from India, Han ceramics from China and Dong Son drums from north Vietnam.

Extensive archaeobotanical research at the port-city Khao Sam Kaeo and at the entrepôt Phu Khao Thong has revealed that the settlers and traders at these sites relied on the China-originating *japonica* rice established since the Neolithic, and a suite of Indian pulse crops that arrived in Thailand at this time (Castillo 2013; Castillo *et al.* n.d.), including mung bean (*Vigna radiata*), horsegram (*Macrotyoloma uniflorum*), pigeon pea (*Cajanus* sp), and urd bean (*V. mungo*). Thus the food package at these sites suggest what is referred to as "deterratorialization" (see Jennings, this volume), where the diverse range of *dhals* to accompany rice was more akin to cooking in contemporaneous India than it was to elsewhere or later in Southeast Asia. It appears that from the 'South Asian pulse package,' only the mungbean was adopted for the long-term whereas other pulses, such as the horsegram were not (Castillo 2013; Castillo *et al.*, n.d.). This process is more representative of 'localization' (Wolters 1999) or 'global localization (glocalization)' (Pitts & Versluys 2014). Although 'localization' was originally used to understand the appropriation of foreign beliefs into local culture providing locals with agency (Wolters 1999), we can find examples of food localization in this region such as with the mungbean and rice. The adoption of the mungbean into Southeast Asian cuisine was probably not as a dhal but the more localised use as a vegetable, as sprouts (Castillo 2013). On the other hand, *indica* rice was not initially adopted in Peninsular Thailand since *japonica* rice was already produced and consumed, so although *indica* rice was available, it was not necessary. Mungbean was also found at Pacung 1X (163 BC - 137 AD), another site with close links to the Indian Ocean trade network which illustrates the continuity of the use for this pulse in SE Asia (Calo *et al.* 2015; Castillo 2013). The culinary versatility of mungbean, its use as sprouts or as sweet flour, were suited to eastern culinary tradition and encouraged its long-term adoption in prehistoric SE Asia. This points to pulse of globalization associated with culinary repertoire of Phu Khao Tong and Khao Sam Kaeo at the end of the first millennium BC.

The situation with other crop translocations in this pulse of globalization is less clear. Cotton and sesame also arrived in southern Thailand from India by the late centuries BC (Castillo 2013; Castillo *et al*., n.d.). Archaeobotany and historical linguistics relating to Indonesian sandalwood, coconuts, Areca nut, mango and *Citrus* fruits provide some limited evidence of the introduction of plants from SE Asia into southern India during the Iron Age or even centuries earlier (Fuller 2007; Fuller *et al*. 2011b); the earliest possible introduction may be sandalwood found in the southern Deccan at ca. 1300 BC. In other words, there is evidence for multiple directions of crop transfers, with beginnings in a pre-urban, and pre-Indianisation period of SE Asia (Figure 8.2.1), but what differed in the late first millennium BC was the wider package of cultural practices, from cooking to craft, that showed directionality *from* India.

In contrast to these early introductions from India (beans, sesame, cotton), Indian rice was delayed in its uptake in Southeast Asia. Today most of mainland SE Asia cultivates *indica* rice, but archaeobotanical evidence indicates it did not arrive during the period of first contact with India but probably during the historic period (Castillo 2011; 2013; Fuller and Castillo, in press). *Indica* rice was probably introduced into the Thai-Malay peninsula with wetland farming systems as a result of sustained contact and exchanges with India at a date that still needs to be established (Castillo 2011), but post-dates the late first millennium BC (Castillo *et al*. 2015). While *indica* was ultimately a productive addition to farming, it may not have suited the established tastes, creating more resistance and delay in its adoption.

Discussion: globalizing and localizing forces in the genesis of agricultural systems
The origins of agriculture did much to make cultural landscapes similar, leading to sedentism, systems of land ownership and larger areas under cultivation dominated by relatively few taxa (compared with biodiversity of wider regions). Demographic increase in humans and their domesticates facilitated the spread of human groups, and probably lead to a cultural geography in which fewer large language families dominated the lands. Farmers from different region and cultural traditions could readily exchange crops and adoptions of transferred species was a recurrent process. This began in a big way from the later third millennium BC in China and India, with links to central Asia and even Africa. Nevertheless, the initial impact of adopted species may have been quite minor, as established Neolithic staple foods continued to dominate agriculture (Boivin *et al.* 2012; 2014). During the first

millennium BC, especially the second half, crop exchanges between India and Southeast Asia intensified. New crops, however, were not always accepted—this is evident with many pulses in Southeast Asia, and once adopted could take centuries or millennia to get serious traction in local cultivation, such as wheat in China or African millets in India. Some varieties did not transfer, such as sticky millets outside Eastern Asia, or the long delay before *indica* rice reached Southeast Asia and began to take land over from the established *japonica* rices. These examples of the selectiveness of adoptions highlight the strong role of cultural traditions in filtering adoptions, otherwise known as localization. Crops had to agree with existing food traditions, acquired tastes and methods of cooking, as well as fitting into cultivation ecologies. New crops could be auditioned and rejected, relegated to marginal status, and in some cases transformed by selecting new mutations, as the examples of glutinous barley, sorghum or maize in China demonstrate, or green vegetable forms of cowpea and hyacinth bean in East and Southeast Asia suggest (such forms are absent from the African centres of origin and most of India). In the theatre of food the stage and script were set by culinary tradition and the crops were the players.

In terms of globalizing processes, agriculture certainly provided the substrate on which intercultural transfers were facilitated, and lead to an increasing range of cultural taxa, and ideas of what to do with them being shared over large areas. In at least some limited case this led to deterritorialization of cuisine, such as diverse *dhals* taken up for a few centuries in southern Thailand, or spread of plate culture (presumably with rice and flat breads) from north to south in India. Some broad regions may have had some trends to standardization, as suggested by the distribution of sticky rice and other sticky cereals in East and Southeast Asia. The "Columbian Exchange" of the 16th century was only different in degree, in rapidity, and not in kind from earlier food globalization (see also Robertson, this volume).

Nevertheless, we do not see all the hallmarks of globalization suggested by Jennings (this volume). The world was not made flat. There was much friction that resisted crop transfers and adoptions. In the context of Monsoon Asia this was less about topography or real environmental differences and appears to have been mostly about cultural differences, those of taste, or culinary methods and preferences, illustrated by differing approaches to pulses in the Indian world and that of East and Southeast Asia, by attitudes towards the stickiness of rice and other cereals. Perhaps also to links between how cooked food were eaten, shared or not shared, and perceived in terms of reinforcing relations of commensality or threatening pollution (see Fuller and Rowlands 2011). Newly adopted species were often adapted to local traditions of preparation and serving rather than transforming culinary traditions. In this sense regional and local traditions persisted and may have even been enhanced despite the increase in trade and translocation. The primary materials, domesticated species, were shared, but the secondary foodstuffs were culturally transformed in line with persistent habits of tradition.

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