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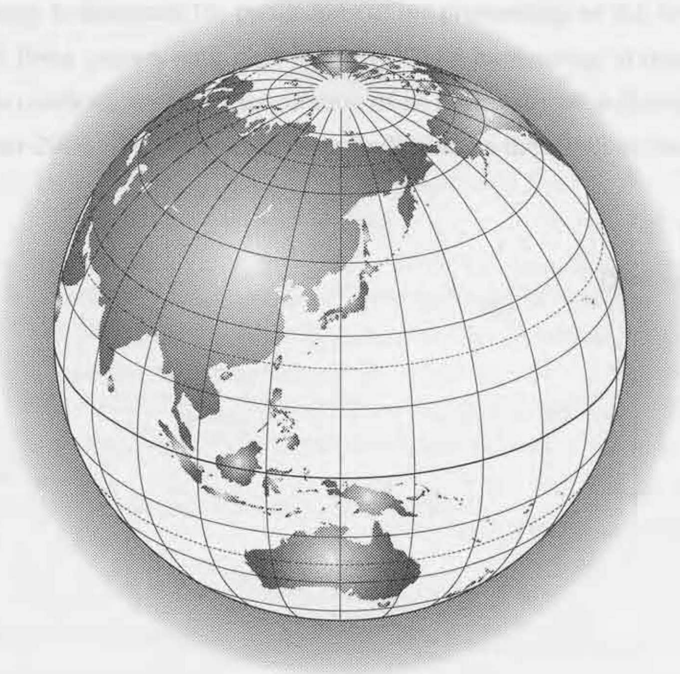

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Silence before Sedentism and the Advent of Cash-Crops: A Status Report on Early Agriculture in South Asia from Plant Domestication to the Development of Political Economies (with an Excursus on the Problem of Semantic Shift among Millets and Rice)

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Abstract/Summary

The current archaeological evidence from South Asia indicates that at the period when sedentary villages emerged agriculture was already established, and that the first agriculture in various parts of the subcontinent differed. While in Pakistan, sedentary agricultural villages are established by the 6th millennium BC, in Gujarat villages were present by the third millennium, and in the middle Ganges region and South India they emerged between 2500-1800 BC. A key feature of most these sites is that they have good preservation of archaeobotanical evidence, and indicate that cultivation is present, but that each of these regions has a different selection of crop species. Prior to the emergence of villages, however, sites are poorly documented and sites with good botanical preservation are almost unknown. Thus there are no clear regional sequences in South Asia that track the transition from hunting-and-gathering to farming, but nevertheless the presence of only, or predominantly, endemic species suggests the likelihood of local plant domestications in Gujarat, South India and the Ganges in the centuries or millennia prior to the emergence of villages. Evidence from lowland Orissa indicates the emergence of agricultural sedentism even later towards the end of the second millennium BC, but a plausible case for local domestications. In Gujarat, we can suspect domestication of little millet (*Panicum sumatrense*) as well as a companion species of *Setaria,* possibly *Brachiaria ramosa,* and urd bean (*Vigna mungo*). In South India, we can suspect domestication of Browntop millet (*Brachiaria ramosa*), brisley foxtail (*Setaria verticillata*), mungbean (*Vigna radiata*) and horsegram (*Macrotyloma uniflorum*). While in the Ganges rice (*Oryza sativa* subsp. *indica*), perhaps again *Brachiaria ramosa* or other small millets, with horsegram and mungbean were the early cultivars. The earliest agriculture of Pakistan is likely to have been wholly introduced as crops from Southwest Asia. The emergence of sedentism is likely to be connected to demographic processes of territorial compression and increased population density. Thus this is likely to come towards the end of any major processes of population expansion and agricultural colonisation that can be suggested to relate to patterns of language family spread. Previously, I have suggested that in Peninsular India such processes might be responsible for the expansion of South and Central Dravidian subgroup languages over much of the Peninsula. Subsequently in the more settled Late Neolithic/Chalcolithic period (ca. 1800-1000 BC on the Peninsula or in the Ganges, but millennia earlier in Pakistan and Gujarat), there is increasing evidence for interregional interactions through trade. An important set of transformations occurred during the course of each regional Neolithic sequence as long-distance trade increased, local craft-production developed and social hierarchy emerged. During this process, forms of non-subsistence agriculture emerged, focused on 'cash-crops' like cotton and flax, or perennial fruit trees and vines. A challenge for future research is the recovery of the hitherto invisible beginnings of agriculture in India, from a stage when

settlement was less sedentary, and there is also a possibility of tuber-based vegeculture rather than grain crops.

Introduction

The origins of agriculture represents a particularly important transition in human prehistory. By producing food through cultivating plants, and to a lesser degree by herding animals) it became possible to store surpluses which could support larger settled populations (sedentism and increased population density), specialist occupations, or non-food producers, such as potters and priests and eventually all of the diversified occupations of cities and civilizations. The potential to stay in one place, sedentism, and to produce large surpluses, freed mobile foragers from reproductive constraints that tended to limit the numbers of infants and small children that could be dealt with at one time (Cohen 1977; 1991). Thus with agriculture was created the potential for much increased rates of population increase. This demographic difference of the idealized early farmer from the idealized hunter-gatherer is the fundamental assumption for many powerful models of prehistoric population change, genetic change and language spread. Starting with the 'wave of advance' model of Ammerman and Cavalli-Sforza (1971), of 'demic diffusion' through the linkage of farming spreads with language family (or macro-family) dispersals with the Neolithic (Renfrew 1987; 2001; Bellwood 2001; 2004), the demographic advantage of farmers over hunter-gatherers has been an essential assumption. This topic has received particular attention in the context of Neolithic Europe with its obvious Near Eastern derivation (e.g. Renfrew and Boyle 2000) and in the settlement of Oceania (e.g. Bellwood 1997; Kirch 1994), as well as the American southwest (Hill 2001; 2003; Bellwood 2004: 240-244). For many other parts of the world, however, the linkages between early agriculture, cultural and linguistic dispersals have only been considered superficially. Modern distribution maps of language families have been compared to conventional maps of agricultural centers of origin to provide hypotheses of Neolithic dispersal of farming populations with ancestral forms of modern languages (e.g. Bellwood 2001; Diamond and Bellwood 2003). Amongst these superficial linkages, the Indo-European spread to South Asia has been suggested (Renfrew 1987; Bellwood 2004), and Elamo-Dravidian often features (Renfrew 1987; Bellwood 1996; 2001; 2004).

In the present paper, evidence against the spread of languages into India with the Neolithic is presented. This evidence takes the form of a balanced review of current archaeological evidence, with an emphasis on archaeobotany, for early systems of cultivation and the distribution of cultivars in late Prehistory. The botanical and archaeological evidence supports at least three indigenous centers of plant domestication in South Asia: in Gujarat, and the Ganges, and the South, while poorly known Orissa could be a fourth. The northwest constitutes a fifth region of early agricultural developments although several fundamental components (staple crops) were derived from Western Asia. This current archaeological picture is congruent with findings of historical linguistics, which have identified core early agricultural vocabulary of indigenous species in an early stage of Dravidian (Southworth 2005; this volume; also, Fuller 2003a), in Proto-Munda (Zide and Zide 1976), and at least two distinct substrate language(s) of northern/northwestern South Asia (Masica 1979; Witzel 1999; 2005; this volume; Fuller 2003a). Nevertheless, within South Asia, the expansions of these language groups may be attributed in part to the demographic expansions of early farmers. All is not clear, however, and limitations to current knowledge of early agriculture in South Asia should be stressed. More data and more field research is needed. One problem which has become increasingly clear in recent years is that almost all well-documented Neolithic sites in South Asia represent sedentary sites, and yet generally have full-blown food production with domesticated crops and usually livestock. This implies that the beginnings of cultivation and herding must have been earlier in as yet unidentified sites. These earlier sites must therefore be less apparent on the ground, especially to the traditional village-informant form of archaeological survey in India, and are presumably non-sedentary. This implies that the development of agriculture in India did not follow the idealized trajectory that textbooks have abstracted from the Levantine evidence.

I will begin by raising this problem of sedentism, before moving onto the evidence from botany and archaeology for delineating five important zones of early agriculture in South Asia. I will also briefly consider the evidence for long-distance crop introductions from Africa, presumably via early Indian ocean contacts. I will then consider the confounding factors that will affect an attempt to write a true history of millets in South Asia. This includes challenges in archaeobotanical identification, and numerous examples of published mis-identification are known. But there is also a more pertinent issue for linguists, which is varying degrees of superficial similarity between millet species, and indeed between various millet species and rice, which provides a logical basis for trying to understand semantic shift amongst millets and from millet names to rice names.

Sedentism and the 'Neolithic' revolution

The transition to agriculture has long been recognized as a fundamental social and technological watershed in human prehistory. The archaeologist Gordon Childe (1936) coined the term "Neolithic Revolution" and defined a number of key developments that could be associated with this transition: plant domestication, animal domestication, ceramic production, and sedentism. Childe also regarded textile production to be part of the "Neolithic revolution," but for many regions at least this appears to be a subsequent development, perhaps to be more associated with the development of political economies and the kinds of social changes that Childe associated with the development of copper metallurgy. While Childe saw the association between his components of the Neolithic as a revolution, it was already clear in his day that these four developments did not happen all at once. Indeed, as evidence from different parts of the world has accumulated it has become increasing clear that in some regions plant cultivation precedes animal herding, while in other regions it follows. Pottery may develop without food production or considerably after.

Sedentism also may develop prior to farming or be delayed until afterwards. In general, human societies that live by hunting and gathering, as all did prior to perhaps 12,000 years ago, were constrained by what was available in the environment at a particular time of the year. In most cases, hunter-gatherer societies were mobile, or at least mobility was used strategically to cope with seasonal shortages in the surrounding environments. Nevertheless various technologies of storage have been significant among hunter-gatherers (Harris 1977; Tesart 1982; Kelley 1995), and in theories of social evolution the transition from immediate-return hunting-and-gathering and delayed return hunting-and-gathering is an important one (Woodburn 1968; Watanabe 1968; Harris 1977: 198, 208, m211-212; Kelly 1995). Agriculture made an important change from this because, even though it relies on a seasonal cycle of planting, growing and harvesting, it provides a storable surplus that can sustain populations through lean seasons, and thus potentially sustain populations constantly in one place. As food production relies on extended labor investment before there are any returns, it encourages protective stewardship of resources. Herds must be protected from predators, including other human groups, and cultivated plants must be tended and guarded. The latter, in particular, encourages cultivators to stay put, at least through the season of cultivation (4-6 months) and often much longer, as the resulting stored material may be too much to move. Thus sedentism is in large part about defending immovable resources. As argued by Rosenberg (1998,) territoriality that focused on key resource patches can be predicted to develop amongst mobile hunter-gatherers as population density relative to scattered clumps of resources increases. It becomes increasingly advantageous to stay near, and lay claim to, rich resource areas, and once one or a few groups do this, other bands will be forced to follow suit. In Southwest Asia increasingly sedentary societies developed during the Late Pleistocene amongst the Natufian period hunter gatherers (12,300-10,800 BC) (Bar-Yosef 1998; Moore et al 2000). In other parts of the world a shift towards increasing sedentism is also associated with terminal Pleistocene or Early Holocene hunter-gatherers, such as the ceramic making fisher-hunter-gatherers of the Jomon tradition of Japan (Imamura 1996; Kobayashi et al 2004) or Khartoum Mesolithic(Arkell 1949; Haaland 1987; Edwards 2004).

Not all transitions to agriculture occurred amongst settled hunter-gatherers, however, and some early farmers were initially mobile. Models of early agriculture in Mesoamerica generally assume an important seasonal mobility (Marcus and Flannery 1996: 49-70; MacNeish 1992; Piperno and Pearsall 1998). In the Sudan the adoption of livestock at the end of Khartoum Mesolithic period led to increased seasonal mobility (Haaland 1987; Edwards 2004), while seasonal mobility is regarded as remaining the pattern amongst the Neolithic societies of Britain (Whittle 1999; Scarre 2005: 414; but cf. Rowley-Conwy 2004). The evidence from India, as reviewed below, similarly indicates that the beginnings of food production in most parts of India preceded recognizable sedentism, and thus the identification of the various regional transitions to farming remains elusive.

The available archaeological evidence from India derives largely from more settled and hence archaeologically, and archaeobotanically, more visible sites. Mobility can be considered through two variables: the longevity of occupation episodes and the length of time between residential moves (Figure 1). Thus even some agriculturalists who live in one place year round may be more or less sedentary. As an example one can contrast fixed locale intensive farmers with those who practice shifting cultivation with residual moves after every few years. Those communities which practice greater degrees of seasonal mobility or shifting cultivation have been less often documented in South Asia, because their sites are less obvious on the ground, and require much more intensive archaeological survey than has been the norm, and because sites of shorter duration are more prone to post-depositional destruction. The latter factors particularly impact archaeobotanical evidence which is fragile and prone to physical disintegration if it is not buried. Thus it is more sedentary sites in which recurrent charring of plant materials and higher sedimentation rates provide better archaeobotanical evidence. As such our current evidence is biased towards the end of the process of agricultural origins and increasing sedentism rather than the beginnings.

Searching for the sources of Indian agriculture

The study of the origins of agriculture is inherently interdisciplinary. Biogeography and biological systematics provide essential information about how species known today in domesticated form came into being. Through systematics, from traditional taxonomy to the increasingly powerful tools of molecular genetics, the closest free-growing or free-ranging relatives of crops or livestock can be identified, i.e. wild progenitors. Comparisons between these provide a basis for identifying wild progenitors and how the domesticated forms differ from their wild relatives and may thus be identified archaeologically. Once identified, the ecology and geographical distribution of wild progenitors in the present day provides essential evidence from which to infer where these species would have been available to past human groups and thus where they could have been first brought under human control. This information about modern distribution does, however, needs to be considered in relation to past climate and environmental changes. In the case of southwest Asia there are a number of crops which occur wild in the transitional zone between the Mediterranean oak woodlands, and open park woodland and the transition to grassland steppe, in a zone that averages 400-600mm of annual rainfall, especially in the Levant, Anatolia and the parts of the Taurus Mountains (Zohary and Hopf 2000; Moore et al. 2000: 58). These are the founder crops of the agriculture in the fertile crescent, most of which were also of importance to the agriculture of South Asia, especially in the northwest and the greater Indus region. The areas in which they were potentially domesticated have been inferred by combining their modern ecological distribution with information about paleoecology through the late Pleistocene and early Holocene (Hillman 1996; Hillman 2000: 327-339), with confirmation through archaeobotanical evidence (Garrard 1999; Willcox 2002; 2005). For crops originating in China and Southeast Asia, Simoons (1991) provides a useful overview. The wild progenitors and ecologies of the most important seed crops of African origin were outlined by Harlan (1971; 1992), with only minimal refinements through more recent work (see Fuller 2003b; Neumann 2004). The equivalent level of information is not available for crops originating in other regions, and for some South and Southeast Asian species we are still in the early stages of documenting the distribution and environmental tolerance of wild progenitors, let alone trying infer from paleoecologoical sources their distribution immediately prior to domestication. Nevertheless, a first attempt to synthesize information from agronomic and floristic sources for grain crops of Indian origin has been published (Fuller 2002: 292-296).

South Asia is the source region for six millet crops, five major pulse crops, sesame, tree cotton, and numerous gourds (including cucumbers). But this does not mean that the whole subcontinent is a center of origin. The geography of each of these species needs to be better understood, so as to help define more restricted geographical zones of origin, which can then be explored through archaeobotanical evidence. Recently the author has begun to reassess herbarium collections of wild progenitors of horsegram, mung and urd. On the basis of herbarium collections in Pune and Calcutta it is possible to suggest a refined distribution of wild mung and urd beans, which derive from similar but distinct progenitors (Figure 2), as well as horsegram (Figure 3), whereas pigeonpea progenitors had already studied by Van der Maeson (1986). The millets are generally quite cosmopolitan within monsoonal India and as such could have been domesticated in any of several places and potentially more than once. Meanwhile sesame and tree cotton are presumably from the northwest. Rice and various cucurbits are largely of northern or eastern origin, with a separate domestication in China (see below). Recent botanical investigations on the bitter gourd (*Momordica charantia*) and sponge luffah (*Luffa cylindrica*) suggest that these species have two distinct dometsications each, in Northern India/Nepal and in Yunnan, China (Marr et al. 2004; 2005a). This pattern of parallel domestication of the same species in Northern/Eastern South Asia as well as somewhere in China is being found to occur across many species.

In outlining the archaeology of early agricultural traditions in South Asia, I will simplify this into five key zones (Figure 4; building on Fuller 2002; 2003d). First there is the northwest, including the greater Indus valley and its hilly flanks to the west and north. In these regions summer monsoon rains are limited or unreliable and much cultivation depends either on the limited by regular winter rains or else river water, which rises in the spring and summer as Himalayan snow melts (Leshnik 1973; Fuller and Madella 2001). Second there is the middle Ganges zone, an area with the benefits of both significant monsoons rains and numerous perennial river systems that are fed by the monsoons. This area incorporates significant cultural diversity in the archaeological record. Thirdly, it may be necessary to consider Neolithic traditions in Orissa to the east as distinct from the Gangetic Neolithic, although the Neolithic there is still poorly documented and could relate to the Gangetic pattern (cf. Fuller 2003d; Harvey et al., in press). Fourthly, there is Gujarat, especially the Saurashtra peninsula but possibly also parts of Southeast Rajasthan and the area around Mount Abu. This region also is favored by monsoons and represents the ecological transition from the dry Thar Desert into the semi-arid monsoon tropics that supports a mosaic of savannahs and deciduous woodlands. Fifthly, there is the Southern Neolithic zone in the semi-arid peninsular interior which has received increasing attention as a region of domestication of monsoon-adapted pulses and millets in the later middle Holocene (Fuller et al. 2001a; 2004; Fuller and Korisettar 2004; Korisettar 2004; Asouti et al. 2005)

Near Eastern crops and dispersal to the Northwest

In northwestern South Asia the dominant crops from the time of earliest evidence derived from the Southwest Asian Neolithic Founder crops (sensu Zohary 1996; Zohary and Hopf 2000). These crops, especially wheats and barley, but also lentils, peas, chickpeas, grasspea, flax and safflower, can now be placed in the Levantine zone and southeastern Anatolia. Cultivation of some of the cereals has now been postulated for the Late Pleistocene, after ca. 11,000 BC, while domesticates are clearly widespread in the region by the beginning of the Pre-Pottery Neolithic B (ca. 8800 BC) (Harris 1998a; Willcox 1999; 2002; Moore et al. 2000; Hillman et al. 2001; Garrard 1999; Colledge and Conolly 2002). Representatives of this crop package had spread to Central Asia by ca. 6000 BC, the time of the Djeitun Neolithic (Harris 1998b) and to western Pakistan by the time that Neolithic Mehrgarh was founded, certainly by the Sixth Millennium BC, and according to some as early as ca. 7000 BC (Possehl 1999; but see the original dating evidence for Mehrgarh in Jarrige 1987; Meadow 1993: The outlier early dates are more plausibly attributed to old wood, with occupation beginning closer to 6000 BC). At this period global climate was recovering from an arid spell of a couple of centuries which is evident in this region from isotopic data from the Arabian sea (Staubwasser et al 2002; 2003). Thus establishment of sedentary agricultural villages in Baluchistan can be attributed to the mid-Holocene period of warmer and wetter winters.

Despite some arguments in favour of cereal domestication in Pakistan (e.g. Possehl 1999: 412-414), the lack of wild progenitors (for all wheats, all the pulses, flax and safflower) and the late available dates by comparison to Southwest Asia, points towards the spread of crops from the Near East. While this could have involved the spread of farmers, diffusion of just the crops is also possible, and current archaeological evidence from which to assess this is limited. While early archaeobotanical evidence of these other Near Eastern crops (pea, lentil, chickpea, grasspea, flax and safflower) is missing from the Neolithic, this is likely a product of limited sampling. It is clear that these species were important cultivars, well-established and widespread in the Indus region by the time of Harappan urbanism in the Third Millennium BC (Meadow 1996; 1998; Fuller and Madella 2001), although it is not yet clear whether all of the crops which were present by then had arrived already or together by the Neolithic.

While the evidence from Mehrgarh is the only early evidence for the beginnings of cultivation, the nature of this system and crop preferences remains unclear. While some ca. 6000 plant impressions in mudbrick were examined (Costantini 1983; Possehl 1999: 459), which are dominated (ca. 95%) by naked barley, it is not possible to relate these data directly to dominance in agriculture nor to local domestication. Impressions, such as these, are created by the use of crop-processing by-products (i.e. winnowing waste) as clay tempering, and are thus biased in species representation. The barley is largely naked, six-row barley, identified not from the grain products but from the chaff and rachis. This species, as opposed to hulled barley or glume wheats, like emmer, is produced readily from the first round of processing likely to take place during harvest season, whereas abundant sources of other species like wheat glumes will be produced in smaller quantities on a year-round basis (cf. Fuller et al. In press A). Some wild barley is also reported. Co-occurrence of wild and domesticated forms of a plant, however, is insufficient to establish a local transition/transformation from one to the other. Although wild Barley is found in this region, it may have dispersed as an early weed of cultivation from the west, since it is known largely from secondary habitats rather than dense primary stands (Zohary and Hopf 2000), or local wild barley may have become established as a weed after domesticated barley was introduced from the West.

While the staple crops were all introduced, livestock and other crops indicate a number local domestications. The best documented of these is the domestication of zebu cattle inferred from metric changes in bones through the Mehrgarh sequence as well as distinctive humped cattle figurines (Meadow 1984; 1993). Phylogenetic evidence from DNA is also clear in indicating separate domestication (or two) of humped zebu cattle from Near Eastern (and African) taurine cattle (MacHugh et al. 1997; Bradley et al. 1998; Kumar et al. 2003; Bruford et al 2003). Goats appear domesticated from the earliest occupation at Mehrgarh, but recent genetics suggests one or two domestications of goats additional that of the Near East (probably Iran) (Luikart et al. 2001; Bruford et al 2003: 905). Genetic evidence for sheep is similar, with a plausible domestication in Central Asia or Baluchistan (Hiendleder et al. 2002; Bruford et al. 2003: 905). Bone evidence from Mehrgarh could indicate a sheep domestication process in this region (Meadow 1984; 1993). By the end of Period I, early in the fifth millennium BC, finds of cotton seeds and cotton thread suggests that this fibre crop had been brought under cultivation from local, but now extinct, ancestors. Sesame and a local variety of the date palm may also have been brought under cultivation during this period, although undisputed finds only come from several millennia later during the Harappan period.

It was the food production established at Mehrgarh by the 6th millennium BC, based on wheat, barley, winter-grown pulses and cotton as well as livestock that formed the basis on which settlement of the Indus valley and the later Harappan civilization developed. In addition, the fibre crop cotton appears at Mehrgarh during the Neolithic, perhaps by 5000 BC, and is a likely domesticate of this region (Costantini and Biasini 1985; Fuller 2002; Moulherat et al. 2002). The native cotton, *Gossypium arboreum*, is a woody shrub and as such was likely to have been cultivated in perennial orchards like fruits. Mehrgarh also provides evidence for grapes and jujube that might have been cultivated or managed for fruit. The status of the large true date seeds from Mehrgarh is problematic as they are uncharred and undated, but at the Harappan site of Miri Qalat in Makran wild type date stones (probably *Phoenix sylvestris*) occur confirming date consumption (and probably cultivation) in this region (Tengberg 1999), while true dates (*Phoenix dactylifera*) were certainly present in Iran (Tengberg 2005). Sesame is also domesticated in this region although the earliest finds are from the Mature Harappan period (Fuller 2003c; Bedigian 2004; Tengberg 1999; Benecke and Neef 2005). Another important domesticate of the Indus region is the water buffalo, which has been well-documented as a domesticate at the Harappan city of Dholavira in the great Rann of Kutch, culturally and climatically a outlier of the Sindh region (Meadow and Patel 2003).

The Northern Neolithic

Another but later Neolithic tradition is documented from Kashmir and the far north of Pakistan (the Swat Valley). Generally known as the Northern Neolithic, this tradition is best represented by sites in the Kashmir valley, although related sites can be identified in Swat (Northwest Pakistan). Here sites occupy the milder valley bottoms and begin to be occupied between 3000 and 2500 BC, represented by the sites of Burzahom, Gufkral and Ghaleghay, but with more evidence and sites dating closer to 2000 BC (e.g. Sharma 1982; 1986; Allchin and Allchin 1982: 111-116). The earliest phases are characterised by broad deep pits, with bell-shaped profiles. While these have conventionally been interpreted as pit houses, recent debates have raised the likelihood that they were large storage features (Conningham and Sutherland 1998). Whatever the case it is clear from these sites that the dominant crops were winter wheat, barley, peas and lentils (Lone et al 1993; Kajale 1991; Pokharia and Saraswat 2004), and thus derive from the same ultimate Near Eastern source. The plant evidence is therefore opposed to the idea that the Kashmir Neolithic can be related to a westward dispersal of millet-growing Sino-Tibetan speakers as some have argued (Parpola 1994: 142; Van Driem 1998: 76-84; Possehl 2002: 39). The crops and livestock species present are clearly not those of Yangshao China. The presence of Chinese like stone harvesting knives in Kashmir remains curious but must be regarded as a technological diffusion given the subsistence data. The agricultural situation might therefore be congruent with the suggestion of a distinct linguistic substrate in Kashmir (Witzel 1999: 6-7).It is possible that the Near Eastern crops had diffused to local hunter-gatherers from the Indus region to the South or from Central Asia (the latter favoured by Lone et al 1993), together with domesticated animals. Although an immigration of farmers from these directions is also possible. It is tempting to suggest that the late arrival of agriculture here was due to an ecological barrier, as cultivation here requires winter tolerant, vernalizing forms of cereals and might therefore be compared to the processes involved in the delay of agricultural spread between Southeast Europe and the central European plains (cf. Bogaard 2004: 160-164). Impressions in pottery from Ghalegay suggest some localized *indica* rice cultivation as well, which must have diffused from the Gangetic region to the Southeast.

The Eastern Indus periphery: indications of separate crop origins

One the eastern margins of the Harappan zone, the cultivation of these Near Eastern winter crops was constrained by climatic conditions, in particular the predominance of summer rainfall. Within such monsoon zones we might expect summer crops to dominate, as was the case in Gujarat and South India. The perennial rivers of the Ganges system, however, offered a means to grow winter crops as well as monsoon crops. Indeed Early Harappan and Mature Harappan archaeobotanical evidence from this region consistently shows the presence of native Indian monsoon crops alongside the Harappan (Near Eastern) winter crops (e.g. Willcox 1992; Saraswat 1991; 1993; 2002; Saraswat and Pokharia 2002; 2003). The earliest known agricultural settlements in the Upper Ganges plain date to the Early Harappan period, starting from ca. 3000 BC, and the available evidence suggests that winter and summer crops were already both part of the agricultural system at such sites (e.g, Kunal). These crops included native Indian pulses such as horsegram (*Macrotyloma uniflorum*), which might be from domestication in Rajasthan, Gujarat or the Peninsula, and the mungbean (*Vigna radiata*) which could have a western Himilayan origin as well as one on the peninsula. Of particular interest in this regard is the presence of small, Indian millets from Early Harappan levels at Harappa (back to the Ravi Phase, ca. 3200 BC), especially *Panicum sumatrense* (Weber 2003). This implies that the monsoon crops were already available as cultivars, perhaps from this region in an as yet undocumented pre-sedentary period or else from areas to the east, such as the middle Ganges. This hints at domestication of monsoonal millet crops that is earlier than and perhaps independent of those further South on the Peninsula or in Gujarat. Further archaeological evidence is needed to document the emergence of agricultural villages and pre-Harappan sites in this eastern Harappan zone and the upper Ganges as well as their cultural relations to developments in the middle Ganges.

The areas to the South and East of the Thar Desert, the Indian states of Gujarat and Rajasthan, are likely to have been regions both of the extension of the winter-crop agriculture and livestock from Baluchistan as well as local traditions of cultivation based on indigenous domestication. Gujarat is likely to have been a centre for the domestication of local, monsoon-adapted crops, perhaps after livestock were adopted into this area from the Indus region to the west in the Fourth Millennium BC. Archaeobotanical evidence for the beginnings of cultivation in this region is not yet available from the earliest ceramic bearing sites, of the Padri and Anarta traditions (ca. 3500-2600 BC), but the extensive sampling on Harappan period sites in the region after 2600 BC indicates the predominance of small millets, in particular little millet (*Panicum sumatrense*) but probably also *Setaria* spp. and *Brachiaria ramosa* (Weber 1991; Reddy 2003; see discussion of identification in Fuller 2002: 277-281; 2003b; 2003d *Brachiaria* has been suggested more recently, Weber pers. comm.). Nevertheless, these sites and contemporary "mesolithic" (i.e. aceramic) sites further north on the Thar desert fringes of northern Gujarat and Rajasthan have produced evidence for some possible domestic fauna, including directly dated cattle bones from the mid fourth millennium BC Chalcolithic levels at Loteshwar (Patel 1999; Meadow and Patel 2003: 74) and probable domestic fauna from Chalcolithic Padri (Shinde 1998). Other sites, such as Bagor, are often cited as evidence for the adoption of livestock by mid-Holocene aceramic hunter-gatherers (Possehl 1999: 473-480; Chattopadyaya 2002) although current knowledge highlights the need for more systematic archaeobotanical and archaeozoological investigations as well as direct dating (Meadow and Patel 2003: 72-74).

East of the Thar Desert there is clear evidence for establishment of agricultural villages before the end of the Fourth Millennium BC. Demonstrated by excavations at the site of Balathal, more or less sedentary ceramic-producing farmers became established in this region alongside hunter-gatherers such as those of Bagor. Limited archaeobotanical data suggests that Balathal agriculture was based on the winter crops from