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# Indus Ethnobiology

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## Chapter 9

# Indus and Non-Indus Agricultural Traditions: Local Developments and Crop Adoptions on the Indian Peninsula

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Subsistence is a cross-cultural universal. A fundamental aspect of the organization of any society is its mode of subsistence and species involved in providing food. Subsistence regimes change with the development and diffusion of technologies and food taxa. The prehistory of food taxa in South Asia remains sporadically documented and incompletely understood. Whereas archaeological syntheses have traced the regional developments and interregional influences in material culture (e.g., Allchin and Allchin 1982, 1997; Chakrabarti 1999), the equivalent understanding of agricultural systems remains rudimentary. This chapter makes a contribution to South Asian agricultural prehistory by outlining new archaeobotanical evidence for the early development of agriculture in South India, and reviewing the important role of a 'Harappan crop package' in transforming cultivation practices on the Indian Peninsula. It will be suggested that the agricultural basis of the Chalcolithic societies of the Northern Peninsula (e.g., Savalda, Malwa, Jorwe cultures) represents the coalescence of agricultural developments in the Harappan northwest and the Neolithic of South India. The importance of winter cereal and pulse cultivation in the agricultural regimes of inner India (i.e., east of the Greater Indus Valley) appears to represent a legacy of the Harappan/ Pre-Harappan northwest within indigenous traditions of summer cereal and pulse cultivation. Possible causal processes for the addition of new crops into existing regimes may have involved processes of food stress or social motivations ('food choice'), although the latter appears more likely for the establishment of the Harappan crop package in peninsular India.

### The Southern Neolithic

Perspective can be gained on the Harappan food crop package by considering the agricultural basis of contemporary and somewhat later cultures in adjacent

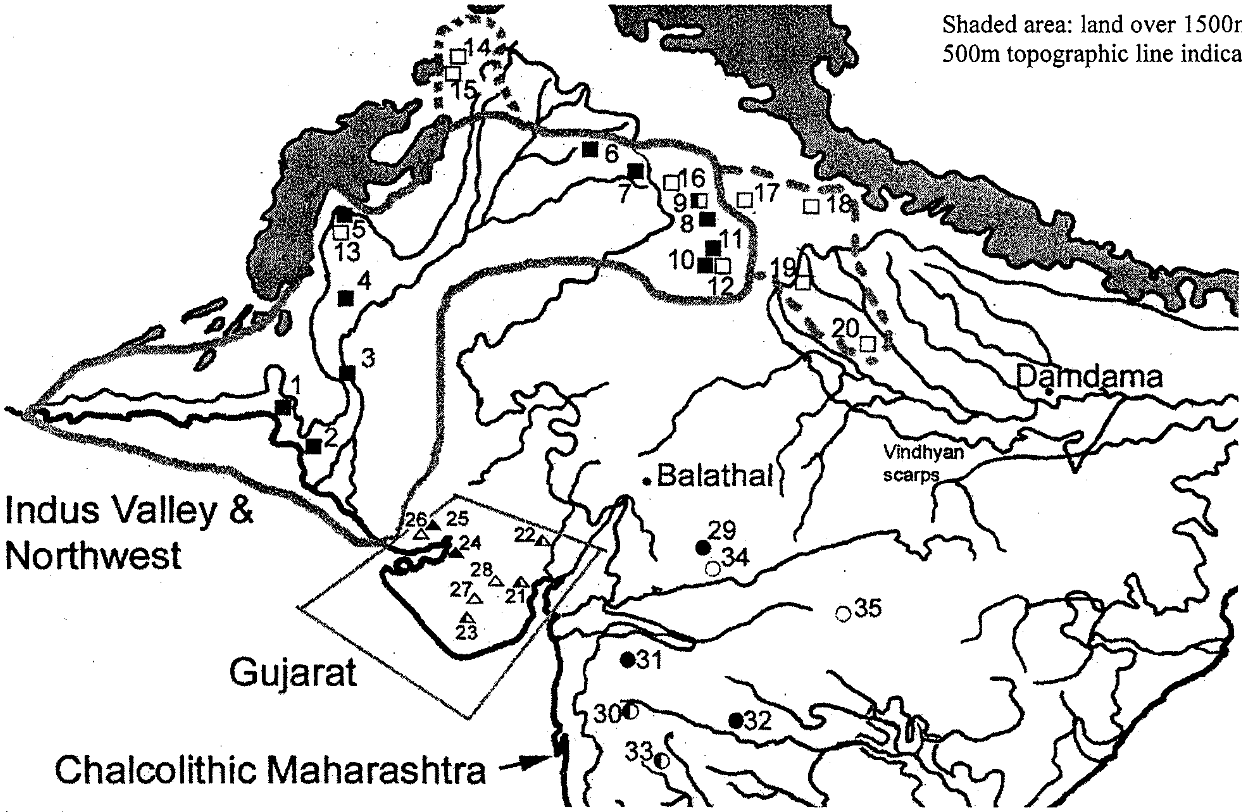


Figure 9.1

Key to Fig. 9.1 Map of India showing major archaeological regions discussed in this chapter and selected sites.

| Mature Harappan Phase, greater Indus Valley (black squares): | Late Harappan North-west (white squares): | Harappan Gujarat (black triangles): | Late Harappan Gujarat (white triangles): | Pre-Malwa/ Malwa: | Jorwe: |
|---|---|---|---|---|---|
| 1. Balakot | 9. Rohira; | | 21. Rangpur; | 29. Dangwada; | |
| 2. Allhadino | 12. Mitathal; | 21.Rangpur; | 22. Lothal; | 30. Daimabad; | 30. Daimabad; |
| 3.Chanudaro | 13. Pirak; | 22. Lothal; | 23. Rojdi; | 31. Kaothe; | 33. Inamgaon; |
| 4. Mohenjodaro; | 14. Loebanhr; | 23. Rojdi; | 26. Surkotada; | 32. Apegaon; | 34. Navdatoli; |
| 5. Nausharo; | 15. Bir-Kot-Ghwandai | 24; Kuntasi; | 27. Babor Kot; | 33. Inamgaon; | 35. Tuljapur Garhi. |
| 6. Harappa; | 16. Sanghol | 25. Shikarpur; | 28. Oriyo Timbo; | | |
| 7. Kalibangan; | 17. Rupar; | | | | |
| 8. Mahorana; | 18. Hulas; | | | | |
| 9. Rohira; | 19. Lal Quila; | | | | |
| 10. Burthana Tigrana; | 20. Atranjikhera; | | | | |
| 11. Laduwala; | | | | | |

(Primary archaeobotanical literature reviewed in Fuller 2000).

regions, such as peninsular India (figure. 9.1). An important contrast in terms of the evidence for crop species can be found in the Southern Neolithic. The Southern Neolithic represents an archaeological culture complex in Karnataka, Andhra Pradesh, and to some extent Tamil Nadu (Paddayya 1973; Allchin and Allchin 1982; Murty 1989; Korisettar et al. 2001), defined for the most part in relation to an archaeologically distinctive tradition of northeastern Karnataka, including the districts of Shorapur, Raichur, Bellary, and Anantapur (of Andhra Pradesh). Within the latter four districts are found a characteristic archaeological site type, the ashmound, consisting of a large layered accumulation of ash deriving from heaped and burnt cattle dung (Foote 1916; Zeuner 1959; Allchin 1963; Paddayya 1973).

Excavation evidence indicates that these ashmounds were sites of cattle pens with associated human habitation (Allchin 1963; Paddayya 1998). Opinions differ as to whether these represented seasonal cattle camps (Allchin 1963; Korisettar et al. 2001) or permanent settlements (Paddayya 1992; 1993a; 1993b). It seems clear, however, that the ashmounds indicate that cattle pastoralism was an important element in the economy of the Southern Neolithic. An important issue regards the social organization of this pastoralism, whether carried out by specialist ethnic groups, segments within a wider society, or a standard component of household economies. An understanding of the seasonal contribution of the plant components of the diet provides indirect evidence for addressing the organization of pastoral elements in the economy, and it can be suggested that the ashmounds were indeed seasonal encampments of segments of the society who moved periodically and probably cyclically with their herds (Fuller 1999; Fuller et al. 2001a). A full exploration of this issue, however, is beyond the scope of the present chapter.

Occurring in the same region as the ashmounds, are a large number of non-ashmound settlement sites, most often located on the flat summits of granite tors (inselbergs) that break the flat plains of the Mysore Plateau. These hilltop sites include often deeply stratified archaeological deposits and have yielded much artifactual evidence as well as structural features in the forms of post-hole defined round huts at excavated sites such as Sanganakallu (Subbarao 1948; Ansari and Nagaraja Rao 1969), Maski (Thapar 1957), Piklihal (Allchin 1960), and Tekkalakota (Nagaraja Rao and Malhotra 1965). In addition there are some settlement sites without ashmouds occurring on the plain beside or away from hills, although these have not yet produced evidence for buildings, such as Brahmagiri (Wheeler 1948), Watgal (Deveraj et al. 1995) and Kurugodu (sampled in the present study).

Although the Southern Neolithic is generally assumed to have incorporated some degree of crop cultivation, there has long been a lack of hard evidence. Archaeobotany, the study of archaeologically preserved plant remains, has only been sporadically undertaken on Southern Neolithic material, although the situation is now being remedied by the study of systematically collected samples, generally through the technique of flotation (e.g., Venkatasubbaiah and Kajale 1991; Kajale and Eksambekar 1997: 221; Kajale 1998; Fuller 1999; Fuller et al. 2001a; Fuller et al. 2001b; on flotation generally, see Pearsall 1989: 19-79). Older published evidence was only sporadically collected and consisted generally of one or a few species of millet, pulse or the occasional fruit or nut (e.g., Nagaraja Rao and Malhotra 1965; Vishnu-Mittre 1971, 1974; Vishnu-Mittre and Savithri 1979a; Kajale 1974, 1989, 1991). In some instances casual reports have been made in preliminary excavation accounts, although the reliability of such information is not certain, especially for reports for finger millet (e.g., Rao 1968; Devaraj et al. 1995), which has been often misidentified, even by specialists (see Fuller 1999, 2002; in press, n.d.B).



## The Current Research Program

A research program was carried out with two Indian colleagues, Professor Ravi Korisettar of Karnatak University and Dr. P. C. Venkatasubbaiah from Kurnool, to systematically sample Southern Neolithic sites for ancient plant remains, in order to address directly the nature of ancient agriculture in the region (figure. 9.2). Sites were chosen to provide both regional and interregional comparisons, including sites across different geographical-environmental zones, as well as those from different subcultures within the Southern Neolithic (three different 'variants' of Paddayya 1973). The material came from archaeological levels that can be referred to phases as II and III in the Southern Neolithic chronology of Allchin and Allchin (1982). These periods are equivalent to the better-dated phases from Watgal (Devaraj et al. 1995), IIB (2300-1800 cal.B.C.) and III (post-1800 cal.B.C.). The Neolithic plant remains were collected from bulk sediment samples from Neolithic sites and separated by means of bucket flotation (cf. Pearsall 1989: 19-27). The remains considered in this study were preserved by charring, and occasional uncharred seeds were considered modern intrusives. A few silicified remains have been considered ancient, as the same taxa occur charred on the same sites. Sediment was collected in bulk in 10L bags for flotation and at many sites two 10L bags were collected from each stratigraphic unit to allow checking between samples. At most sites, layers were sampled from more than one sampling locus. For habitational fill layers this method allowed the recovery of charred macroremains, including wood charcoal, charred parenchyma tissue fragments, and seeds/fruits. With the ashy, dung-derived sediments from ashmounds (see Zeuner 1959 and Allchin 1963 with regards to the formation of these sites), however, flotation was not successful. Although a total of nineteen sites were visited at which some form of sampling or observation was undertaken, the archaeobotanical macroremains recovered from flotation came from only twelve sites (figure. 9.1) out of which four yielded the most extensive and important datasets: Hallur, Sanganakallu, Tekkalakota, and Hanumantaraopeta. The results of flotation in this study produced an archaeobotanical dataset that places our understanding of Southern Neolithic agriculture on a firm footing (Fuller et al. 2001a; Fuller et al. 2001b). Nevertheless, the amount of sampled and studied material is statistically limited, and raises nearly as many questions as it answers, thus calling for additional archaeobotanical work in South India and equivalent research in other regions.

Before discussing the archaeobotanical evidence of peninsular India, however, preliminary consideration is given to two areas of background information. The first concerns the current picture of geographical origins of crops in India to highlight the likely directions of their spread. The second concerns assumptions regarding the formation processes of the archaeobotanical record, and the implications of taphonomy for interpreting plant remains in terms of agricultural systems.

## An Outline of Agricultural Packages: Harappan, Gangetic, and South Indian

A starting point for any consideration of agricultural origins is locating the regions from which potential cultivars originally came. General regions of origin for domesticated species can be inferred from modern botanical data by identifying probable wild progenitor populations through phylogenetic evidence and by inferring past distribution on the basis of modern biogeography and ecology. This approach was pioneered by De Candolle (1886) and has been continuously refined over the past century by numerous botanists (see, e.g., Vavilov 1992; Harlan 1971, 1992, 1995; Zohary 1969; Zohary and Hopf 1993; Zeven and De Wet 1982; Hawkes 1983; Smartt and Simmonds 1995). Increasing genetic evidence is able to provide information on the minimum number of domestication events in a crop's prehistory (for the traditional approach, see Blumler 1992; Zohary 1996, 1999; for newer approaches producing more complex models, see Talbert et al. 1998; Brown 1999; Allaby 2000). Although general syntheses disregard South Asia as a possible center for independent domestication (e.g., Hawkes 1983; Harlan 1992, 1995; MacNeish 1992), there are numerous crop species that derive from native South Asian species, as Vavilov (1992 [1935]: 330) had recognized in his "Indian Center of Origin."

Many early reviews of the origins of South Asian agriculture lacked the modern botanical data to localize the sources of domesticates as well as the archaeobotanical record to trace their spread (e.g., Vishnu-Mittre 1974; 1978; Hutchinson 1976). Since the application of sieving and flotation in Indian archaeobotanical sampling (Kajale 1979, 1982, 1988b; Buth et al 1988; Weber 1991; Reddy 1991a; Saraswat et al. 1994), the evidence of ancient crops has increased dramatically. These data still need to be critically assessed in relation to the probable regions of domestication in order to understand the relative contributions of local domestication and external adoption. Although a full review of the phylogenetic and biogeographical evidence relating to the sources of crops in prehistoric South Asia is beyond the scope of this chapter (see Fuller 1999, 2002), at least five main geographical groups crops (and fauna) need to be considered (figure. 9.2):

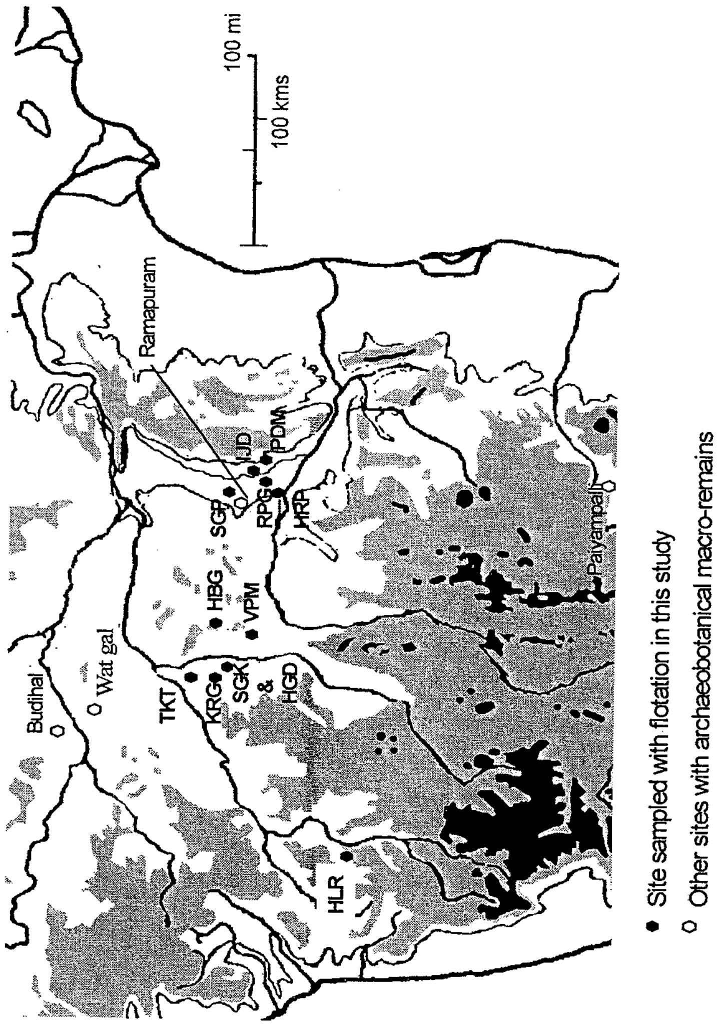


Figure 9.2. Southern Neolithic sites with archaeobotanical evidence. Floatation samples in this study were collected from sites indicated by three letter abbreviations. Other important Southern Neolithic sites with published archaeobotanical evidence are indicated by open symbols and full names.

Abbreviations as follows:
Hallur (HLR),
Tekkalakota (TKT),
Kurugodu (KRG),
Sanganakallu (SGK),
Hiregudda (HRG),
Hattibelagallu (HBG),
Velpumadugu (VPM),
Singanapalle (SGP),
Injedu (IJD),
Rupangudi (RPG),
Peddamudiyam (PDM),
Hanumantaraopeta (HRP).
Elevations indcated: 300 m. contour, 600 m. contour (grey), 900m. contour (black).

1. Southwest Asian crops: Wheats (*Triticum* spp.), barley (*Horduem vulgare* L. *sensu lato*), lentils (*Lens culinaris* Med.), chickpeas/ gram (*Cicer arietinum* L.), peas (*Pisum sativum* L), grass pea (*Lathyrus sativus* L.), and flax/ linseed (*Linum usitatissimum* L.). This crop package, the "founder crops of Southwest Asian agriculture" (Zohary 1996) was well established in the Indus Valley by the time of the Harappan civilization (Vishnu-Mittre and Savithri 1982; Costantini and Biasini 1985; Meadow 1989, 1996; Zohary and Hopf 1993; Weber 1998, 1999; Tengberg 1999; Fuller and Madella 2001). It remains to be clarified whether or not these crops came to South Asia together at the period of agricultural beginnings, represented by the site of Mehrgarh where systematic flotation samples were not available (Costantini 1983), or whether the pulses diffused separately over a much longer period, as might be suggested by the evidence from Miri Qalat (Tengberg 1999).

In addition to cereals, pulses, and flax, domesticated animals also entered South Asia from the west, most notably sheep and goats, which are present from early in the Mehrgarh sequence. Goats appear domesticated from the earliest levels, and were probably introduced that way, while sheep show changes in size and frequency that could indicate local domestication in Baluchistan (Meadow 1984; 1989; 1996; 1998). Recent genetic work on sheep suggests two domestications, including indeed an 'Asian' lineage of unidentified wild ancestry (Hiendleder et al. 1998). The domestication of zebu cattle appears to have occurred in Northwestern South Asia (Meadow 1984; 1993; 1996; Bökoyni 1997a), but it remains unclear whether there were additional zebu domestications in inner India (Allchin and Allchin 1974; Alur 1990; Thomas and Joglekar 1994; Meadow 1998).

2. African crops: *Jowar*/ great millet (*Sorghum bicolor* (L.) Moench.), *ragi*/ finger millet (*Eleusine coracana* (L.) Gaertner), *bajra*/ pearl millet (*Pennisetum glaucum* (L.) R. Br., syn. *P. americanum* (L.) Leeke, syn. *P. typhoides* Rich.), cowpea (*Vigna unguiculata* (L.) Walp.) and probably hyacinth bean (*Lablab purpureus* (L.) Sweet) (Zeven and De Wet 1982; Smartt 1990; Harlan 1992; 1995; De Wet 1995b, 1995d). Although from the South Asian perspective these crops share African origin, they in fact have different regional origins within Africa and we would therefore expect potentially separated routes and periods of entry into South Asia. Indeed, these crops appear in a somewhat piecemeal fashion within various parts of India from the early second millennium B.C., presumably spreading via the Indian Ocean or Arabian Sea (Fuller 2002; Fuller and Madella 2001).

3. Chinese or Central Asian Crops: common foxtail millet (*Setaria italica* (L.) Beauv.), proso millet (*Panicum miliaceum* L.), hemp (*Cannabis sativus* L.). Rice (*Oryza sativa* L.), although domesticated at least once in South/Central China (Sato et al. 1991; Glover and Higham 1996; Chen and Jiang 1997; Cohen 1998; Anping 1998; Zhao 1998; Xingcan 1999), must be considered separate both because of its tropical origin and the possibility that it was domesticated a second time in India (Fuller 2002; see below). As with the African crops, these species do not form a coherent package and may have had separate geographic origins, with the two millets of probable temperate Chinese origin (Lu 1998, 1999), with possible second domestications in southeastern Europe or the Caucasus (De Wet et al. 1979, 1987; De Wet 1995a, 1995c; Zohary and Hopf 1993; Li et al. 1998). The *S. italica* cultivated in India today seems to derive in part from both Chinese and European genetic stock (Li et al. 1998). These crops are likely to have reached South Asia from the north or northwest via central Asia, perhaps as early as the Harappan period although with clearest evidence for the Late Harappan period (after 2000 B.C.). Recently, Meadow (1998) suggested that rice also might have come to South Asia by this route, although the present author favors a separate domestication to the east, perhaps in Gangetic India (see below).



It is also possible that certain tree crops were introduced into South Asia by this route, although overland trade in fruit and nuts probably had become important. Tree crops that have been reported from the Late Harappan period include peaches and apricots in Neolithic Kashmir (*Prunus persica* (L.) Batsch., *P. armeniaca* L.), walnuts (*Juglans regia* L.), and almonds (*Amygdalus communis* L.) (Lone et al. 1993; Saraswat 1993; Fuller and Madella 2001). While the *Prunus* spp. and *Juglans regia* are thought to be native to the mountains of Central Asia or west China, almonds probably were domesticated in Southwest Asia, in the Levant (Zohary and Hopf 1993). As these species are not grown on the hot humid plains of India, they must have reached sites such as Hulas by trade. In historical times there has been an extensive trade in fruits (mostly dried) and nuts from Afghanistan into South Asia via Peshawar (Anonymous 1898: 229, 233; Dichter 1967: 180; Chakrabarti 1990: 169; Kenoyer 1998: 169), and it is certainly is plausible that this trade was underway by 2000 B.C. In addition, these species are cultivated on a limited scale in cooler mountain regions of northwestern South Asia, including variously Chitral and Gilgit (Northwestern Frontier Province), Ladakh, Kashmir, Himachal Pradesh, and Kumoan (Watts 1908; Maheshwari and Singh 1965; Baquar 1995), which are also regions from which there may have been some trade of timber to the plains (see Chowdhury et al. 1977).

The route by which millets, fruits, and nuts came into South Asia from the north and northwest was also the probable source of at least one domesticated animal. The Bactrian camel is in evidence from the Late Harappan period (by ca. 1800 B.C.), and could have contributed to the transport of dried fruits and nuts (Meadow 1996; 1998; cf. Shaffer 1988). Horses also probably entered the continent from this direction, although the antiquity of domesticated horses in South Asia remains controversial (Bokoyni 1997b; Meadow 1996, 1998).

4. North Indian origin or northeastern introduction: Most notably rice (*Oryza sativa* L.), probably moth bean (*V. acontifolia* (Jacq.) Marechal) and possibly also black gram (*Vigna mungo* (L.) Hepper), as well as fruits and vegetable crops such as cucumbers (*Cucumis sativus* L.), the ivy gourd (*Coccinia*

*grandis* (L.) Voigt.), and *Citrus* fruits. Rice was domesticated at least once in south China, along with chickens (West and Zhou 1988), and although some would tie it to a hypothetical 'Austric' package (*sesnu* Blust 1996) that dispersed by migration into northeastern India (e.g., Higham 1995; Glover and Higham 1996; Bellwood 1996), the genetic evidence is clear in indicating a minimum of two domestications for *Oryza sativa* (Sato et al. 1990; Sano and Morishima 1992; Chen et al. 1993, 1994; Wan and Ikehashi 1997; Crawford and Shen 1998), with the second domestication conceivably in the Gangetic basin. Unfortunately, despite some suggestive early dates from contexts containing rice, which many accept as indicating the domestication of rice in the Vindhya Plateau of north central India ca. 6000-5000 B.C. (Sharma et al. 1980; Saraswat 1992; Mehra 1997), the dating of the evidence is highly problematic (cf. Allchin and Allchin 1982; Sharma and Sharma 1987; Possehl and Rissman 1992; Glover and Higham 1996), with the mid-fourth to early third millennium B.C. representing a conservative estimate (Fuller 2002; cf. Chakrabarti 1999: 207); systematic sampling and direct AMS datings are needed. Nevertheless early third or fourth millennium evidence from Damdama (in the region across the Ganges north of the Vindhyas) suggests wild rice use, together with other wild grasses (cf. *Eleusine indica, Dactylocitnum* sp., Kajale 1990) by a society that may have been sedentary although engaged in hunting (Chattopadyaya 1996). This indeed represents an intriguing candidate culture for independent rice domestication in South Asia. As with rice and chickens, water buffalo could have been independently domesticated in India as well as China (cf. Patel and Meadow 1997; Meadow 1998).

5. Peninsular domesticates: Horsegram (*Macrotyloma uniflorum* (Lam.) Verdcourt), mung (*Vigna radiata* (L.) R. Wilczek) (the botanical evidence on the progenitors of these pulses remains poor, but see Siensonma and Lanpang 1989; Jansen 1989; Smartt 1990; Lawn 1995; Fuller 1999); little millet (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum* L.), sawa millet (*Echinochloa colona* (L.) Link), yellow foxtail millet or korali (*Setaria pumila* (Poir.) Roem and Schultz, syn. *S. glauca* auct. pl.) and browntop millet or pedda sama (*Brachiaria ramosa* (L.) Stapf.) (for botanical data on these see, De Wet et al. 1979, 1983a, 1983b, 1983c; De Wet 1995a; Hulse et al. 1980; Hilu 1994; M'Ribu and Hilu 1996; Grubben and Partohardjono 1996). Pigeon pea (*Cajanus cajan* (L.) Millsp) can be included in this general category although its origins are delimited to the Bastar region and southern Orissa (van der Maeson 1986).

## Recognizing Staple Crops: Assumptions of Formation Processes

The starting point for an understanding of the broad pattern of Neolithic agriculture is establishing which plant species served as the staple crops. For those taxa that are not considered indigenous to the Indian Peninsula, their presence can be attributed only to human action. Thus species like *Hordeum vulgare, Triticum* spp., and *Lablab purpureus,* as well as *Linum usitatissimum* must have been present as crops. In addition, 'native' crops can be inferred to have been cultivated if they are found on sites occurring in regions or environments in which wild populations are unlikely to have occurred in the past, such as finds of *Vigna* cf. *radiata* in the Bellary district of the Central Deccan since wild *V. radiata* ssp. *sublobata* is restricted primarily to the moist deciduous forest zone on the interior of the Western Ghats (see Saldanha 1984). To a large extent any assignment of plant remains to crop status relies on analogy with crops known in the present or recent past, although with systematic collection of a greater number of archaeobotanical samples and analysis of the taxa they contain it may become possible to detect cultivation without relying solely on the analogy of species cultivated today, nor on the presence of morphologically domesticated types (which are dependent on cultivation for propagation). Indeed, in Southwest Asian archaeobotany, arguments have been put forward that predomestication cultivation can be inferred on the basis of the presence of arable weed communities associated with wild crops (Willcox 1996, 1999; Harris 1998; Hillman 2000; Hillman et al. 2001). Unfortunately, for South Asia identification criteria for wild/weedy seed taxa are as yet inadequate to attempt such ecological modeling.

Rather weaker proxy criteria must be relied upon at present to infer cultivation. For those species considered native to the peninsula little evidence has been forthcoming to establish morphological/ genetic domestication, and thus provide a *terminus ante quem* for cultivation. Compiled measurements for *Vigna radiata* from published Indian sites, as well as the author's study, do not indicate significant increase in size until the late second millennium B.C. (Fuller 1999, n.d.A). Evidence for some tough rachis browntop millet spikelets was found at Kurugodu, although this site is not yet dated and could be fairly late in the Neolithic (Fuller 1999, n.d.B), and in any case modern cultivated browntop millet, as with other Indian millet species, shows a spectrum of degrees of 'domestication' in terms of seed retention (De Wet 1995a; Grubben and Partohardjono 1996). Therefore an assessment of quantitative dominance has been relied upon. This works on the taphonomic assumption that those species that are major foodstuffs are more likely to be regularly processed in relatively large quantities thus becoming incorporated in the archaeological record consistently and frequently. This assumption is further predicated on the seeds deriving primarily, if not exclusively, from crop processing rather than the burning of dung. In the case of the current material dung can probably be ruled out due to the fact that the taxa encountered were generally highly limited especially in terms of grasses. Most grasses found in the samples can be identified to two species, despite the fact that grasslands of peninsular India include some 120 species, including numerous taxa palatable to cattle (Bor 1960; Whyte 1964). This implies that a more focused selective force (i.e., culture) was in operation than we would expect for grazing animals. In addition charred dung fragments are absent, except for a single sample at Hallur. Further detailed consideration of the wild/weed taxa present may be useful for differentiating dung-derived from non-dung assemblages (cf. Charles 1998), and phytolith assemblages provide another means for distinguishing dung fuel from primarily wood fuel fires (Madella, this volume). Such approaches might be usefully applied to the data from Rojdi in Gujarat, where a decrease in the ubiquity of wood charcoal through time and an increase in the ubiquity and frequency of noncrop seeds has been suggested to indicate deforestation and a shift toward dung-fuel use (Weber 1991: 152-55; Weber 1999), although the change in weed taxa could also represent diversification in cultivation environments as might be suggested also by the increased range of crop taxa (Fuller and Madella 2001; Fuller 2001).

An understanding of the formation of archaeobotanical assemblages is fundamental for archaeobotanical interpretation. Given that our remains are charred, fire played a crucial mitigating role in preservation, and as charring experiments have shown this is likely to have biased samples in some ways by destroying certain components preferentially including cereal chaff and certain weed seed types (Wilson 1984; Boardman and Jones 1990; Viklund 1998). This will tend to bias samples toward the more robust seeds, including cereal grains/grass caryopses and pulses, with less (or no) associated parts (e.g., chaff, pulse pods, etc.). Of crucial importance, however, are the processes that brought together the precursor assemblages that came in contact with fires in the first place. Seeds might enter fires through dung, and thus the grazing or foddering of animals influences their contents. The potential importance of dung has been highlighted and debated in Near Eastern archaeobotany (Miller and Smartt 1984; Miller 1984, 1991, 1996, 1997; Bottema 1984; Hillman et al. 1997; Charles 1998), and has been discussed more recently in South Asian contexts (Reddy 1994; Weber 1999). As already noted, however, this appears unlikely to have been the case for the Southern Neolithic samples dominated by a highly restricted and consistent group of millet grasses and pulses. The other important source is cultural, especially the accidental loss of food plants during preparation and the disposal of by-products from routine processing of crops. The importance of crop-processing assemblages has long been inferred in European archaeobotany (e.g., Knörzer 1971; Dennell 1972, 1974, 1976; M. Jones 1985), and has been explicitly modeled on the basis of ethnoarchaeological studies (Hillman 1981, 1984; G. Jones 1984; 1987). More recently ethnographic models have been developed for a range of tropical crop taxa, including millets (Reddy 1991b; 1994; 1997), African finger millet (Young 1999), Ethiopian tef (D'Andrea et al. 1999), and rice (Thompson 1996). A few key insights of these studies will be highlighted here to provide a set of baseline assumptions regarding the relationship of the archaeobotanical remains discussed in this chapter with ancient cultural practices.

Once harvested, crops such as cereals and pulses must be processed to separate the edible seed or grain from the rest of the plant and contaminating weeds. In general, the basic processes required are constrained by the species' morphology (Hillman 1981, 1984), and thus ethnographic observations can be used to produce models of the expected contents in the products and by-products of different processing stages (Hillman 1984; G. Jones 1984, 1987; Reddy 1994). In general there are certain key variables that influence the contents of



processing stages and the likelihood of archaeological preservation. At the stage of harvesting, the choice to harvest basally or uproot, as opposed to sickling ears or panicles (or plucking individual pods, in the case of pulses) is important, as the second set of choices biases against the incorporation of weeds into the processing sequence. Another (crucial) distinction, which is taxonomically constrained, is whether species are free-threshing or not. Free-threshing species (including naked barley, bread wheat and durum, pearl millet, finger millet, some sorghum races such as durra and guinea, all Southwest Asian pulses, as well as *Vigna* spp. and *Lablab purpureus*) have seeds that readily separate from "chaff" during the first threshing, which means they require less processing labor overall. Less processing implies less opportunity for accidental loss that might be charred and preserved. Hulled cereals on the other hand (e.g., emmer wheat, hulled barley, all of the small panicoid millets, race bicolor sorghums) require additional pounding and winnowing to remove glumes and/or lemma/paleas, and thus more labor and more opportunities for loss and charring. Equivalent to hulled cereals are 'pod-threshing' pulses (e.g., *Macrotyloma uniflorum, Cajanus cajan)* in which the first winnowing serves to separate intact pods that must be gathered up and pounded again (Fuller 1999, n.d.A). Crop processing in and of itself does not lead to charring, but rather it is those processing stages that are carried out on site routinely, or else stored on site for use as fuel, that are most likely to consistently lead to archaeological preservation and hence archaeological ubiquity.

In the Southern Neolithic samples examined in this study, crops dominated over weeds, and the reasoning of crop processing makes it possible to assess the probable source of these remains. It should be noted that virtually all samples included pulses (usually *Macrotyloma* as well as *Vigna* and sometimes *Lablab* in large quantities) as well as small, dehulled millets. The co-occurrence of pulses and small millets implies that the residues from processing of different sets of crops are mixed in the samples, perhaps mixed at the charring locus as components of the fuel. The small quantity of weed seeds points toward later processing stages, while the fact that the wild taxa encountered were consistently similar in size to millet caryopses but not the pulses, suggests that these weeds accompanied the millets (often including the same families that dominate ethnographic samples, compare Reddy 1994; full weed data for the present study in Fuller 1999). The samples likely include by-products from the final pounding and winnowing of small millets. These millet by-products have been mixed with pulses that were perhaps charred in dry-roasting accidents or else were retained in 'waste' pods from processing. This consistent final millet cleaning and pulse cleaning/roasting assemblage type is probably to be explained by a 'daily' processing model in which semi-cleaned crops were removed from stores routinely and processed in small amounts. This accounts for the fairly consistent recovery of the same taxa, as it is likely that processing stages carried out prior to storage would have been more spatially and temporally restricted and are also more likely to have been carried out off-site. By comparison with Reddy's (1994) ethnographic data it seems most likely that the millets were harvested below the panicle thereby decreasing weed content, whereas the chaff (lemma and paleas) disposed of together with lost grains is likely to have been destroyed by the charring process. This surmised taphonomy for the current samples readily explains their fairly consistent contents as well as implying that these are useful samples for assessing the most frequently processed crops and hence the likely staples.

## South Indian Neolithic Staples: Archaeobotanical Evidence

Having clarified that Southern Neolithic plant remains very likely derived from crop-processing residues, but are nevertheless dominated by crop taxa rather than weeds, it becomes possible to reconstruct the basic outlines of Southern Neolithic cultivation. Taxa recovered from sampled strata at various sites are given in table 9.1, while ubiquities are given in table 9.2. Figures 9.3 and 9.4 show the chronological trends evident at Sanganakallu and Hallur, while figures 9.5 and 9.6 illustrate representative specimens of some of taxa identified. The most consistently encountered taxa are *Macrotyloma uniflorum, Vigna radiata,* and a small millet complex, including predominately *Brachiaria ramosa* and *Setaria verticillata;* as well as a few *Echinochloa colona* types from Tekkalakota. In addition, charred fragments of parenchyma tissue are almost ubiquitous, although detailed microanatomical study has not yet been undertaken to allow identification. These species (two pulses, two millets) can be considered the 'basic Neolithic package' of the South Indian Neolithic and the Ashmound Tradition in particular. Given that *Vigna radiata* at least occurred on Bellary district sites beyond its likely wild range, it must have been cultivated and thus the other frequent taxa seem equally likely to have been cultivated.

I would argue that this 'basic package' represents the products of indigenous domestications in South India, which can be suggested on chronological grounds (cf. Allchin and Allchin 1982; Liversage 1991; Korisettar et al. 2001), to be a case of independent agricultural origins. The first phase of the South Indian Neolithic is dated at a number of sites with radiocarbon dates back to 2800 cal.B.C. (Paddayya 1973; Allchin and Allchin 1982; Possehl and Rissman 1992; Deveraj et al. 1995). This can be contrasted with the earliest dated village settlements (some with evidence for crops) further north on the peninsula, where the earliest levels date to ca. 2500 cal.B.C. in the Narbada and Tapi valleys, e.g., the sites of Kayatha and Savalda (Possehl and Rissman 1992). Farther south in Maharashtra, however, one is hard pressed to find villages with ceramics and evidence of cultivation to date to 2000 cal.B.C. or before, with Kaothe dating between 2400 and 2200 cal.B.C. on the basis of a single radiocarbon date (Shinde 1994). Admittedly, this evidence relies on excavations at readily recognizable (probably fully sedentary) habitational mounds with evident ceramics, and thus the problematic association of ceramics-sedentism-food production (cf. Alexander 1969; Bar-Yosef and Meadow 1995; Hoopes and Barnett 1995). There is thus the possibility that an earlier less-sedentary and non ceramic

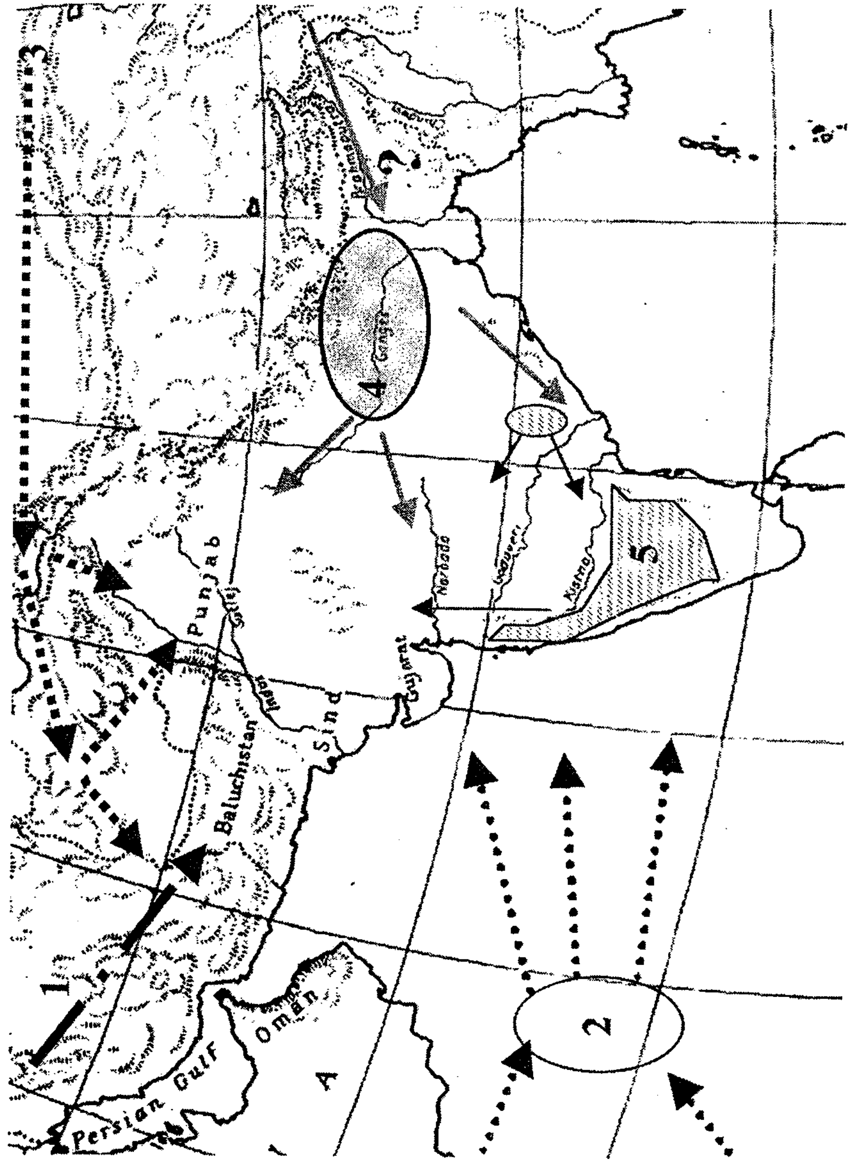


Figure 9.3. Schematic representation of the five geographical sources of crops and general directions of their spread: (1) Crops of Southwest Asian origin; (2) Crops of African origin; (3) Crops of (Northern) Chinese origins; (4) Crops from north / northeast India (some of which may have arrived earlier from South China; (5) Peninsular origins (including outlier of Bastar region from which *Cajanus cajan* derives).

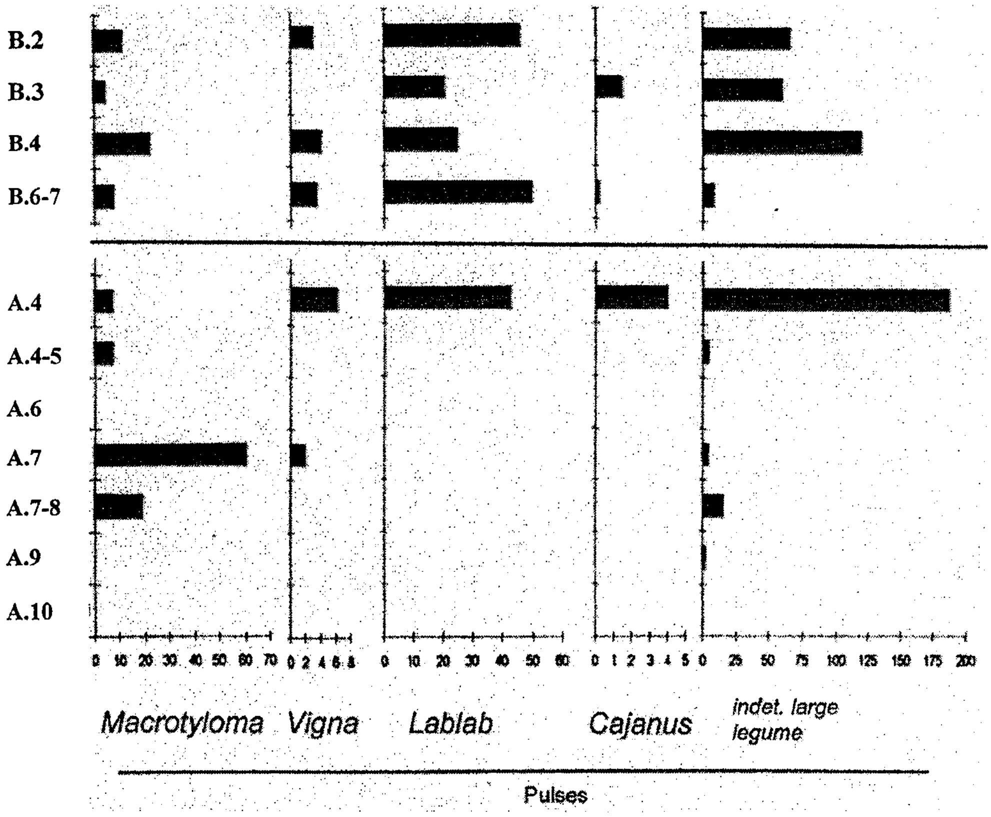


Figure 9.4a, 9.4b, 9.4c Multi-histogram of changing quantities of crops, parenchyma the most common weed types through the sequence at Sanganakallu. The bottom half of the chart derived from a single sample for each stratum from profile SGK.98A, while the top half derive from trial trench SGK.98B strata. Preliminary field assessment of ceramics and depth suggest that SGK.98A.4 is possibly equivalent to SGK.98B.4. SGK.98A can be correlated with previous excavations and hence ceramic dating evidence (Subbarao 1948; Ansari and Nagaraja Rao 1969). SGK.98A.6-10 represent Phase II (of Allchin and Allchin 1982), SGK.98A.4-5 ands above represent Phase III.

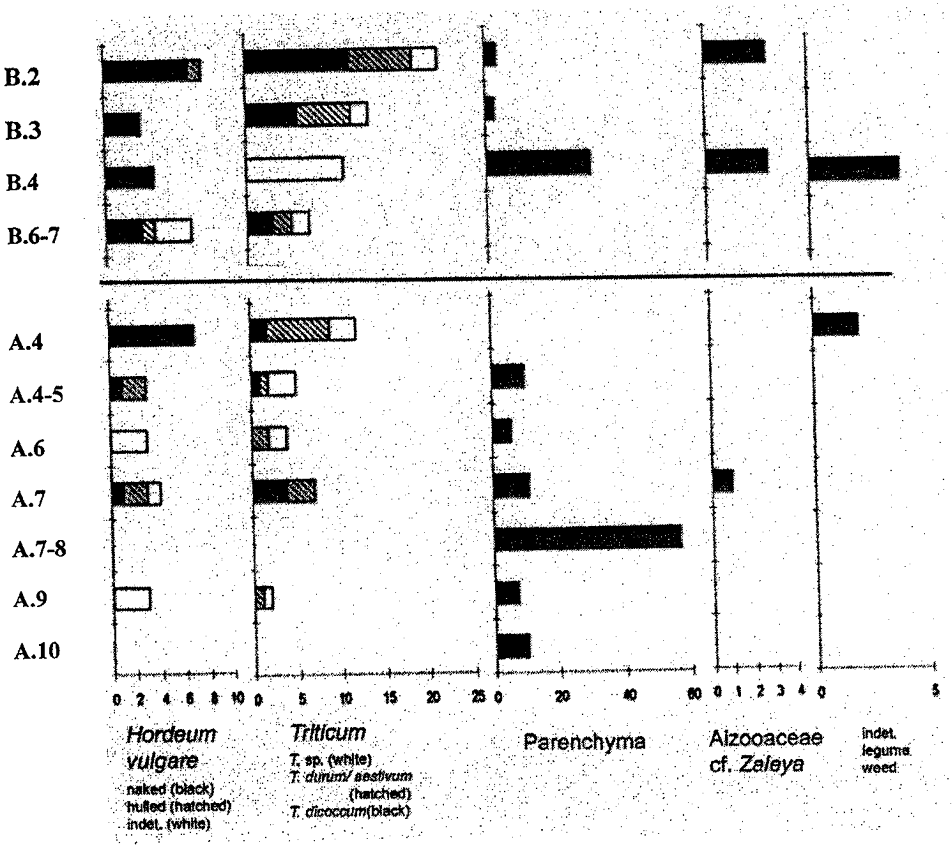


Figure 9.4b

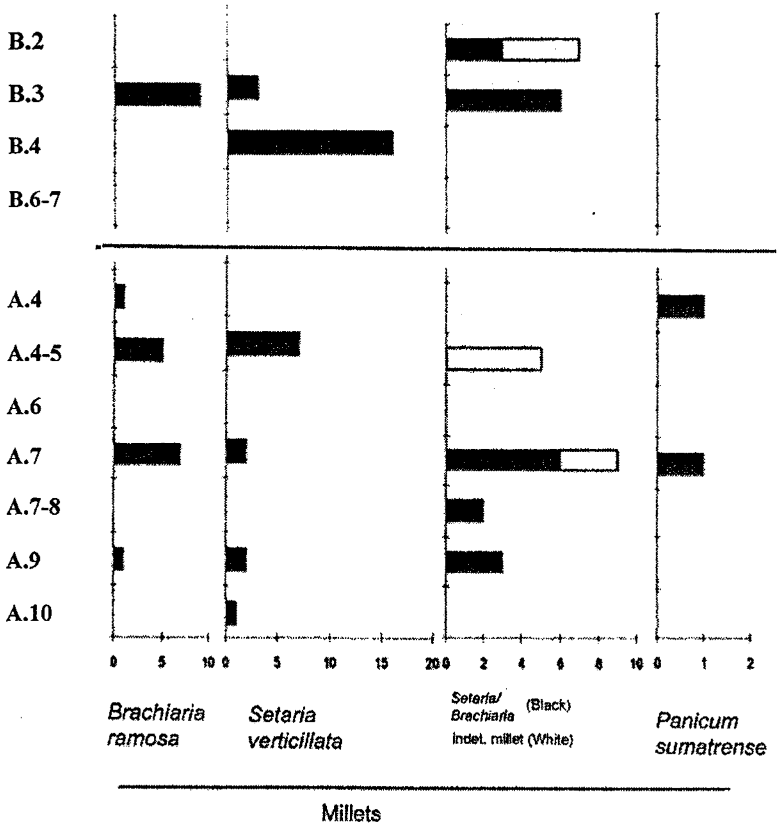


Figure 9.4c

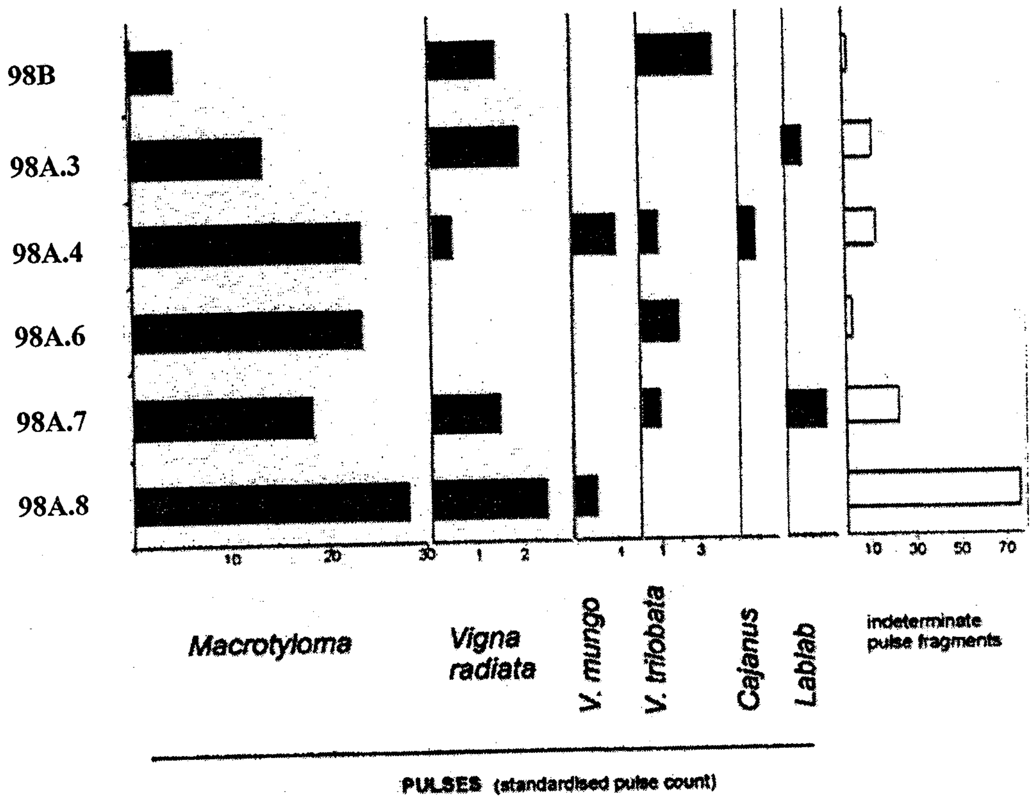


Figure 9.5a, 9.5b, 9.5c. Multi-histogram of changing quantities of crops, parenchyma the most common weed types through the sequence at Hallur. The precise dating of the sequence is unclear, but field assessment suggests phases II-III of the Southern Neolithic, with some possible Phase I at the base of the sequence.

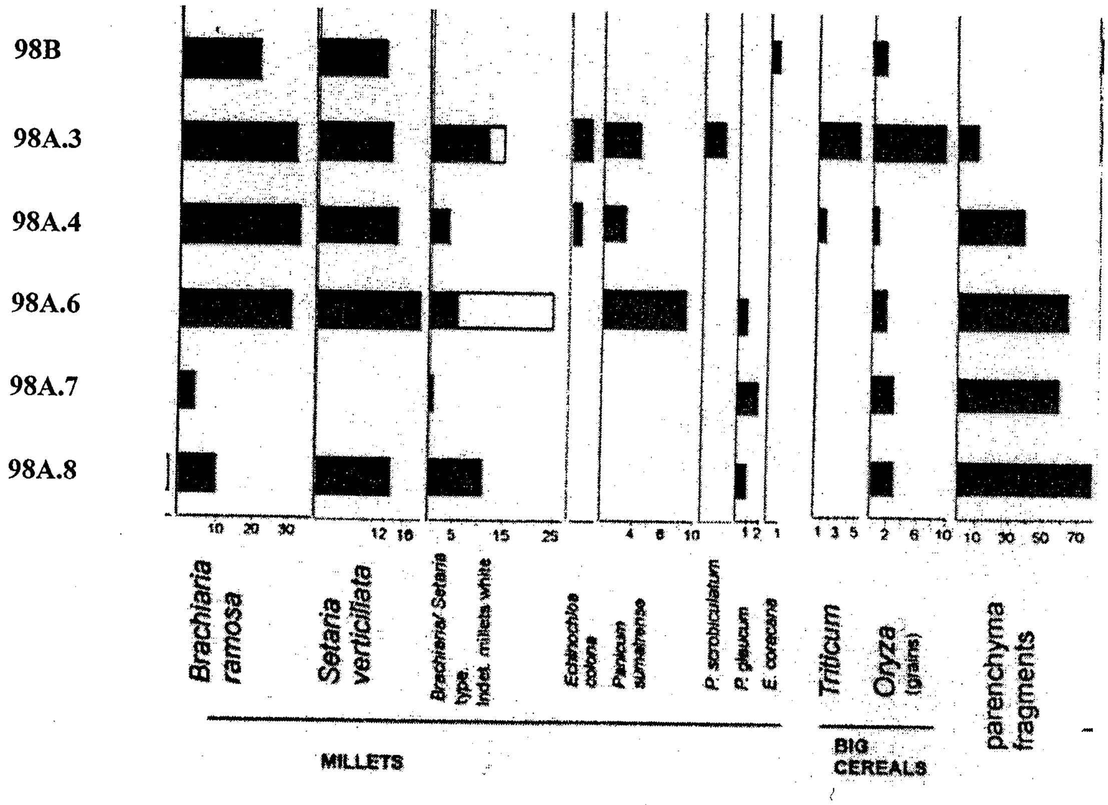


Figure 9.5b

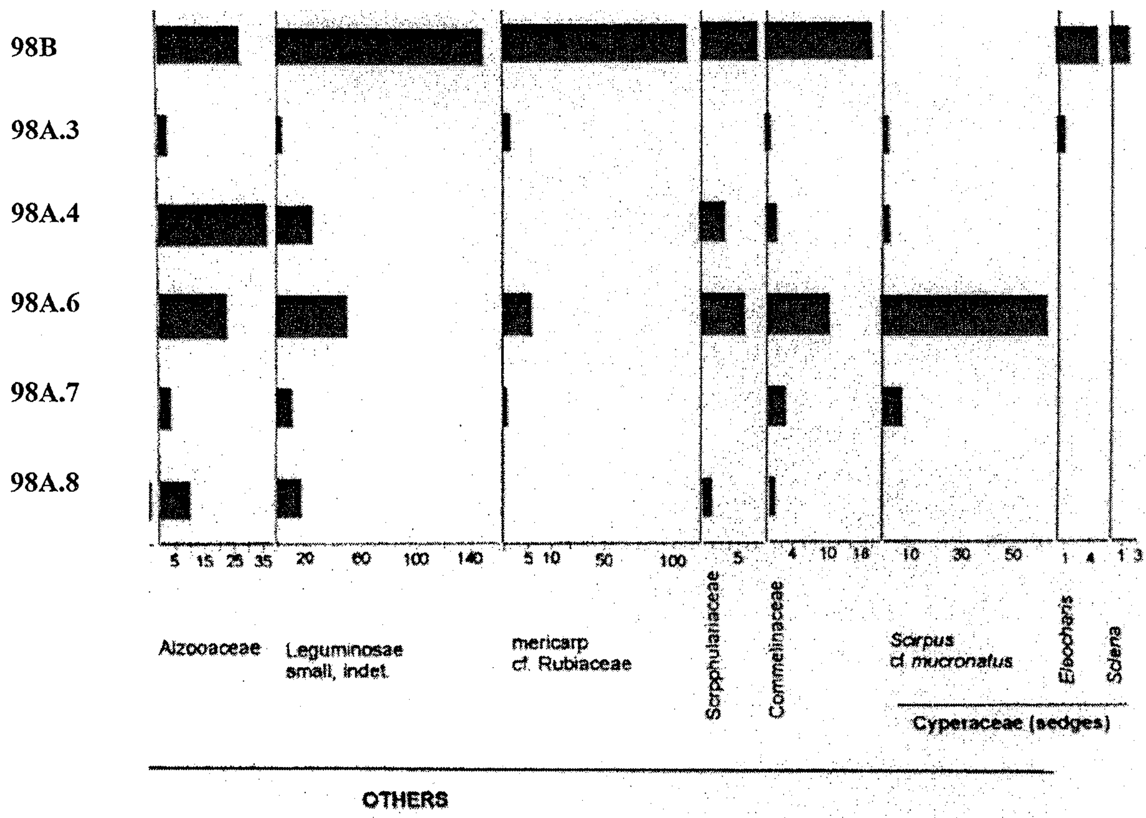


Figure 9.5c

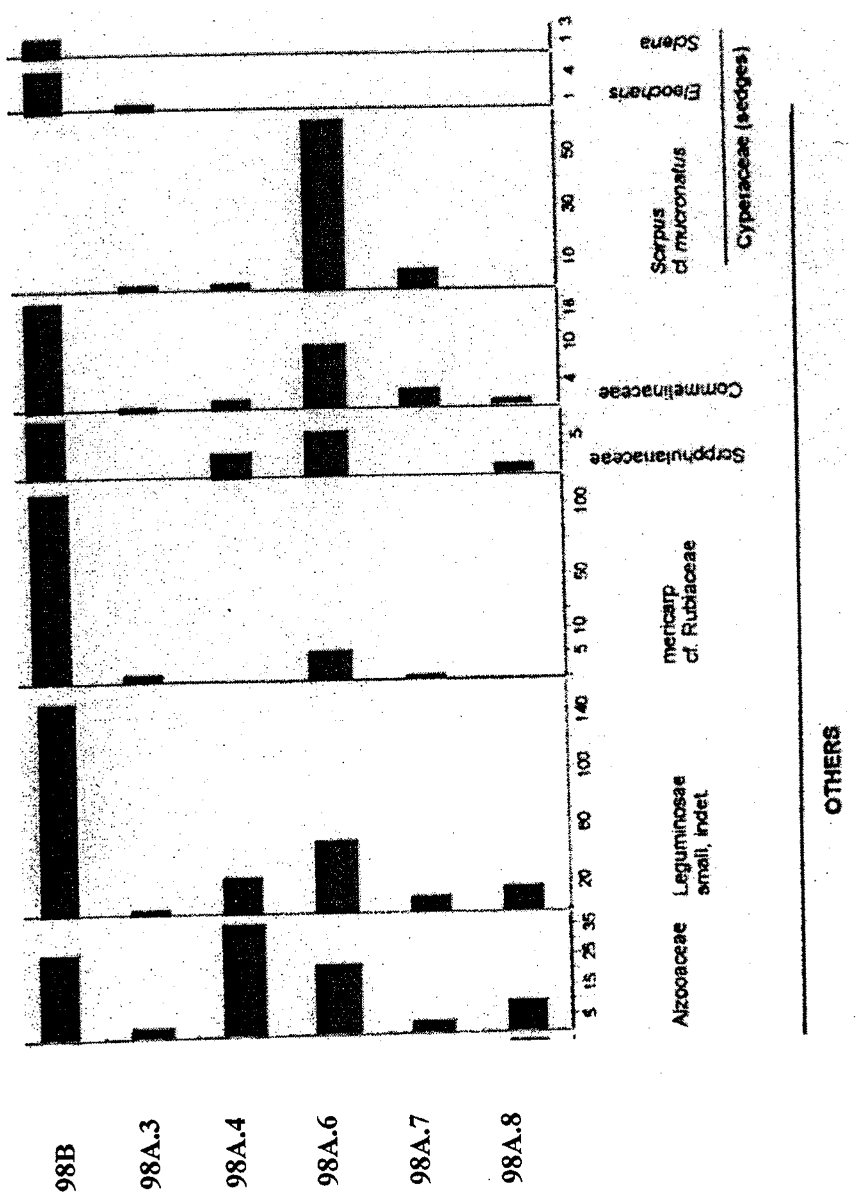


Figure 9.5c



period in Maharashtra has thus far gone unrecognized. Indeed the lack of well-dated and excavated Mesolithic (preceramic, microlithic) sites on the peninsula is a major weakness with the current database of Indian archaeology. Nevertheless, the earlier dates for the Southern Neolithic sites does raise the possibility independence.

The clearest aspect of the available evidence is the importance of pulses, especially those of tropical origin, which are usually grown in the summer (monsoon) season (*kharif*). The two most common are species of South Asian origin, and some can be attributed, with more or less certainty, to more restricted regions of probable domestication on the peninsula. The most widespread pulse on Southern Neolithic sites is horsegram/ *kulthi* (*Macrotyloma uniflorum* (Lam.) Verdc., synonym *Dolichos uniflorum* Lam.).[1] This pulse occurs from the earliest samples, such as the lowest level at Sanganakallu. It has also been recovered from all regions of the Neolithic thus far sampled. The green gram/ *mung* (*Vigna radiata* (L.) Wilczek, syn. *P. aureus* Ham.) is also widespread. The closely related black gram/ *urid* (*Vigna mungo* (L.) Hepper) is less widely represented in Neolithic samples, definitely identified only from two specimens, one from Hallur and one from Hanumantaraopeta, and a likely one from Peddamudiyam, although it has been found from the late (?) Neolithic of Hallur (Kajale 1989) and from the Iron Age (first millennium B.C.) at Veerapuram, Kurnool District (Kajale 1984). All three species are present also in Chalcolithic Maharashtra.

These pulse species are of South Asian origin. As for horsegram, wild progenitor populations remain to be clearly defined and delimited, although Jansen (1989: 54) indicates that variety *stenocarpum* (Brenan) Verdc. is a "wild plant in *Acacia* bushland and thicket in Africa and India"—although the current distribution of cultivation suggests it was domesticated only in India. In the past the wild progenitors of green and black gram were considered the same species, *Phaeseolus sublobatus* Roxb., although it is now clear that both species derive from morphologically and genetically distinct populations (Arora et al. 1973; Lukoki et al. 1980; Chandel et al. 1984; Smartt 1990; Lawn 1995; Kaga et al. 1996). Unfortunately, the geographical distribution of these two distinct progenitors is not as well documented as might be hoped (For an attempt at synthesis see Fuller 2002). Nevertheless it is clear that the mung progenitor (*V. radiata* ssp. *sublobata* (Roxb.) Verdcourt) occurs in the Western Ghats and may occur to the exclusion of wild urid (*V. mungo* ssp. *silvestris* Lukoki, Maréchal and Otoul) in the southern portion of that range. Both wild types have been found in the Himalayan foothills. On contextual evidence, the co-occurrence of *V. radiata* with other indigenous species may suggest a domestication in the south as do the wild populations in the Western Ghats. However, the sites where it has been recovered so far are presumably outside the ecological range in which the species was first domesticated (except perhaps Hallur), and thus earlier finds might be expected from Neolithic sites along the Western Ghats.

The Southern Neolithic millets identified in this study differ from those reported in previous work. During initial sorting it was noticeable that two or three modalities of size and form are present among the millets, in addition to other rarer types. A comparative study of modern millet caryopses was undertaken. Based on a study of modern material of forty species in ten genera (many of which had never been explicitly discussed by archaeobotanists in South Asia before), a preliminary key to the identification of millet grains (caryopses) was developed which focuses on aspects of overall shape and form, and in particular the length of the embryo in relation to the overall grain, since it is these features which are consistently preserved archaeologically (Fuller 1999, 2002, in press). This morphological key was supplemented with a preliminary study of micro-morphological features of the pericarp surface examined with a scanning-electron-microscope (SEM). Although the SEM study has been preliminary only, it appears to provide additional supporting characters for the identifica-tions in this study. On this basis published and illustrated reports of millets were reassessed and numerous probable misidentifications were found (see Fuller 1999, 2000). In particular the presence of finger millet appears to have been greatly exaggerated through the misidentification of dehulled long-embryo cary-opses (of, e.g., *Setaria* spp, *Echinochloa* spp., *Brachiaria ramosa*).

The two most widespread millets identified in the present study have been referred to *Setaria verticillata* (bristley foxtail millet-grass) and *Brachiaria ramosa* (browntop millet). The latter is a minor, but widespread crop in South India today, especially Karnataka and Andhra Pradesh, within which some populations are domesticated in the sense of whole or partial loss of natural seed dispersal, i.e. non-shattering panicles (see Rachie 1975; De Wet et al. 1983a: 167; De Wet 1995a; Grubben and Partohardjono 1996; Kimata et al. 2000). It would appear, as suggested by De Wet (1992), that this represents a relict crop that has been largely overshadowed by the more productive, and more easily processed, African millets. *S. verticillata*, on the other hand, is known to have been gathered from wild stands for human consumption at a number of localities in the Deccan in recent times (Gammie 1911), and is reputedly cultivated by some groups (Maheshwari and Singh 1965: 145-46), although no domesticated form has been reported. These taxa are widespread in a wild/ feral state through-out the plains of peninsular India, and it is conceivable that they could have been brought into cultivation together, grown and processed together. Other millet types recovered may have been present as 'weeds' in the fields of browntop mil-let and bristley foxtail. In general the small millets increase through time, as do the introduced large-grained cereals, whereas absolute parenchyma fragment quantities decline (figures 9.4). This could indicate a trend toward increasing cultivation of cereals and declining reliance on root foods, a trend in agreement with the ethnoecological hypothesis that seed-based agriculture tends to replace root-crop cultivation in savanna environments (Harris 1972, 1973).

## Economic Change: Added Crops from Africa and the North

Also present on Southern Neolithic sites were a number of non-native cereal taxa. Almost always occurring together were emmer (*Triticum dicoccum*) and free-threshing wheat (*T. durum/aestivum*) and barley (*Horduem vulgare* L. *sensu*



*lato*, including both some hulled and naked forms, and some twisted grains of four/six-row forms). These cereals from the Southwest Asian package were found in small quantities in most of the samples from Sanganakallu, as well as a minority of samples from Tekkalakota, Hiregudi, and Kurugodu. Only wheat was found occasionally at Hallur, and barley at Hattibelagalu. These cereals were found only in the uppermost sample (an arbitrary stratum) at Hanumanta-raopeta. Barley had been previously reported from Ramapuram (in the Kunderu river valley) and Budihal (Venkatasubbaiah and Kajale 1991: 81; Kajale and Eksambekar 1997: 221), and wheat from Tekkalakota (Kajale 1991). The chance finds from Tekkalakota and Hallur are inadequate to infer a chronological pat-tern, as are the small samples from the bottom of the stratigraphic sequence at Sanganakallu. Nevertheless, there is a trend toward increasing frequency of these cereals at Sanganakallu, suggesting that they became more important through time. It is perhaps with their increasing importance in the Bellary region that they were taken up in the Kunderu Valley to the east. By comparison to sites on the northern peninsula (see below) or in the Gangetic Valley (cf. Kajale 1991; Saraswat 1992; Fuller 2002), the rarity of these two cereals is notable, and presumably not due to preservation factors such as charring biases. While crop-processing techniques that biased against the preservation of these cereals can-not be ruled out, it is most straightforward to accept their absence or low pres-ence as reflecting low use. Their patchy occurrence within the region is more marked at the beginning of individual sites and sequences suggests that they were not basic to Neolithic subsistence and were only adopted gradually and sporadically.

The use of rice was similarly minor and restricted. The only evidence for rice comes from Hallur (confirming earlier reports, Vishnu-Mittre 1971; Kajale 1989a) where it occurs in low numbers throughout the Hallur sequence but showing a slight rise in frequency through time. Given that true rice (*Oryza sa-tiva* L.) was not native to the region (cf. Hooker 1897: 92; Fischer 1928: 1844; Vaughn 1989), this would have to be considered an introduced crop.[2] While rice was certainly being cultivated in northern India by the third millennium B.C., and appears to have been known to some communities on the peninsula (Kajale 1988: 783, 1977; Vishnu-Mittre 1961), finds are few until the first millennium B.C. when it appears to have taken off as a crop in Peninsular India (Kajale 1989b; Fuller 2002 ).

Two pulses that were probably later additions have been recovered from Southern Neolithic sites, one of which probably originated in Africa. Pigeon pea/ *Tuvar/ Arhar* (*Cajanus cajan* (L.) Millsp.) was derived from the wild *Ca-janus cajanifolia* (formerly considered a separate genus, *Atylosia*), which is re-stricted to southern Orissa and Bastar (van der Maeson 1986, 1995). Ar-chaeobotanical finds are few but suggest that the domesticate was diffusing on the peninsula in the mid-second millennium B.C., that is, Late Neolithic/ Early Jorwe, including Sanganakallu (this study), Peddamudiyam, Cuddapah district (Venkatasubbaiah and Kajale 1991), and Tuljapur Garhi, Maharashtra (Kajale 1996a). Another pulse widely recovered from second millennium B.C. sites on the peninsula is hyacinth bean/ sem (*Lablab purpureus* (L.) Sweet). Although this species shows its highest diversity within South Asia, wild progenitors have not been identified there and the botanical evidence suggests an origin in East Africa (Verdcourt 1970; Smartt 1990). Thus the present evidence suggests that this crop became available through some form of sea trade that reached south India in the second millennium B.C.

Although hyacinth bean is a clear example of an African crop present during the Southern Neolithic, the much-discussed African millets do not appear to have played a significant role. *Pennisetum glaucum* occurs only as rare finds in the three earliest Hallur samples, although as suggested above, there may be inherent biases against this species entering the archaeological record since it is a free-threshing millet. Similar processing qualities probably also act against finger miller, *Eleusine coracana,* which was only recovered as a single grain in the late HLR.98B. Earlier reports of finger millet from Hallur and elsewhere on the Indian peninsula (e.g., Vishnu-Mittre 1971, 1974; Vishnu-Mittre et al. 1986; Devaraj et al. 1995) should be disregarded as those illustrated appear to be likely misidentified and those not illustrated cannot be judged by other specialists (for a more detailed discussion of millet identification problems, see Fuller 1999, 2002, in press, n.d.B).

Other crops found infrequently could have entered the Southern Neolithic by diffusing from the north. These include *Linum* sp. (if identified with *L. usitatissimum*), found from Hallur (HLR98B). The *Cucumis* sp. appears to be a local wild species rather than either of the domestic crops, which are natives of Southwest Asia and Northern India respectively (Bates and Robinson 1995). Rice recovered from Hallur also occurs as odd specimens in most sorted samples from the site. Evidence for cotton comes from the late HLR.98B. Prior to this time cotton is already known from northern and northwestern India (see Janaway and Coningham 1995; Saraswat 1993; Fuller 2002), although this find from South India is particularly interesting given that it is a possible region of domestication for *Gossypium arboreum* (cf. Hutchinson 1947; Samnantham and Hutchinson 1974). *Abelmoschus* sp., which could be one of several native species and could have been a garden crop, also only occurred as a rarity, at HLR.98A.3, and at Hanumantaraopeta. It was reported previously from a Kunderu valley site (Venkatasubbaiah and Kajale 1991).

The core staples imply a basic seasonality of the Southern Neolithic that was focused around the monsoon cultivation of small millets and pulses. This was presumably balanced by the dry season availability of a range of fruits as well as wild yams (and presumably other tubers). It should be noted that, despite the common sowing period for the crops, there are likely to have been two harvest periods, one for the millets (October) and one for horsegram (November), while mungbean pods would have been picked intermittently as they matured. This basic scheduling is shared across the entire Southern Neolithic region and occurs in the lowest levels of sites studied here such as Tekkalakota, Hanumantaraopeta, and Hallur. This simple biseasonality is therefore a good candidate for the original cultivation regime of the Southern Neolithic and could represent an indigenous development of cultivation from a seasonal foraging schedule based around the same resources, postmonsoon grains and pulses and dry season fruit and tubers potentially having been gathered in different vegetational zones, the dry deciduous woodlands and grassland on the one hand and the (semi-) evergreen or wet deciduous forests on the other. At particular sites (and regions) this basic scheduling was augmented by the adoption of additional crops, made available from other regions, including both additional summer crops that expanded the postmonsoon harvest season, and perhaps the cultivated area, and winter cereals that added a new cropping season not tied to natural rainfall availability (i.e., December-March). This latter point may be particularly telling when it comes to understanding the reasons for these crop adoptions.



## The Southern Neolithic in Subcontinental Perspective

Having outlined the archaeobotanical evidence from the Southern Neolithic, it can be put into a broader perspective by considering it in relation to the archaeobotanical record of other regions of South Asia. There are immediate difficulties encountered in attempting to compare these data with published sources, including different sampling techniques, different identification criteria, and, in many cases, lack of quantified reports. Given these difficulties the only applicable form of quantification is ubiquity analysis, which can in any case yield insights into broad chronological and inter-regional patterns (see, e.g., Hubbard 1975,1980). In order to characterize regional agricultural 'packages,' evidence will be grouped into sites from cultural regions and periods for which there are a fair number of well-studied sites, including Chalcolithic Mahrashtra (divided into an early Pre-Malwa/Malwa phase and a late Jorwe phase) and Gujarat (Harappan and Late/Post-Mature Harappan period) and the greater Indus Valley (including some sites in the Ganges—Yamuna Doab) from the Harappan and Post-Mature Harappan periods. It should be noted that the early phase of Maharashtra is for the most part contemporary with the late phases further North (i.e., first half of second millennium B.C.). For the Southern Neolithic, no attempt will be made to provide chronological divisions at this stage, and all the data will be lumped although probable chronological patterns will be raised in discussion. This is justified since the predominant taxa remain important throughout the stratigraphic sequence at the sites studied here: pulses of Indian origin, millets of Indian origin, millets and pulses of African origin, and Southwest Asian crops. Total ubiquities for different regions can be compared in terms of groups of crops sharing similar regional origins of seasonality and ecology.

The groups of crops that have been identified as the main staples of the Southern Neolithic, small millets and summer pulses of Indian origin, show a strong presence in the adjacent Maharashtra. It is only this adjacent region where *Macrotyloma* and *Vigna (Ceratotropis)* sp. occur in 50 percent to 100 percent of sites (and also have a high ubiquity at the level of samples). These taxa make only an occasional appearance in the Harappan regions (Gujarat and Greater Indus Valley) in the later period. It is tempting to interpret this pattern as the result of a spread of these taxa from the peninsula northward during the early second millennium B.C. In Gujarat only the small millets make a strong showing, while pulses of any kind are rare with winter pulses of Southwest Asian origin being present to a small extent in the late period. The winter pulses (especially *Pisum, Lens, Lathyrus*) represent the most significant difference between Maharashtra and the Southern Neolithic, as they are absent from the south (with the possible exception of a small presence of *Lathyrus sativus*, reported by Vishnu-Mittre and Savithri 1979) but have very high frequencies in Maharashtra. They have relatively high frequencies in the Indus Valley where they are likely to have been important crops along with the Southwest Asian cereals. The latter, wheat and barley, are also extremely important in northern Mahrashtra, and occur in high frequencies and high ubiquities (at least at Inamgaon, Kajale 1988), suggesting that these are staple crops on the northern Peninsula. South Asian millets and pulses as mentioned are likely to have been important too.

African crops play little role in the overall pattern, although they follow the general pattern of South Asian millets and pulses. Another link between Maharashtra and the Southern Neolithic is the presence of *Lablab*, a taxon absent from the generally pulse-poor sites of Gujarat. On the other hand occasional finds of *Pennisetum glaucum* in Maharashtra, Gujarat, and the south, suggest a similar proclivity in all regions to take on introduced cereals that fit the seasonality for the more important South Asian small millets. Thus African crops suggest a linkage of Gujarat-Maharashtra-South India in terms of millets but only Maharashtra-South India in terms of pulses. The available evidence for crops of African origins does not support contentions that these species were important for allowing settlement of the peninsular savanna and the beginnings of summer cultivation (e.g., Hutchinson 1976; Possehl 1986).

One of the more intriguing patterns is that of Gujarat, which despite being a region generally included in the Harappan civilization (see, e.g., Possehl 1980, 1997b; Kenoyer 1998; Chakrabarti 1999) shows a very different agricultural system from the Indus valley. In part this can be attributed to local ecology since Gujarat lacks the perennial irrigation of a major river and instead must rely on monsoon rains—to which the summer-cultivated millets are better suited. The fact that already by the middle of the third millennium B.C., these small millets were being cultivated in this region suggests that either they were crops that were available as domesticates from elsewhere by this time or they were domesticated locally.

It is possible that small millets in Gujarat were available as domesticates from the Indian Peninsula, although a detailed reconsideration of specific identifications is warranted to clarify the separation of indigenous taxa from introduced 'Chinese' millets. Although it is clear that these millets were important in early north Chinese agriculture, it seems likely that *S. italica,* and perhaps *P. miliaceum* as well, was domesticated more than once in Eurasia, with southeastern Europe and/or the Caucasus as possible regions (cf. Burkill 1953; Prasada-

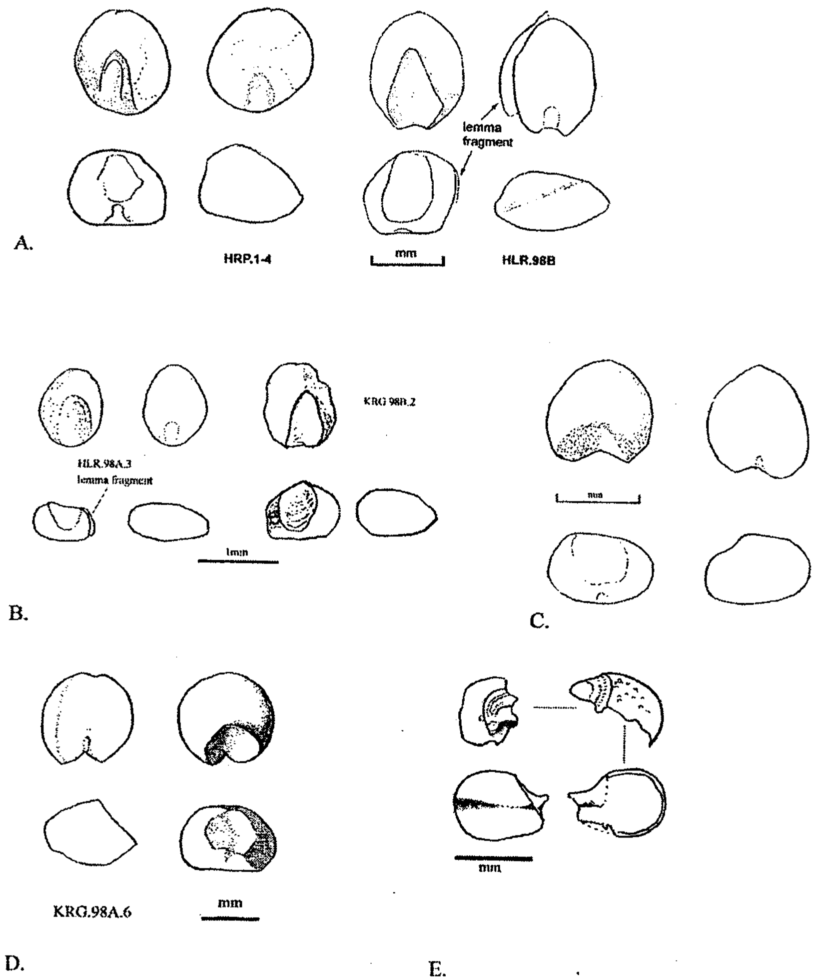


Figure 9.6. Drawings of selected identified millets types. A. Examples of archaeological *Brachiaria ramosa.* HLR.98B. B. Examples of archaeological *Setaria verticillata.* C. Archaeological *Panicum sumatrense,* HLR.98A.4. D. Archaeological *Paspalum scrobiculatum,* from KRG.98A.6. E. Archaeological *Eleusine coracana* from HLR.98B.

Rao et al. 1987; Zohary and Hopf 1993; Li et al. 1998). The reported identifications of *Setaria italica* (Vishnu-Mittre 1990; Weber 1991; Reddy 1994), if confirmed, would indicate that the adoption of 'Chinese' millets from a different source, presumably Central Asia had already occurred. The report of *Panicum miliaceum* from Pirak, 1900-1500 B.C. (Costantini 1979), which appears well-identified,[3] indicates some diffusion of the Chinese millets into peripheral South Asia by ca. 2000 B.C., and this millet comes from roughly the same period at Shortugai in Afghanistan (Willcox 1991). However, the reported *P. miliaceum* from Tepe Yahya V implies even more ancient availability back to perhaps 5000 B.C. (Costantini and Biasini 1985; Lamberg-Karlovsky and Tosi 1989). The spread of these millets is still poorly understood, however, as by contrast *S. italica* appears to be absent from Mesopotamia until the Iron Age while *P. miliaceum* has been found from the early second millennium (Nesbitt and Summers 1988; Miller 1991). Both of these taxa are reported present further north in the Caucasus as early or earlier than Tepe Yahya (Litsina 1978, 1984), but were absent from Turkmenistan (Moore et al.1994; Miller 1999). In addition, they were present in parts of Neolithic Europe (Marnival 1992). Further research to clarify the distinction between domesticated *S. italica* ssp. *italica* and the widespread wild *S. italica* ssp. *viridis* for many of the Eurasian archaeological finds is needed, but the available evidence does suggest a long prehistory of availability of these crops in regions beyond South Asia. The spread of these millets, delayed in so many regions, suggests that it was a highly selective process, dependent in part on whether additional summer cropping seasons were needed (in winter crop-growing regions), or feasible, and thus constrained in part by cultural traditions of cultivation techniques.

Returning to our focus on the Indian Peninsula it is possible to conclude that the Southern Neolithic had a distinctive cropping tradition despite the crude level of comparison. It appears that the crops upon which the Southern Neolithic were based had a separate history from the Southwest Asian crops. Southern Neolithic sites were notably pulse rich as was also the case with adjacent Maharashtra, although in the latter region this included both Indian and Southwest Asian taxa. Other regions were generally more pulse poor. The implications of the frequency of pulses, in terms of either taphonomy or diet, needs further investigation.

## Agricultural Fusion: The Emergence of Agricultural Villages in the Northern Deccan

In general Maharashtra appears to combine both the staples from the Indus Valley, the winter crops from Southwest Asia, and the staples of the Southern Neolithic. This suggests the hypothesis that both groups of crops were established as parts of cultivation systems and that the emergent villages on the north peninsula could draw upon and combine two separate agricultural traditions one from South India and one from the Harappan civilization of the Indus Valley.



The contrast between climatically similar Maharashtra and Gujarat is intriguing. Both share a seasonality in which moisture derives from the monsoon. And average rainfall levels are similar (Meher-Homji 1967), at least for the Saurashtra Peninsula (where archaeological sites like Rojdi, Babor Kot, and Oriyo Timbo are located) and the interior northwestern Deccan Plateau of Maharashtra (where the studied Chalcolithic sites are located). Despite these environmental similarities, from which one would predict ancient agricultural similarities, the winter cereals and pulses became well established in the northwestern Deccan prior to 2000 B.C. while they were almost entirely absent for the Saurashtra sites, except for trace quantities of barley during the Mature Harappan phase at Rojdi (Weber 1991), small quantities of *Lathyrus, Lens* and *Pisum* from Rojdi C (2000-1700 B.C.), and a few wheat/barley from the Harappan enclave of Kuntasi (Dhavalikar 1995). We would not expect the winter cereals to have been adopted for reasons of ecological adaptation as it is the summer millets and pulses that are adapted to the monsoon seasonality of this region and as is evident from Gujarat and the Southern Neolithic sites reported on here, monsoon crops were already in cultivation. Although it is possible that the adoption of crops of winter seasonality represented a form of intensification by making the same parcels of land productive during another season, it would indeed have required intensive practices, including irrigation (as in Kajale 1988: 808).

The generally limited evidence for winter cultivation in Saurashtra implies that the diffusion of these crops to the peninsula moved through a different route, such as through Rajasthan. Indeed evidence from the site of Balathal takes sedentary agriculture based on winter cereals back to at least 3000 B.C. (Kajale 1996; Shinde 1999). It is interesting to note that the period in which Balathal emerged as an agricultural settlement (fourth millennium B.C.), was the tail end of the mid-Holocene wet phase indicated in the pollen record of western Rajasthan's playas (Singh et al. 1974, 1990; Enzel et al. 1999; Fuller and Madella 2000).[4] As the high levels of *Artemisia* pollen suggest a good portion of the moisture can be attributed to winter rains, extending further south from the western Himalayas (Swain et al. 1983; cf. Singh et al. 1973). The rather limited evidence from Saurashtra/ Gujarat indicates only the gradual weakening of the rains from the mid-Holocene with minimal impact of winter rains (Vishnu-Mittre and Sharma 1979; cf. Vishnu-Mittre and Sharma 1975). Therefore, in the fourth millennium B.C. climatic conditions in Rajasthan may have been more conducive to the spread of winter-cropping into the region, a legacy of early (pre-Urban) Harappan cultures farther west—although it is unclear whether this was brought by migrants or diffusion.

Once established, this 'Indus' agricultural package had an inertia of its own. Despite the absence of significant winter rains, these crops spread southward, presumably requiring more intensive agricultural practices, such as irrigation, and double-cropping to bolster yields with monsoon crops such as the native South Asian pulses and small millets. Winter cereals and pulses presumably moved southward through the Malwa Plateau, where they are in evidence by 2000 B.C. (see Kajale 1991; Fuller 2002). The movement of these cereals southwards would appear to have been very rapid, as sites in Maharashtra, such as Daimabad date back to this time. Although they are not yet well dated, the finds of wheat and barley from the Southern Neolithic may also be from the end of the third or beginning of the second millennium. The speed of this spread is such that it does not make sense in terms of gradual population growth and dispersal, as might be predicted for a migrationist model such as 'demic diffusion' (sensu Ammerman and Cavalii-Sforza 1971). An alternative hypothesis might suggest that the instability of this agricultural package led to dispersal without overpopulation (see Rindos 1984: 271-80), although the longevity of numerous excavated Chalcolithic sites that lasted from pre-Malwa times through to the Early Jorwe period seems to indicate otherwise (unless these sites turn out to be the exceptions and not the rule). Thus diffusion southward into established societies would appear to be indicated.

The adoption of these crops implies a process of social acceptance. Although it remains to be determined whether these were entirely hunter-gatherer societies or already practiced cultivation of some kind, villages with evidence for wheat(s), barley, and winter pulses proliferate in the early second millennium B.C. on the northern peninsula. This acceptance of these crops contrasts with the situation in Saurashtra, where there is little evidence for interest in winter cultivation, and presumably therefore associated forms of cuisine. In Maharashtra, by contrast, the winter crops, together with summer crops provided the subsistence base for a large number of settlements that may have been organized into chiefdoms (Dhavalilar 1988; Shinde 1994; Chakrabarti 1999). Yet another situation held for the Southern Neolithic, where wheat and barley were selectively taken up without the associated pulses.

## Toward an Understanding of Crop Adoptions: Food Stress or Food Choice?

Models for explaining subsistence change can be broadly divided into 'push' models, those of food stress, and 'pull' models, relying on social motivations or food 'choice' These broader paradigms can be considered when understanding the reasons behind the adoption of a winter crop package in Maharashtra as well as the selective uptake of these same crops farther south (in Karnataka). Versions of these models have been outlined in the past with reference to the origins of agriculture. The predominant push-model paradigm posits as important factors, population pressure (due to high/ increasing population density and fixed or contracting group territories), staple food reduction or shortages, and environmental change (e.g., Redding 1988; Henry 1989; McCorriston and Hole 1991; Moore and Hillman 1992; Bar-Yosef and Meadow 1995; Hillman 1996; Harris 1998; see also Harris 1977). The models for dispersal already mentioned are in a similar vein (Ammerman and Cavalli-Sfroza 1971; Rindos 1984). A few other scholars have put forward a pull-model in which people took up cultivation for social reasons, in particular to obtain surpluses and/or special foods for social



display and competition (e.g., Bender 1978; Farrington and Urry 1985; Hayden 1990; 1996; Sherratt 1999). In the case of early cultivating societies in Southwest Asia, however, the requisite social complexity and competition does not appear to have been present as Hayden's (1990, 1996) competitive feasting model predicts (Bar-Yosef 1998; cf. Kuijt 2000). Be that as it may, the role of social choices and intrasociety competition remains a possible reason for changes in food preparation and production in later periods, such as the later Neolithic/Chalcolithic of South Asia.

In understanding agricultural transitions in later prehistory, we are again faced with trying to distinguish between causation by food stress or by social factors. Although hypotheses of food stress have been put forward for parts of India in the second millennium B.C. (e.g. Dhavalikar 1988; Weber 1992), the evidence for them remains unconvincing. For example it has been suggested that new crops should be adopted in times of food stress (Weber 1992). But new species may be adopted for any number of reasons, including the seeking of new status foods, along the lines indicated by Hayden (1990, 1996). More importantly, it seems unnecessarily foolhardy for communities suffering from food stress to take up cultivation of new crops the potential performance of which would have been unknown and thus unpredictable. Surely it makes more sense for those in times of need to invest further efforts in trying to assure the success of familiar crops, either through increasing the area cultivated or by intensifying methods of production—indeed this is the classic cause of agricultural intensification, as observed by Geertz (1962) and Boserup (1965). It seems much more likely that new, unknown crops would have been experimented with during periods of relative plenty and stability (cf. Sauer 1952: 20-21). Indeed such are the implications of the 'diet breadth model' derived from evolutionary ecology which predicts that intensification of secondary food sources played a role in risk-buffering before they became staples (Winterhalder and Goland 1993, 1997; Broughton and O'Connel 1999). In the case of crops not locally available and not climatically suited, however, we are left with the question of why they would have been taken up on a small scale as secondary food sources in the first place. With food stress providing insufficient causation, we are left with food choice, that is, some culturally determined value to consume or at least try this new crop. Such a pull factor brought a crop into the cultivation system on a small scale, and it could then be selected for intensification in times of stress, or not. Indeed for the African millets, *after* they had been adopted on a small scale, their utility for increasing yields and decreasing processing labor in the monsoonal environment probably led to their increasing cultivation to reduce risks.

An additional line of evidence from South India suggests that food preparation and consumption practices played an increasingly prominent social role during the period that the winter crops were taken up in South India. Ways of dealing with food can in a general way be inferred from ceramics, the primary medium for preparation, serving and consumption (cf. Arnold 1985: 234; Rice 1987: 211-17, 236-42; Dietler 1996). In Phase II of the Southern Neolithic and increasing in Phase III, a range of new vessel forms entered the repertoire of

Southern Neolithic potters, and these can be inferred to relate to range of new food preparation and serving functions (Allchin 1960; Allchin and Allchin 1982: 287; Korisettar et al. 2001). These ceramic developments relate largely to liquid preparations, including perforated "strainers," spouted forms and liquid carrying/serving jars. Although these new forms may not be directly related to the consumption of new cereals, indeed some of these new forms have been suggested to relate to milk-based preparations (Allchin 1960; Fuller 1999), they can be linked to increased cultural contact and convergence with the Northern Deccan (Maharashtra), where winter crops were of paramount importance. Generally, this diversification in culinary arts might be suggested to be part of the same larger process of intersocietal influence and exchange that promoted agricultural diversification through the adoption of new crops.

In general, as peninsular Indian societies increased in social complexity and incipient hierarchies developed, food can be expected to have taken on an important function in the negotiation of social status and identity (see Goody 1982: 99-101; Wilson 1988: 81ff.; Hayden 1996; Dietler 1996; Gummerman 1997; Sherratt 1999). The provisioning of food, either in large quantity or of unusual preparations, can serve to create or reinforce the relationships of social debt upon which social hierarchy is based (Dietler 1996; Hayden 1996). For Maharashtra, the Malwa to Early Jorwe period has been suggested to represent societies falling in the complexity grade traditionally referred to as chiefdoms (Dhavalikar 1988; Shinde 1994; Chakrabarti 1999). In the Southern Neolithic, there is little evidence for hierarchical organization, although the increasing range of long-distance imports, probably including copper artifacts, during the second millennium may have contributed to some status disparities. Nevertheless, Southern Neolithic societies must have included some degree of 'horizontal complexity,' or heterarchy (sensu Crumley 1995), that served to integrate segments of sedentary cultivators and the seasonally mobile cattle-herders who left behind the ashmounds. Food may have played a role in such relationships, and it is tempting to see feasting having taken place at the ashmound sites (see Paddayya 1998: 150-151). Since cuisine often functions as a "prestige technology" (Hayden 1997), increasing social hierarchy provides motivations for the adoption of new foodstuffs, both novel forms of preparation and new cultivars. From the point of view of Southern Neolithic communities, something must have been particularly prestigous about the wheats and barley but not the pulses.

## Summary and Conclusions

Evidence presented above suggests that the Near Eastern winter crops, those that formed the subsistence basis of the Harappan civilization, diffused into peninsular India where they were combined with native pulse and millet domesticates. As a working hypothesis it is suggested that native pulses, including mungbean and horsegram, were domesticated in the wet to dry deciduous forests of the South Deccan, where small millet-grasses were also utilized, probably as cultivars (*Brachiaria ramosa*, *Setaria verticillata*, and perhaps others). Root foods, as yet unidentified, were also utilized but were eventually eclipsed by seed crops. This Southern Neolithic staple package was adopted by the early village societies of the northern peninsula (Chalcolithic Maharashtra) where they were combined with the winter/Harappan crop package. Although not diffused during the Harappan civilization, but prior to it, the winter crops must have had significant prestige associations that aided their rapid uptake on the peninsula. From the point of view of the Southern Neolithic it was only barley and wheats that had social attractions and were adopted into cultivation. The adoption of these crops corresponds generally to a period of increasing culinary elaboration as inferred from ceramics, and to an era of increasing long-distance trade and exchange of cultural influences with the chiefdoms of the northern peninsula. To better understand these processes in South Asia, we need more evidence for past subsistence, such as from archaeobotany. We need to critically assess that data in terms of its formation processes and consider it then in relation to other lines of archaeological and palaeoenvironmental evidence.

The prehistoric tapestry of food production and consumption in South Asia includes the merging and diverging of practices from different regions. While these processes have been constrained and facilitated by environmental conditions, I have argued that it is food 'choice,' the social valuation of particular foods that underlies important aspects of the prehistoric pattern, in particular the wide diffusion of winter cereals. The development and spread of agriculture in South Asia should not be reduced to responses to environmental or population pressure, although these were doubtless important historical factors at times. Indeed I have suggested that increased precipitation in the fourth millennium B.C. facilitated the spread of winter crops to Rajasthan but not to Gujarat. In addition, more evidence is needed to assess the potential role of gradual aridification during the fourth and third millennia in South India for increasing the availability or importance of native millet-grasses (Fuller 1999). Environment alone (external stimulus) seems insufficient to explain the archaeological patterns, and account must be taken of cultural (internal) factors. The archaeobotanical record of the Indian Peninsula argues that the palaeoeconomies of South Asia need to be understood as embedded in social systems, as anthropological and substantivist models of 'economy' argue more generally (see, e.g., Polanyi 1968 [1944]; Gregory 1982; Wilson 1988; Gosden 1989). From this perspective an "emphasis on the aesthetic value of food and other products dominates the value placed on food as a means to satisfy hunger" (Wilson 1988: 83). While this does not deny the potential of environmental constraints or climatic changes to determine the course of subsistence change, it does imply that most variation and much change will occur through social processes, which might then flourish or fail under certain environmental conditions. Although the particular meaning of foodstuffs and the character of social drives may remain inaccessible, the operation of social factors can be inferred, in situations such as the Indian Peninsula, from the incongruence of ecological conditions, available food species and the actual taxa in evidence. The wide, and rapid dispersal of the

Southwest Asian winter crops, especially wheats and barley, can therefore be seen as a (pre-) Harappan legacy adopted within extra-Harappan and post-Harappan communities of inner India.

## Notes

1. Although this species has been generally referred to as *Dolichos biflorus*, this is in fact an invalid name for this crop as the Linnean type was a form of cowpea. For the taxonomy see Verdcourt 1970; Smartt 1990; synopsis in Fuller 2002.

2. Further work on wild rices of South India is needed. It is not possible to be entirely sure that these specimens are not from the wild *Oryza granulata* Nees et Arn. ex G. Watt, which according to Fischer (1928: 1845, as *O. meyeriana*) occurs in all Madras presidency districts, although one wonders whether this distribution was not brought about by its spread as a weed of cultivated *O. sativa*, perhaps from native habitats in coastal or northern swampy parts of India, as implied by the distribution given by Hooker (1897). Comparative material or published morphological studies of *O. granulata* were not available to the present author. In addition modern populations of spontaneous rices (*Oryza rufipogon* sensu lato) in western Karnataka have an anamolous distribution that could indicate relict, truly wild populations rather than just feral weeds of cultivation (cf. Akihama and Toshimitsue 1972).

3. From the published photograph (Costantini 1979, pl. LVI.A), and indicated size range, this appears correctly identified. The native wild *Panicum turgidum* Forssk. has more elongate/ovate seeds, rather than nearly globose, and seems a good candidate for the other *Panicum* sp. morphotype from Pirak.

4. The chronologies of *Singh* et al. (1974; 1990; also Swain et al. 1983), require critical analysis, conversion to a standard half-life, and calibration. The well-dated and calibrated sequence of Enzel et al (1999) is a better baseline, and can be correlated with broader interregional evidence for changes in monsoon strength, such as evidence from the Tibetan plateau (Wei and Gasse 1999), tropical Africa (Hassan 1997; Gasse 2000), and the Arabian Peninsula (Lezine et al. 1998). A review of the implications of this data and the available evidence from South Asia for understanding environmental change during the Harappan period is forthcoming (Madella and Fuller n.d.).



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# Chapter 10

# Minimizing Risk? Approaches to Pre-Harappan Human Ecology on the North-West Margin of the Greater Indus System

**Kenneth D. Thomas**

The South Asian subcontinent includes a great diversity of climatic and ecological zones in which people in the past have settled and to which they have adapted in various ways. Especially interesting among these are the environments of the semi-arid zones, which present particular challenges and opportunities for human settlement and subsistence ecology because they are, in many ways, marginal in comparison with more humid or mesic environments. The study of human adaptations to various kinds of marginal environments is itself a topic of increasing interest in archaeology (e.g., Mills and Coles 1998), particularly with regard to present-day environmental concerns. It is also of interest to understand how traditional systems for coping with environmental problems enabled sustainable settlement in difficult environments. In this chapter I will consider aspects of pre-Harappan human ecology in an environmentally marginal area to the north west of the Greater Indus region.

The Bannu region can be viewed as being marginal from various perspectives. In geographical terms it is certainly located on the western margin of the Indus system. Environmentally, it is marginal for successful agrarian-based production and subsistence. Both these aspects of marginality will be considered in this discussion, but the main focus here will be on the range of sources of evidence that are being used by the Bannu Archaeological Project to understand past human subsistence ecology in that region. My discussion will build upon recent reviews of ethnoarchaeology (Khan 1994) and pre-Harappan subsistence systems (Thomas 1999) in Bannu. The chapter will first consider the Bannu region in terms of environments and their marginality. Next I discuss the main archaeological sites, the culture sequence, and absolute chronology. The main part of the chapter considers the range of different approaches being adopted to help understand past subsistence systems in the Bannu area, ranging from archaeobotanical and zooarchaeological data sets to ethnoecology and ecological modelling. Finally, the subsistence systems of the main culture phases are discussed and a model for the evolution of social and subsistence systems, based on risk management strategies, is tentatively proposed.

| Region | Shimoga dist.: Hallur | | | | | | Bellary District | | | | | | | | | | | | | | | | | | | | | | | | | | | | Cuddapah Basin | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | HLR | 98A | | | | | Sangankallu 98B | | | | Sanganakallu 98A | | | | | | | Tekkalakota: TKT.98 | | | | | | | | | Hiregudda: HGD.98A | | | | | | | | Hanumantaraopet | | | |
| Level | 98B | 3 | 4 | 6 | 7 | 8 | 2 | 3 | 4 | .6-7 | 4 | .4-5 | 6 | 7 | .7-8 | 9 | 10 | A2 | A3 | B2 | B3 | C4 | D2 | D3 | D4 | D5 | 3 | 4-5. | 6 | 7 | 8 | KRG | HBG | VPM | 3 | 4 | 5 | 6 |
| pulses | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Macrotyloma uniflora* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | | | X | X | | X | X | X | X |
| *Vigna radiata* | X | X | X | | X | X | X | X | X | X | | X | | X | | | | X | X | X | X | X | X | X | X | X | | X | | X | | | X | | X | | X | X |
| *Vigna* cf. *mungo* | | | + | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| *Vigna trilobata* | w | | w | w | w | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | w | | w |
| *Lablab purpureus* | | | + | | + | | ++ | ++ | ++ | ++ | ++ | + | | | | | | | | | | | | | | | | | | | | | | | | | ? | |
| *Cajanus cajan* | | | | ? | | | | + | | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | ? | |
| millets | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Brachiaria ramosa* | X | X | X | X | X | X | | X | | | X | X | | X | | X | | X | X | X | X | X | X | X | | X | ? | X | X | ? | ? | X | X | X | X | X | X | X |
| *Setaria verticillata* | X | X | X | X | | X | X | X | | | | X | | X | | X | X | | | X | X | X | X | | | X | ? | X | X | ? | X | X | X | X | | X | X | |
| *Echinochloa* cf. *colona* | | w | w | | | | | | | | | | | | | | | | | | | w | | | | | | w | | | | | | | | w | | |
| *Setaria pumila* | | | | w | | | | | | | w | | | w | | | | | | | | | | | | | | | | | | | | | | | | |
| *Panicum sumatrense* | | w | w | w | w | w | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Paspalum scrobiculatum* | | w | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | w | | | | | | |
| *Pennisetum glaucum* | | | | + | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eleusine coracana* | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| large cereals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hordeum vulgare* | | | | | | | + | + | + | + | + | + | + | + | | + | | | | | + | | | | + | | | | | + | | + | + | | + | | | |
| *Triticum* sp. | | | + | + | | | + | + | + | + | + | + | + | + | | + | | | | | + | | | | + | | | | | + | | + | | | + | | | |
| *Triticum diococcum* | | | + | | | | + | + | | + | + | + | | + | | | | | | | | | | | | | | | | + | | | | | | | | |
| *Triticum durum/aesitvum* | | | | | | | + | + | | + | + | + | + | + | | + | | | | | | | | | | | | | | + | | | | | | | | |
| *Oryza* sp. | + | + | + | + | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| misc. food/crop plants | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ziziphus* sp. | | | | x | x | | x | | | | | | x | | x | | | | | | | x | | | | | | | | x | | x | | | x | | | |
| *Ficus* sp. | x | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | x | | |
| cf. *Syzigium cumini* | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| cf. *Artocarpus* | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cf. *Cucumis* | x | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | x | x |
| cf. *Luffa* | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Linum usitatissimum* | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gossypium* sp. | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Abelmoschus* sp. | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | |
| parenchyma fragments | | X | X | X | X | X | X | X | X | | | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | | X | X | | | X | X | | X | | X | |

samples arranged by level for each site with youngest levels at left
X= native culitvar, significant presence
?= as above, but uncertain due to less specific identification
x= possible native cultivar or gathered fruit with minor presence

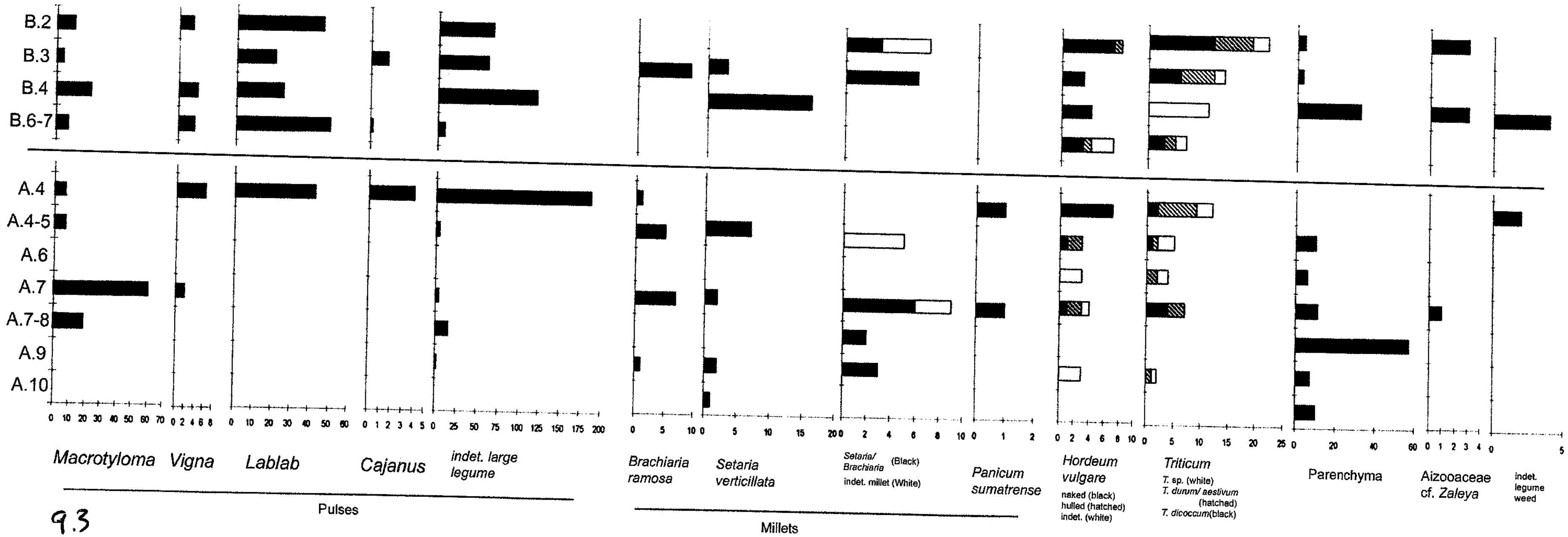
w= potential native cultivar, minor presence, probable weed
+ = introduced cultivar, minor presence
++=introduced cultivar, significant presence

PDM and Ramapuram data, at far right, are included on the basis of published evidence (Venkatasubbaiah and Kajale 1991)

9.1 Table 1. Presence absence data for examined samples from Southern Neolithic sites, interpreted in terms of probable level of use and source. Note only HRP is included from the Kunderu river valley due to the limited evidence recovered from other sites in the area which does not add to the picture from HRP. Higher numbers represent lower levels.

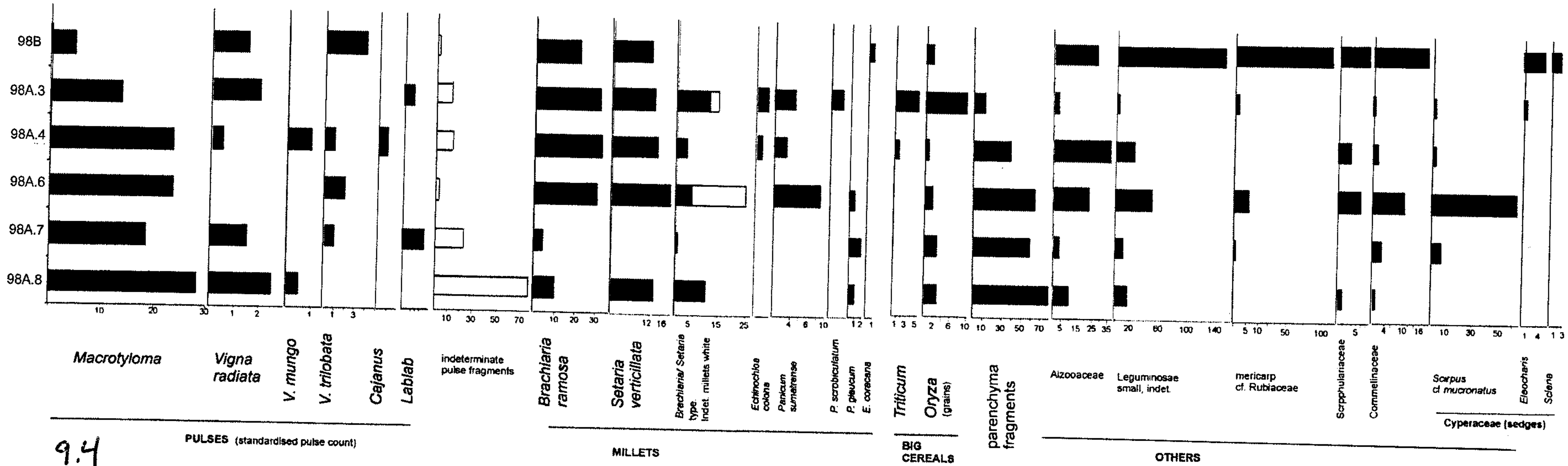
| | Total | Sample ubiquity by site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PULSES** | sample ubiquity | SGK | HGD | TKT | KRG | HBG | VPM | HRP | PDM | IJD | RPG | SGP | HLR.98A-B |
| *Macrotyloma uniflorum* | 69% | 92% | 40% | 91% | 75% | 71% | 0 | 100% | 50% | 100% | 0 | 40% | 100% |
| *Vigna radiata* | 46% | 58% | 40% | 82% | 0 | 14% | 0 | 80% | 25% | 0 | 25% | 40% | 75% |
| *Vigna mungo* | 6% | 0 | 0 | 0 | 0 | 0 | 0 | 20% | 25% | 0 | 0 | 0 | 25% |
| *Lablab purpureus* | 13% | 58% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25% |
| *Cajanus cajan* | 7% | 33% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13% |
| **CEREALS** | | | | | | | | | | | | | |
| *Brachiaria ramosa* | 51% | 42% | 40% | 73% | 100% | 29% | 60% | 100% | 0% | 0 | 0 | 0 | 100% |
| *Setaria verticillata* | 42% | 50% | 60% | 45% | 50% | 14% | 40% | 40% | 25% | 0 | 25% | 0 | 88% |
| *Bracharia/Setaria* millets | 72% | 75% | 100% | 91% | 100% | 29% | 80% | 100% | 75% | 0 | 25% | 20% | 100% |
| *Echinochloa colona* | 10% | 0 | 20% | 9% | 0 | 0 | 0% | 60% | 0 | 0 | 0 | 0 | 25% |
| *Panicum sumatrense* | 10% | 17% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63% |
| *Paspalum scrobiculatum* | 3% | 0 | 0 | 0 | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13% |
| *Pennisetum glaucum* | 4% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38% |
| *Hordeum &/or Triticum* | 31% | 83% | 40% | 18% | 100% | 14% | 0 | 20% | 0 | 0 | 0 | 0 | 25% |
| *Hordeum vulgare* | 18% | 75% | 20% | 9% | 25% | 0 | 0 | 20% | 0 | 0 | 0 | 0 | 0% |
| *Triticum sp.* | 22% | 75% | 20% | 9% | 50% | 0 | 0 | 20% | 0 | 0 | 0 | 0 | 25% |
| *Oryza* sp. | 10% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 88% |
| **Other Foods** | | | | | | | | | | | | | |
| *Ziziphus* | 17% | 25% | 40% | 9% | 25% | 29% | 0 | 20% | 0% | 0 | 0 | 0 | 25% |
| misc. fruit/nut frags. | 33% | 42% | 40% | 45% | 25% | 0 | 0 | 80% | 25% | 0 | 0 | 0 | 75% |
| parenchyma | 69% | 75% | 40% | 73% | 75% | 100% | 60% | 100% | 50% | 0 | 50% | 60% | 75% |
| no. of samples counted | total: 72 | 12 | 5 | 11 | 4 | 7 | 5 | 5 | 4 | 2 | 4 | 5 | 8 |

9.2 **Table 2.** Ubiquity of potential cereal and pulse crop taxa recovered from Southern Neolithic sites in this study.



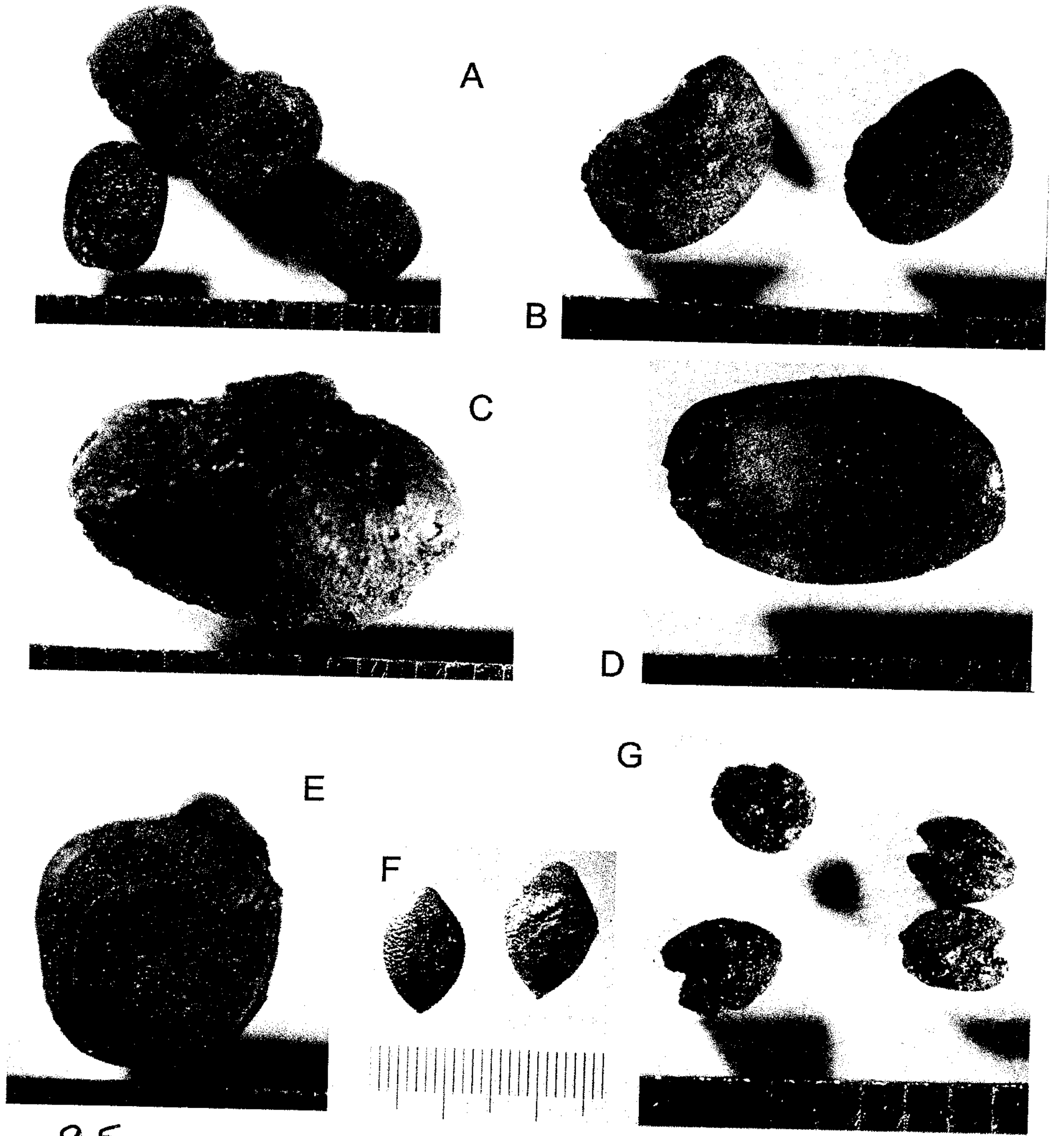

9.3

**Figure ~~4~~.** Multi-histogram of changing quantities of crops, parenchyma the most common weed types through the sequence at Sanganakallu. The bottom half of the chart derived from a single sample for each stratum from profile SGK.98A, while the top half derive from trial trench SGK.98B strata. Preliminary field assessment of ceramics and depth suggest that SGK.98A.4 is possibly equivalent to SGK.98B.4. SGK.98A can be correlated with previous excavations and hence ceramic dating evidence (Subbarao 1948; Ansari and Nagaraja Rao 1969). SGK.98A.6-10 represent Phase II (of Allchin and Allchin 1982), SGK.98A.4-5 ands above represent Phase III.




9.4

**Figure 5.** Multi-histogram of changing quantities of crops, parenchyma the most common weed types through the sequence at Hallur. The precise dating of the sequence is unclear, but field assessment suggests phases II-III of the Southern Neolithic, with some possible Phase I at the base of the sequence.




9.5

**Figure 6.** Photomicrographs of representative pulses and millets. A. *Vigna* cf. *radiata*, with both cotyledons intact, testa missing, SGK.98A.4. B. *Macrotyloma uniflorum,* whole seed, SGK.98A.4. C. *Lablab purpureus,* whole seed with fragments of strophile (ornamentation above hilum) preserved, SGK.98A.4. D. *L. purpureus* cotyledon showing placement of plumule on inner surface (at lower left), SGK.98A.4. E. *Cajanus* cf. *cajan* cotyledon, showing placement of plumule on inner surface (at top right), SGK.98A.4. F. Intact millet spikelets, with rugose lemma characteristic of *Setaria verticillata,* PDM.4. G. Charred millet caryopses referred to *Brachiaria ramosa,* HLR.98A.6. Scale increments 0.5mm (A-E, G); 0.1mm (F)