Current Status of Archaeobotanical Studies in Harappan Civilization: An Archaeological Perspective

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Received: 18 September 2013; Accepted: 30 September 2013; Revised: 15 October 2013
Heritage: Journal of Multidisciplinary Studies in Archaeology 1 (2013): 118-137

***Abstract**: The paper reviews the notable development in plant economy of the Harappan civilization with cultural development during Early Harappan (3000-2600 BC), Mature Harappan (2600-2000 BC) and Late Harappan (2000-1200 BC) times. The records of crop remains of West Asian, Eurasian, African and indigenous origin from widely scattered sites indicate well-knit trade contacts and socio-economical and cultural integration which kept evolving in new forms during the course of growth and fading of culture in diverse geographical regions. Several new advances in the recovery and analysis of plant remains during the recent past hold out the possibility of obtaining new information which may drastically change our existing archaeobotanical concepts.*

Keywords: Archaeobotany, Harappan Civilization, Double-cropping, Dryland Farming, Palaeoecology, Eastern Region, Southern Region

Introduction

Archaeobotany is a composite discipline, combining botanical knowledge with archaeological materials. The subject matter includes the study of plant remains, such as carbonized and silicified seeds, fruits, wood charcoals, phytoliths, traces of husk or glumes, fibres, imprints on pottery and burnt mud-clods etc. recovered from archaeological settlements during course of excavations. Archaeobotany in India is young and fast-growing field in recent times. Against the earlier sketchy picture, the amount of dataset has grown exponentially, with the systematic collection of carbonized macro-remains by water-floatation technique through active participation in the excavations and routine publication of results as part of site reports.

Study of plant remains of human workmanship, survived in pre- and protohistoric settlements; provide evidences to reconstruct the history of man-plant relationship in the Dark Ages. Owing to the importance of the subsistence economy in the ancient times, focus on agricultural crops was the main field of research. The reports on the food refuse in the form of carbonized seeds and fruits from the Harappan settlements unravelled the history of plant domestication and agriculture. During the early phase of development the archaeological plant remains also attracted the attention of

Professor Birbal Sahni, the founder of Birbal Sahni Institute of Palaeobotany, Lucknow, U.P. Prof. Birbal Sahni (1936), reported some food grains from an Early Historical site at Khokra-Kot, Rohtak District, Haryana and assessed the values of archaeological discoveries for the understanding of early man. Chowdhury and Ghosh (1946) for the first time studied archaeological wood remains from Arikamedu near Pondicherry. Their work on woods which were used to make coffin at Harappa, revealed an interesting data and this widened the scope of charcoal studies in archaeology (Chowdhury and Ghosh, 1951). The development in the archaebotanical studies, to a large extent during last thirty years has been due to some archaeologists, realizing the importance of botanical remains in shaping the economic potential of cultural settlements. This enabled the archaeologists to systematically collect and generate data to reconstruct the agricultural economy and the shifts in the importance of crop plants. Vishnu-Mittre (1969, 1971, 1972, 1974), Savithri (1976), Sharma (1983), Chanchala (1984) and Saraswat (1986, 1991, 1993, 1997) and Pokharia (1998, 2008a, 2008b, 2011) at the Birbal Sahni Institute of Palaeobotany have generated a mass of data on the ancient plant economy. At Deccan College, Pune, Kajale (1974, 1975, 1977a, 1977b, 1979, 1981, 1982, 1984, 1988a, 1988b, 1989) has made significant contribution on the crop economy, particularly in the ancient cultures of peninsular India. Buth *et al*., (1982, 1986) at Kashmir University, Srinagar has accomplished the research work on the cultural plant remains of Kashmir Valley. At present, BSIP, Lucknow is the leading centre where the morphological as well as anatomical details of seeds, fruits, cuticles, fibres and wood charcoals are being studied. The study does not pertain only about the subsistence pattern but to reconstruct the models of ecological potential of the cultural settlements.

In Indian subcontinent at the present moment, a major interest has been on the finds from the Harappan civilization. There are some areas such as Madhya Pradesh, Himachal Pradesh, Bengal, North-east and Kerala, from where either practically no information is available or it is too little to be considered. This is a serious gap in our knowledge which can of course be filled up in due course of time when more promising sites with plant remains are discovered.

The present information on the plant remains from Harappan sites in Indian subcontinent has been synthesized from systematically studied sites. The archaeobotanical dataset is increasingly rich and recent interpretations of it promise to broaden scope and our understanding of the man-plant relationships during Dark Ages. The summary of the finds of food grains from the Harappan sites in northern and southern regions of India is presented in Table I. Evidences suggest that Harappans were also far more sophisticated in their use of plants for vegetable, culinary and medicinal purposes as evident from 3rd millennium BC to second half of second millennium BC.

The Harappan Culture

The Harappan Culture (or Indus Civilization) represents the earliest large scale urbanization in the Indian subcontinent from 3000 to 1500 B.C. Once splendid in its

Table 1: Field-crops from Harappan Sites in Northern and Southern Regions of India

Taxa	Northern Region													Southern Region Kanmer							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Kunal: Early Harappan (3000-2500 BC)	Early-Harappan (2750- 2500 BC) **Banawali**	Mature-Harappan (2500-2000 BC)	Early-Harappan (2300-2000 BC) **Balu**	Mature-Harrapan (2000-1700 BC)	Early–Harappan (2300-2000 BC) **Rohira**	Mature-Harappan (2000-1700 BC)	**Mahorana** (2100-1900 BC)	**Kalibangan** (2000 BC)	**Sanghol** (1900-1400 BC)	**Hulas** (2000-1200 BC)	**Ropar** (2500-1700 BC)	**Mitathal** (2000-1400 BC)	**Laduwala** (2800-2300 BC)	**Tigrana** (2500-200 BC)	**Surkotada** (2000-1800 BC)	**Shikarpur** (2500-2000 BC)	**Rangpur** (2500-1400 BC)	**Rojdi** (2500-2000 BC)	**Kuntasi** (2600-2000 BC)	Early Harappan (2800-2600 BC)	Mature Harappan (2600-2000 BC)	Late Harappan (2000-1700 BC)	**Oriyo Timbo** (1900-1800 BC)	**Babar Kot** (2000-1700 BC)
CEREALS AND MILLETS																				
Hordeum vulgare	+	+	+	+	+	+	+	+		+	+	+				+	+	+		+
Hordeum vulgare var. *nudum*	+	+	+	+		+	+													
Triticum dicoccum	+	+	+																	
Triticum aestivum	+	+	+	+			+	+						+				+	+	+
Triticum compactum	+	+	+		+		+	+												
Triticum sphaerococcum	+	+	+	+	+			+										+		+
Triticum sp.									+	+		+					+			+
Avena sativa								+												
Sorghum bicolor	+	+	+	+				+										+		
Eleusine coracana								+					+	+	+	+			+	+
Pennisetum glaucum																		+	+	+
Setaria italica							+	+						+		+		+	+	
Oryza sativa	+	+	+					+												
Paspalum cf. *scrobiculatum*	+																			
Panicum miliacum																			+	+
Panicum sumatrense															+	+			+	+
LEGUMINOUS CROPS																				
Lens culinaris	+	+	+	+	+		+	+	+	+						+				+
Pisum arvense	+	+	+			+	+	+										+		

Taxa	1	2		3		4		5	6	7	8	9	10	11	12	13	14	15	16	17	18		19	20
LEGUMINOUS CROPS																								
Cicer arietinum	+	+	+		+				+	+	+													
Macrotyloma uniflorum	+	+	+	+	+	+	+			+	+	+	+								+	+		
Lathyrus sativus	+	+			+					+	+								+			+		+
Vigna radiata	+		+	+	+						+										+	+		
Vigna mungo			+								+								+					
Vigna radiata/mungo													+		+								+	+
Vigna unguiculata											+													
Lablab purpureus								+		+														
Trigonella foenum-graecum	+		+				+															+		
OIL-SEEDS/ FIBRES																								
Linum usitatissimum	+															+			+			+	+	+
Sesamum indicum	+	+	+		+					+												+	+	
Brassica juncea		+	+																				+	+
Brassica campestris																			+					
Ricinus communis											+													
Gossypium sp.-cf. *arboreum / herbaceum*	+	+	+								+		+									+	+	
MISCELLANEOUS CROPS																								
Allium sativum					+																			
Cucumis melo	+			+															+					
Citrullus lanatus				+																				
Vitis vinifera	+				+	+		+		+														
Phoenix cf. *dactylifera*	+				+	+						+												
Juglans regia											+													
Prunus amygdalus											+													
Citrus limon	+									+														
Emblica officinalis	+									+														
Terminalia chebula				+																				
Ziziphus mauritiana																			+					
Ziziphus nummularia				+	+												+		+		+	+	+	
Ziziphus sp.													+	+	+			+	+					+
Ficus religiosa											+													
Papaver cf. *somniferum*										+														
Cannabis sativa	+																							

isolation in the Indus Valley (Pakistan), it is now seen to have occupied a much wider area greater than that of the contemporary civilizations of Egypt and Mesopotamia put together, and to have had strong cultural connections to the west at the time of its birth and powerful eastward influence in the later phases. Nearly, a thousand and five hundred sites are spread over a vast area which approximates to one million sq. km, centered on the Indus and Ghaggar-Hakra river systems. This culture extends from Sutkagen-Dore (Western-most of Makran Coast, Pakistan and near the present-day frontier with Iran) on the west and Alamgirpur (Saharanpur District of UP, India) on the east (Possehl, 2002). Its northern most sites at Manda (Jammu and Kashmir, India) and Daimabad (Maharashtra, India) mark the southern boundary (Figure 1). After reaching a fully urbanized state in the nuclear area of Indus Valley, the Harappan culture witnesses an overall disintegration of cities and towns during its expansion and the emergence of small, more nebulous settlements with a phenomenal lack of standards and material economy betraying a bias in favour of rural economy (Saraswat, 1992). The Harappan civilization is marked by high level of technological achievements in town planning and architecture, ceramics, metallurgy, bead styles, terracotta, seals, intensive agriculture, long distance trades, uniform script, and uniform standards of weights and measures. The wealth of archaeological data makes it accessible fully to review the information in the present context of plant economy. The cultural uniformity over such a wide area of Harappan culture leaves no doubt that a stable sociological relationship existed between cities, towns and the rural settlements and in the communities of craftsmen, traders and the agriculturists. Mostly the archaeologists in the past have remained less interested to the botanical source material; therefore, the information on plant economy is rather limited as compared to its wider expansion. The available data on plant remains is summarized under three areas as under:

The Indus Valley in Pakistan

In the nuclear zone of Indus Valley the information on the food economy at Mohenjo-Daro, Harappa, Chanu-Daro, and Pirak is based on the reports by Percival (1921), Stapf (1931), Luthra (1936,1941), Burt (1941), Shaw (1943), Mackay (1943), and Costantini (1979, 1981). The principal food grains consumed by the Harappans have been found as belonging to the species of wheat (*Triticum aestivum, T. compactum* and *T. sphaerococcum*) and the hulled and naked forms of six-rowed barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*). The evidence of rice (*Oryza sativa*) at Pirak, outside the zone of its natural habitat in Ganga Valley, seems in consequence of its dispersal at an early date, owing to the suitable moist conditions in this region. Sesame (*Sesamum indicum*) from Harappa, linseed (*Linum usitatissimum*) from Pirak and field-brassica (*Brassica juncea*) from Chanu-Daro were the main oil-seed crops. A few vestiges of seeds comparable to those of grape (*Vitis vinifera*), melon (*Cucumis* sp) and two faience sealings shaped like date-stone (*Phoenix dactylifera*) indicate the familiarity of Harappans with these fruits. Occurrence of lotus fruit in faience and some earthen-ware vases shaped like a pomegranate (*Punica granatum*) and coconut fruits (*Cocos*

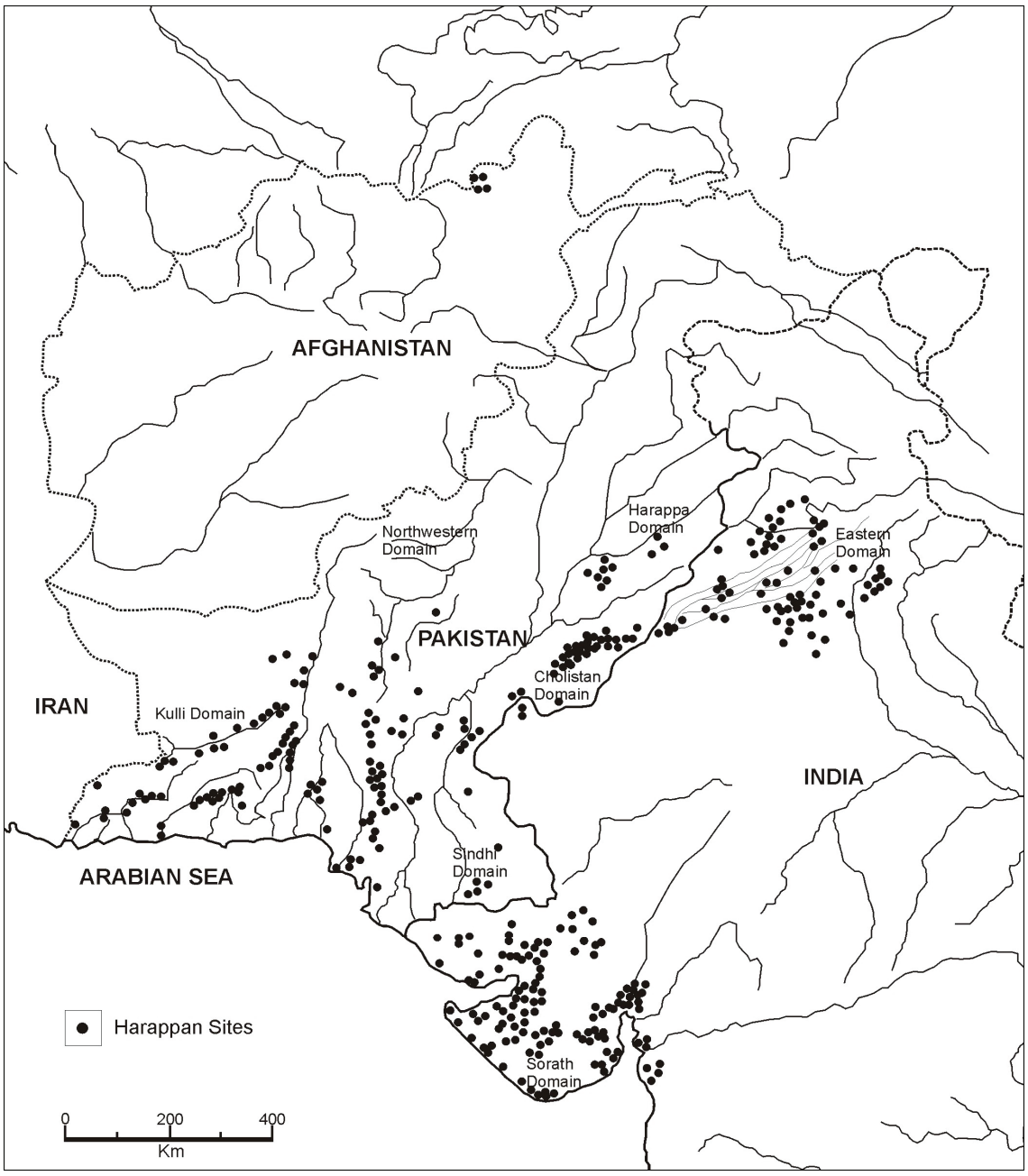

Figure 1: Distribution of Harappan Sites in Domains of the Indus Civilization (Adapted: Possehl 1996, 2002b)

nucifera) also tend to suggest that Harappans knew these fruits (Saraswat, 1992). Since a pendant shaped like lemon leaf, lemon may also not be left out of question in the Harappan economy (Vats, 1941). The cotton fibre found adhering to a silver vase at Mohenjo-Daro was identified as belonging to a coarse variety of *Gossypium arboreum* (Turner and Gulati, 1928). Apart from actual fibre, numerous woven textile impressions were found on faience, vessels, etc. at Mohenjo-Daro and Harappa (Marshall. 1931). The earliest civilization known to have spun and woven the cotton was the Harappan. The cotton textiles in the Indus Valley were the product of a

sophisticated textile-craft (Santhanum and Hutchinson, 1974). Sind was so famous for cotton in the ancient Greek World that its product was called Sindhu (Sindon in Greek). From a figure painted on a pot from Harappa it is seen that *dhoti* was in use. Likewise, the sculpture of a priest or *yogi* from Mohenjo-Daro shows that shawl was used as an upper garment. The presence of needles, buttons, buckles, etc. may conclude that stitching of garments was in practice. The various purposes for which woods were used at Harappa indicate that Harappans must have had experience of this raw material for a pretty long period (Chowdhury and Ghosh, 1951). To make coffins the Harappans used the scented woods of deodar (*Cedrus deodara*) and rosewood (*Dalbergia latifolia*). The Harappans knew the importance of forest wealth of Himalayas and central India for the exploitation of deodar and rosewood respectively. The use of jujube wood (*Ziziphus* sp.) to make wooden mortar for pounding grains indicates their knowledge of the shock-absorbing quality of this timber (Chowdhury, 1970). The faunal remains are also the source of information to know the biological environment prevailing in the Indus Valley. They domesticated cow/ox (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus aegagrus*), horse (*Equus coballus*), elephant (*Elephas maximus*), camel (*Camelus dromedarius*), pig (*Sus scrofa cristatus*), dog (*Canis familiaris*), cat (*Felis catus domesticus*), fowl (*Callus* sp.) etc. (Badam and Sathe, 1991). Statistical analysis by Singh (1983) revealed that domesticated pig played a dominant role in the food economy at Mohenjo-Daro followed by cattle, sheep and fowl. Consumption of meat with the vegetarian diet tends to suggest the balanced carbohydrate and protein contents in the Harappan food economy. Besides, Harappans exploited fish, turtles, stag, sambar, deer, hog deer, spotted deer, chinkara, etc. for obtaining protein-rich diet. A well documented data of botanical and faunal remains presents a picture of a mixed but well settled economy based on crop and animal husbandry, which highlights one of the prominent aspects of economic status of Harappan society.

The Eastern Region

From the lower Indus, this culture moved east and north-east and having come upon the now extinct stretch of Ghaggar-Hakkara (ancient Saraswati), moved upstream and spread in regions of Rajasthan, Punjab, Haryana and western Uttar Pradesh (Dikshit, 1980; Sharma, 1982). The settlers in this region developed their own way of life and became indigenous. Eventhough the pre-Harappan preceded mature Harappan culture; their differentiation is not satisfactorily demonstrated even in Pakistan, much less in India. The pre-Harappan sites in India are much later than those on the lower Indus and they bear the impact of the mature Harappan culture; in the state of cultural amalgam pre-Harappans and Harappans continued to live together for many centuries. Till date a large number of sites have been excavated. However, few sites such as Kalibangan in Rajasthan, Rohira, Mahorana and Sanghol in Punjab, Banawali, Kunal, Balu, and Farmana in Haryana and Hulas and Alamgirpur in western Uttar Pradesh have revealed the data on the plant economy of Harappan culture-complex in the eastern region of the Indus civilization.

Kalibangan, Ganganagar District, Rajasthan on the bank of now dry Ghaggar revealed the Early Indus or pre-Harappan phase, dated from 2450 to 2300 B.C. In this period, no evidence of crop economy is available. However, wood charcoals of *Acacia* sp., *Dalbergia* sp. and *Tectona grandis* have *been* found (Savithri, 1976). The most important is an evidence of ploughed-field surface showing the marks of furrows in two directions at right angle to each other (Lal, 1970-71). Discovery of ploughed-field showing closely spaced furrows in one direction and crossed widely spaced furrows in the other are indicative of mixed cropping which is still in practice in this region. In the closely spaced furrows horse-gram or sesame is grown, intersected by the widely spaced rows of mustard (Allchin and Allchin, 1982). In the following mature Harappan phase, dated about 2000 B.C., food grains of hulled and naked barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*), field-pea (*Pisum arvense*) and chick-pea (*Cicer arietinum*) have been recovered (Vishnu Mittre and Savithri, 1982). Remains of timber taxa exploited by the settlers have been identified as *Calligonum* sp., *Ficus* sp. (*F. glomerata/F. religiosa*), *Dalbergia sissoo, Boswellia serrata, Tamarix dioica, Morus indica, Salvadora persica, Terminalia* sp., *Albizia lebbeck, Acacia* sp., *Anogeissus latifolia* and *Tectona grandis* (Savithri, 1976).

Rohira is situated on Ludhiana-Manerkotla Road in district Sangrur of Punjab. Investigations on the carbonised plant remains from the earliest pre-Harappan occupational phase (ca. 2300-2000 B.C.) revealed the presence of hulled barley (*Hordeum vulgare*), dwarf-wheat (*Triticum sphaerococcum*), emmer-wheat (*Triticum dicoccum*) and jowar-millet (*Sorghum bicolor*). Lentil (*Lens culinaris*) and horse-gram (*Macrotyloma uniflorum*) were among the legumes. Date stone (*Phoenix dactylifera*) and grape seed (*Vitis vinifera*) constituted the important evidence of the fruit remains (Saraswat, 1988). Wood charcoal remains of *Capparis aphylla, Manilkara hexandra, Tectona grandis, Cedrus deodara, Cedrela toona, Lawsonia inermis, Vitis vinifera, Acacia* sp. and *Tamarix* sp. have also been found from the pre-Harappan levels (Saraswat, 1988). In addition to the similar finds of hulled barley, dwarf wheat, emmer wheat, lentil and horse gram, naked barley (*Hordeum vulgare* var. *nudum*) and fenugreek (*Trigonella foenum graecum*) are new additions in the following mature Harappan phase dated to ca. 2000-1700 B.C. (Saraswat, 1986). Wood charcoal remains belonging to *Acacia* sp., *Prosopis spicigera, Tamarix dioica, Dalbergia sissoo, Ziziphus* sp., *Nyctanthes arbor-tristis* and *Vitis vinifera* have also been found from this phase.

Mahorana, about 8 km south-west of Manerkotla in Sangrur District, Punjab (Saraswat, 1991) have revealed the remains of hulled barley (*Hordeum vulgare*), dwarf-wheat (*Triticum sphaerococcum*), club-wheat (*T. compactum*), lentil (*Lens culinaris*), grape (*Vitis vinifera*) and hyacinth bean (*Lablab purpureus*: syn. *Dolichos lablab*) from an early phase of transformation of Baran Culture from the pre- Harappan (Ca. 2100-1900 B.C.). The origin of Baran culture is not very clear, however, its beginning and development appears to be derived from the pre-Harappan traditions. It is also surmised that when the cognate Baluchi Village farming communities descended into the Indus plains, some developed urban Harappan society, while others formed complimentary rural

communities in the Harappan culture-complexes of Punjab and Haryana (Sharma, 1973, 1981; Sharma and Sharma, 1982). Houses in the Baran culture settlements were made of mud-brick walls. Painted motifs on pottery, bull figurines, bangles and beads are other important objects sharing the partial affinities with the Harappans.

Sanghol, a prominent site of Baran culture (Ca. 2000-1400 B.C.) is situated in Ludhiana District of Punjab. Remains of hulled and naked forms of barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*), bread-wheat (*T. aestivum*), club-wheat (*T. compactum*), dwarf-wheat (*Triticum sphaerococcum*), jowar-millet (*Sorghum bicolor*), italian-millet (*Setaria italica*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*), chick-pea (*Cicer arietinum*) and horse-gram (*Macrotyloma uniflorum*) have been recorded. A few seeds of poppy *(Opium* sp.) have also been identified. Fruit remains include grape (*Vitis vinifera*) and emblic myrobolan/anwala (*Emblica officinalis*). These evidences provide the parallels with the typical Harappan economy.

Further eastward there is concentration of Harappan sites in the region of Haryana and western Uttar Pradesh. Information on plant economy from Haryana and Uttar Pradesh based on archaeobotanical studies at Banawali, Kunal, Balu, Farmana, Hulas and Alamgirpur (Saraswat, 1993, 1995; Saraswat and Pokharia, 2002, 2003; Weber *et al*., 2011; Singh *et al*., 2013) is as follows:

Banawali, District Hissar, have brought to light the agricultural economy based on cereals, millets, legumes and oil seeds belonging to hulled-barley (*Hordeum vulgare*), naked-barley (*Hordeum vulgare* var. *nudum*), emmer-wheat (*Triticum dicoccum*), dwarf-wheat (*Triticum sphaerococcum*), bread-wheat (*Triticum aestivum*), club-wheat (*T. compactum*), jowar-millet (*Sorghum bicolor*), horse-gram (*Macrotyloma uniflorum*), field-pea (*Pisum arvense*), lentil *(Lens culinaris*), chick-pea (*Cicer arietinum*), grass-pea (*Lathyrus sativus*), til (*Sesamum indicum*) and field-brassica (*Brassica juncea*) during pre-Harappan phase (2750-2500 BC). The succeeding mature Harappan phase revealed the same kind of crop remains as from the pre-Harappan level. However, rice (*Oryza sativa*), green-gram (*Vigna radiata*), fenugreek (*Trigonella foenum-graecum*), cotton seeds (*Gossypium arboreum/herbaceum*) and date-stone (*Phoenix* sp.) are new records.

The most reckoning evidence of herbal shampoo from early Harappan settlement at Banawali, evidenced by the mixture of soapnut or reetha (*Sapindus* cf. *emarginatus*), anwala (*Emblica officinalis*) and shikakai (*Acacia rugata*), which are universally used even in the present times for shampooing hair, denotes the high standard of hygiene deeply rooted in the prehistory of India.

Kunal, another site in District Hissar, located along the now-dried course of a mighty river Sarasvati was subjected to large scale excavations by the Department of Archaeology and Museums, Government of Haryana, Chandigarh. The excavations have brought to light about 3.10 m thick occupational deposit of Early Harappan Culture, divisible into three sub-periods, named Ia, Ib and Ic. The carbonized remains from sub-period Ia (3000-2850 BC) revealed the presence of hulled barley (*Hordeum*

vulgare) and lentil (*Lens culinaris*). In the subsequent sub-period Ib (2850-2600 BC), rich and varied agricultural economy is evident by the cultivation of hulled barley (*Hordeum vulgare*), emmer-wheat (*Triticum dicoccum*), bread-wheat (*Triticum aestivum*), dwarf-wheat (*Triticum sphaerococcum*), rice (*Oryza sativa*), field-pea (*Pisum arvense*) and oleiferous linseed (*Linum usitatissimum*). It is of considerable importance that the settlers of early Harappan community at Kunal, who were primarily the cultivators of winter crops viz. wheat and barley in their traditional agriculture, included the rice in their crop economy at such an early date. Sub-period Ic, show further advancement in the agricultural economy by the addition of naked barley (*Hordeum vulgare* var. *nudum*), club-wheat (*Triticum compactum*), jowar-millet (*Sorghum bicolor*), green-gram (*Vigna radiata*), grass-pea (*Lathyrus sativus*), horse-gram (*Macrotyloma uniflorum*), chick-pea (*Cicer arietinum*), fenugreek (*Trigonella foenum-graecum*), til (*Sesamum indicum*) and cotton (*Gossypium arboreum/herbaceum*). In addition to these field-crops seeds and fruits of *Ziziphus nummularia* (jujube), *Phoenix* sp. (date), *Emblica officinalis* (anwala), *Cucumis melo* (musk-melon) and *Vitis vinifera* (grape) were also recorded, indicating the importance in the subsistence economy. Besides, large numbers of wood charcoal, weeds and wild taxa have been encountered suggesting prevalence of semi-arid type of climate in the region of ancient Kunal.

Balu in District Kaithal, have revealed the crop economy of settlers during pre-Harappan (2300-2000 BC) and Mature Harappan (2000-1700 BC). The finds of cereals and legumes from pre-Harappan levels include rice (*Oryza sativa*), hulled barley (*Hordeum vulgare*), two forms of wheat; dwarf-wheat (*Triticum sphaerococcum*) and bread-wheat (*Triticum aestivum*), green-gram (*Vigna radiata*), horse-gram (*Macrotyloma uniflorum*). Settlers during this period also used to grow musk-melon (*Cucumis melo*) and water-melon (*Citrullus lanatus*). From the succeeding Mature Harappan level (2000-1700 BC) the remains, are of the same kinds as from the pre-Harappan level. However, naked-barley (*Hordeum vulgare* var. *nudum*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*), chick-pea (*Cicer arietinum*), grass-pea (*Lathyrus sativus*) and til/sesame (*Sesamum indicum*) are new finds. Finds of date (*Phoenix* sp.) and grape-seeds (*Vitis vinifera*), suggest that these fruits were in the subsistence economy. The most important find from the Mature Harappan period at Balu is garlic (*Allium sativum*). The sole record of this Central Asian species in the archaeological context of south and southeastern Asia is to be reckoned with.

Recently, the excavations at Mature Harappan site Farmana, District Rohtak, by Deccan College, Pune in collaboration with Research Institute for Humanity and Nature, Kyoto, Japan has revealed the evidence of barley (*Hordeum vulgare*), bread-wheat (*Triticum aestivum*), dwarf-wheat (*Triticum sphaerococcum*), rice (*Oryza sativa*), jowar-millet (*Sorghum* sp.), proso-millet (*Panicum sumatrense*), green-gram (*Vigna radiata*), horse-gram (*Macrotyloma uniflorum*), lentil (*Lens culinaris*), grass-pea (*Lathyrus sativus*), brinjal (*Solanum melongena*), garlic (*Allium sativum*), ginger (*Zingiber officinale*), turmeric (*Curcuma* sp.) and mango (*Mangifera indica*) (Weber *et al*., 2011).

Hulas in Saharanpur District, Uttar Pradesh has revealed the Late Harappan crop economy, dated from 2000 to 1200 B.C. The assemblage of seeds and fruits includes barley (*Hordeum vulgare*), bread-wheat (*Triticum aestivum*), clubwheat (*Triticum compactum*), dwarf-wheat (*Triticum sphaerococcum*), rice (*Oryza sativa*), jowar-millet (*Sorghum bicolor*), oat (*Avena sativa*), finger-millet (*Eleusine coracana*), cow-pea (*Vigna unguiculata*), lentil (*Lens culinaris*), grass-pea (*Lathyrus sativus*), chick-pea (*Cicer arietinum*), field-pea (*Pisum arvense*), horse-gram (*Macrotyloma uniflorum*), green-gram (*Vigna radiata*), black-gram (*Vigna mungo*), cotton (*Gossypium arboreum/herbaceum*), Kundru (*Coccinia grandis*), walnut (*Juglans regia*), almond (*Prunus amygdalus*), castor (*Ricinus communis*), pipal (*Ficus religiosa*) (Vishnu-Mittre *et aI.,* 1985; Saraswat, 1993).

Alamgirpur, situated in the Meerut district of Uttar Pradesh has revealed hulled barley (*Hordeum vulgare*), naked-barley (*Hordeum vulgare* var. *nudum*), bread-wheat (*Triticum aestivum*), dwarf-wheat (*Triticum sphaerococcum*), rice (*Oryza sativa*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), horse-gram (*Macrotyloma uniflorum*), green-gram (*Vigna radiata*), black-gram (*Vigna mungo*), as the common food plants used by the Harappans (Singh *et al*., 2013).

The Southern Region

The expansion of Harappan culture in the peninsular India covers Kutch, and Saurashtra regions of Gujarat and some hinterland of Maharasthra. In this peripheral zone the Harappan traditions and material culture displayed an independent regional style with the local indigenous hunter and food-gathering communities. The characteristic traditions of Harappans are documented at many sites (e.g., Kanmer, Khirsara, Rojdi, Rangpur, Lothal, Surkotada, Kuntasi etc.), whose material culture and town planning are similar to that of the Indus Valley.

Economy and other technological advancement evidenced in inscribed seals, ceramics, metal work and bead manufacturing, which are typical of mature phase, are known from Gujarat by about 2600 B.C. Lothal and Prabhas Patan were the important seaports. The sea-trade was a major stimulus of Harappan immigration. An expectation of uniformity in the cultural milieu or chronological span has not been observed in this region. Seeds and grains from the archaeological sites for some time until the recent past have casually been reported. A large number of seeds and fruits of the cultivated and wild taxa, useful to humans as a food source, fodder, etc., have been recovered and analysed recently (Wagner, 1983; Weber, 1991; Chanchala, 1994; Reddy, 1994; Pokharia *et al*., 2011).

Rojdi, in District Rajkot, Saurashtra region of Gujarat, is best viewed as a permanent site, almost the size of a town, to give an idea of regional expressions of the mature Harappan phase that was established around 2600 BC. The assemblage of crop plants from Rojdi (2600-1700 BC) includes *Hordeum vulgare, Eleusine coracana, Pennisetum typhoides, Sorghum bicolor, Lens culinaris, Lathyrus sativus, Vigna radiata, Pisum arvense, Linum usitatissimum, Brassica campestris, Echinochloa crus-galli, Setaria italica, Panicum*

miliare. Fruit remains of jujube *(Ziziphus mauritiana)* and cucumber *(Cucumis* sp.) have also been reported. In addition to these crops, a large number of weeds and wild taxa have been identified from Rojdi. Not surprisingly, many species do have economic uses. These seeds in the habitational sites must have come through the direct or indirect human activities. Quite a few might have come from the agricultural fields, along with the crop produce and may give enough indication about the ecological conditions in which the crops fit in.

At Lothal, the husk and spikelet impressions were found on pot-sherds and at Rangpur rice husks, apparently used as binding material for mud-plaster, were found embedded in burnt and partially burnt mud-lumps (Ghosh, 1961; Ghosh and Lal, 1962-63). The identification of these *Oryza* remains as to the wild or cultivated taxa, remained tentative. Fairservis (1979), however, is of the opinion that Harappans during the phase of decline opted for the rice cultivation. Wood charcoal studies show the exploitation of *Acacia* sp., *Adina cordifolia, Albizia* sp., and *Tectona grandis* (Rao and Lal, 1985) Other than *Acacia, Albizia* and *Soymida* Harappans also exploited the timbers of *Azadirachta indica, Pterocarpus santalinus* and *Tamarix* sp., at Rangpur (Ghosh and Lal, 1962-63). Except the *Tectona grandis* (Teak) and *Pterocarpus santalinus* (I.al-chandan), rests are the elements of local dry deciduous forests. Quality wood of teak in its natural distribution occurs at the distance of 100 km in north eastern and eastern direction from Lothal. *Pterocarpus santalinus* (Lal-chandan) is native of eastern Deccan, from the Godavari to Palar River (Brandis, 1971). Highly prized wood of Lal chandan was exploited by the Harappans from this area. Although it's utility can not be demonstrated, but the great use of the wood in old times was for the source of a red *dye-santalin.* It is not soluble in water. Dissolved in alcohol, it dyes cloth a beautiful salmon pink colour. Besides, the wood is excellent for carving work, especially for making idols and other woodwork purposes. Wood charcoal of *P. santalinus* at Rangpur bears considerable cultural significance, as it claims priority to a sound knowledge of efficient wood utilization.

Oriyo Timbo and Babar Kot also in Saurashtra region have revealed the Late Harappan crop economy, dated from 2200 to 1700 BC. The assemblage of seeds and fruits includes finger millet (*Eleusine coracana*), pearl-millet (*Pennisetum glaucum*), Italian-millet (*Setaria italica*), proso-millet (*Panicum miliaceum*), little-millet *(Panicum sumatrense*), and foxtail-millet (*Setaria* sp.) (Reddy, 1994).

From Shikarpur and Surkotada in District Kutch, Gujarat, carbonized seeds have been referred to Bread-wheat (*Triticum aestivum*), finger-millet (*Eleusine coracana*), pearl-millet (*Pennisetum glaucum*), little-millet (*Panicum* sp.), and foxtail-millet (*Setaria viridis*) along with a large number of weeds and wild taxa such as *Amaranthus* sp., *Andropogon* sp., *Brachiaria* sp., *Carex* sp., *Chenopodium album*, *Dactyloctenium aegyptium*, *Digitaria* sp., *Echinochloa* sp., *Eragrostis* sp., *Eriophorum* sp., *Euphorbia pycnostegia, Phragmites karka, Poa* sp., *Polygonum* sp., *Portulaca* sp., *Scirpus supinous, Trifolium repens* etc (Savithri, 1976; Chanchala, 1994).

Kanmer, a multicultural site in District Kutch, has revealed cultural sequence from Early Harappan to Medieval times. A joint venture of Indo-Japan archaeological Research Project (Institute of Rajasthan Studies, Udaipur, Rajasthan, Department of Archaeology, Govt. of Gujarat and RIHN, Kyoto, Japan) has evidenced distinct agricultural strategies, the first involving winter crops (2800-2600 BC) viz. barley (*Hordeum vulgare*), bread-wheat (*Triticum aestivum*), field-pea (*Pisum arvense*) and jujube (*Ziziphus nummularia*), the second for winter/summer crops (2600-2000 BC) viz. barley (*Hordeum vulgare*), wheat (*Triticum aestivum* and *T. sphaerococcum*), rice (*Oryza sativa)*, pearl-millet (*Pennisetum glaucum*), rice (*Oryza sativa*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), green-gram (*Vigna radiata*), horse-gram (*Macrotyloma uniflorum*), sesame (*Sesamum indicum*), linseed (*Linum usitatissimum*), and cotton (*Gossypium arboreum/herbaceum*) and last, the addition by the early 2nd millennium BC of summer drought-resistant crops (*Sorghum bicolor*, *Pennisetum glaucum*, *Setaria* sp.). The cultivation of drought-resistant crops during the Late phase (2000–1700 BC) would have been desirable and advantageous in the prevailing ecological conditions (Pokharia *et al*., 2011).

Dominance of millets during Late Harappan times (2000-1700 BC) in Gujarat region indicates the human adaptation in response to prolonged drought during late Holocene (~4 ka). The amount of annual rainfall in Gujarat is so unpredictable that systems for the control and management of water were probably important factors of Harappan agricultural economies. Where rainfall patterns were favourable and the irrigation possible, both winter and summer crops were grown. In the areas where rainfall was not adequate, millets played an important role in the subsistence strategies. Enormous quantities of seeds of wild grasses, sedges and other species recovered from a number of sites have been used to determine the regional ecological conditions of the Harappan settlements. The conditions in the habitational sites can be easily modified on a large scale, through the human activities. Further, soils of the seasonal tropical environment like that of Gujarat are often highly fertile and can be very productive if they are supplied with sufficient water. Such changes may have entailed development of a tolerance for a wide range of habitat conditions, and consequently a dispersal of the species beyond their natural range. It is, therefore, not always easy to feel sure about the past climatic conditions, on the basis of data obtained from habitational sites.

Discussion and Conclusion

Understanding the interplay between subsistence strategies and settlement patterns is fundamental for elucidation of past economical and cultural changes. The records of crop remains of West Asian (barley, wheat, lentil, field-pea, grass-pea, chick-pea, linseed, fenugreek, grape, pomegranate etc.), Eurasian (Italian-millet, garlic), African (ragi-millet, jowar-millet, bajra-millet, cow-pea) and indigenous (rice, kodo-millet, horse-gram, green-gram, black-gram, Indian mustard, sem) origin from widely scattered sites indicate well-knit trade contacts and socio-economical and cultural integration which kept evolving in new forms during the course of growth and fading

of culture in diverse geographical regions. The areas of the origin of the sesame (*Sesamum indicum*) and castor (*Ricinus communis*) appear unresolved, some favour Africa, while others India. De Candolle (1886) suggested that India might have received sesame from the Far East. Vavilov (1951) considered it to be of polyphetic origins, and the regions in which he considered sesame to have originated were Ethiopia and Central Asia. It is also proposed that sesame could have originated either in Ethiopian region or in peninsular India, or even in both independently (Nayar and Mehra, 1970; Nayar, 1976). Similarly, there is some disagreement regarding the origin of castor (*Ricinus communis*). Castor is reported to run in wild state in the scrubby jungles of the outer Himalayas, suggestive of its origin in Indian region (Watt, 1892; Hutchinson, 1976). Castor is also widespread as a wild plant throughout East and North Africa, the Yemen and the Middle East (Mehra, 2003). The archaeological record from Badarian culture of Egypt during the first half of 4th millennium BC (Arkell and Ucko, 1965) is much earlier to the ancient records in India, during 2nd millennium BC (Saraswat, 1993). *Cucumis melo* (musk-melon) and *Citrullus lanatus* (water-melon) are also African domesticates. *Cucumis melo* is truly wild in eastern tropical Africa and exploded into numerous cultivars in India. *Citrullus lanatus* is reported to be feral in the warmer regions but it is truly wild or native only in the sandy and dry areas of South Africa, mainly in Kalahari Desert (Whitaker, 1976). The earliest civilization known to have spun and woven the cotton was the Harappan. The cotton textiles in the Indus Valley were the product of a sophisticated textile-craft. Cotton (*Gossypium* sp.) comprises thirty tropical and subtropical species in the Old World. *G. herbaceum* race *africanum*, distributed in the savanna vegetation of South Africa was probably first cultivated in Arabia and Syria before finding its way to the Indian subcontinent where *G. arboreum* had differentiated under cultivation in north-western India and Pakistan (Santhanum and Hutchinson, 1974, Phillips, 1976).

So far, the course of social and economic evolution of Harappans in India has increasingly been shaped by cultivation of cereals, pulses and oilseeds, and fibre-crops. Seeds along with the charcoals of grapevine, pomegranate, garlic and hyacinth bean from cultural deposits at Harappan sites provide an unequivocal evidence of horticultural practices. Hyacinth bean (*Lablab purpureus*) from Mahorana is an infallible record of green vegetable cultivation (Saraswat, 1991). Its cultivation indicates that an assured irrigation and high intrinsic soil fertility would have been maintained for growing this vegetable crop. These evidences suggest that the knowledge of horticulture was highly advanced in the Harappan communities of Punjab. Charcoal of *Lawsonia inermis* (heena) and *Nyctanthes arbor-tristis* (parijat) also provide information on the gardening activity of Harappans. Till recent past, there had been no report on the horticultural and gardening practices in the archaeological studies. The most reckoning evidence of herbal shampoo from early Harappan settlement at Banawali, which is used even in the present times for shampooing hair, denotes the high standard of hygiene deeply rooted in the prehistory of India. The recent work has added a new dimension to the economy of Harappans.

Gujarat, on the periphery of the Harappan civilization, has shown distinct agricultural strategies, the first involving winter crops, the second for winter/summer crops, and last, the addition by the early 2nd millennium BC of summer drought-resistant crops. The cultivation of drought-resistant crops during the Late phase (2000–1700 BC) would have been desirable and advantageous in the prevailing ecological conditions. The constant but more gradual change seen in the subsistence system supports hypotheses concerning Harappan subsistence in north-western region on one hand and the potential for new subsistence models particularly in Gujarat, on the other.

Harappan culture is spread in a vast area of about 4,80,000 sq. km. in diverse geographical regions. In spite of the considerable advancement in archaeological work, the knowledge of plant economy of this culture is still inadequate. Future systematic work as well as much better understanding between archaeologists and archaeobotanists, will take us a long way towards a clear understanding of various aspects of the exploitation pattern of floral wealth.

Acknowledgement

We are grateful to the Director, Birbal Sahni Institute of Palaeobotany, Lucknow for providing us facilities to accomplish this work.

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