Archaeobotany and archaeology at Kanmer, a Harappan site in Kachchh, Gujarat: evidence for adaptation in response to climatic variability

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Understanding the interplay between subsistence strategies and settlement patterns is fundamental for elucidation of past economical and cultural changes. Gujarat, on the periphery of the Harappan universe, has distinct regional traditions, including material culture displaying an independent style with the local indigenous hunter and food-gathering communities. Long traditions of the Harappan influence are documented at a number of sites, whose material culture and town planning are similar to those of the Indus Valley Civilization. Thus, Gujarat stands as an important region for understanding larger spheres of interaction during the Harappan period. Two agricultural strategies can be identified at Kanmer, one is based on rabi crops on which the Harappan Civilization was founded, and the second by the addition of kharif crops. This article presents the constant but more gradual change seen in the subsistence system and at the same time supports hypotheses concerning Harappan subsistence in the northwestern region on one hand, and the potential for new subsistence models, particularly in Gujarat, on the other.

Keywords: Archaeobotany, archaeology, climatic variability, double-cropping.

THE Indus or Harappan Civilization located in the northwestern part of the Indian subcontinent, unquestionably appears prominently in the literature as one of the earliest urban civilizations of the ancient world[1,2]. About 1500 sites are known to occur in an ecologically diverse environment throughout the northwestern region. The socio-political, economic and environmental conditions that existed during the Indus Civilization are still debated[3]. The Harappans flourished in Gujarat mainly during the urban phase (2600–1900 BC). The Harappan urbanism is characterized by typical weights, ceramic types, town-planning, seals, a variety of craft specializations and diversified subsistence economy, whereas the Late Harappan is defined by de-urbanization, expansion of settlements into new regions, changes in subsistence systems, etc. The information on archaeobotanical remains in the region under discussion is limited. However, sites[4–7] (Figure 1) like Oriyo-Timbo, Rojdi, Babor Kot, Shikarpur and Surkotada have yielded a number of foodgrains, seeds and fruits of the cultivated and wild taxa, useful to humans as a food source.

The Kanmer Archaeological Research Project (KARP), a joint venture of the Institute of Rajasthan Studies, Udaipur; Gujarat State Archaeology Department, Gandhinagar, and Research Institute for Humanity and Nature, Kyoto, Japan, was initiated for multidisciplinary studies as the site of Kanmer revealed a thick cultural deposit, besides exciting archaeological remains during the surface survey. The first author of this article collected the botanical remains during the course of excavations from 2005–2006 to 2009–2010.

The site and its archaeology

The Harappan site of Kanmer (lat. 23°23′N; long. 70°52′E), also locally known as Bakar Kot, is situated close to the Little Rann, Kachchh District, Gujarat. A hillock which looks like the letter ‘V’ (upside down) is located next to the site, marking the location well from a distance. An ephemeral stream, originating in the truncated pyramid-shaped hillocks and situated northwest of the site, drains the area around the ancient site[8]. According to Rajaguru and Sushama[9], the ‘nullah’ that flows near the site, was probably perennial when the Harappans flourished at Kanmer. The mound is roughly squarish, measuring 115 m (N–S) by 105 m (E–W), and suddenly

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rises up to a height of about 8 m from the ground level (i.e. 20 m amsl). The main mound, being quite high and roughly square on top looks like a small plateau and is visible from a considerable distance (Figure 2). As many as five cultural periods such as Early Harappan, Mature Harappan, Late Harappan, Historic and Medieval have been identified at the site[8,10]. The Early Harappan (KMR-I) cultural deposit is found resting directly on the bedrock in the central part and on a 15 cm thick deposit of virgin soil in the western part. The cultural material is mainly represented by ceramic assemblages, composed of a variety of red ware, bichrome and cream slipped pottery. The shapes are represented by bulbous and spherical jars/pots with averted or externally projecting rims. The urban or mature phase (KMR-II) deposit is represented by characteristic Harappan pottery, seals, seal impressions, terracotta cakes, pot-sherds inscribed with Harappan letters and a variety of beads. The ceramic assemblage is composed of a variety of red ware. Paintings including both geometrical and non-geometrical, have been carried out on the outer surface. A planned settlement was built during this phase, which was secured with a massive and strong fortification. In the second half of the urban phase, new pottery types like white-painted black and red ware (Ahar type) and gritty red ware appeared at the site. The remains of post-urban phase identified as KMR-III (Late Harappan) were found overlying the remains of KMR-II. It appears that they initially used existing rampart but did not maintain it as it was not required then, and finally they raised their houses right on top of the rampart. Thus, there is no cultural discontinuity throughout the deposit of Harappan vintage. Many pottery types of Early and Mature periods continued, but in general the quality of their surface treatment declined and design pattern and shapes changed[11]. After the decline of the Harappans, the site remained unoccupied for about 1600 years, as indicated by a thick layer of dark greyish sandy soil, often loose in composition and devoid of structural remains. The findings of hundreds of drill bits, the unique seal impressions and a few seals were some of the exciting discoveries of the excavation.

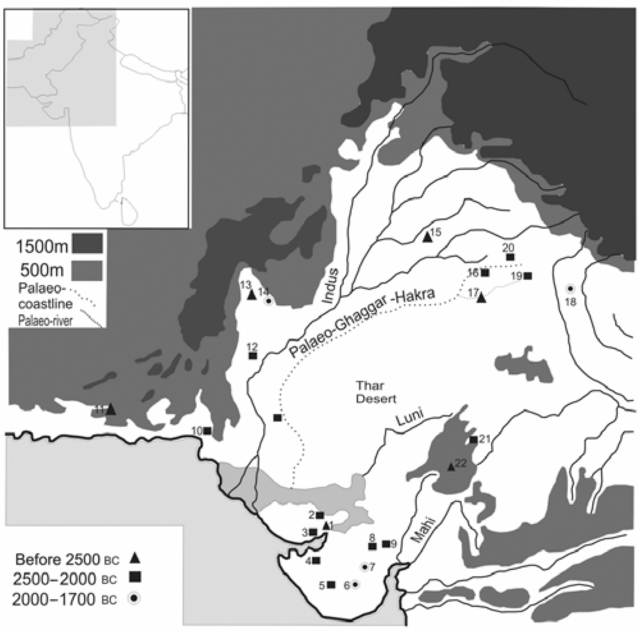

Figure 1. Map of the northwestern part of the Indian subcontinent showing archaeological sites discussed in the text (1) Kanmer, (2) Surkotada, (3) Shikarpur, (4) Kuntasi, (5) Rojdi, (6) Babor-kot, (7) Oriyo Timbo, (8) Rangpur, (9) Lothal, (10) Balakot, (11) Miri Qalat, (12) Mohenjo-daro, (13) Mehrgarh, (14) Pirak, (15) Harappa, (16) Banawali, (17) Kunal, (18) Hulas, (19) Balu, (20) Rohira, (21) Ojiyana and (22) Balathal (modified after Fuller[48]).

Material and methods

The objective of archaeobotanical studies at Kanmer has been to identify what plants ensue in the archaeological record during different Harappan phases, and then finally to use this information in understanding the nature of the subsistence economy and to elucidate spatial and temporal variations in the plant material in response to climatic variability. The retrieval of botanical remains by water floatation technique was undertaken in parallel with the excavations from 2005–2006 to 2009–2010. For floating the cultural sediments near the excavation site water was fetched from a far-flung supply using bullock carts, as there was no water source close to the site. In water floatation, differences in density of organic and inorganic materials are utilized to achieve separation of organic remains from the soil matrix, which greatly enhances both the quality and range of botanical material that can be recovered archaeologically. Soil from the deposits was poured into the body of water in a tub and gently agitated so that light botanical material could be buoyed to the surface and skimmed-off through a 25 mesh geological sieve. Remains were then collected into a cloth, tagged and allowed to dry in the shade. Finally after drying, the material was packed in polythene bags, with archaeological provenience for laboratory study. Floatation allowed recovery of botanical material of all sizes and classes preserved in the sediment, making qualitative and quantitative analysis possible. A large amount of carbonized material was gleaned from well-stratified trenches located in the central, northwestern, northeastern, southeastern and eastern parts of the mound.

The samples consisting of carbonized botanical remains, modern rootlets, shells and charcoal were examined under stereo-binocular microscope. Seeds/fruits were then separated out and placed in vials for further analysis. Charcoal present in almost all the samples was collected (sample-wise) and used for radiocarbon dating, to reconstruct the chronology of Kanmer. Botanical remains (seeds/fruits) have been found in an utterly fragile, highly burnt and mutilated state of preservation. The remains

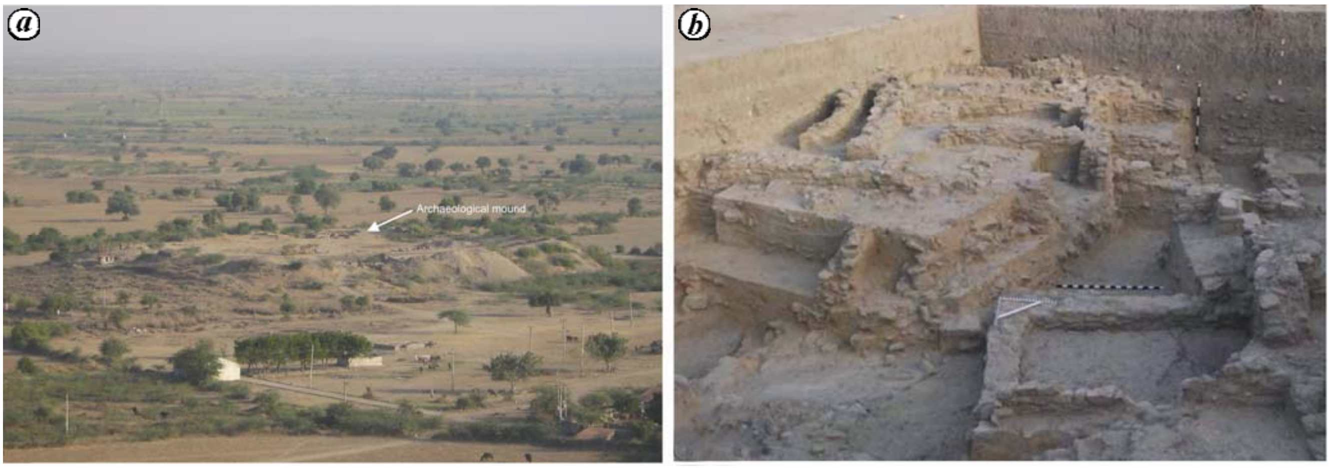

Figure 2. ***a***, General view of the archaeological mound under excavation. ***b***, Residential structures in the central part.

were thereafter cleaned in acid-alcohol (glacial acetic acid 10% + ethyl alcohol 50% in equal volume). The identification is based on the morphological details preserved in the carbonized grains and seeds by comparing with the corresponding parts of the extant plants of the same species. Like artifacts, seeds can also be identified, their spatial and temporal distribution can be determined, and their utility can be inferred[12]. As a result, the systematic collection of archaeobotanical remains supports well-founded inferences about the state of agriculture-based subsistence economy during the Early (2850–2500 BC) and its subsequent development in the Mature (2500–2100 BC) and Late (2100–1700 BC) phases in the Rann of Kachchh.

Radiocarbon dating

In order to reconstruct the chronology at Kanmer, we have so far received 9 radiocarbon dates carried out at Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow and 16 accelerator mass spectrometry (AMS) dates of charcoal and grain samples at Palaeo-Labo Co Ltd, Japan (Tables 1 and 2). Some more AMS dates of grain samples are expected soon to testify their cultural authenticity. These dates appear to support our identification of different cultural periods.

Archaeobotanical evidence and identification

The present data of macrobotanical remains recovered and identified from Kanmer were obtained from 91 out of 103 samples collected till date. Absolute count of plant taxa, ubiquity[13], and Shannon–Weaver index or diversity index (DI)[14] were used to analyse the data (Table 3). Ubiquity is the percentage of samples from which a specific taxon or plant was recovered, whereas DI (Shannon–Weaver index) summarizes data to describe the composition of a plant assemblage. DI was calculated using the following formula.

$$\mathrm{DI} = -\sum (N_X/N_T) \log (N_X/N_T),$$

where N_X is the number of seeds 'X' in the phase and N_T is the total number of seeds in the phase. The morphological description and information related to occurrence and use of these remains are discussed here.

Hordeum vulgare L. emend. Bowden (barley, Figure 3 *a*): All barley grains were carbonized and highly burnt. Grains are either complete/broken. However, more or less all the grains retained features typical of *H. vulgare*. The elongated grain, tapering towards the apex with a widening ventral furrow and a shallow dorsal depression shows maximum breadth in the middle region. Barley, a winter-crop of West Asian origin was one of the staples of the Harappan Civilization[12,15–20]. Barley was already in cultivation during the 7th millennium BC in the archaeological deposits of Period IA at Mehrgarh in the North Kachi Plain of Pakistan[21].

Measurements: L (4.75–5.18) $4.95 \times B$ (2.60–3.24) $2.92 \times T$ (1.40–2.00) 1.85 mm.

Indices: L/B = 1.70 mm, L/T = 2.68 mm, B/T = 1.57 mm.

Triticum sp. L (wheat, Figure 3 *b* and *c*): Grains turned to be a mixture of two types. The short, broad and more or less rounded grains compare in morphological characters with the caryopses of Indian dwarf wheat (*Triticum sphaerococcum*). Whereas the elongated caryopses with deep ventral furrow and hump-like circular area raised on their dorsal side, resemble those of West Asian bread wheat (*Triticum aestivum*). Wheat requires dry, temperate climatic regions. Both were present by the 6th millennium BC in the Baluchistan region of Pakistan, and *T. sphaerococcum* has long been considered as a staple crop of the Harappan Civilization[18,22,23].

Table 1. ^{14}C dates of wood charcoal from Kanmer archaeological site

Trench	Depth (cm)	Layer	Lab ref. no. (BSIP, Lucknow)	^{14}C date (yrs BP)	Calibrated date (BP)	Calibrated date (BC)
Y-30	930	20	BS-2619 (Charcoal)	4190 ± 80	4838–4573	2850–2623
Z-30	942–967	12	BS-3028 (Charcoal)	4630 ± 90	5152–5472	3099–3600
Z-30	900–923	11	BS-3042 (Charcoal)	4750 ± 100	5356–5578	3100–3600
Y-30	307	8	BS-2685 (Charcoal)	4200 ± 120	4825–4531	2875–2581
R-21	466	7	BS-2627 (Charcoal)	3870 ± 100	4344–4262	2470–2149
HH-20	529	4	BS-2699 (Charcoal)	4720 ± 180	5610–5295	3660–3345
Z-18	395	4	BS-3027 (Charcoal)	4660 ± 110	5168–5526	3037–3600
HH-30	280	3	BS-2628 (Charcoal)	3610 ± 90	4080–3735	2130–1785
R-20	320	2	BS-2698 (Charcoal)	4290 ± 80	4956–4827	3006–2877

Measurements (*T. aestivum*): L (3.92–4.82) 4.37 × B (2.50–2.75) 2.62 × T (1.80–2.20) 2.00 mm.

Indices: L/B = 1.66 mm, L/T = 2.18 mm, B/T = 1.31 mm.

Measurements (*T. sphaerococcum*): L (2.95–3.22) 3.08 × B (2.48–2.80) 2.65 × T (2.00–2.20) 2.10 mm.

Indices: L/B = 1.16 mm, L/T = 1.46 mm, B/T = 1.26 mm.

Oryza sativa L. (rice, Figure 3 *d*): Grains, either complete or broken without husk were found. Complete grains are elongate to narrowly oblong, flattened and ribbed. Ribs vary in number. The position of embryo is well marked. Morphologically, they compare with the grains of some cultivated form of rice (*O. sativa*). Husk impression on only two pot-sherds was also noticed in the field. Rice is the crop of Ganga Valley region and its presence in the economy of pre-Harappan, Harappan and contemporaneous Ahar culture (Banas Valley Culture) in the northwestern part of the subcontinent has also been recorded earlier[19,20,24–30]. The evidence of rice at Kanmer was recorded from Mature and Late Harappan phases. However, the two samples of rice grains from both the cultural phases based on AMS date determination at Paleo-Labo Co Ltd, Japan dated to AD 335 (95.4%) AD 425 (PLD-16351) and AD 321 (80.1%) AD 410 (PLD-16353), suggesting the grains may have percolated down and mixed with the older remains due to reworking by the historic and medieval settlers at the site. We need more evidence of rice from Kanmer and other sites in Gujarat to establish its presence in Harappan times. Only future work and more AMS dates will help in understanding the cultivation of rice in this region.

Measurements: L (3.20–4.12) 3.66 × B (1.50–1.96) 1.73 × T (1.00–1.20) 1.10 mm.

Indices: L/B = 2.11 mm, L/T = 3.32 mm, B/T = 1.57 mm.

Pennisetum glaucum (L) R. Br. (bajra millet, Figure 3 *e*): Caryopsis with one end narrow and somewhat tapering and the apex broad and rounded has been recorded from the Late phase. However, single grain was recorded from the Mature phase. This cereal of widespread importance in traditional Indian agriculture was obtained from domestication in Africa[31]. Earlier records in Late Harappan Gujarat (2000–1700 BC) have been reported from Babor Kot[6] and Rangpur[25].

Measurements: L (0.77–1.00) 0.89 × B (0.57–0.72) 0.65 × T (0.40–0.80) 0.60 mm.

Indices: L/B = 1.36 mm, L/T = 1.48 mm, B/T = 1.08 mm.

Sorghum bicolor (L.) Moench (jowar millet, Figure 3 *f*): Carbonized grains, obovate and dorso-ventrally symmetrical have been encountered from the Late phase at Kanmer. Oval–round hilum scar attains almost half the length of the grains. Grains are comparable with those of jowar-millet. Studies based on linguistics, and genetics, place the origin of *Sorghum* cultivation to eastern Africa[9,32]. It is planted as a rabi crop at the end of monsoon and ranks third among cereals in importance and use, after wheat and rice.

Measurements: L (2.94–3.65) 3.30 × B (2.75–3.27) 3.01 × T (1.40–2.00) 1.70 mm.

Indices: L/B = 1.09 mm, L/T = 1.94 mm, B/T = 1.77 mm.

V. mungo (L.) Hepper and *Vigna radiata* (L.) Wilczek (black/green gram, Figure 3 *g* and *h*): Leguminous seeds are somewhat globular to cylindrical. Cotyledons are mostly elongated, with rounded to angular ends. *V. radiata* and *V. mungo* seeds have a number of common characters and even size and shape of seeds overlap. Therefore, the carbonized seeds and cotyledons have been kept under *Vigna* sp. However, on the basis of hilum, if preserved, distinction between the two can be made without doubt. *V. mungo* have a raised hilum with an encircling lip (small portion in Figure 4 *g*), whereas in *V. radiata* hilum is more or less flush with the seed coat surface[33,34]. Green gram/black gram, like rice and horse gram is also an indigenous crop.

Measurements: L (3.78–4.50) 4.14 × B (2.97–4.50) 3.73 × T (2.50–3.50) 3.00 mm.

Indices: L/B = 1.10 mm, L/T = 1.38 mm, B/T = 1.24 mm.

Pisum arvense (L.) Poir (field pea, Figure 3 *n*): The round and smooth seeds with small ovate hilum are comparable to field-pea. *P. arvense*, a West Asian winter crop has also been recorded in the Neolithic economy of Baluchistan[26].

Table 2. AMS radiocarbon dating of charcoal/grains of Kanmer archaeological site

Archaeological provenience (trench/layer/ depth)	Lab ref. no. (Paleo-labo, Japan)	δ^{13}C (‰)	Conventional radiocarbon age (not rounded)	Conventional radiocarbon age (rounded)	Calibrated age (BC)	
					1σ range	2σ range
AA-17/6/3.63m Sample type: Charcoal	PLD-14748	–25.08 ± 0.25	3782 ± 26	3780 ± 25	2278 (22.7%) 2251	2292 (95.4%) 2137
FF-29/3/3.85m Sample type: Charcoal	PLD-14749	–25.50 ± 0.28	3751 ± 27	3750 ± 25	2204 (62.6%) 2134 2077 (5.6%) 2064	2279 (7.2%) 2250 2230 (1.5%) 2220 2211 (68.2%) 2121 2095 (18.5%) 2041
FF-29/3/3.85m Sample type: Charcoal	PLD-14750	–25.54 ± 0.21	3769 ± 24	3770 ± 25	2271 (8.0%) 2259 2206 (60.2%) 2141	2287 (92.7%) 2133 2079 (2.7%) 2061
Z-30/12/9.72m Sample type: Charcoal	PLD-14751	–22.76 ± 0.13	3984 ± 24	3985 ± 25	2564 (37.9%) 2534 2494 (30.3%) 2472	2571 (56.2%) 2513 2504 (39.2%) 2466
Z-30/10/9.04m Sample type: Charcoal	PLD-14752	–24.76 ± 0.13	3935 ± 24	3935 ± 25	2476 (35.6%) 2437 2421 (30.3%) 2404 2379 (20.2%) 2349	2560 (3.2%) 2536 2491 (92.2%) 2341
EE-30/4/4.58 Sample type: Charcoal	PLD-14753	–24.53 ± 0.24	3682 ± 24	3680 ± 25	2132 (44.8%) 2084 2058 (23.4%) 2030	2141 (89.2%) 2011 2001 (6.2%) 1977
Q-28/11/8.00m Sample type: Charcoal	PLD-14754	–25.92 ± 0.29	3896 ± 25	3895 ± 25	2462 (42.4%) 2398 2384 (25.8%) 2346	2467 (95.4%) 2299
Q-28/12/8.20m Sample type: Charcoal	PLD-14755	–26.07 ± 0.14	3866 ± 25	3865 ± 25	2455 (16.2%) 2420 2406 (15.5%) 2377 2350 (36.5%) 2291	2464 (90.4%) 2281 2250 (3.9%) 2231 2219 (1.1%) 2212
Z-28/12/8.91m Sample type: Charcoal	PLD-14756	–25.45 ± 0.20	3873 ± 24	3875 ± 25	2455 (19.0%) 2419 2406 (17.3%) 2377 2350 (31.9%) 2296	2465 (94.9%) 2286 2247 (0.5%) 2243
AA-28/9/788 Sample type: Charcoal	PLD-14757	–11.41 ± 0.22	3809 ± 23	3810 ± 25	2286 (68.2%) 2205	2337 (2.2%) 2323 2308 (86.7%) 2196 2172 (6.5%) 2146
Q-28/13/8.45m Sample type: Charcoal	PLD-14758	–21.25 ± 0.18	3892 ± 24	3890 ± 25	2459 (42.1%) 2391 2385 (26.1%) 2346	2466 (95.4%) 2298
Q-28/11/8.09m Sample type: Charcoal	PLD-14759	–25.29 ± 0.14	3898 ± 22	3900 ± 20	2462 (42.8%) 2402 2382 (25.4%) 2348	2468 (87.9%) 2335 2324 (7.5%) 2301
AA-28/8/7.11m Sample type: Charcoal	PLD-14760	–22.33 ± 0.15	3875 ± 23	3875 ± 25	2455 (20.0%) 2419 2406 (17.7%) 2377 2351 (30.5%) 2298	2464 (95.4%) 2288
Q-28/10/8.03m Sample type: Charcoal	PLD-14761	–25.68 ± 0.17	3886 ± 27	3885 ± 25	2457 (68.2%) 2342	2466 (95.4%) 2292
A-28/12/9.24 Sample type: Charcoal	PLD-14762	–24.22 ± 0.20	3814 ± 24	3815 ± 25	2288 (18.5%) 2267 2260 (49.7%) 2206	2344 (90.6%) 2196 2172 (4.8%) 2146
Y-30/20/9.30m Sample type: Grain	PLD-16352	–24.14 ± 0.12	3882 ± 20	3880 ± 20	2456 (25.6%) 2418 2408 (22.9%) 2374 2368 (17.7%) 2340 2314 (2.1%) 2310	2461 (95.4%) 2298

Macrotyloma uniflorum (lam.) Verdcourt (horse gram, Figure 3 *o*): The seeds are flat, ellipsoidal to somewhat kidney-shaped or reniform. The hilum on the lateral margin of the seed can be seen. It is widely cultivated as a summer crop in India. Not much is known about its wild progenitors, although they were probably native to the sub-savanna or thorny vegetation of the Indian peninsula[34].

Measurements: L (4.30–4.36) $4.33 \times B$ (2.50–2.94) $2.72 \times T$ (1.00–1.50) 1.25 mm.

Indices: $L/B = 1.59$ mm, $L/T = 3.46$ mm, $B/T = 2.17$ mm.

Table 3. Abundance, ubiquity and diversity index of charred remains from occupational phases at Kanmer

	Early Harappan (13 samples)			Mature Harappan (53 samples)			Late Harappan (25 samples)			Diversity Index			
Taxon	Absolute counts	Present in samples	Ubiquity	Absolute counts	Present in samples	Ubiquity	Absolute counts	Present in samples	Ubiquity	Total	Early Harappan	Mature Harappan	Late Harappan
Hordeum vulgare	117	4	30.8	114	26	49.1	7	5	20.0	238	0.06	0.13	0.03
Triticum aestivum	3	1	7.7	10	6	11.3	2	2	8.0	15	0.04	0.03	0.01
Triticum sphaerococcum	0	0	0.0	4	1	1.9	0	0	0.0	4	0.00	0.01	0.00
Oryza sativa	0	0	0.0	12*	4	7.5	83*	3	12.0	95	0.00	0.03	0.13
Pennisetum glaucum	0	0	0.0	2	2	3.8	105	7	28.0	107	0.00	0.01	0.14
Sorghum bicolor	0	0	0.0	0	0	0.0	63	5	20.0	63	0.00	0.00	0.1
Pisum arvense	2	1	7.7	2	2	3.8	0	0	0.0	4	0.03	0.01	0.00
Lathyrus sativus	0	0	0.0	1	1	1.9	0	0	0.0	1	0.00	0.00	0.00
Macrotyloma uniflorum	2	2	15.4	3	1	1.9	6	3	12.0	11	0.00	0.01	0.02
Vigna sp.	2	2	15.4	56	11	20.8	51	14	56.0	109	0.00	0.09	0.10
Linum usitatissimum	0	0	0.0	15	4	7.5	12	3	12.0	27	0.00	0.04	0.04
Sesamum indicum	0	0	0.0	15	4	7.5	14	2	8.0	29	0.00	0.04	0.04
Gossypium arboreum/ herbaceum	0	0	0.0	1	1	1.9	4	3	12.0	5	0.00	0.00	0.02
Trigonella cf. *foenum-graecum*	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Coix cf. var. *lachryma-jobi*	0	0	0.0	0	0	0.0	4	1	4.0	4	0.00	0.00	0.02
Coix cf. var. *monilifera*	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Setaria sp.	0	0	0.0	170	14	26.4	32	11	44.0	202	0.00	0.15	0.08
Trianthema triquetra	0	0	0.0	5	3	5.7	4	2	8.0	9	0.00	0.02	0.02
Trianthema cf. *portulacastrum*	8	4	30.8	165	30	56.6	64	13	52.0	237	0.07	0.15	0.11
Scirpus sp.	0	0	0.0	4	3	5.7	5	3	12.0	9	0.00	0.01	0.02
Solanum sp.	0	0	0.0	4	1	1.9	0	0	0.0	4	0.00	0.01	0.00
Scleria sp.	0	0	0.0	3	2	3.8	4	1	4.0	7	0.00	0.01	0.02
Ziziphus sp.	2	1	7.7	16	14	26.4	10	8	32.0	28	0.03	0.04	0.03
Cyperus sp.	0	0	0.0	2	1	1.9	5	1	4.0	7	0.00	0.01	0.02
Asphodelus sp.	0	0	0.0	32	2	3.8	30	2	8.0	62	0.00	0.07	0.07
Rumex dentatus	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Acacia sp.	0	0	0.0	3	1	1.9	0	0	0.0	3	0.00	0.01	0.00
Citrullus cf. *colocynthis*	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Abutilon sp.	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Cenchrus ciliaris	0	0	0.0	0	0	0.0	1	1	4.0	1	0.00	0.00	0.01
Total	136			639			511			1286	0.2	0.9	1

*Recorded from related cultural phases, but skeptical about time of deposition.

Lathyrus sativus L. (grass pea, Figure 3 *l*): Single seed, somewhat squat and wedge-shaped, appears triangular in cross-view. It is considered to be native to West Asia and is grown as a pulse crop.

Measurements: *L* (2.23) × *B* (2.30) × *T* (2.20) mm.

Trigonella cf. *foenum-graecum* L. (fenugreek, Figure 3 *m*): Single partly broken seed, somewhat oblong with a deep groove between the radicle and the cotyledon in the collection has been identified as *Trigonella* cf. *foenum-graecum*. It is an annual herb indigenous to the countries bordering on the eastern shores of the Mediterranean[35] and also occurs in wild state in the areas of Kashmir and Punjab of the Indo-Pakistan region and also in the upper Gangetic Plain[36]. Fenugreek in Early and Mature Harappan phases has also been recorded at Kunal and Banawali in Haryana, and Rohira in Punjab[15,20,29].

Sesamum indicum L. (sesame, Figure 3 *i*): The carbonized seeds have smooth/faint lines on the surface. Seeds of wild varieties of *Sesamum mulayanum* N.C. Nair found in northern and western India[37] can easily be distinguished from those of cultivated sesame (*S. indicum*) in having reticulate–rugose surface. Recent evidences from Miri Qalat, Baluchistan, Pakistan and northwestern India (Harappan region and Rajasthan), suggest that the cultivation of sesame was more widespread in the subcontinent by the second half of the 3rd millennium BC (refs 19, 20, 30 and 38).

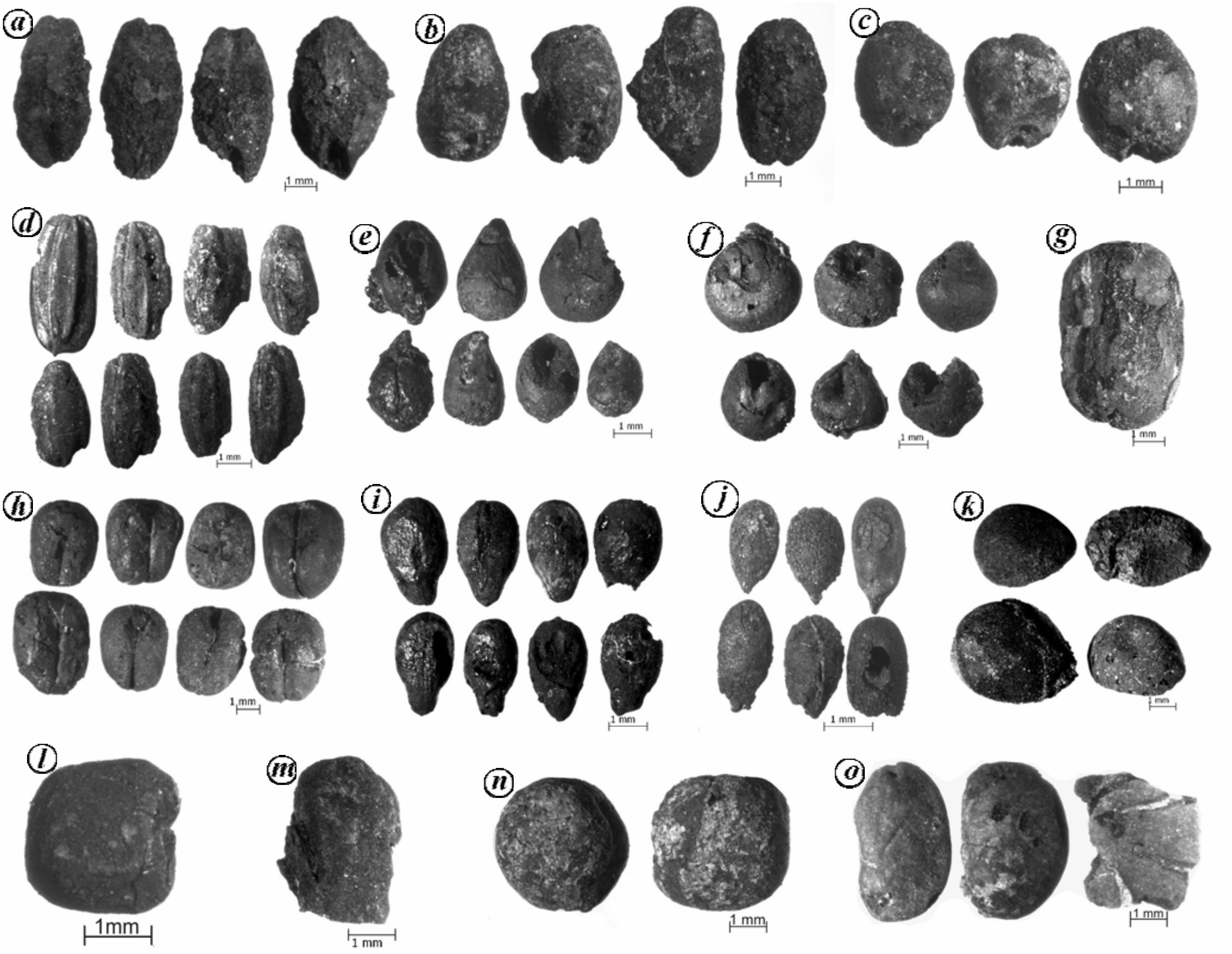

Figure 3. ***a***, *Hordeum vulgare*; ***b***, *Triticum* cf. *aestivum*; ***c***, *Triticum sphaerococcum*; ***d***, *Oryza sativa*; ***e***, *Pennisetum glaucum*; ***f***, *Sorghum bicolor*; ***g***, *Vigna* cf. *mungo*; ***h***, *Vigna* cf. *radiata*; ***i***, *Sesamum indicum*; ***j***, *Linum* cf. *usitatissimum*; ***k***, *Gossypium arboreum/herbaceum*; ***l***, *Lathyrus sativus*; ***m***, *Trigonella* cf. *foenum-graecum*; ***n***, *Pisum arvense*, and ***o***, *Macrotyloma uniflorum*.

Measurements: L (2.50–2.78) $2.64 \times B$ (1.48–1.68) $1.58 \times T$ (1.20–1.30) 1.25 mm

Indices: L/B = 1.67 mm, L/T = 1.12 mm, B/T = 1.25 mm.

Linum cf. *usitatissimum* L. (linseed, Figure 3 *j*): The seeds, all carbonized, are flattish or compressed, elliptic to elliptic–ovate with one end narrower. The apex with a hooked tip was noticed in a single seed from trench AA-28; depth, 7.11 m, layer, 8; however, unfortunately it got devoured while handling with forceps. The slightly curved/broken tip in other seeds can be seen. The morphology of these seeds compares close to *Linum* sp. It is a winter crop requiring moderately high rainfall (>75 cm) or irrigation during this period[5]. It can be sown immediately after the monsoon, in an area having high rainfall or water-retaining clayey soils, or into remaining standing water of harvested rice field[39]. Linseed belong to Near-Eastern group of crops, where evidences of its cultivation go back to as far as those of barley and wheat[40].

Gossypium arboreum/herbaceum L. (cotton, Figure 3 *k*): Seeds having one end rounded and the other end narrow and slightly angular in cross-view have been recorded in the collection. The seed surface is ragged as a result of the distortion of seed coat. Ventral side of the seeds is somewhat flattened and the dorsal side shows bulging. In all morphological respects, the seeds compare with those of cotton, an important fibre-crop grown in Gujarat. Seed-coat remains showing cell pattern on inner side of the testa can be seen. Archaeobotanical records from Mehrgarh (6000–4500 BC), Mohenjo-daro (2600–2000 BC), Balakot (2500–2000 BC), Harappa (2600–1900 BC), Kunal (2500–2000 BC), Banawali (2200–1900 BC) and Hulas (1800–1300 BC) attest its importance in the early development of textile production in the Indus region. Cotton may have grown in parallel with grapes and dates, since pre-Harappan times[18].

Measurements: L (3.83–4.70) $4.26 \times B$ (3.11–3.80) 3.45 mm.

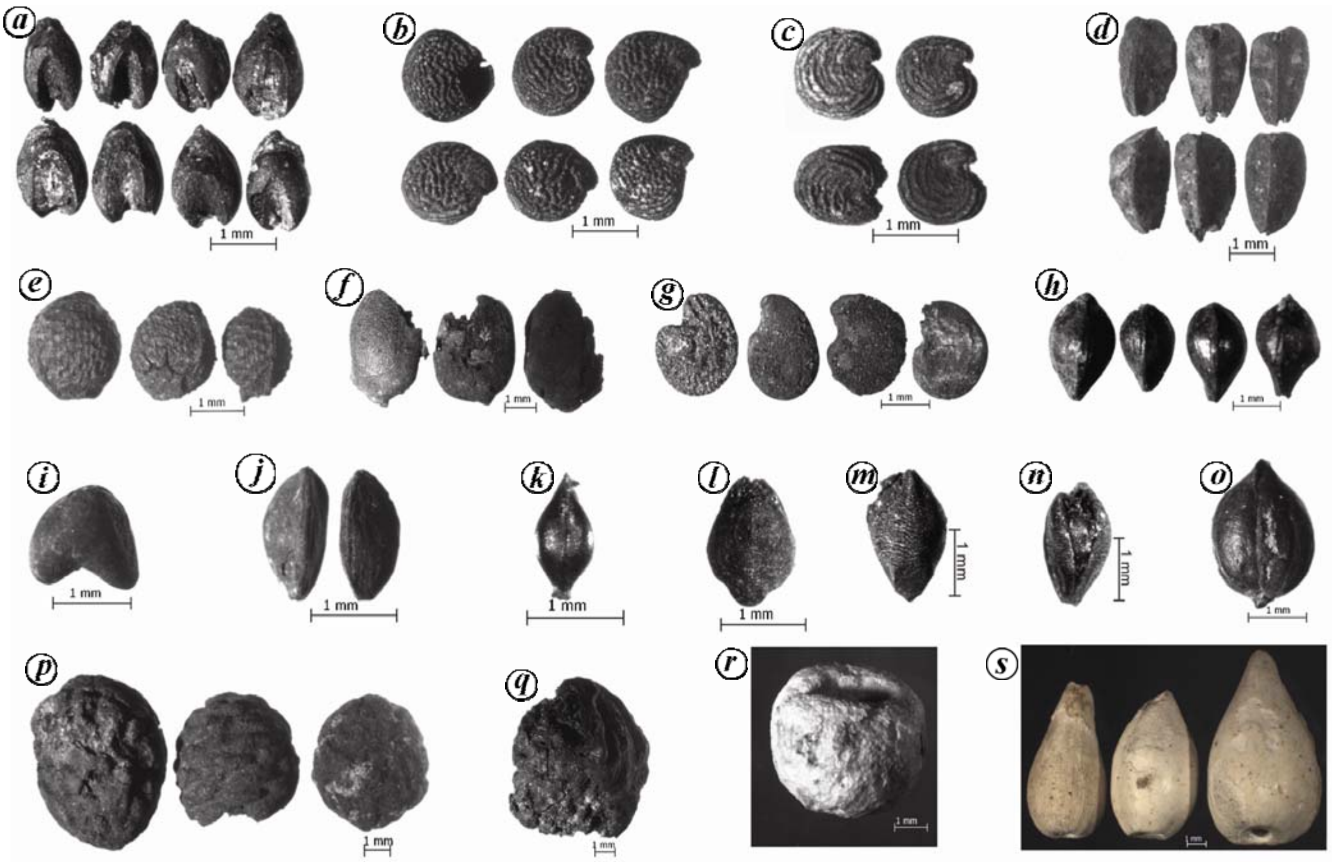

Figure 4. ***a***, *Setaria* sp.; ***b***, *Trianthema portulacastrum*; ***c***, *Trianthema triquetra*; ***d***, *Asphodelus* sp.; ***e***, *Scleria* sp.; ***f***, *Acacia* sp.; ***g***, *Solanum* sp.; ***h***, *Scirpus* sp.; ***i***, *Abutilon* sp.; ***j***, *Cyperus* sp.; ***k***, *Rumex* sp.; ***l***, *Cenchrus* sp.; ***m***, ***n***, *Setaria* sp. (husked); ***o***, unidentified; ***p*** and ***q***, *Ziziphus* cf. *nummularia*, and ***r***, ***s***, *Coix lachryma-jobi.*

Setaria sp. (L) P. Beauv. (foxtail-grass, Figure 4 *a*, *m* and *n*): Small-sized grains have been found in conspicuous amount in a number of samples. The grains are mostly without husk. Grains are ovoid to somewhat oblong. Hilum is conspicuously broad and about one-third to half of the length of the caryopses. Carbonized grains compare with those of *Setaria* grass.

Measurement: L (1.40–1.57) × B (0.88–1.08) mm.

Trianthema portulacastrum L. (santo; Figure 4 *b*): Seeds compressed, orbicular–reniform with prominent wavy ribs, are beaked near the hilum. Seeds closely compare with those of *T. portulacastrum*. It is a common weed in cultivated and waste lands in the arid regions of Kachchh and Saurashtra in Gujarat, and Rajasthan.

Measurements: L (1.50–1.36) × B (1.20–1.30) mm.

Trianthema triquetra Rottle. ex Willd. (lunki, lutanki; Figure 4 *c*): Seeds discoid, with concentric broken undulating raised lines, are characteristically beaked near the hilum. On morphological grounds the seeds closely compare with those of *T. triquetra.*

Measurements: L (0.95–1.02) × B (0.95–1.03) mm.

Asphodelus sp. Cavan (banpiazi, Figure 4 *d*): Triquetrous seeds, pointed more sharply on one end and having sharp ridges. The concave sides are transversely undulated and show a granular surface structure. It commonly occurs as weed of winter crops.

Measurements: L (2.08–2.33) × B (1.29–1.38) mm.

Scleria Berg. (Figure 4 *e*): Nuts, ovoid to globose in shape and having pitted reticulate surface. Remains of deciduous stigma in broken state could be seen. On morphological grounds the nuts are similar to *Scleria* sp.

Measurements: L (1.65–1.96) × B (1.30–1.76) mm.

Acacia L. (babul; Figure 4 *f*): Seeds broken or complete are compressed and sub-orbicular. The faces are marked by faint oval line, more or less concentric with the outline of the seed. In all the morphological features the carbonized seeds exhibit close conformity with seeds of *Acacia* species. Several species of *Acacia*, viz. *jacquemonti* Benth., *leucophloea* (Roxb.) Willd., *nilotica* (L.) Del., *senegal* (L.) Willd., and *pinnata* (L.) Willd. commonly occur in the northwestern region.

Measurements: L (3.32–3.52) × B (2.22–2.56) mm.

Solanum L. (nightshade; Figure 4 *g*): Seeds, discoid in outline with a notch and marginal scar and pitted surface, are comparable to *Solanum* sp., a weed of damp and waste places. Specific identity of the seeds is not possible in carbonized state of preservation.

Measurements: L (1.97–2.12) × B (1.45–1.70) mm.

Scirpus sp. L. (bulrush, Figure 4 *h*): Nuts ovate in outline and varying from triangular or planoconvex to lens-shaped. The presence of blunt or pointed style base in these smooth-surface nuts helps distinguish *Scirpus* from nuts of other Cyperaceae[41]. Sedge is adapted to bogs and marshes as well as saline conditions.

Measurements: L (1.82–2.24) × B (1.20–1.44) mm.

Abutilon sp. (Kanghii, Figure 4 *i*): Single, reniform seed with one end ascending and the other descending, measures 1.42 mm × 1.07 mm ($l \times b$). Surface is faintly tubercled.

Cyperus sp. L. (flat-sedge, Figure 4 *j*): Carbonized nuts, trigonous in shape, measure 1.47–1.50 mm × 0.70–0.74 mm ($l \times b$). Surface shows minute and somewhat papillate cellular markings. On morphological ground, the ancient nuts are comparable to those of *Cyperus* sp. It grows in paddy field and swampy and saline areas.

Rumex sp. L. (dock, Figure 4 *k*): Single nut with smooth surface and angled, measuring 1.25 mm × 0.62 mm ($l \times b$), closely resembles *Rumex* sp. It occurs mostly as weed in moist places such as ditches, channels and bunds of paddy fields.

Cenchrus cf. *ciliaris* L. (anjan-grass, Figure 4 *l*): Single, ovate, hulled caryopsis with rugose surface and arched ventral side is comparable to *Cenchrus* sp. Grains measure 1.48 mm × 1.05 mm ($l \times b$).

Ziziphus nummularia (Burm. f.) W. & A. (jharberi; Figure 4 *p* and *q*): Globose or somewhat oval stones in carbonized state have been recorded in the collection. Pericarp attached at some places shows undulations and unevenness on the surface. These stones have been found comparable to those of jharberi.

Measurements (stones): 7.68–5.00 mm × 6.75–4.42 mm.

Coix lachryma-jobi L. (job's tear, Figure 4 *r* and *s*): Five spheroidal to pear-shaped involucres of *Coix* grass formed from the hard shell-like bracts or metamorphosed leaf sheaths have been encountered[42–44]. *Coix* grows commonly in wild state along water-courses, ditches, etc. and is also cultivated on well-drained highlands during monsoon. Pear-shaped involucres are similar to *Coix lachryma-jobi* var. *mayuen*, whereas spheroidal form compares to those of *C. lachryma-jobi* var. *monilifera*[45].

Discussion and conclusion

The study of plant macro-remains from archaeological sites provides ample information on the activities occurring in a settlement and the existing environment during its occupation[46]. Winter-crop (rabi) agriculture is well attested in the Greater Indus Valley in the 7th millennium BC at Mehrgarh in North Kachi Plain, Baluchistan region of Pakistan during Period IA[21]. However, by the Mature Harappan, there are evidences of well-developed winter/summer agricultural staples grown in lowland areas in and around the Indus Valley[2,12,19,20], as uni-seasonal subsistence strategies involve risk to feed large populations in any given locale, particularly with the yearly variation in climatic conditions that epitomize the particular region[21]. Despite being a region of Harappan Civilization, Gujarat is known to have been a centre for the domestication of local, monsoon-adapted crops, meaning that its agricultural system was different from the multi-cropping system of the Indus Valley due to local ecology, as this region lacks the perennial irrigation by major rivers and agriculture relies on monsoonal rains[5,18,47]. The charred remains from Kanmer reveal how the founder elements of Harappan subsistence existed, along with significant shifts in the plant use with the introduction of new taxa. This article demonstrates how subsistence economy appears to be changing in relation to social and environmental changes over time.

Charred seeds/fruits recovered systematically by water floatation technique from stratified layers embody a number of West Asian, African and indigenous origins. The remains of crop plants of double-cropping system (Table 4 and Figure 3) comprise cereals such as barley (*H. vulgare*), bread-wheat (*T. aestivum*), dwarf-wheat (*T. sphaerococcum*), rice (*O. sativa*), pearl-millet (*P. glaucum*), and jowar-millet (*S. bicolor*); leguminous crops are represented by field-pea (*P. arvense*), grass-pea (*L. sativus*), green-gram/black-gram (*Vigna* sp.), horse gram (*M. uniflorum*) and fenugreek (*T. foenum-graecum*); oeliferous crops include linseed (*Linum* cf. *usitatissimum*) and sesame (*S. indicum*) and fibre crop, represented by cotton (*G. arboreum/herbaceum*) denotes how the settlers at the site adopted and assimilated into their farming practices the different crops, both indigenous and borrowed from other regions.

The earliest occupation (Early Harappan) based on ceramics (Amri wares) and radiocarbon date (BS: 2619, Table 1) was recovered from trench (Y-30) in the central part of the mound during the first season excavation. A total of 125 seeds could be segregated and identified from a single sample of this occupation. About 114 grains of barley (*H. vulgare*), the founder crop in the advent of early agriculture in West Asia along with bread-wheat (*T. aestivum*), and field-pea (*P. arvense*) were encountered from this level, suggesting extension of the winter-crop agriculture from the Baluchistan region[48].

Table 4. Seasonality of plant remains recorded at Kanmer

Plant remains	Cropping season: Winter	Cropping season: Summer
Cereals	*Hordeum vulgare* (barley) *Triticum aestivum* (bread-wheat) *Triticum sphaerococcum* (dwarf-wheat)	*Oryza sativa* (rice) *Sorghum bicolor* (jowar-millet) *Pennisetum glaucum* (pearl-millet)
Leguminous crops	*Pisum arvense* (field-pea) *Lathyrus sativus* (grass-pea) *Trigonella foenum-graecum* (fenugreek)	*Vigna radiata/mungo* (green/black-gram) *Macrotyloma uniflorum* (horse-gram)
Oilseeds	*Linum usitatissimum* (linseed)	*Sesamum indicum* (sesame)
Fibre crop		*Gossypium arboreum/herbaceum* (cotton)
Fruit	*Ziziphus* sp. (jujube)	

Barley was already in cultivation, along with wheat in the 6th millennium BC in the Baluchistan region[49]. In addition, *T. portulacastrum* and *Ziziphus* sp. were also recorded as weeds. Further, more Early Harappan material studied from trenches Z-28 and Z-30 during the fourth season excavation revealed only two broken pieces each of indigenous pulses *V. radiata* (mungbean), which could be of western Himalayan origin, and *M. uniflorum* (horse gram), along with *H. vulgare* (barley). Barley and wheat are the most common cereals recovered from the Harappan sites in the Indian subcontinent. But, these cereals are poorly represented in the Gujarat region either from Harappan or Late/post-urban levels[5–7,21,22,50]. Rojdi and Kuntasi which date to Mature Harappan in Saurashtra region, Gujarat, have also revealed barley and wheat. However, the ubiquitous and dominant species are summer-cultivated millets[5,51].

The quantity of barley at Kanmer in comparison to other crops is to be reckoned with. Barley being dominant makes up over 90% of all seeds recovered from this Early Harappan phase (Figure 5 *a*). However, other winter/summer crops represented in the Early Harappan samples account for less than 10% of the recovered seeds. This definitely shows that the agricultural strategy during the Early Harappan phase was based on cultivation of winter crops which account for 96% of the total seeds. The barley grain from the mixture of total grains from this particular phase dated to (2461 BC (95.4%) 2298 BC) by AMS radiocarbon date determination (PLD-16352) at Paleo-Labo Co Ltd, Japan indicates that some of the grains from the upper layer may have percolated down.

The sign of significant change or diversification in crop economy at Kanmer has in fact been witnessed from the subsequent phase which shows a double-cropping system of winter and summer, such as barley, wheat, field-pea, grass-pea and linseed as winter crops, and rice, bajra, green/black-gram, horse gram, sesame and cotton as summer crops. Agricultural system demonstrates greater range of crop plants, although barley (AMS date: PLD-16354–2469 BC (90.0%) 2335 BC) still appears to be the main crop and accounts for 49% of the total winter/summer crops recovered from this phase (Figure 5 *b*).

The evidences can be attributed to effective moisture during the Early and Mature periods because of significant winter precipitation as well as relatively high summer rainfall, as indicated by studies of sediment cores in the western part of India[52–54]. The anthracological analysis from Kanmer shows that a variety of woods were exploited during this phase and the environment was different from that of the present day. Abundance of riverine species indicates that a river course was probably flowing near the site, suggesting more water than in recent times[55]. Furthermore, the archaeozoological analysis revealed nilgai (*Boselaphus tetracamelus* Pallas) and four-horned antelope (*Tetracerus quadricornis* Blainville), which prefer woodland habitats[56]. Antelopes do not live very far from water courses[57]. Finally, the geological studies support the presence of higher water table around the ancient site[9].

The post-urban phase (KMR-III) represents a continuation of the urban-phase ceramics traditions, a year-round occupation, similar to present-day cultivation, except for rice. However, the evidence of winter-oriented cultivation in the Late phase is meagre in comparison to preceding occupational phases. Barley occurs prominently in KMR-I and KMR-II, but declined in KMR-III and accounted for only 2% of the total crop seeds. In contrast, millets (38%) and rice (24%) predominate in the Late Harappan (Figure 5 *c*). Although the winter cultigens can be seen in the record, the climatic conditions may have limited their cultivation. The new cropping system may have not been accepted merely for the reason that it became available somewhere through their contacts, but would have also been desirable and advantageous to them in their ecological situations. Dominance of millets and rice, which are significant as summer monsoon-adapted crops in contrast to the winter crops during the Late phase, gives an impression that these are the result of the Harappan agriculture

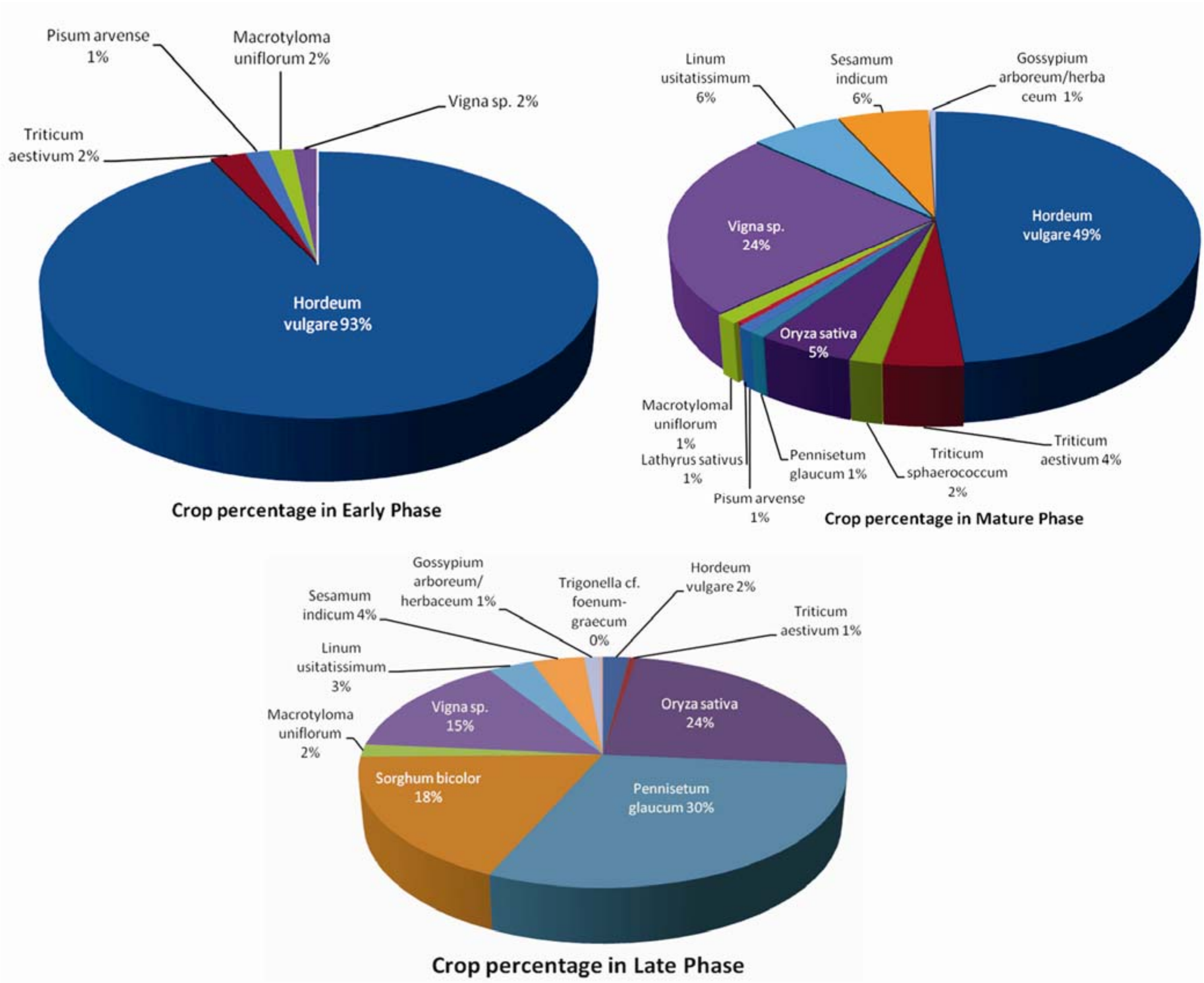

Figure 5. Percentage of crop taxa found at Kanmer during different phases.

practices in which the control and management of water for irrigation might have been the important factor in the Rann of Kachchh. It is likely that the millets supplemented rather than replaced earlier subsistence practices and played an important role in the food production systems in this phase.

This region lacks a major river for irrigation and instead relies on monsoon rains. As a result, in areas where rainfall was encouraging and the irrigation was possible, both winter and summer crops were grown. Millets also recorded from Oriya Timbo, Rojdi, Surkotada, Sikarpur, Babor Kot and Rangpur in Gujarat indicate that the cultivation of drought-resistant summer crops played an important role in the subsistence strategies during the Late Harappan[4–7,25]. The dataset at Kanmer during the Late Harappan phase also shows similarity with other Late Harappan sites in Gujarat. These drought-resistant crops show shift in the dependence on existing species, suggesting a warmer or drier climate, as SW monsoonal activity decreased considerably during this phase in Gujarat[58]. Adverse climatic conditions due to declining monsoon might have provided suitable conditions for these crops in Gujarat[5].

Macrobotanical remains of rice have been wanting in the Gujarat region prior to the Kanmer excavations. Excavations have revealed evidence of rice both from urban and post-urban phases, but the AMS dates of two samples dated to AD 335 (95.4%) AD 425 (PLD-16351) and AD 321 (80.1%) AD 410 (PLD-16353), suggesting the grains might have percolated down and mixed with the older remains due to reworking by the historic and medieval settlers at the site. We need more evidence and AMS dates before establishing rice cultivation during the Harappan times. However, presence of husk impression found on pot-sherds at Lothal and embedded in burnt and partially burnt mud lumps at Rangpur[24,25] supports rice in this region. Furthermore, phytoliths from glumes and leaves from sediments dated to 2200 BC at Harappa confirm the presence of rice in the northwestern part of the Indian subcontinent[59,60]. Charcoal pieces from the same stratum from which rice grains were encountered in trench R-21 during first season excavations dated to 2470–2149 BC (Table 1, BS-2627).

A recent report on plant remains from Ojiyana in adjacent Rajasthan indicates the presence of rice since the beginning of culture, suggesting localized cultivation in western India by 2500–1500 BC (ref. 30). Earlier evidence of cultivated rice by 2850–2200 BC, beyond its probable wild zone, has been recorded at the Early Harappan Kunal, Banawali and Balu in Haryana[19,20,29,61,62] as well as by the 3rd millennium BC in the Swat Valley of Pakistan[26,27], which must have diffused from its natural habitat in the Ganga Valley to the northwest through cultural contacts. Keeping in view the presence of rice in the Indus zone, the possibility of rice cultivation during the post-urban phase in Gujarat cannot be ignored. Future work and more AMS dates can resolve the phenomenon of rice introduction and timing in this part of the subcontinent.

Job's tear (*Coix lachryma-jobi*), a pseudo-cereal native to SE Asia, known from a number of Neolithic–Chalcolithic sites in the Gangetic region, might also have diffused along with rice from this region. It grows along water-courses, ditches, etc. Occurrence of *C. lachryma-jobi* has also been reported from Kuntasi, Gujarat and Balathal and Ojiyana, Rajasthan[30,51,63]. Job's tear is thought to be an older domesticate than rice and at present it is rather a minor cereal, having been replaced to a great extent by rice cultivation.

Another minor cereal, *Setaria* sp. has also been recorded at the site. The abundance of *Setaria* grains suggests that they did not arrive only as contaminants, but were gathered or stored from the crop harvested. *Setaria* might have been cultivated in association with rice and job's tear. The practice of mixed cultivation, in which small-seeded millets and pulses to large-seeded job's tear are cultivated along with rice is reported from SE Asia[64].

Cultivation of oil-yielding crops at this site is evidenced by *Sesamum* and *Linum* cf. *usitatissimum*. It is well known that sesame and field-brassica were grown by Harappans in the Indus Valley. The cultivation of *Sesamum* was well established in northwestern India by the time of Harappan Civilization and had spread west to Mesopotamia before 2000 BC (ref. 65). Recent archaeobotanical evidence from the Harappan site of Miri Qalat in Baluchistan, places the sesame finding dating back to the Mature Harappan[38]. Sesame has also been reported from Harappan sites in Punjab and Haryana dating back to the Early to Late Harappan[20,59,66]. Linseed belongs to the Near Eastern group of crops, where evidences of its cultivation go back to as far as those of wheat and barley[40]. Archaeobotanical evidence in the Indian region goes back to the Early Harappan (2850–2600 BC) at Kunal, Haryana[20].

Cotton (*G. arboreum*/*herbaceum*) occupied the foremost place among commercial crops of the Harappans. According to Sanathanam and Hutchinson[67], cotton textile in the Indus Civilization was the product of 'sophisticated textile-craft'. Apart from actual fibre[68], numerous woven textile impressions were found at Mohenjo-daro and Harappa[69]. Evidence of cotton seeds and impressions of cloth-fragments on pot-sherds at Kunal, Haryana[20] and now at Kanmer, draws our attention towards economic transformation and about the nature of agriculture. Thus, non-staple food plants may have acted as commodities of trade and united communities together, that promoted the emergence of food production.

The archaeobotanical evidences from this study indicate crops of indigenous, West Asian and African origins in all likelihood occupied a place in the diet of the settlers. Finally, the purpose of this article was to identify the types of changes that were taking place in subsistence from 2800 to 1700 BC. The shift in plant-use strategies of new plant taxa which were not used in this region, may be seen as an adaptation to climatic variability during the Late Harappan.

The high number of weeds and wild taxa associated with these crops reveal that they were cultivated by the site occupants. Majority of weeds and wild taxa (Figure 4) in healthy state of preservation permitted safe identification to the species of *Setaria* sp., *T. triquetra*, *T. potulacastrum*, *Abutilon* sp., *A. tenuifolius*, *Scleria* sp., *Trianthema* sp., *Scirpus* sp., *Rumex* sp., *Cyperus* sp., *Cenchrus* sp., *C. lachryma-jobi*, *Acacia* sp., *Solanum* sp. and *Z. nummularia*. These remains are only a fraction of the biological material. Therefore, reconstruction of the environment cannot be attempted at present only on the basis of them alone. However, on the basis of the evidences it is possible to reconstruct what the surrounding habitat may have looked like around the settlement. Weeds of frequent occurrence around the settlement, in the crop fields, ditches, along water-courses and moist places, such as *R. dentatus*, *Cyperus* sp., *Scirpus* sp., *Scleria* sp., *Trianthema* sp., *Asphodelus* sp., *Cenchrus* sp., *Solanum* sp. and *C. lachryma-job*[45,70,71] may have turned up in the collection with/without human interference, or as an admixture with crop remains. Ephemeral growth of these grasses, sedges and herbs follows the rain and may be regarded to subsist in the well-watered and marshy areas around the ancient settlement. Xeric elements, such as *Ziziphus* sp., *Abutilon* sp. and *Acacia* sp. may have turned up unintentionally. Fruit remains of *Ziziphus* sp. may be regarded to have been collected by the settlers for consumption.

The variability in agricultural production at Kanmer can be linked to cultural change in relation to environmental conditions from time to time. Kanmer can be seen as one of the sites where relationship between agriculture and cultural change can be addressed.

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ACKNOWLEDGEMENTS. A.K.P. thanks the Director of BSIP, Lucknow for encouragement, support and permission to join Indo-Japan Kanmer Archaeological Research Project. We thank Carlos A. Lehnebach, New Zealand for help and guidance in relation to taxon ubiquity and diversity index during the course of study and the members of the Radiocarbon Dating Laboratory at BSIP, Lucknow and Paleo-Labo Co Ltd, Japan. We also thank Hansmukh Seth, Rajesh Meena, Suresh Meena, K. P. Singh, Sameer Vyas, Asif Hussain, Hitesh Bunkar and Ajit Singh for collecting data during excavations and the anonymous reviewer for his valuable comments and suggestions that helped improve the manuscript.

Received 8 December 2010; revised accepted 5 May 2011