
Archaeobotanical remains in ancient cultural and socio-economical dynamics of the Indian subcontinent

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The paper describes the ancient plant economy in the Indian subcontinent in a chronological framework of cultural development from the earliest Neolithic cultures of primitive village-farming communities to highly advanced Iron Age cultures of Early Historical Period around the beginning of the Christian Era. In an impressive array of archaeobotanical data generated during the last four decades, some of the salient developments include the earliest evidence of west Asian cereal cultivation dated to C. 7,000 B.C., in Neolithic Baluchistan, Pakistan, and the earliest evidence of rice cultivation during sixth millennium B.C. in the Middle Ganga Valley, India. Similarly, other notable developments sifted from the data include the viticulture and cultivation of some garden plants by the Harappans in Punjab and evidences of highly systematised and rational medicinal plants from the Iron Age cultures in Ghaghra Valley of eastern Uttar Pradesh deciphering the meaningful perspective of medicinal history in the Indian archaeological context. Throughout the cultural development from Harappan times to the end of first millennium B.C. the records of crop remains of West Asian, 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 heterogeneous cultural groups 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 informations which may drastically change our existing archaeobotanical concepts.

Key-words—Archaeobotany, Ancient plant economy, Neolithic, Chalcolithic, Harappan Culture, India.

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सारांश

भारतीय उपमहाद्वीप की प्राचीन सभ्यता एवं सामाजिक-आर्थिक प्रगति से सम्बद्ध पुरातत्वव्यवस्थागत अवशेष

कृपा शंकर सारस्वत

इस शोध-पत्र में भारतीय उपमहाद्वीप में प्राचीनतम नवपाषाणी सभ्यता से लेकर ईसा के जन्म के आस-पास की अत्यन्त विकसित लौह-युग सभ्यता तक की प्राचीन पादप अर्थ-व्यवस्था की क्रमबद्ध विवेचना की गई है। पिछले चार दशकों में उपलब्ध महत्वपूर्ण आँकड़ों से कई तथ्य उभर कर सामने आये हैं इनमें लगभग 7,000 वर्ष ई०पू० नवपाषाणी बिलोचिस्तान (पाकिस्तान) में पश्चिम एशियाई अनाज उत्पादन तथा भारत में मध्य गंगा घाटी में लगभग 6,000 वर्ष ई०पू० धान की खेती के प्राचीनतम प्रमाण उल्लेखनीय हैं। इसी प्रकार पंजाब में हड़प्पा कालीन मानव द्वारा अंगूर की खेती एवं उद्यान से सम्बद्ध कुछ पौधों का उगाना तथा पूर्वी उत्तर प्रदेश में घाघरा घाटी की लौह युग सभ्यता से औषधीय पौधों के प्रमाण भी महत्वपूर्ण हैं। हड़प्पा कालीन संस्कृति से अत्यन्त विकसित लौह युग तक की प्रगति से सम्बद्ध पश्चिम एशियाई, अफ्रीकी एवं स्थानीय उद्भव के फसली अवशेषों से व्यक्त होता है कि विभिन्न भौगोलिक क्षेत्रों में इन सभ्यताओं में सुनियोजित पारस्परिक व्यापारिक, सामाजिक-आर्थिक और सांस्कृतिक सम्बन्ध रहे हैं। यह भी सम्भव है कि हाल में किये गये अनुसंधान से उपलब्ध नयी जानकारी से वर्तमान पुरातत्व-व्यवस्थागत विज्ञान के क्षेत्र में आमूल परिवर्तन हो सकते हैं।

STUDY of the scanty plant remains of human workmanship, survived in pre- and protohistoric settlements, provides evidences to reconstruct the history of man and plant relationship in the Dark Ages. The cultural models of plant remains in European archaeology have dominated the thoughts and speculations for about 125 years, yet we have to look only at relatively recent events beginning with

the discovery and excavations of sites of Harappan culture in the Indus Valley, from 1921-22 to 1946-1947. Owing to the importance in the subsistence economy in the ancient times, centrality of agriculture was the main field of research. The

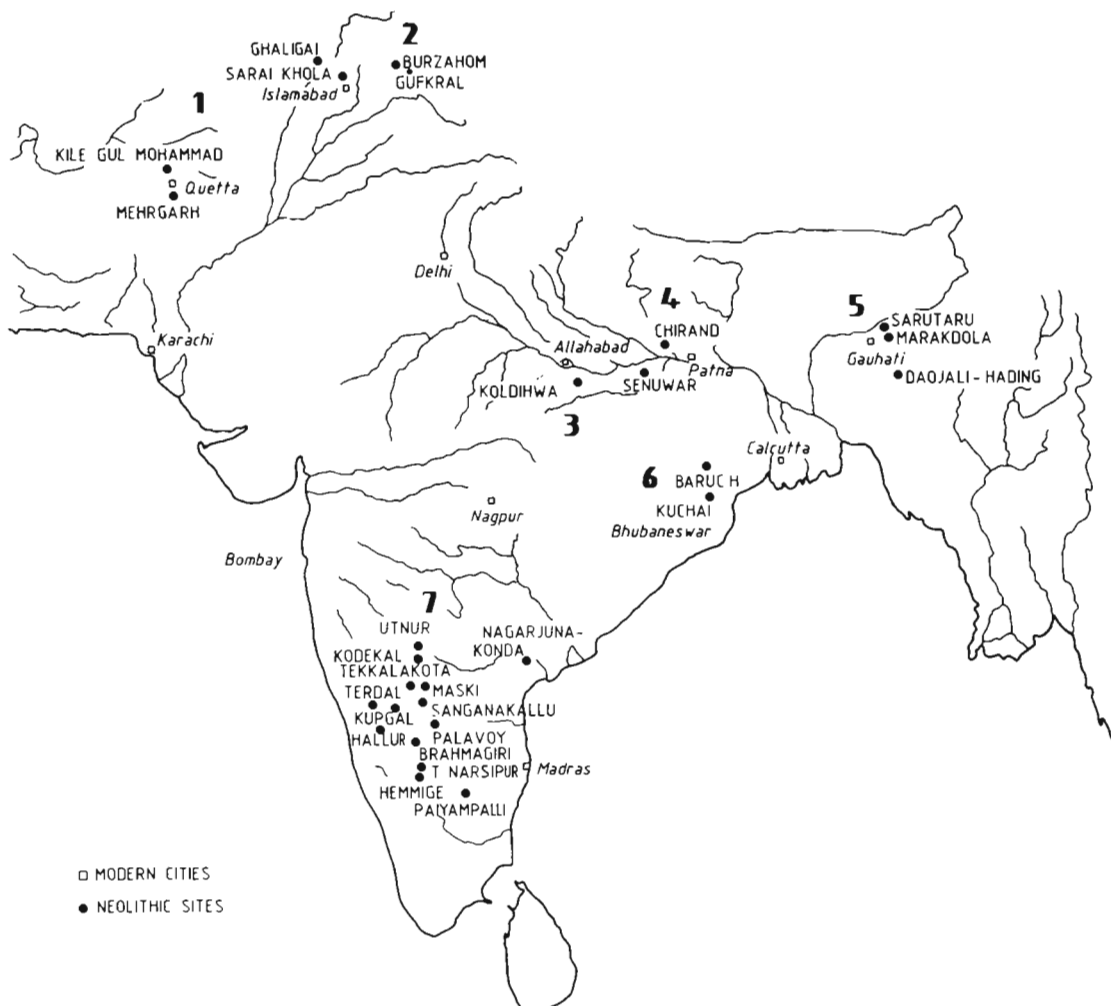
reports on the food refuse in the form of carbonized seeds and fruits from the Harappan settlements unravelled the history of plant domestication and agriculture. During this early phase of development the archaeological plant remains also attracted the attention of Professor Birbal Sahni. In 1936, he 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, during the period which constitutes a link between the time scales of the geologists on one side and of the prehistoric archaeologists on the other.

It was in 1946 that Chowdhury and Ghosh for the first time studied archaeological wood remains from Arikamedu near Pondicherry. In 1951, their work on woods which were used to make coffin at Harappa, revealed an interesting data and this widened the scope of xylotomical studies in archaeology. Vishnu-Mittre and his students—Savithri (1976), Sharma (1983) and Chanchala

(1984) at the Birbal Sahni Institute of Palaeobotany generated a mass of data on the ancient plant economy. At Deccan College, Pune Kajale made significant contribution on the crop economy, particularly in the ancient cultures of peninsular India. No work was done by them on the anatomical studies of archaeological material. Butth and his students at Kashmir University, Srinagar have accomplished the research work on the cultural plant remains of Kashmir Valley.

At present, Birbal Sahni Institute of Palaeobotany 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.

During the period of last four decades, as a result of increasing interest of archaeologists and botanists in each other's spheres of activity, a rich data has been gathered on the ancient plant



Map 1—Shows seven zones of Neolithic Culture.

economy. In India and Pakistan at the present moment, a major interest has been on the finds from the early farming communities, alternatively termed as Neolithic cultures, some of them as early as 6,000-7,000 B.C. The bulk of the plant remains in most of the sites consists of carbonized seeds and fruits. Moreover, for various sites only preliminary results are published. The dissimilarity in the available information on plant husbandry at the individual sites is a handicap to carry out comparative study.

Differences in the plant assemblages established between sites may be an artifact in sampling methods or due to the nature of evidence. To compare the data on various sites with a view towards establishing possible developments in the crop husbandry over a larger area, it is necessary to have well-dated information.

Archaeobotanical information on available data falls short in terms of both quantity and quality. The role of plant economy in relation to the exceedingly



Map 2—Important sites of Harappan and other copper and iron-using cultures.

broad aspect of socio-economy and cultural evolution of widely scattered ancient settlements is a challenging study (Maps 1, 2). There are some areas such as Assam, Arunachal Pradesh, Bengal, Kerala, Himachal Pradesh and Haryana, 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 course of time when more promising sites with plant remains are discovered. Important sources of information have been cited and coverage of references of many inconclusive and fragmentary reports is regretfully omitted. Some have only been touched upon. Summary of the finds of food grains from the ancient Neolithic times to the Early Historical cultures in different regions is presented in Table I. The present information on plant remains has been synthesized from well-settled farming

communities. The data on the origin of agriculture is still insufficient. The domestication and cultivation of plants and taming of animals developed step-by-step out of food-gathering and hunting stage. It is an outcome of the continuing increase in the extent and intensity of manipulation of natural ecosystems by the Stone Age man. Under the circumstances, it is quite difficult to fix a point when the phenomenon of agriculture actually started. Future research in this direction would likely throw some light on this issue.

NEOLITHIC BEGINNING

The plant and animal domestication was a fundamental adaptive element which contributed to the emergence of permanent sedentary settlements of Neolithic Culture which is characterized by mud

Table 1—Archaeological record of field-crop plants in the Indian subcontinent

TAXA	NEOLITHIC CULTURE					EARLY CHALCOLITHIC CULTURE	HARAPPAN CULTURE	CHALCOLITHIC CULTURE		IRON-AGE CULTURE		
	1 Baluchistan, Swat & Upper Sind in Pakistan (Ca. 7,000-2,920 B.C.)	2 Kashmir, India (Ca. 2,600-1,500 B.C.)	3 Central Gangetic Plain (Ca. 6,570-5,440 B.C.)	4 Bihar (Ca. 2,000-1,200 B.C.)	5 South India (Ca. 2,450-1,000 B.C.)	6 Baluchistan & Afghanistan (Ca. 5,500-1,000 B.C.)	7 Indus Valley in Pakistan & North-Western India (Ca. 2,500-1,200 B.C.)	8 Gujarat & Maharashtra (Ca. 2,500-1,400 B.C.)	9 Gangetic Plain (Ca. 2,000-800 B.C.)	10 Rajasthan, Madhya Pradesh & Maharashtra (Ca. 2,200-800 B.C.)	11 Northern Plains (Ca. 1,100-200 B.C.)	12 Peninsular India (Ca. 1,000-50 B.C.)
<i>Oryza</i> L.*						+	+	+			+	
<i>Oryza rufipogon</i> Griff. (Wild Perennial Rice)			+	+			+	+	+	+		
<i>Oryza nivara</i> Sharma et Shastri (Wild Annual Rice)			+									
<i>Oryza Sativa</i> L. (Cultivated Rice)		+	+	+		+	+		+	+	+	+
<i>Aegilops speltoides</i> Tauscl. (Spelt grass)						+						
<i>Aegilops tauschii</i> Coss. Syn. <i>Triticum tauschii</i> (Coss.) Schmal. (A wild grass)						+						
<i>Triticum monococcum</i> (Einkorn Wheat)	+					+						
<i>Triticum dicoccum</i> Schubl. (Emmer Wheat)	+					+	+					
<i>Triticum durum</i> Desf. (Hard Wheat)	+					+						
<i>Triticum aestivum</i> L. emmend. Thell. (Bread Wheat)	+	+		+		+	+		+	+	+	+
<i>Triticum compactum</i> Host. (Club Wheat)	+	+				+	+		+	+	+	

Contd.

Table 1—Contd.

	1	2	3	4	5	6	7	8	9	10	11	12
<i>Triticum sphaerococcum</i> Perc. (Dwarf Wheat)	+	+		+		+	+		+	+	+	
<i>Hordeum spontaneum</i> C. Koch. (Wild Barley)	+											
<i>Hordeum distichum</i> L. (Two-row hulled Barley)	+					+						
<i>Hordeum vulgare</i> L. emmend. Bowden. (Six-row hulled Barley)	+	+		+		+	+	+	+	+	+	+
<i>Hordeum vulgare</i> var. <i>nudum</i> L. emmend. Bowden. (Six-row naked Barley)	+					+	+					
<i>Eleusine coracana</i> (L.) Gaertn. (Finger millet/Ragi-millet)				+	+		+	+		+	+	+
<i>Echinochloa crus-galli</i> (L.) P. Beauv. (Barn-yard millet)								+			+	
<i>Panicum miliaceum</i> L. (Broomcorn-millet)						+						
<i>Panicum miliare</i> Lam. (Slender-millet)								+				
<i>Paspalum scrobiculatum</i> L. (Kodon-millet)									+	+	+	+
<i>Pennisetum typhoides</i> (Burm.) Stapf & Hubbard (Pearl-millet/Bajra)								+	+			
<i>Setaria italica</i> (L.) P. Beauv. (Fox-tail millet)							+	+		+		
<i>Sorghum bicolor</i> (L.) Moench (Sorghum-millet/Jowar)				+		+	+	+	+	+	+	
<i>Avena fatua</i> L. (Fatua grass/Wild Oat)		+										
<i>Avena</i> L.* (Oat)						+						
<i>Avena Sativa</i> L. (Oat)							+					
<i>Cajanus cajan</i> L. (Pigeon-pea)										+		+
<i>Cicer arietinum</i> L. (Chick-pea)				+			+		+	+	+	
<i>Dolichos biflorus</i> L. (Horse-gram)			+	+	+		+		+	+	+	+
<i>Lablab purpureus</i> (L.) Sweet, Syn. <i>Dolichos lablab</i> L. (Hayacinthbean)							+			+	+	+
<i>Lathyrus sativus</i> L. (Grass-pea/Khesari)				+	+		+	+	+	+	+	+
<i>Lens culinaris</i> Medik. (Lentil)	+	+		+		+	+	+	+	+	+	+
<i>Phaseolus lathyroides</i> L. (Phasemy-bean)										+		
<i>Phaseolus Lunatus</i> L. (Sieva-bean)										+		
<i>Phaseolus vulgaris</i> L. (Kidney-bean)					+					+		
<i>Pisum arvense</i> (L.) Poir (field-pea)	+	+		+		+	+	+	+	+	+	+
<i>Trigonella foenumgraecum</i> L. (Fanugreek)							+					
<i>Vigna aconitifolia</i> (Jacq.) Marechal (Aconite-bean)									+			
<i>Vigna mungo</i> (L.) Hepper. (Black-gram)							+		+	+	+	+
<i>Vigna radiata</i> (L.) Wilczek (Green-gram)							+	+	+	+	+	
<i>Vigna unguiculata</i> (L.) Walp., Syn. <i>Vigna Sinensis</i> L. Savi ex Hassk. (Cow-pea)							+			+		
<i>Linum usitatissimum</i> L. (Linseed/ Flax)						+		+	+	+		
<i>Brassica campestris</i> L. (Yellow- mustard)								+	+			
<i>Brassica juncea</i> (L.) Czern. & Coss. (Field-brassica)							+		+		+	
<i>Carthamus tinctorius</i> L. (Safflower)									+	+	+	
<i>Ricinus communis</i> L. (Castor)							+		+			
<i>Sesamum indicum</i> L. (Sesame/Til)							+		+		+	
<i>Gossypium</i> L.* (Cotton- wild or cultivated)						+						
<i>Gossypium arboreum</i> L. (Cultivated cotton)							+					
<i>Gossypium arboreum</i> L./ <i>G. herbaceum</i> L. (Cultivated cotton)							+		+	+	+	

+ Present; * Specific identification not clear

architecture, bone tools, chert blades and scappers, packed and ground stone objects and hand-made or wheel-made pottery. Use of metal was either absent or negligible. Primary Neolithic economy consisted of small scale cultivation with hoe or digging stick and the pasturing of flocks and herds. Neolithic sites that were initially regarded to represent the transition from the stage of food-gathering and hunting to that of incipient agriculture, have subsequently proved to depict relatively late stage of crop husbandry.

The Neolithic cultures in India have tentatively been grouped into six different geographical regions (Thapar, 1978, 1984), to which one may be added from Pakistan (Map 1). The available information on plant and animal remains is summarized as under:

1. North-western Zone

This zone covers Baluchistan, Swat and the contiguous area of Upper Sind Valley in Pakistan. For many years the earliest evidence of pastoralism characterized by the taming of sheep, goat and cattle with limited cereal cultivation was best documented at Kile Gul Mohammad in the Quetta Valley, Baluchistan dated to about 4,000 B.C. (Fairservis, 1974). Now, in view of the excavations carried out by the French Archaeological Mission from 1973 to 1979 the indigenous process of plant and animal domestication in Neolithic settlements has been traced back as early as Ca. 7,000 B.C. near a village Mehrgarh at Bolan Pass in the Kachi plains of Baluchistan. In the earliest Aceramic Neolithic phase the cereal grains of einkorn wheat (*Triticum monococcum*), emmer wheat (*Triticum dicoccum*), hard wheat (*Triticum cf. durum*), wild two-row barley (*Hordeum spontaneum*), two-row hulled barley (*Hordeum distichum*) and the hulled and naked forms of six-row barley (*Hordeum vulgare*—termed as *H. sphaerococcum* due to the rounded shape of kernels and *H. vulgare* var. *nudum*) have been recovered along with the date fruits of cultivated *Phoenix dactylifera* (Jarrige & Meadow, 1980; Costantini, 1984; Costantini & Biasini, 1985). With the continuing cereal cultivation, hunting of wild animals also played an important role in the subsistence economy (Meadow, 1984).

The process of animal and plant domestication at Neolithic Mehrgarh was largely completed by the mid-sixth millennium (ca. 5,500 B.C.) in the ceramic phase (Pds. IB, IIA, IIB) characterized by hand-made pottery. Bones of domesticated sheep (*Ovis aries*), goat (*Capra hircus-aegagrus*) and cattle (*Bos indicus*) indicate a marked shift from hunting to the stage of animal domestication. Advancement in the crop husbandry is evidenced by the appearance of

highly evolved hexaploid forms of bread wheat (*Triticum aestivum*), club wheat (*T. compactum*) and dwarf wheat (*T. sphaerococcum*), in addition to einkorn, emmer and hard wheats and hulled and naked forms of barley already encountered in the preceding phase. Other than the cereals, seeds and fruit remains of *Acacia* sp., *Phoenix dactylifera*, *Prunus* sp. and *Ziziphus* sp. have also been found (Costantini & Biasini, 1985).

So far, wheat and barley were regarded to have been introduced from West Asia, through established farming systems. The data available now suggests the expansion of centres of origin of crop plants proposed by Vavilov, as supported by Zhukovsky (1968). The process of West Asian cereal domestication had undergone outside the narrow limits earlier suggested by Vavilov. According to Zhukovsky the "Indian Centre" should become the "Indian Subcontinent" Megacentre, while the "Asian Centre" be expanded to include the eastern portion of the "Near Eastern Centre" which can be extended from the fertile Crescent (Iran & Iraq) towards Arabian Peninsula. In view of this, the Baluchistan would wholly be contained in the "Central Asian Centre" (no. 5 proposed by Vavilov) and the cis-Indus territories would lie on the boundaries of the "Hindustani Centre" or "Indian Subcontinent" (Centre no. 4). In this formulation, Baluchistan regains its unitary nature by retaining its links with the adjoining "Central Asian" and the Indian areas. The finds of cereals at Mehrgarh, which is one of the best studied sites in Baluchistan, indicate the indigenous process of West Asian crop domestication within the region of the Indian Subcontinent, contemporarily with the Neolithic revolution in West Asia.

The other notable sites at Saraikhola (Ca. 3,100-2,800 B.C.) and Ghaligai (Ca. 2,970-2,920 B.C.) suggest that Neolithic culture in Baluchistan continued till the opening of second millennium B.C. Barley (*Hordeum vulgare*), wheat (*Triticum* sp.), rice (*Oryza sativa*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*) and grape seed (*Vitis vinifera*) have been found in Period-III at Loebanr in the sequence of Ghaligai settlements of the Swat Valley (Allchin & Allchin, 1982). It is interesting that rice turned up in the Neolithic economy of Baluchistan at such an early date. Basically the Neolithic farmers in this region were the growers of wheat, barley, etc. Rice, which is the crop of Gangetic plains, possibly moved in competition with these crops through the cultural contacts. Future work can only resolve the phenomenon of rice introduction in the Baluchistan. Whatever the data available, Neolithic foundation in Baluchistan during

the course of further cultural development, provided the basis for economic growth in the subsequent Chalcolithic phases in the north-western Indian subcontinent.

2. Northern Zone

Out of about three dozens of sites representing the Neolithic culture in the Kashmir Valley on the elevated flats of Karewas, Burzahom and Gufkral have been systematically excavated (Khazanchi, 1977; Sharma, 1982, 1991). Neolithic phase at Burzahom has been dated from ca. 2,400 to 1,500 B.C. (Agrawal *et al.* 1978), and at Gufkral dated to about 2,600 B.C. Three phases of evolution—Aceramic, Ceramic and Late Neolithic have been identified. Subsistence economy seems to have been specialized food-gathering, hunting and farming. Settlers in Aceramic phase lived in subterranean pits and used both stone and bone tools. They were predominantly dependent on wild games and domesticated only sheep and goat. Pottery came in the use in ceramic phase. The animal domestication also showed progressive increase with the additional evidences of domesticated cattle and dog. It is the late phase of Neolithic in the early half of second millennium B.C. in which the overground dwelling structures built of mud and mud-bricks are found. Entire herd of sheep, goat and cattle is found to be domesticated, although hunting also continued (Sharma, 1982; Thapar, 1984).

Investigations have established that the Neolithic settlers in the Kashmir Valley were also conversant with the cultivation of crops (Vishnu-Mitre, 1968, 1974; Kajale, 1982; Buth & Kaw, 1985). Interestingly, the remains of dwarf-wheat (*Triticum sphaerococcum*), bread-wheat (*T. aestivum*), club-wheat (*T. compactum*), barley (*Hordeum vulgare*), lentil (*Lens culinaris*) and field-pea (*Pisum arvense*) have been reported from the earlier phases of Neolithic deposits at Gufkral and Burzahom. Rice (*Oryza sativa*) which makes staple diet of modern Kashmir, appeared at Gufkral in the later phase. Associated with the crop remains the weeds belonging to *Lithospermum arvense*, *Medicago denticulata*, *Lotus corniculatus*, *Avena fatua* and the species of *Trifolium*, *Medicago* and *Ipomoea* have also been identified. Wood charcoal remains of *Celtis* sp., *Ulmus* sp., *Cedrus deodara*, *Pinus* sp., and *Parrotia Jacquemontiana* have been reported from Burzahom (Savithri, 1976). At Gufkral, *Pinus wallichiana*, *Aesculus indica*, *Juglans regia*, *Picea smithiana*, *Ulmus wallichiana*, *Prunus cornuta* and *Buxus wallichiana* have been found to be exploited by the settlers (Chanchala, 1984, 1986; Lone *et al.*,

1988). But for *Buxus wallichiana* (boxwood tree), the rest of timber taxa are the local components of vegetation around the sites. Boxwood trees are not reported from the Kashmir Valley (Stewart, 1972). Of the two species of boxwood, *Buxus papillosa* occurs in Murree, Baluchistan, etc., in North-western Frontiers and *B. wallichiana* in the region of Poonch and Udhampur, on the south of Pir Panjal. Boxwood is highly esteemed for engraving and carving work. All the same, their preference to boxwood in propensity to many locally available woods, indicates their technical skill to utilize the quality forest-products. In animal domestication, crop husbandry and the forest economy, considerable advancement can, therefore, be seen in the Neolithic cultures of Kashmir Valley.

3. Central Gangetic Plain

Neolithic culture in the Belan Valley and Vindhyan Plateau of Uttar Pradesh is admittedly of its own kind in India to establish the primacy of this culture and the existence of antecedent stages thereof. Chopani Mando, Koldihwa and Mahagara, about 85 km south-east of Allahabad, represent a sequence of transition from the stage of food-gathering and selective hunting (in Epi-Palaeolithic Period) through incipient food producing (Proto-Neolithic) to settled village farming in the Neolithic times (Sharma *et al.*, 1980; Sharma, 1985). In this region, potential domesticates were present from very early times; cattle right from the Lower Palaeolithic and sheep/goat from the Upper Palaeolithic cultures. Within the chronological framework provided by radiocarbon dates ($6,570 \pm 210$ B.C. and $5,440 \pm 240$ B.C.) evidence of the Neolithic culture at Koldihwa and Mahagara deserve our attention. At Mahagara a cattle-pen with a number of hoof-marks of animals, huts of wattle and daub represented by floors and post-holes and with scattered pottery, Neolithic tools of stones and bones and faunal remains suggest permanent settlement. Economy of the Neolithic settlers was based on hunting and farming, as evidenced by the occurrence of both wild (cattle) and domesticated (cattle, sheep, goat and horse) animals and rice. Rice was used in this region even in the advanced Mesolithic or Pre-Neolithic period ($8,080 \pm 115$ B.C.), but it was of wild variety. Pottery from Koldihwa and Mahagara contains the husk-impressions of cultivated rice (*Oryza sativa*) along with those of annual and perennial forms of wild rice, viz., *Oryza nivara* and *Oryza rufipogon* respectively. Also the grains of cultivated *Oryza sativa* have been found at Mahagara (Savithri, 1976; Sharma, 1980, 1985; Sharma, A., 1983; Sharma *et al.*,

1980). The evidences show a long term continuity of the gradual intensification in the techno-economic aspects of early hunting and food-gathering community, which led to the resource husbandry in Neolithic times. The evidence for the cultivation of rice in view of the radiocarbon dates for the early Neolithic levels, dates it as the earliest in the World (Sharma *et al.*, 1980). Pal (1986) believes that these early dates do not belong to the Neolithic strata in Belan Valley. In his opinion Neolithic culture in this region could be placed within second millennium B.C. The evidence of the cultivated barley (*Hordeum vulgare*) from Neolithic Mahagara (Dixit, Aruna S., 1987), also supports this view. The oldest record of barley in the Indian subcontinent is known from Mehrgarh in Baluchistan (7,000-6,000 B.C.) and there is no evidence regarding the cultural contacts of Neolithic farmers of the Belan Valley with those of Baluchistan, in this early age. It must have been from the Harappan or Pre-Harappan settlements (2,500-2,000 B.C.) that the diffusion of wheat and barley took place in Ganga Valley, as evidenced by their cultivation during second millennium B.C. in the Neolithic context of Bihar. The basic qualification of evidence is authenticity: Is the source of barley specimen accurate? Does it belong to the cultural level indicated? Presence of barley from the same Neolithic strata (Dixit Aruna S., 1987) which revealed rice remains (6,570 ± 210 B.C.-5,440 ± 240 B.C.) creates a lot of confusion. Correct situation should be resolved by re-examination of the facts through controlled sample collection. Whether or not these barley remains should be taken as a genuine sample of crop economy of the Neolithic people of the Belan Valley, during the sixth-fifth millennia B.C. is yet to be decided.

4. Mid-eastern Zone

A number of Neolithic settlements have come to light in the alluvial plains of Bihar. Two of them, Chirand in the alluvial tract of the Ganges in Saran District (Narain, 1970; Verma, 1970-71) and Senuwar in the vicinity of Kaimur ranges in Rohtas District (Singh, 1990), have been excavated. Farming, herding and foraging provided the subsistence base for these early farming communities. The Neolithic culture in this region can be assigned to a general time-bracket of 2,000-1,200 B.C., characterized by the use of stone and bone implements. Food grains from the Neolithic Chirand included hulled barley (*Hordeum vulgare*), dwarf wheat (*Triticum sphaerococcum*), rice (*Oryza sativa*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*) and grass-pea (*Lathyrus sativus*). Wild rice (*Oryza rufipogon*) has also been encountered (Vishnu-Mittre, 1972).

Recent excavations at Senuwar from 1987 to 1989 reveal the evolutionary trend in neolithic culture. Characterized by Red Ware the earliest phase (Ca. 2,000-1,800 B.C.) is metal free. Succeeding phase dated from 1,800 to 1,200 B.C. shows marked improvement in the ceramic technology with the use of copper (Singh, 1990).

Systematic collection of the plant remains has been made by floatation technique (Saraswat, unpublished). Food grains from the earliest phase of pure Neolithic (2,000-1,800 B.C.) include cultivated forms of rice (*Oryza sativa*), barley (*Hordeum vulgare*), dwarf wheat (*Triticum sphaerococcum*), jowar millet (*Sorghum bicolor*), finger-millet (*Eleusine coracana*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*) and grass-pea (*Lathyrus sativus*). Weeds and other wild seeds and fruits comprise *Setaria glauca*, *Vicia hirsuta*, *Vicia sativa*, *Amaranthus* sp., *Oryza rufipogon*, *Panicum* sp., *Rumex dentatus*, *Bromus* sp., *Coix lachryma-jobi*, *Ipomoea pes-tigridis*, *Artocarpus lakoocha* and *Ziziphus nummularia*. In addition to these crop remains, farmers in the following Neolithic Chalcolithic Period (1,800-1,200 B.C.) also opted for the cultivation of bread-wheat (*Triticum aestivum*), chick-pea (*Cicer arietinum*), green-gram (*Vigna radiata*) and horsegram (*Dolichos biflorus*). *Polygonum plebejum*, *Lathyrus aphaca*, *Coccinia grandis*, *Trianthema monogyna*, *Datura* sp. and *Ziziphus oenoplea* provide additional information about the weedy and wild taxa recovered in association of crop remains. Rice was the local crop of this region. The eastward migration of wheat, barley, lentil, field-pea, chick-pea, etc., suggests the direct or indirect contacts of Neolithic farmers in Bihar with the cultures in north-western India. Efforts should be made to find out such elements that act as indicators of the leading margins of innovation waves. The problem of the diffusion of this advanced system of crop cultivation in the Neolithic context of Bihar is at present not easy to understand.

5. North-eastern Zone

The only excavated site in the north-eastern zone is Deojali-Hading in northern Cachar hills, Assam (Sharma, 1981). No direct evidence for the domestication of animals and plants has so far been obtained. On the circumstantial evidence Thapar (1978), however, suggested that the shifting cultivation must have been practiced.

6. Central-eastern Zone

Similarly, no remains of plants and animals are found at Kuchai in district Mayurbhanj, Orissa

(Thapar, 1985). Evidence of the grinding stone-tools for some sort of agricultural activity is certainly a dubious one. These implements might have been used to grind some wild seeds and fruits (Thapar, 1978).

7. Southern Zone

Neolithic culture in southern India is better known as compared to other zones. In the Deccan Plateau granite hills favoured for settlement, wherever they contained suitable caves and rock-shelters. Small plateau on the summits of hills or level areas on hill sides were likewise exploited. A large number of sites have been excavated in recent years. They are Utnur, Kodekal, Nagarjunakonda and Palavoy in Andhra Pradesh, Tekkalakota, Maski, Terdal, T. Narsipur, Sanganakallu, Kupgal, Hallur, Brahmagiri and Hemmige in Karnataka and Paiyampalli in Tamil Nadu (Thapar, 1978; Sundara, 1985). Allchin and Allchin (1968, 1982) have distinguished three phases of Neolithic culture in south India. The earliest phase without metal and characterized by the use of hand-made pottery, use of stone tools at Utnur, Brahmagiri-IA, Lower Piklihal, Kodekal and Maski-I, can be assigned to date Ca. 2,450-1,900 B.C. The occurrence of ashmounds at some sites suggested to be the accumulation of burnt cow-dung, is attributed to pastoral economy (Thapar, 1978). The following phase (Ca. 1,900-1,350 B.C.) is characterized by dull burnished grey ware, stone and bone tools, bead making and the use of copper at Brahmagiri-IB, Sanganakallu-I (i), Tekkalakota-I and Hallur-IIA. Towards the close of Neolithic, the last phase (Ca. 1,400-1,000 B.C.) at Tekkalakota-II and Hallur-IIB shows contacts with the Chalcolithic cultures of the northern Deccan, which resulted in the economic advancement by the use of copper and wheel-made pottery.

The animal bones have been examined from Maski (Nath, 1957), Piklihal (Srinivasan, 1960), Utnur (Srinivasan, 1961), T. Narsipur (Alur, 1971a), Sanganakallu (Alur 1969), Tekkalakota (Rao & Malhotra, 1968), Hallur (Alur, 1971b), Kodekal (Shah, 1973) and Nagarjunakonda (Gnanamuthu, 1958). In the light of the evidence cattle, sheep and goat were found to be commonly domesticated. The domestication of horse has been witnessed at Hallur. the presence of buffalo has been observed at Maski, Nagarjunakonda and Kodekal. Besides, bones of domesticated ass, dog and pig have also been found at Maski and Brahmagiri. The overall evidences indicate that the animal husbandry became the chief source of their economy. The ankylosis of hock joints and exostosis on certain parts of skeleton also

suggest that the cattles were used for heavy draft and weight-bearing works. The ass must have served as beast of burdon (Zeuner, 1963). Among the wild fauna, the bones of tortoise, monitor lizard, hare, sambhar, spotted deer, stag, nilgai, black-buck and gazelle indicate that hunting and trapping also played an important role in the southern Neolithic economy. Soil analysis below the Neolithic deposits at Kupgal shows that the region experienced wetter climate and had more vegetation with scrub forest and grassland, providing a suitable environment for the wild games (Majumdar & Rajguru, 1966), contrary to the present drier conditions in the region.

The plant remains from southern Neolithic are inadequately known. Fruit stones of date (*Phoenix* sp.) are known from Tekkalakota in Karnataka and Utnur in Andhra Pradesh (Allchin & Allchin, 1968). Hallur evidence brings to light the cultivation of finger-millet (*Eleusine coracana*) (Vishnu-Mittre, 1971). Seeds of wild *Eleusine indica* were also found in the collection. The discovery of fruits of teak (*Tectona grandis*) at Hallur is yet another interesting record. Teak usually grows in dry climate subject to heat and drought, but also in fairly moist and warm climate experiencing high rainfall. It does not grow at present in the region of granite hills. This suggests that the teak was the component of local forests in the Neolithic times and the climate was also not so dry as today (Vishnu-Mittre, 1971). Wood charcoal remains from Hallur-IIA belong to *Holarrhena antidysenterica* and the species of *Polyalthea*, *Anogeissus* and *Albizia* (Savithri, 1976). Horsegram (*Dolichos biflorus*), an indigenous crop commonly used as a feed for cattle and horses, is known from the Neolithic Tekkalakota in Karnataka (Vishnu-Mittre, 1968) and Paiyampalli in Tamil Nadu (Allchin & Allchin, 1968). Savithri (1976) identified the wood charcoal of *Soymida febrifuga* from Tekkalakota. From the same site, in locus-GWD and locus-II, a bean comparable to *Phaseolus vulgaris*, horse-gram (*Dolichos biflorus*), grass-pea (*Lathyrus sativus*) and the fruit-stones of jujube (*Ziziphus nummularia*) have also been reported (IAR, 1974-75), but the chronological cultural affiliation of the samples is not clear. Fruit-stones of jujube (*Ziziphus vulgaris*) are also known from Kodekal in Karnataka (Kajale, 1974). Obviously this indicates that crop husbandry did not form a major part in the economy of Neolithic settlers in the peninsular India. They were probably heavily dependent on cattle husbandry.

Looking to the periods of Neolithic occupation in the various regions, it appears that the environment and the exploitive technology

combined with adaptability were largely responsible for the food-producing economy. There are, however, possibilities for recognizing another Neolithic region in Rajasthan and Gujarat. Still many areas in India remain unexplored.

EARLY CHALCOLITHIC CULTURES IN BALUCHISTAN AND AFGHANISTAN REGION

In the region of Baluchistan and Afghanistan, following the Neolithic culture (Seventh to mid-sixth millennium B.C.) a continuing elaboration of Chalcolithic cultures across the vast area from the present Iranian border to north-western India, has shown the progressive improvement in the architecture, technical activities, crop and animal husbandry and even the ideology till the end of second millennium B.C. Some cultures co-existed with the Harappan Civilization (Ca. 2,300-1,700 B.C.). The relationships within these cultural groups are yet to be established, but it seems that from the northern Baluchistan the cultural impulses travelled to southern Baluchistan and the Indus System.

In the Kachi plains of Baluchistan at Mehrgarh a marked change in the economic prosperity has been noticed during an early Chalcolithic phase (Ca. 5,500-4,300 B.C.), following the preceding Neolithic culture. Introduction of improved hand-made pottery, granaries for storage of agricultural produce, bead manufacturing of soap stone with flint drills and the use of copper were the important advancements. Long distance trades with Iran, Central Asia, northern Afghanistan and coastal regions of Arabian Sea, also brought altogether change in their economy and culture (Jarrige & Meadow, 1980; Jarrige, 1981; Allchin & Allchin, 1982; Possehl, 1990). Hunting of wild games practiced in Neolithic times was given up and almost all the bone remains have been found to be of domesticated cattle, sheep and goat. Continued from the Neolithic, the cereal remains from this phase include *Triticum monococcum*, *T. dicoccum*, *T. cf. durum*, *T. aestivum*, *T. compactum*, *T. sphaerococcum*, *Hordeum vulgare* and *H. vulgare* var. *nudum*. Among the non-cereals, other than *Phoenix dactylifera* the fruits of *Ziziphus* and *Prunus* and cotton seeds (*Gossypium* sp.) were added to the economy. However, due to poor preservation it could not be determined with certainty whether cotton seeds were of wild or cultivated species (Jarrige & Meadow, 1980; Costantini & Biasini, 1985).

Subsequent development in the following Period-III (Ca. 4,300-3,500 B.C.) is marked with the

manufacturing of wheel-made pottery and lapis-lazuli, turquoise and carnelian beads made by the drills of green jasper of the same type that was used in 3rd millennium B.C. in Afghanistan, and Iran, and in the Harappan culture during 2,350 B.C. Practice of cultivating the high yielding hexaploid bread wheat (*Triticum aestivum*), club wheat (*T. compactum*), dwarf wheat (*T. sphaerococcum*) and the hulled and naked barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*) and herding of cattle, sheep and goat continued.

Further in Ca. 3,500 B.C. large buildings have been exposed and the production of stamp-seals of bone material suggests the ingenuity in trade and commerce. By 3,200 B.C. Mehrgarh was reasonably similar in many respects to several sites in eastern Iran and western Pakistan. Economic prosperity advanced further as a result of an impetus from Central Asia. Crop remains of emmer, bread wheat, club wheat, dwarf wheat, hulled and naked forms of barley have been found. In addition to date (*Phoenix dactylifera*) and apricot (*Prunus* sp.), grapes (*Vitis vinifera*) were also added to the subsistence economy (Costantini & Biasini, 1985). Although, in the succeeding phase opening up to 2,000 B.C. ceramics and terracotta figurines show affinity with those of the Harappans; there is no evidence of a Harappan culture phase at Mehrgarh. Harappan culture dated to Ca. 2,000 B.C. has been found at a neighbouring site Nausharo. An advanced crop economy at Mehrgarh in the third millennium B.C. has been evidenced by bread wheat (*Triticum aestivum*), club wheat (*T. compactum*), dwarf wheat (*T. sphaerococcum*), hulled barley (*Hordeum vulgare*), naked barley (*H. vulgare* var. *nudum*) and oat (*Avena* sp.). Wild seeds of *Acacia*, *Lolium*, *Polygonum* and *Chenopodium* have also been found. Jujube (*Ziziphus*) and grape (*Vitis vinifera*) were the important fruits (Costantini & Biasini, 1985). The wood charcoals from Mehrgarh consist of *Tamarix*, *Prosopis*, *Populus*, *Ziziphus*, *Juniperus* and *Vitis* species (Thiebault, 1989). The presence of wild grapes in the northern Kachi plain has been excluded on the basis of phytogeography. Thus the occurrence of charcoals of *Vitis* at Mehrgarh indicates grapevine cultivation. In Baluchistan, Mehrgarh is the best studied site to assess the gradual development of technical and economical innovations from 7,000 B.C. to the Harappan times. These evidences collectively indicate that the Chalcolithic village farming began on the north of Indus Valley in the mid-sixth millennium B.C., and this established the foundation for the highly advanced agricultural economy of Harappans.

During the fourth and third millennia B.C. a

large number of small village cultures flourished in the Quetta and Zhob valleys of Baluchistan. Excavations at Kile Gul Mohammad in Quetta Valley have revealed the use of copper in about 3,200 B.C. Similar culture was discovered at Damb Sadaat revealing social interaction within and outside Baluchistan (Fairservis, 1956). In the later phases, contacts of these cultures were established with Indus Valley. Balakot in southern Baluchistan (Ca. 4,000-2,900 B.C.) has revealed the evidence of barley (*Hordeum vulgare*), vetch (*Vicia* sp.), jujube (*Ziziphus* sp.) and melon or gourd (*Cucumis* sp.). The cattle, sheep and goat were domesticated (Dales, 1979, 1982; Allchin & Allchin, 1982). Mundigak near Kandahar (Ca. 4,000-2,000 B.C.) in Afghanistan witnessed transformation of the rural culture into an urban settlement. Club wheat (*Triticum compactum*), bread wheat (*T. aestivum*), hulled barley (*Hordeum vulgare*), naked barley (*H. vulgare* var. *nudum*), jujube (*Ziziphus vulgaris*) and the wood charcoal of *Salvadora persica* have been found at this site. Cattle, sheep, goat, horse, ass and dog were domesticated and hunting of wild animals was also practiced (Allchin & Allchin, 1982; Costantini, 1984; Costantini & Biasini, 1985).

At Shahr-i-Sokhta (Ca. 3,200-2,100 B.C.), in Iranian Sistan, analysis of wood charcoals has revealed the presence of *Tamarix*, *Populus*, *Fraxinus*, *Ulmus*, *Acer*, *Celtis*, *Dalbergia sissoo*, *Adnanthera* cf. *pavoniana* and *Adina cordifolia*. Fruit trees of Pistachio, grapevine and date palm are also represented. The carbonized cereal grains included einkorn wheat (*Triticum monococcum*), emmer wheat (*T. dicoccum*), bread wheat (*T. aestivum*), dwarf wheat (*T. sphaerococcum*), two-row barley (*H. distichum*), hulled barley (*H. vulgare*), naked barley (*H. vulgare* var. *nudum*), lentil (*Lens culinaris*), flax (*Linum usitatissimum*) and secale (*Secale cereale*). Fruits which played important role in the subsistence economy, have been represented by the seeds of *Vitis vinifera*, *Cucumis melo*, *C. sativus* and *Citrullus colocynthus*. Assemblage of wild and weed taxa comprise *Hordeum spontaneum*, *Aegilops speltoides*, *Chenopodium album* and the species of *Bromus*, *Lolium*, *Phalaris*, *Polygonum*, *Rumex*, *Vicia* and *Capparis* (Costantini & Biasini, 1985).

At another site at Deh-Morasi Ghundi near Kandahar the domestication of sheep, goat and cattle is evident during Ca. 2,700-2,600 B.C. (Shaffer, 1978). The grains recovered from a mud structure believed to be an 'alter shrine complex', included (*Hordeum vulgare*) and a fodder grass *Aegilops tauschii* (Chowdhury, 1963). Also from Tarakai Qila in the same region (Allchin & Allchin, 1982), an

incipient phase of urban development has revealed the domestication of cattle, buffalo, sheep and goat and the cultivation of wheat (*Triticum* sp.), barley (*Hordeum vulgare*), lentil (*Lens culinaris*) and field-pea (*Pisum arvense*).

From Nindowari in Ornach Valley, Pakistan (Third Millennium B.C.), silicified skeletons and glumes of *Triticum aestivum* and *Hordeum vulgare*, a rachis fragment of wheat, one complete grape, a large number grape pips (*Vitis vinifera*) and silicified wood remains of the grapevine have been reported (Costantini & Biasini, 1985). From Pirak, a site dated from 2,200 to 1,000 B.C. near Jacobabad in Baluchistan, an assemblage of the crop plants include *Triticum aestivo-compactum*, *T. sphaerococcum*, *Hordeum vulgare* var. *nudum*, *Oryza sativa*, *Avena* sp., *Sorghum* sp., *Panicum miliaceum* and *Linum usitatissimum*. The fruit remains comprise *Ziziphus jujuba*, *Vitis vinifera* and *Citrullus* cf. *colocynthus*. The rice-straw deposit varying 30-50 mm in thickness, evidently suggests the paddy cultivation in Baluchistan. Remains of *Sorghum* millet, an African domesticate, amply demonstrate its introduction in the economy of Baluchistan during the second millennium B.C. (Costantini & Biasini, 1985).

The Chalcolithic sites in the region of Afghanistan and Baluchistan are widely scattered and a number of them are still unpublished. By and large, the essential basis for the agricultural and technological advancement in the Harappan Culture must be seen in the economic interaction within these cultures.

THE HARAPPAN CULTURE

The Harappan Culture (or Indus Civilization) represents the earliest large scale urbanization in the Indian subcontinent from 2,500 to 1,500 B.C. Once splendid in its 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. This culture extends from the Arabian sea-board in Baluchistan in the west to the border of Haryana and western Uttar Pradesh to mark the eastern limit, and from Manda in Jammu and Kashmir in the north to Bhagatrava in Gujarat in the south. 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.

The Harappan civilization is marked by high level of technological achievements in town planning and architecture, ceramics, metallurgy, bead styles, terracotta (Votive objects), etched seals, intensive agriculture, long distance trades, uniform script, and uniform standards of weights, measures and even proportions. The wealth of archaeological data makes it inaccessible 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 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 and Chanu-Daro is still based on the earlier reports by Percival (1921), Stapf (1931), Luthra (1936, 1941), Burt (1941), Shaw (1943) and Mackay (1943). Vishnu-Mittre and Savithri (1982) have, however, revised the specific identification of some of the cereal grains. 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-row barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*). Sesame (*Sesamum indicum*) from Harappa and field-brassica (*Brassica juncea*) from Chanu-Daro were the main oil-seed crops. A few vestiges of seeds comparable to those of melon (*Cucumis* sp.) and two faience sealings shaped like date-stone (*Phoenix dactylifera*) indicate the familiarity of Harappans with this fruit. Occurrence of lotus fruit in faience and some earthen-ware vases shaped like a pomegranate (*Punica granatum*) and coconut fruits (*Cocos nucifera*) also tend to suggest that Harappans knew these fruits. Since a pendant shaped like a lemon leaf, lemon may also not be left out of question in the Harappan economy (Vats, 1941).

Among commercial crops, the cotton occupied the foremost place. The cotton fibre found adhering to a silver vase at Mohenjo-Daro was identified as

belonging to a coarse variety of *Gossypium arboreum* (Turner & 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. Cotton textiles in the Indus Valley were the product of a sophisticated textile-craft (Santhanum & 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 *dhobi* was in use. Likewise, the sculpture of a priest or *yogi* from Mohenjo-Daro shows that shawl was used as an upper garment. From the presence of needles, buttons, buckles, etc. one may conclude that stitching of garments was in practice.

The various purposes for which woods were used at Harappa indicate that Harappans in the Indus Valley must have had experience of this raw material for a pretty long period (Chowdhury & Ghosh, 1951). For instance, to make coffin the Harappans used the scented woods of deodar (*Cedrus deodara*) and rosewood (*Dalbergia latifolia*). Against the civilizations of Mesopotamia and Egypt where the scented woods of cypress, juniper, pine and cedar were used for making coffins, the use of Indian deodar and rosewood for the same purpose revealed an interesting data that enabled the archaeologists to draw conclusions of considerable cultural significance. The Harappans knew the forest wealth of Himalayas and central India for the exploitation of deodar and rosewood respectively. Their choice 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 caballus*), elephant (*Elephas maximus*), camel (*Camelus dromedarius*), pig (*Sus scrofa cristatus*), dog (*Canis familiaris*), cat (*Felis catus domesticus*), fowl (*Gallus* sp.), etc. (Badam & 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 tend 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. No

remnants of agricultural implements have been found, but it is surmised that wooden ploughs and sickles of copper were known to them. A synthesis of botanical and faunal data 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

The development of pre-Harappan and Harappan cultural traits began in Baluchistan and Afghanistan, which founded the urban culture in the Indus Valley. From the lower Indus, this culture moved east and north-east and having come upon the now extinct stretch of Ghaggar (ancient Saraswati), moved upstream and spread in regions of Rajasthan, Haryana and Punjab (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. Kalibangan in Rajasthan, Rohira, Mahorana and Sanghol in Punjab and Hulas in western Uttar Pradesh are the important sites to reveal the data on the plant economy of Harappan culture-complex in the eastern region of the Indus civilization.

Kalibangan in Ganganagar District of Rajasthan and on the bank of now dry Ghaggar revealed the Early Indus or pre-Harappan phase, dated from 2,450 to 2,300 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). Closely spaced furrows in one direction and crossed widely spaced furrows in the other are indicative of mixed crop cultivation 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 & Allchin, 1982).

In the following mature Harappan phase, dated about 2,000 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 & 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 lebbek*, *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. 2,300-2,000 B.C.) revealed the presence of hulled barley (*Hordeum vulgare*), dwarf-wheat (*Triticum sphaerococcum*), emmer-wheat (*T. dicoccum*) and jowar-millet (*Sorghum bicolor*). Lentil (*Lens culinaris*) and horse-gram (*Dolichos biflorus*) 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* and the species of *Acacia* and *Tamarix* have also been found from the pre-Harappan levels (Saraswat, 1988, 1988-89). 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 foenumgraecum*) are new additions in the following mature Harappan phase dated to Ca. 2,000-1,700 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.

Remains of *Hordeum vulgare*, *Triticum sphaerococcum*, *T. compactum*, *Lens culinaris*, *Vitis vinifera* and *Lablab purpureus* (Syn. *Dolichos lablab*) have been found from an early phase of transformation of Bara Culture from the pre-Harappan (Ca. 2,100-1,900 B.C.), at Mahorana about 8 km south-west of Manerkotla in Sangrur District (Saraswat, 1990-91). The origin of Bara 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 & Sharma, 1982). Houses in the Baran settlements were made of mud-brick walls. Painted motifs on pottery, bull figuries, bangles and beads are other

important objects sharing the partial affinities with Harappans.

A prominent site of Barta culture is situated at Sanghol (Ca. 2,000-1,400 B.C.) in Punjab. Recently in 1989-90, the present author has made systematic collection and examined the food grains of dwarf wheat (*Triticum sphaerococcum*), bread wheat (*T. aestivum*), club wheat (*T. compactum*), hulled and naked forms of barley (*Hordeum vulgare* and *H. vulgare* var. *nudum*), jowar millet (*Sorghum bicolor*), italian-millet (*Setaria italica*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*), chick-pea (*Cicer arietinum*) and horse-gram (*dolichos biflorus*). A few seeds of poppy (*Opium* sp.) have also been identified. Fruit remains include grape (*Vitis vinifera*) and emblic myrobolan (*Emblica officinalis*). These evidences provide the parallels with the typical Harappan economy.

So far, the course of social and economic evolution of Harappans in India has increasingly been shaped by cultivation of cereals, pulses and oil-seeds, and a sophisticated textile craft. Grape seeds from Rohira, Mahorana and Sanghol along with the grapevine charcoals from different horizons of cultural deposits at Rohira provide an unequivocal evidence of grapevine cultivation (Saraswat, 1988). Hyacinthbean (*Lablab purpureus*) from Mahorana is an infallible record of green vegetable cultivation (Saraswat, 1990-91). In northern India, it is grown as a garden crop. Its cultivation indicates that an assured irrigation and high intrinsic soil fertility would have been maintained for growing this vegetable crop. The evidences suggest that the knowledge of horticulture was highly advanced in the Harappan communities of Punjab. *Lawsonia inermis* (Hinná or Mehandi) evidenced by wood charcoals at Rohira is grown as a hedge plant in India. One may presume that Harappan ladies would have used hinna for embellishment, as the leaves of this plant, when powdered and made into a paste, give dye for colouring the hand-palm and nails. Parijat (*Nyctanthes arbor-tristis*) also deserves a special mention as an ornamental plant grown in the gardens for its fragrant flowers, which open in night and drop off in the morning. There might have been other plants also grown by Harappans in their gardens, but their evidences are lacking. Till recent past, there had been no report on the horticultural and gardening practices in the archaeological studies. The work carried out at the Sahní Institute has added a new dimension to the economy of Harappans.

Further eastward there is concentration of Harappan sites in the region of Haryana and western Uttar Pradesh. Information from Haryana is very

meagre. Seeds of black-gram (*Vigna mungo*) from Daulatpur in Kurukshetra District and some wheat grains from Hissar are reported by Vishnu-Mittre and Savithri (1982). In the territories between the Sutlej River and the Ganga-Yamuna Doab, Harappans and their successors have shown late survival, degeneration and devolution of characteristic traits. Hulas in Saharanpur District has revealed the Late Harappan crop economy, dated from 2,000 to 1,200 B.C. The assemblage of seeds and fruits includes rice (*Oryza sativa*), dwarf-wheat (*Triticum sphaerococcum*), bread-wheat (*T. aestivum*), club-wheat (*T. compactum*), barley (*Hordeum vulgare*), 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 (*Dolichos biflorus*), 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*) and a wild grass *Cenchrus ciliaris* (Vishnu-Mittre *et al.*, 1985; Saraswat, 1987-88). Imprints of the husk of both wild and cultivated forms of rice (*Oryza rufipogon* and *O. sativa*) are noticed on potsherds and the burnt mud-plaster pieces. Wood charcoal remains have also been identified as of *Acacia* sp., *Shorea robusta*, *Tectona grandis* and a species of bamboo (Saraswat, unpublished). It is important to note that during the eclipse of Harappan culture style, the rice cultivation was opted by the Late Harappans due to the influence of contemporaneous cultures in Gangetic plain. This brought a change in the Harappan style of agriculture.

Bones from Kalibangan in Rajasthan and Rupar in Punjab (Ca. 2,062-1,800 B.C.) indicate the domestication of cattle, buffalo, goat, sheep, horse, camel, elephant and pig by Harappans in this region. Barasingha, spotted deer, black partridge, fresh-water and river turtles, etc. were also exploited for the protein-rich diet (Badam & Sathe, 1991).

The Southern Region

The expansion of Harappan culture in the peninsular India covers Kutch, Kathiawar, coastal flats of Gujarat and some areas of hinterland of Maharashtra. 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., Rangpur, Lothal, Surkotada, etc.), whose material culture and town

planning is similar to that of the Indus Valley. Economy and other technological advancements evidenced in inscribed seals, ceramics, metal work and bead manufacturing, which are typical of mature phase, are known from Gujarat by about 2,400 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. No systematic collection by floatation technique, but from Rojdi in Rajkot District, have been made. Records of some millets included *Pennisetum typhoides* from Rangpur in district Surendranagar (Ghosh & Lal, 1962-63), *Eleusine coracana* and *Setaria italica* from Surkotada in district Bhuj (Chanchala, 1984; IAR, 1974-75) as well as Oriyo Timbo in district Bhavnagar (Wagner, 1983), and *Eleusine coracana* from Shikarpur in the Runn of Kutch (Chanchala, unpublished). These finds are dated from different levels between 2,500 B.C. and 2,000 B.C. Rojdi in district Rajkot 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 2,500 B.C. 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). The assemblage of crop plants from Harappan Rojdi includes *Eleusine coracana*, *Pennisetum typhoides*, *Sorghum bicolor*, *Echinochloa crus-galli*, *Setaria italica*, *Panicum miliare*, *Hordeum vulgare*, *Linum usitatissimum*, *Lens culinaris*, *Lathyrus sativus*, *Vigna radiata*, *Pisum arvense* and *Brassica campestris*. Fruit remains of jujube (*Ziziphus mauritiana*) and cucumber (*Cucumis* sp.) have also been reported.

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 & 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., *Soyamida febrifuga* 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 & Lal, 1962-63). Except the *Tectona grandis* (Teak) and *Pterocarpus santalinus* (Lal-chandan), rest 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 its 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 joinery purposes. Wood charcoal of *P. santalinus* at Rangpur bears considerable cultural significance, as it claims priority to a sound knowledge of efficient wood utilization. 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 crops of wheat, barley and pulses, and the summer crops of millets 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.

From Surkotada in the Runn of Kutch carbonized seeds have been referred to *Setaria viridis*, *Phragmites karka*, *Scirpus supinus*, *Trifolium repens*, *Euphorbia pycnostegia*, *Chenopodium album* and the species of *Echinochloa*, *Andropogon*, *Brachiaria*, *Eragrostis*, *Digitaria*, *Panicum*, *Portulaca*, *Poa*, *Carex*, *Eriophorum*, *Dichostylis*, *Polygonum*, *Atriplex*, *Amaranthus*, etc. (Savithri, 1976; Vishnu-Mittre & Savithri, 1978). Similarly, a large number of wild taxa

identified from Rojdi belong to *Blainvillea acmella*, *Boerhaavia diffusa*, *Chenopodium album*, *Cymbopogon martini*, *Dactyloctenium aegyptium*, *Digera muricata*, *Digitaria ascendens*, *Eyphorbia granulata*, *E. prostrata*, *E. thymidolia*, *Glossocardia bosvallia*, *Goniogyna hirta*, *Indigofera linifolia*, *Medicago sativa*, *Melilotus indica*, *M. alba*, *Polygonum plebejum*, *Sapindus laurifolius*, *Setaria tomentosa*, *S. glauca*, *Tragus biflorus* and the species of *Abelmoschus*, *Acacia*, *Borreria*, *Carex*, *Cenchrus*, *Amaranthus*, *Chloris*, *Convolvulus*, *Cucumis*, *Cyperus*, *Desmodium*, *Elyonurus*, *Ficus*, *Fimbristylis*, *Impatiens*, *Ipomoea*, *Lotus*, *Melochia*, *Neptunia*, *Panicum*, *Peltophorum*, *Phyllanthus*, *Polygalla*, *Rorippa*, *Scirpus*, *Sida*, *Solanum*, *Stellaria*, *Trianthema*, *Verbascum*, *Vicia*, etc. (Weber, 1991).

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. The data needs detailed interpretation from this viewpoint.

Harappan culture is spread in a vast area of about 4,80,000 sq km in diverse geographical regions. In spite of the considerable advance in archaeological work, the knowledge of plant economy of this culture is still inadequate. Future systematic work will take us a long way towards a clear understanding of various aspects of the exploitation pattern of botanical wealth.

CHALCOLITHIC CULTURES IN INDIA

The Chalcolithic cultures, characterized by the use of copper, were spread in a wide time range from about 2,200 to 900-800 B.C. They are either partly contemporary with or posterior to the Indus Civilization. From highly varied shape and ornamentation of pottery, archaeologists have been able to distinguish a number of cultures of limited geographical and chronological occurrence and various degrees of relation. These cultures with their chronological time-brackets cover the areas in south-eastern Rajasthan, Malwa region in central western India, Maharashtra and the Ganga-Yamuna Doab (Agrawal *et al.*, 1978; Thapar, 1985). Except for some cultural equipments, the Chalcolithic cultures share a common level of agricultural economy and technology. Their basic economy was based on crop-husbandry, stock-raising, hunting and fishing. The knowledge of socio-political aspects in these cultural settlements without any pretensions to

urbanity, is as yet sketchy, except of Jorwe culture in Maharashtra (Dhavalikar, 1984).

The plant economy is discussed under two broad geographical regions.

Central India and the Deccan

Ahar Culture (Ca. 2,000-1,400 B.C.)—This culture has been named after a type site at Ahar near Udaipur and played an important role in the development and transmission of material economy in the south-eastern Rajasthan during the late and post-Harappan times. It is characterized by mud-brick and kiln-baked structures, abundance of copper objects, bead industry and white-painted black and red wares. Being near the Khetri mines, the people were expert in copper smelting.

Mixed economy based on crop cultivation and animal herding was practiced. It is evidenced by the remains of jowar millet (*Sorghum bicolor*) and rice (*Oryza sativa*), and the bones of domesticated cattle, buffalo, goat, sheep and pig (Vishnu-Mittre, 1969; Sankalia *et al.*, 1969). Among the kitchen middens the bones of cattle, buffalo, goat, sheep, deer, turtle, fish, etc. indicate the exploitation of both domesticated as well as wild animals for food.

Additional evidences of crop-economy of Ahar culture are from Dangwada in district Ujjain, Madhya Pradesh. The finds include wild rice (*Oryza rufipogon*), cultivated rice (*Oryza sativa*), bread-wheat (*Triticum aestivum*), black-gram (*Vigna mungo*), green-gram (*Vigna radiata*), lentil (*Lens culinaris*) and jujube stones (*Ziziphus* sp.) identified by Vishnu-Mittre *et al.* (1984).

Kayatha Culture (Ca. 2,000-1,800 B.C.)—This culture is named after Kayatha Village situated in district Ujjain, Madhya Pradesh. It is followed by the occupational phases of Ahar and Malwa cultures (Ansari & Dhavalikar, 1975). Technical advancement is evident by sturdy violet-painted pinkish-red wares and red-painted buff and combed wares, specialized blade industry of silicious stones, and beads of semi-precious stones and shells (Thapar, 1985). Evidences suggest that Kayatha and Ahar cultures received early technical innovations from the Harappans and accommodated the same to local cultures, prior to onward transmission of post-Harappan cultural traits. Food grains of dwarf-wheat (*Triticum sphaerococcum*), club-wheat (*T. compactum*) and horse-gram (*Dolichos biflorus*) have been reported by Sharma (1983). The bones of domesticated cattle and horse which were slaughtered for meat are suggestive of animal husbandry (Alur, 1975; Dhavalikar, 1979). Detailed evidences are wanting.

Malwa Culture (Ca. 1,700-1,450 B.C.)—Showing a considerable overlap with Ahar Culture, the Malwa Culture spread over a large area in Madhya Pradesh, Malwa region in particular. It is also represented in Maharashtra, but its beginning has been placed in later period around 1,600 B.C. In Madhya Pradesh, main excavated sites of Malwa culture are at Navdatoli-Maheshwar on the Narmada, Nagda on the Chambal, Kayatha on the Chhoti-Kali Sind and Eran on the Betwa rivers. Daimabad on the river Pravara, Prakash on Tapti and Inamgaon on Ghod are the sites in Maharashtra. Malwa people, flourishing in Madhya Pradesh, began to extend their settlements into the Deccan and having come in contact with southern Neolithic communities they adopted burial customs and some other cultural traits (Shinde, 1990).

The culture is depicted by mud houses with floors having cow-dung coating, black-painted red pottery, artefacts of copper and low-grade bronze, stone objects, bead industry of precious and semiprecious stones and terracotta figurines (Sankalia, Subbarao & Deo, 1958; Thapar, 1985; Sankalia, Deo & Ansari, 1971; Ansari & Dhavalikar, 1975; Allchin & Allchin, 1982).

In Madhya Pradesh, the remains of wheat (*Triticum aestivum/compactum*), rice (*Oryza sativa*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), lentil (*Lens culinaris*), black-gram (*Vigna mungo*), green-gram (*Vigna radiata*), linseed (*Linum usitatissimum*) and jujube (*Ziziphus jujuba*) have been identified by Vishnu-Mittre (1961). The seeds of chick-pea (*Cicer arietinum*) have not been confirmed in the collection, though Sankalia *et al.* (1958) mentioned them in the economy of Navdatoli folk. Wheat grains from Kayatha near Ujjain are from uncertain dated context (Allchin & Allchin, 1982). Prakash and Awasthi (1971) examined the wood charcoals belonging to *Acacia* sp., some unidentified conifer and bamboo. The settlers at Navdatoli-Maheshwar domesticated cattle, sheep and goat. Bones of some deer and fishing-hooks of copper suggest that hunting and fishing was also practiced by the Malwa people in Madhya Pradesh.

The excavations at Daimabad and Inamgaon, Maharashtra have revealed separate houses of a craftsman and a priest suggesting the existence of ranked society around 1,600 B.C. The religious complexes excavated at Daimabad, Maharashtra and at Dangwada in Madhya Pradesh (Wakankar & Khare, 1981) indicates that Malwa people did also carry some customs and traditions they practiced in their homeland in the Malwa region (Shinde, 1990). The evidences from burials suggest that they had belief

in life after death. At Inamgaon and Daimabad, several child burials have been found inside as well as outside the houses. Two urns faced mouth to mouth containing the body of a child were buried in a pit with some bowls and jars, probably containing food for the dead. It has also been observed that they obtained copper from south-eastern Rajasthan and conch shells from Saurashtra through their trade contacts (Dhavalikar, 1984).

Food grains from Inamgaon and Daimabad include wheat (*Triticum aestivum* and *T. sphaerococcum*), barley (*Hordeum vulgare*), finger-millet (*Eleusine coracana*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), horse-gram (*Dolichos biflorus*), kidney-bean (*Phaseolus vulgaris*), sieva bean (*Phaseolus lunatus*), phasemy-bean (*Phaseolus lathyroides*), cow-pea (*Vigna unguiculata*), hyacinth-bean (*Lablab purpureus*) and black-gram (*Vigna mungo*). A fair representation of wild seeds and fruits of *Ziziphus jujuba*, *Phoenix sylvestris*, *Syzygium cumini*, *Heteropanax fragrans*, *Chenopodium Amaranthus* and *Rhynchosia* has also been noticed (Kajale, 1977a, 1988a; Vishnu-Mittre *et al.*, 1986). Formerly it was argued that the Malwa farmers in lieu of iron ploughs, could have not successfully exploited the hard and sticky black cotton soil for agriculture purpose in Maharashtra (Kosambi, 1963). Nevertheless, Wallace (1988) has contradicted this view. According to him, black cotton soil breaks easily as a result of its shrinkage and expansion cycle and simply a wooden hoe is sufficient to turn the soil. Malwa people domesticated cattle, sheep and goat. Bones of sambar, chital, black-buck, mongoose and hare suggest the hunting of wild fauna to supplement the protein requirement in their diet

Savalda Culture (Ca. 2,200-1,700 B.C.)—The earliest Chalcolithic culture, after the excavations at Savalda on the bank of the river Tapti in West Khandesh of Maharashtra, is characterized by distinct ceramics in varying shades of brown, chocolate, pink and red colours. Details of cultural equipments are not known. The artistic activity of the Savalda people can be seen in the designs on pottery, showing hatched triangles and diamonds, loops, circles, fishes, peacocks, birds and arrowheads. From the comparable deposits of Savalda culture at Daimabad in Ahmednagar District, the grains of dwarf-wheat (*Triticum sphaerococcum*) and barley (*Hordeum vulgare*) have been found (Kajale, 1977a; Vishnu-Mittre *et al.*, 1986). *Acacia* wood charcoals have also been reported (Chanchala, 1984). In view of the succeeding Late Harappan and Malwa cultures at Daimabad, it may be surmised that wheat, barley,

etc. must have been grown along with a number of leguminous crops.

Jorwe Culture (Ca. 1,400-900 B.C.)—Initially known from Jorwe on the bank of Pravara in district Ahmednagar, this culture has been represented at more than two hundred sites in the semi-arid zone of Deccan Plateau. Amongst them, the important sites are Inamgaon, Theur, Sonegaon and Chandoli in district Pune, Bahal in district Jalgaon, Prakash in district Dhulia and Jorwe and Nevasa in district Ahmednagar. In Madhya Pradesh, Navdatoli-Maheshwar has also shown the presence of this culture. The settlement patterns, socio-political organization, technology, religious beliefs and exchange networks of the Jorwe culture are better represented in archaeological evidences than other Chalcolithic cultures in the Deccan and central India (Dhavalikar, 1984).

Settlements have been identified as villages, some quite small in the vicinity of a large village as farmsteads. Mud houses had the wattle and daub construction. Settlement plan and the burial evidences of Inamgaon indicate the ranked society in the Jorwe communities. Jorwe people traded with many of their contemporaries including the hunter-gatherers. They obtained gold and ivory from Karnataka, copper from Rajasthan, conch shells from the Saurashtra Coast and amazonite from Rajapipla in Gujarat. Copper may also have come from Amreli mines in Gujarat. Within the Jorwe culture zone itself, large centres like Inamgaon and Daimabad may have served for regional exchange and also as redistributive centres under the administrative control of chief-doms.

These farming communities prepared painted and wheel-made pottery. Copper objects, gold ornaments, crucibles and tongs of copper for working of goldsmiths, chalcedony drills used to perforate the beads of semi-precious stones and copper drills for ivory beads indicate the technical advancement attained by Jorwe culture people. Lime-making was a flourishing industry of Jorwe communities, as testified by Inamgaon evidence (Ansari, 1978-79; Dhavalikar, 1984).

Evidences of agriculture from Inamgaon, Daimabad, Nevasa, Apegaon and Tuljapur Garhi in Maharashtra give us a fair idea of cultivation of different species of wheat (*Triticum aestivum*, *T. compactum* and *T. sphaerococcum*), barley (*Hordeum vulgare*), rice (*Oryza sativa*), jowar-millet (*Sorghum bicolor*), kodon-millet (*Paspalum scrobiculatum*), ragi-millet (*Eleusine coracana*), fox-tail millet (*Setaria italica*), green-gram (*Vigna radiata*), black-gram (*Vigna mungo*), lentil (*Lens*

culinaris), grass-pea (*Lathyrus sativus*), field-pea (*Pisum arvense*), pigeon-pea (*Cajanus cajan*), chick-pea (*Cicer arietinum*), horse-gram (*Dolichos biflorus*), kidney-bean (*Phaseolus vulgaris*), hyacinth-bean (*Lablab purpureus*), safflower (*Carthamus tinctorius*) and linseed (*Linus usitatissimum*). Fruit and seed remains of beleric myrobolan (*Terminalia belerica*), jambo (*Syzygium cumini*), Indian cherry (*Cordia myxa*) chiraunji (*Buchanania lanzan*), babul (*Acacia nilotica*), jujube (*Ziziphus jujuba*), wild date (*Phoenix sylvestris*), Karanj (*Pongamia pinnata*), sugandhabala (*Pavonia odorata*) and tarla (*Heteropanax fragrans*) have also been reported (Kajale, 1975, 1977a, 1977b, 1979, 1988a, 1988b; Vishnu-Mittre *et al.*, 1986). An important discovery is that during the Jorwe times cotton was spun in Maharashtra and, at any rate the flax was also used. This inference is based on the discovery of beads strung upon a thread of silk with a cotton nep from Nevasa in district Ahmednagar and second such string in a similar context at Chandoli in district Pune, which had a thread of flax or linseed (Gulati *in* Clutton-Brock *et al.*, 1961). The domesticated animals of the Jorwe culture people included cattle, sheep, goat, buffalo and pig. Bones of deer and nilgai suggest that hunting was also practiced.

It is obvious that in every respect there was a spurt in technological, socio-economical and agricultural developments. The Deccan College, Pune owns the credit of having contributed immensely to the Chalcolithic cultures in the region of Maharashtra.

Chalcolithic cultures of the Ganga Valley

Eastward of Punjab and Haryana no typical Harappan sites are found and instead the indigenous Chalcolithic cultures are encountered. The possible exceptions being some sites like Alamgir and Hulas in the bordering region of western Uttar Pradesh, where the characteristic Harappan traits were watered down by mingling with local cultures. What was diffused into these Chalcolithic cultures were the elements of Harappan technology and agricultural traits, in the forms which increasingly deviated from the original system by successive adaptations, changing in cultural and environmental systems. As one moves eastwards in the Gangetic corridor from the semi-arid Harappan zone, the climatic conditions favoured the development of original forest cover of greater density. The cultural diffusion into the Gangetic corridor would appear to have been initially by boat along the great rivers, followed later by a lengthy process of forest clearance and settlement. Economy of these rural

cultures was mainly based on farming and animal husbandry. Characterized by red ware traditions, the Chalcolithic cultures in the Gangetic plains date from about 2,000 B.C. Their chronological details are not yet fully established, but they run up to 900-800 B.C. These Chalcolithic cultures may be described as under:

Copper Hoard or Ochre Coloured Pottery Culture (Ca. 2,000-1,000 B.C.)—The early Chalcolithic riparian culture characterized by thick ochre-coloured water-rolled pottery, most probably maintained its contacts with the Harappans in Rajasthan and Haryana and diffused various Harappan traits in central and eastern Uttar Pradesh, Bihar and Bengal (Sinha, 1982). Hoards of copper implements have been found from the settlements. Some of the harpoons and spearheads are the superb examples of craftsmanship, employing the use of double mould and close casting of copper and these objects are much finer and better than those seen in the otherwise advanced Indus civilization (Sankalia, 1974). Some of the objects have affinities with Chota Nagpur products in both stone and copper, and there are other links with flat-axe forms from Harappan and Jorwe contexts. People lived on the edges of the flood plain in hamlets of wattle and daub huts, growing various crops, rearing the cattle, and fishing and hunting in the floodplain forests.

The culture has been variously attributed to the Indo-Aryans coming from West. In the course of their homeland in *Saptasindhu* and *Panchanada* (Sind and Punjab) they had gradually settled in the Ganga Valley. Besides adoring terracotta figurine of Mother Goddess (*Prithvi*) and the holy bull (*Vrishabha*), they worshipped terracotta wheels and pottery discs symbolising the Sun and anthropomorphic figures of Lord Indra—the foremost God of Rigvedic pantheon (Kumar, 1984, 1987, 1991). Terracotta wheels from Lal Quila (district Bulandshahr) and Atranjikhhera (district Etah) and the bones of horse from the former site (Gaur, 1973, 1983) are suggestive that horse may have been used as a draft animal in a wheeled cart.

Although a number of Ochre Coloured Pottery cultural settlements are known, so far the information on plant economy is meagre. Remains of rice (*Oryza sativa*), barley (*Hordeum vulgare*), chick-pea (*Cicer arietinum*) and grass-pea (*Lathyrus sativus*), and the wood charcoals of *Acacia* sp., *Shorea robusta*, *Dalbergia sissoo* and *Pinus roxburghii* are known from Atranjikhhera in district Etah, dated to Ca. 2,000-1,500 B.C. (Chowdhury *et al.*, 1977; Saraswat, 1980). Food grains of barley (*Hordeum vulgare*), wheat (*Triticum aestivum*),

chick-pea (*Cicer arietinum*) and field-pea (*Pisum arvense*) from another contemporaneous site at Lal Quila in district Bulandshahr were examined by the present author at Aligarh Muslim University.

In the middle Ganga Valley, information of plant economy of the Ochre Coloured Pottery culture comes from Sringerapur in Allahabad District, dated to Ca. 1,050-1,000 B.C. Food grains of *Oryza sativa*, *Hordeum vulgare* and *Sesamum indicum*, cotton fibres belonging to *Gossypium arboreum/herbaceum* and the wood remains of *Pinus roxburghii*, *Ziziphus* sp., *Acacia nilotica/catechu*, *Mangifera indica*, *Madhuca indica* and bamboo have been reported (Saraswat, 1986, 1989). In the same cultural context the rice-husk is reported to have been used as degreasing in the clay to make pottery at Mirapatti in Allahabad District (Kumar, 1991), but the detailed information is lacking. It is now almost certain that the riverine communities belonged to traders serving the settlers in the Gangetic plain, but their precise stratigraphical provenance and modus-operandi is not known.

Black and Red Ware Culture (Ca. 1,500-800 B.C.)—Black and red wares although known from a number of Iron Age culture sites in Rajasthan, Punjab, Haryana and western Uttar Pradesh, the culture associated with this ceramic style has come into light in district Etah of Uttar Pradesh at Atranjikhhera and Jakhera, within the time bracket of Ca. 1,500-1,200 B.C. (Gaur, 1969; Sahi, 1979). In Rajasthan, Noh in district Bharatpur and Jodhpura in Jaipur District are the important sites dating from 1,100 to 900 B.C. (Agrawal & Kumar, 1976). At Sohaura and Narhan in district Gorakhpur (IAR, 1961-62; Singh & Lal, 1985) and Khairadih in Ballia District (Singh, 1989), the black and red ware users in the Middle Ganga Valley colonized from about 1,100 B.C. to 800 B.C. Settlement plan and socio-economic aspects are not clearly understood. Wheel-made pottery was black inside and red outside. Exclusively the copper objects are found in the Ganga Valley, but in Rajasthan the use of iron has also been reported with this ceramic tradition.

Information on plant economy of the Black and Red Ware culture folk in the Upper Ganga-Yamuna Doab, is regrettably meagre. Food grains of *Oryza sativa* and *Hordeum vulgare*, and the wood charcoal of *Tectona grandis* are known only from Atranjikhhera (Chowdhury *et al.*, 1977). *Oryza sativa*, *Dolichos biflorus* and *Vigna mungo* have been reported by Vishnu-Mittre and Savithri (1974) from Noh in district Bharatpur, Rajasthan.

An intensive investigation carried out at the

Birbal Sahni Institute of Palaeobotany on the plant remains from Narhan in district Gorakhpur has thrown a fresh light on the plant economy of Black and Red Ware people in the Middle Gangetic plain. In the earliest habitational phase at this site a large number of carbonized seeds and fruits, weeds and wild taxa, impressions on pottery and plasters, cuticle remains and wood charcoals have been identified (Sharma, 1989; Saraswat *et al.*, 1988, 1991). The crop remains included rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum sphaerococcum*, *T. aestivum* and *T. compactum*), pearl-millet (*Pennisetum typhoides*), kodon-millet (*Paspalum scrobiculatum*), chick-pea (*Cicer arietinum*), field-pea (*Pisum arvense*), green-gram (*Vigna radiata*), horse-gram (*Dolichos biflorus*), grass-pea (*Lathyrus sativus*), lentil (*Lens culinaris*), moth-bean (*Vigna aconitifolia*), field brassica (*Brassica juncea*), sesame (*Sesamum indicum*) and Linseed (*Linum usitatissimum*). Fruit remains of jujube (*Ziziphus nummularia*), grape or raisins (*Vitis vinifera*), date (*Phoenix* sp.-cf. *P. dactylifera*) and jack-fruit (*Artocarpus heterophyllus*) have also been found. Associated with these crop and fruit remains, the seeds and fruits of weeds and other wild taxa include *Fimbristylis tetragona*, *F. dichotoma*, *F. tenuiculata*, *Rhynchospora hookeri*, *Cyperus* sp., *Elaeocharis* sp., *Dactyloctenium aegyptium*, *Andropogon* sp., *Panicum* sp., *Cenchrus ciliaris*, *Poa* sp., *Echinochloa crus-galli*, *Polygonum barbatum*, *Rumex dentatus*, *Lolium temulentum*, *Amaranthus* sp., *Chenopodium album*, *Cucumis* sp. (cf. *C. melo*), *Trianthema portulacastrum*, *Ipomoea pestigridis*, *Oldenlandia dichotoma*, *Rhynchosia minima*, *Trigonella occulta*, *Vicia sativa*, *Indigofera enneaphylla*, *I. linifolia*, *Desmodium gangeticum*, *Lathyrus aphaca*, *Cleome viscosa*, *Sida alba*, *Malvastrum coromandelianum*, *Commelina benghalensis* and *Argemone mexicana/ochroleuca*. The large collection of these plant remains throws light on the crop and weed association in ancient agricultural fields and gives an indication of the ground vegetation cover around ancient Narhan. Many wild plants might have played an important role in the economy of ancient settlers, as they are still used quite largely.

Information regarding the woods exploited by the Black and Red Ware folk at Narhan has also been derived by the study of wood charcoal remains. The taxa represented in the charcoals belong to dhak (*Butea monosperma*), Karanj (*Pongamia pinnata*), bistendu (*Diospyros montana*), mahua (*Madhuca indica*), mango (*Mangifera indica*), babul/khair (*Acacia nilotica/A. catechu*), mulberry (*Morus alba*), bakar (*Premna mucronata*), sal (*Shorea*

robusta), kuchala (*Strychnos nux-vomica*), tamarind (*Tamarindus indica*), jhau (*Tamarix dioica*), teak (*Tectona grandis*), basil (*Ocimum* sp.—cf. *O. sanctum*), gurch (*Tinospora cordifolia*) and bamboo (*Bambusa* sp.).

Having discussed the agricultural and forest economy, it is difficult to find out whether all the sites of Black and Red Ware culture in the Middle Ganga Valley had attained similar advancement or there were some differences between them. Taking stock of material progress that was made at Narhan about 3,000 years ago the present way of life in the villages of the area does not show any remarkable progress, although foundation of the present crop husbandry seems to have deeper roots in the protohistoric times. Besides, the rich evidence of agricultural advancement and remains of date and raisins (dried grapes) suggests intimate trade connections with the contemporary cultural communities in north-western India.

At Sohgaura in district Gorakhpur, the imprints of wild and cultivated rice (*Oryza rufipogon* and *O. sativa*) have been reported on the pottery (Sharma, 1983).

Khairadih is a small village on the bank of Ghaghra River in Ballia District. The excavations revealed the similar cultural chronology on this site as represented at Narhan. A large number of plant remains have been collected by the author and preliminary examination of seeds and fruits from the earliest phase of Black and Red Ware culture at Khairadih indicates similar advancement in agricultural economy, as from Narhan. In addition to field-brassica (*Brassica juncea*) already known, finds of yellow mustard (*Brassica campestris*) and castor (*Ricinus communis*) are new additions to the Chalcolithic culture of the Middle Ganga Valley (Saraswat, unpublished).

The culture of Sohgaura, Narhan and Khairadih complex shows striking similarity in the ceramic forms and other cultural equipments with those found in Bihar and the Vindhyan region, where the Chalcolithic phase seems to have Neolithic beginning and survives up to a later date. Here, although a large number of sites have been excavated, so far there is little information on plant economy. At Senuwar in district Rohtas of Bihar remains of rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum sphaerococcum* and *T. aestivum*), jowar-millet (*Sorghum bicolor*), chick-pea (*Cicer arietinum*), green-gram (*Vigna radiata*), field-pea (*Pisum arvense*), lentil (*Lens culinaris*), grass-pea (*Lathyrus sativus*), horse-gram (*Dolichos biflorus*), linseed (*Linum usitatissimum*), sesame (*Sesamum indicum*) and safflower (*Carthamus*

tinctorius), have been found from the Chalcolithic levels characterized by black and red ware industry (Saraswat, unpublished).

A few sites discussed here are widely scattered, yet there is sufficient archaeological evidence to show that the bearers of Black and Red Ware traditions in northern India were the skilled farming communities.

IRON AGE CULTURES

Towards the end of second millennium B.C., discovery of iron was by far the most important factor which heralded a new era in the cultural advancement in the Indian subcontinent. A new stimulus and technology emerged by the use of iron as a principal metal for tools, which accelerated more effectively the forest clearance to obtain extensive tracts for settlement and agriculture. Iron metallurgy was long thought to have been introduced into India from western Asia, but the data from geology, ancient literature, ethnography and archaeology has now indicated that the significant technological advance may have been developed independently in the Indian subcontinent (Chakrabarti, 1976). According to Hegde (1991), iron technology developed in India on the basis of a long tradition of successful copper technology which provided the necessary infrastructure for mining, roasting, crushing of the ore and beneficiation and smelting in small furnaces.

During the period of 1,200-1,000 B.C. iron using cultures attested in a considerable number of cairn cemeteries of Baluchistan, replaced the copper-using Chalcolithic folk. Although at Ahar in Rajasthan and Eran in Madhya Pradesh, iron-associated levels have been referred as early as to about 1,300 B.C. (Sahi, 1979), the use of iron on a larger scale does not seem to have stabilized at such an early date (Agrawal, 1982; Deo, 1991). For the beginning of iron technology in central India, Chakrabarti (1976), nevertheless, preferred a more conservative estimate of about 1,100 B.C. Here and elsewhere in southern India, the cultures are associated with Black and Red Ware tradition of the ceramic industry.

Process of iron technology in the cultures of Punjab opens around 1,200-1,100 B.C. and culminates in the Upper Gangetic plain in mid-first millennium B.C. On many of the sites in northern India the Iron Age cultures are associated with a break in pottery style—well-fired Painted Grey Ware (PGW) in the Upper Gangetic plain and in the eastern lowlands giving way to Black Slipped Ware (BSW) derived from earlier Black and Red Ware traditions, and to a very distinctive Northern Black

Polished Ware (NBPW). Beginning of the iron-using PGW culture at Atranjikhhera in district Etah is dated to $1,025 \pm 110$ B.C. In the Middle Ganga Valley in view of the evidence from Narhan, district Gorakhpur, Black and Red Ware folk acquired the iron technology during Ca. 1,160-800 B.C. and transmitted to Black Slipped Ware phase, dated from 800 to 600 B.C. (Singh, 1991). NBPW sites, widely scattered in northern plains, are almost covered by a time-bracket of Ca. 600-50 B.C. (Agrawal *et al.*, 1978).

In northern India a variety of metal equipments made of iron, copper, bronze, lead and tin and iron tools facilitated more effective clearance of woodland. Textile, metalwork, jewellery, pottery and other craft industries had developed giving rise to a measure of specialization and trade. Population increased and a number of settlements emanated with administrative central-place functions, but later adding marketing and commercial activities. Such places known as *Mahajanpadas*, recorded in the literature and now identified on ground (e.g., Kausambi, Varanasi, Rajgrih, Pataliputra, etc.), were to provide the basis for the rise of India's second urbanization. Steps were made in the development of caste system to stabilize the elements of plural society of diverse ethnic and economic components and it was in this period that a complex socio-religious system developed. The iron technology facilitated, for the first time, substantial inroads to be made into the eastern forests for the emerging *Mahajanpadas*, which enhanced the setting of very complex philosophical maturity of the Indian Civilization. The expansion of agriculture facilitated by the iron tools apparently provided an additional "techno-environmental efficiency" (Harris, 1975).

The factual evidence of plant remains, however, does not throw adequate light on this issue. In view of the rich economy of the Harappans and other Chalcolithic cultures, it is clear that the farming was successfully operated even in heavily wooded ecozones, prior to the introduction of iron technology. Maximum number of iron-using sites are in Punjab, Haryana and western Uttar Pradesh. So far more than 650 sites of Painted Grey Ware culture have been discovered (Lal, 1984). But our information on plant economy of this culture in Vedic and Post-Vedic times is regrettably scarce and scattered.

In Punjab, Kodon-millet (*Paspalum scrobiculatum*) and wood charcoals of *Acacia* and *Albizia* species have been reported from NBPW phase at Rupar, dated from 600 to 50 B.C. (Savithri, 1976). Preliminary examination of recently collected food grains from the iron-associated phase (Ca.

1,300-400 B.C.) at Sanghol in district Ludhiana has revealed the presence of *Oryza sativa*, *Hordeum vulgare*, *Triticum sphaerococcum*, *T. aestivum*, *Lens culinaris*, *Vigna radiata*, *Pisum arvense*, *Dolichos biflorus*, *Lablab purpureus*, *Sesamum indicum* and *Brassica juncea* (Saraswat, unpublished). Detailed studies of these remains are likely to fill-up the gap of our knowledge on the Iron Age crop-economy in Punjab.

In western Uttar Pradesh grains of rice (*Oryza* sp.), cuticle remains of *Saccharum spontaneum* and rice-husk and the wood charcoals *Dalbergia sissoo* and *Holarrhena antidysenterica* were identified by Chowdhury and Ghosh (1954-55) from Hastinapura in district Meerut (Ca. 900-500 B.C.). It has, however, not been possible to determine whether rice grains from Hastinapura belong to some wild or cultivated form (Vishnu-Mittre, 1974). At Atranjikhhera in district Etah, *Oryza sativa*, *Hordeum vulgare* and *Triticum compactum* were the food grains from the Painted Grey Ware phase (Ca. 1,025-600 B.C.). The only timber known was chirwood (*Pinus roxburghii*). Ramie-fibre (*Boehmeria platyphylla*) recovered from the face of a fishing-net impression indicates quite advanced knowledge as this fibre has great strength and durability, and high resistance to water action. From the following Northern Black Polished Ware horizon at Atranjikhhera (Ca. 600-200 B.C.), in addition to *Oryza sativa*, *Hordeum vulgare* and *Triticum aestivum*, black-gram (*Vigna mungo*) has also been reported. Timbers of farash (*Tamarix articulata*), laurel (*Terminalia tomentosa*), cypress (*Cupressus torulosa*) and deodar (*Cedrus deodara*) have also been identified. Shaft of an arrow-head has been identified as of *Dendrocalamus strictus* (Chowdhury *et al.*, 1977). Exploitation of chirwood, cypress and deodar from the Himalayan forests is definitely a sign of an advanced knowledge of timber utilization in the iron-using cultures of the Upper Ganga-Yamuna Doab.

From a number of sites in Middle Ganga Valley, evidences of Iron Age plant economy have come to light in recent years. Food grains of *Oryza sativa*, *Hordeum vulgare* and *Pisum arvense* have been reported from Painted Grey Ware and Northern Black Polished Ware phases at Radhan in district Kanpur (Kajale & Lal, 1988). From Black Slipped Ware and Northern Black Polished Ware cultures (Ca. 800-200 B.C.) at Hulaskhera in district Lucknow, food grains of *Oryza sativa*, *Hordeum vulgare*, *Eleusine coracana* and *Vigna radiata* have been found in association with wild seeds and fruits of *Chenopodium album*, *Echinochloa crus-galli* and the species of *Fimbristylis*, *Indigofera* and *Cyperus* (Chanchala, 1992).

In Allahabad District, Kausambi is an important site. From Northern Black Polished Ware culture (Ca. 600-200 B.C.), barley (*Hordeum vulgare*), cotton seeds (*Gossypium arboreum/herbaceum*) and the timbers of *Soymida febrifuga*, *Holarrhena antidysenterica*, *Adina cordifolia*, *Ziziphus*, *Terminalia*, *Lagerstroemia*, *Anogeissus* and *Dalbergia* species have been reported by Chanchala (1986-87, 1987-88). At Sringaverapura, a key-site of Ramayana Age on the bank of Ganges in district Allahabad, the phases of iron-using cultures are characterized by Black Slipped, Black and Red, Burnished Grey and associated red wares, dated from 950 to 700 B.C. Rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum sphaerococcum* and *T. compactum*), chick-pea (*Cicer arietinum*) and green-gram (*Vigna radiata*), cuticles of barley husk and leaf epidermal remains of rice, palm (*Phoenix* sp.) and khus-grass (*Vetiveria zizanioides*) have been identified (Saraswat, 1982-83; Vishnu-Mittre *et al.*, 1985). Wood charcoals belong to *Madhuca indica*, *Mangifera indica*, *Mesua ferrea*, *Ziziphus* sp., *Albizia* sp., *Betula utilis* and *Bombax malabarica* (Saraswat, 1989). In the preceding Chalcolithic period at this site, dated from 1,050-1,000 B.C., presence of *Pinus roxburghii* charcoals was noticed along with other locally available timbers. *Pinus* occurs in the outer Himalaya and Siwalik Range, and also in the valleys of some Himalayan rivers at an elevation of about 1,500-7,500 feet. In this period the exploitation of still higher ranges of the Himalaya is noticed by the presence of bhojpatra (*Betula utilis*). Bhojpatra trees are found from Kurram Valley in western Himalaya at the elevation of 11,000 feet to Bhutan, ascending to about 14,000 feet; rarely descending below 10,000 feet (Gamble, 1902). The possible nearest source of bhojpatra to the settlers at Sringaverapura seems likely to have been the Garhwal Himalayas. It is important that the Iron Age people in the Ganga Valley had a know-how of the upper Himalayan forest wealth. Use of bhojpatra wood for some constructional purpose, in propensity of several quality timbers available in the plains, is naturally dropped. Main product of this tree is bark, consisting of thin papery layers peeling off in broad horizontal rolls. The regional utility of bark in upper Himalayas is attested for roofing, umbrellas, etc. The papery bark has been used for writing since much ancient times. It is safer in practice to transport thick branches of bhojpatra to avoid any damage to bark. Quite likely this may have been the reason for the finding of bhojpatra wood at Sringaverapura. The Indus people had an inscription in 2,300 B.C. Brahmi script was widely known during the Ashokan

period. Some scholars also conceive the writing (pro-Brahmi script) must have existed long before the Ashokan time. In view of this fact it is left to the scholars to decide whether or not the evidence of bhojpatra material at Srngaverapura should be taken as a genuine indication of writing on bhojpatra bark, during 950-700 B.C. Another important evidence is iron-wood (*Mesua ferrea*) which is one of the hardest, heaviest and strongest timbers in India. Iron-wood is an element of evergreen forests in Assam and Bengal. For what purpose it was brought, is not known. But the people in the Middle Ganga Valley should be having a well-knit trade system to have exploited this valuable raw material of the far-flung eastern localities.

From the later phase of Black and Red Ware culture dated to about 800 B.C. at Narhan on the bank of Ghaghra River presence of a few rusted-iron particles on the surface of an impression of a fishing-hook indicates that the hook was made of iron. From the surface of a thread impression associated with that of hook, recovery of ramie-fibre (*Boehmeria* sp.) is important. In the present state of our knowledge, ramie is the most suitable fibre for fishing-thread. The use of ramie for making fishing-net by PGW folk at Atranjikhhera has already been reported. The carbonized grains of rice, barley, field-pea and green-gram from the Black Slipped Ware culture (Ca. 800-600 B.C.) are of the same kind as from Period I characterized by Black and Red Wares (see Chalcolithic cultures). Safflower (*Carthamus tinctorius*) is a new introduction in this period. The wood remains of *Acacia* sp., *Madhuca indica*, *Diospyros montana*, *Shorea robusta*, *Tamarindus indica*, *Mangifera indica*, *Ocimum* sp. and *Tectona grandis* have been found, in continuation from the earlier Chalcolithic period. However, the wood charcoals of sissoo (*Dalbergia sissoo*), anwala (*Emblia officinalis*), kaim (*Mitragyna parviflora*) and jambolana (*Syzygium cumini*) are new elements represented in this phase.

During the following period of NBPW culture (Ca. 600-200 B.C.) food grains of *Oryza sativa*, *Hordeum vulgare*, *Triticum sphaerococcum*, *T. aestivum*, *Paspalum scrobiculatum*, *Vigna mungo*, *Vigna radiata*, *Lathyrus sativus* and *Sesamum indicum* have been found. Fruit remains include jujube (*Ziziphus mauritiana*) and emblic-myrobalan (*Emblia officinalis*). Remains of cuticles recovered from the mud plasters of some wattle and daub structure have been found to be of rice-husk and leaf, bamboo and wild grasses—*Saccharum spontaneum* and *Desmostachya bipinnata*. Wood charcoals of *Lagerstroemia parviflora*, *Pinus roxburghii*, *Santalum album* and *Boerhavia diffusa*

are new additions to the timber taxa of *Madhuca indica*, *Ocimum*, *Tamarindus indica* and *Mangifera indica* from the preceding phase of BSW culture. The rich information on the bulk of botanical remains at Narhan has contributed significantly to our understanding of the Iron Age plant economy in Ghaghra Valley (Saraswat & Sharma, 1985, 1986-87; Saraswat *et al.*, 1988, 1987-88, 1990, 1991; Sharma, 1989). Meat was also an important component in their diet as evidenced by a large number of charred animal bones with cut marks. Cattle, sheep or goat and horse bones are found indicating animal husbandry (Singh, 1991).

Khairadih, on the right bank of Ghaghra in Ballia District, is another site keeping with the general trend of chronology and other material remains similar to Narhan (Singh, 1989). A sizable quantity of the carbonized material has been collected from this site. Studies are at present in the preliminary stage. Food grains of rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum sphaerococcum* and *T. aestivum*), green-gram (*Vigna radiata*), chick-pea (*Cicer arietinum*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), lentil (*Lens culinaris*), etc. have been found which belong to Northern Black Polished Ware culture (Ca. 600-200 B.C.). Wood charcoal remains belong to mahua (*Madhuca indica*), babul/khair (*Acacia nilotica/A. catechu*), mango (*Mangifera indica*), kandi (*Flacourtia indica*), sal (*Shorea robusta*), neem (*Azadirachta indica*), teak (*Tectona grandis*), sissoo (*Dalbergia sissoo*), dhak (*Butea monosperma*), maha-ruk (*Ailanthus excelsa*), bistendu (*Diospyros montana*), tamarind (*Tamarindus indica*), chilbil (*Holoptelia integrifolia*) and dhela (*Alangium salvifolium*). Further studies are still in progress (Saraswat, 1989-90; Saraswat *et al.*, 1990).

The finds of some herbal-drug yielding plants from different cultural horizons during first millennium B.C. at Narhan and Khairadih, created a good deal of excitement. At Narhan the presence of date (*Phoenix dactylifera*), draksha (*Vitis vinifera*), tulsi or basil (*Ocimum* sp. cf. *O. sanctum*), Kuchla (*Strychnos nux-vomica*) and gurch (*Tinospora cordifolia*) from Black and Red Ware culture (Ca. 1,100-800 B.C.) and that of emblic-myrobalan (*Emblia officinalis*) and sandalwood (*Santalum album*) from Northern Black Polished Ware phase (Ca. 600-200 B.C.), have been noticed. At Khairadih the remains of nutmeg or jaiphal (*Myristica fragrans*), emblic-myrobalan (*Emblia officinalis*), haritaki or chebulic-myrobalan (*Terminalia chebula*), draksha (*Vitis vinifera*) and chiraunji (*Buchanania lanzan*) are found in Northern Black

Polished Ware culture, dated Ca. 600-200 B.C. (Saraswat *et al.*, 1990). A great deal of information on the use of medicinal plants, scattered pell-mell in Vedic and Buddhist canonical literature and in Ayurvedic treatises is known. The ancient remains of medicinal plants are highly valued, making the archaeological and historical reconstruction more meaningful, particularly to ascertain their relevance within the Vedic and post-Vedic system of medicine in the first millennium B.C. During this period the religion was closely interwoven with economy, trade and commerce. The finds of sandalwood which is native of Mysore and surrounding region, nutmeg of Moluccas, Celebes and Sumatra islands, and draksha and date which were obtained from north-western Indian subcontinent, affirm that medicine domain was no exception to the well-knit organization of trade and commerce in the Middle Ganga Valley.

Further eastward in Bihar the excavation work at Manjhi, on the bank of Ghaghra in Saran District, has revealed the occupational phases of iron-using Black Slipped Ware and Northern Black Polished Ware cultures (Roy, 1987). Food grains of *Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Vigna radiata* and *Pisum arvense* have been preliminarily examined from the Northern Black Polished Ware culture (Ca. 600-200 B.C.) at this site. During Early Historic period the piles of wooden palisade at Pataliputra were made of *Shorea robusta* (Ghosh & Lal, 1958). Wood remains of *Acacia* sp., *Holarrhena antidysenterica*, *Boswellia serrata*, *Casearia* sp. and *Soyimida febrifuga* have been identified from Sisupalgarh (Ca. 300 B.C.-350 A.D.) near Bhubaneshwar, Orissa (Chowdhury & Ghosh, 1952). The information on plant economy from the eastern region is meagre. Systematic collection of material from new excavations would enrich our knowledge in this context.

The south Indian Burial complex—usually referred to as Megalithic, comprises a great variety of grave forms, including stone circles with urn burials, legged pottery sarcophagi, cist graves, stone alignments, and rock-cut chambers. Concentrated in south India, they are also found in many other areas of the subcontinent. Chronology of Iron Age Megaliths has been extended recently by typology and radiocarbon cross-dating to about 1,000 B.C. Megaliths are mainly commemorative rather than sculptural. Having considerable diversity of local traditions, they have certain things in common. The grave pottery is predominantly Black and Red Ware. A variety of beads, small gold ornaments and objects of bronze, copper and iron are universally represented among the grave goods. The latter include iron axes, sickles, chisels, knives, tripods,

lamp-pendants, daggers and swords, all of so similar manufacturing techniques as to indicate a closely organized community (or caste) of smiths serving the local pastoral population. That some of the cultural traits represented in this complex were transmitted from Central Asia and Iran by Indo-European migrants is generally accepted, as is the proposition that others were developed from traditions already extant among the Neolithic-Chalcolithic population of the area. In the present context it is sufficient to remark that at the southern end of the Deccan corridor a regional picture of considerable persistence developed that can not be entirely accounted for by the diffusion of innovations from the north.

Dozens of sites have been excavated in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. Only a few have revealed the information on plant remains. Agricultural activity of the Megalithic people in Maharashtra is corroborated by the finds of agricultural tools like sickles and hoes and the food grains recovered from the Megalithic sites at Naikund and Bhagimohari in district Nagpur. The assemblage of food grains comprises rice (*Oryza sativa*), barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), kodon-millet (*Paspalum scrobiculatum*) and finger-millet (*Eleusine coracana*). Besides, the seeds of legumes like field-pea (*Pisum arvense*), lentil (*Lens culinaris*), black-gram (*Vigna mungo*), grass-pea or khesari (*Lathyrus sativus*), horse-gram (*Dolichos biflorus*), hyacinth-bean (*Lablab purpureus*) and pigeon-pea (*Cajanus cajan*) and fruit remains of jujube (*Ziziphus* sp.) have also been reported (Kajale, 1981, 1989).

Food grains reported from Satavahana period (450-50 B.C.) and Indo-Roman period (50 B.C.-200 A. D.) at Nevasa on the bank of river Pravara in Ahmednagar District, indicate the crop economy similar to that of Megalithic culture (Kajale, 1976-77). The information on the food economy of Megalithic, Early historical and the overlapping phases of these two cultures (C. 500 B. C.-400 A. D.) is drawn from the excavations at Veerapuram in district Kurnool, Andhra Pradesh (Kajale, 1984). The food grains of *Oryza sativa*, *Hordeum vulgare*, *Paspalum scrobiculatum*, *Pisum arvense*, *Dolichos biflorus*, *Lablab purpureus* (syn. *Dolichos lablab*), *Vigna mungo* and the fruit remains of jujube (*Ziziphus* sp.) and beleric-myrobolan (*Terminalia belerica*) have been found. It is obvious that the settlers at Veerapuram enjoyed the food economy similar to the Megalithic people in Maharashtra. The remains of *Dolichos biflorus*, *Lathyrus sativus* and fruit-stones of *Ziziphus jujuba* from Iron Age levels at Tekkalakota (Savithri, 1976), and *Paspalum*

scrobiculatum and *Oryza sativa* from Hallur, Karnataka (Vishnu-Mittre, 1971) are known. Only *Dolichos biflorus* seeds are known from Iron-Age cultures at Paiyampalli in Tamil Nadu (Allchin & Allchin, 1968). These sites may have been rich, but yielded too little to be convincing.

Studies on wood charcoal remains in the context of Iron Age and Early Historical cultures in south India have been carried out only from a limited number of sites. *Tectona grandis* and the species of *Acacia*, *Dalbergia*, *Anogeissus* and *Terminalia* (Rao & Sahi, 1967) are known from Prakash in West Khandesh, Maharashtra (Ca. 600 B.C.-600 A. D.). Purpose for which these woods were used, is not known. At Maski in Raichur District of Karnataka, dated from early first millennium B.C. to First century A.D., *Acacia* and *Chloroxylon swietenia* were exploited for firewood (Chowdhury & Ghosh, 1957). Arikamedu near Pondicherry in Tamil Nadu, is an Early Historical site (Ist century B.C.-I century A.D.). Here timbers of *Diospyros*, *Mimusops* and *Heritiera* species were used to make boats, toys and other wooden furniture (Chowdhury & Ghosh, 1946).

In the far south innovations from the north arrived by the southern corridor (Daksinapath) ahead of the Mauryan expansion by 4th century B.C., and diffusion by seaways became equally significant. In view of the discussion, the informations of plant remains from the settlements of the Iron Age cultures belonging to I millennium B.C. and widely scattered all over the country. The iron, indeed, equipped the settlers for great potentialities to achieve significant economic prosperity. A large gap occurs in our present knowledge of the plant economy, during the later phases of protohistoric period and the beginning of Early Historical cultures.

CONCLUSION AND REMARKS

There is no dispute that we have built up affluent information concerning the plant economy of various archaeological periods and an extensive use of radiocarbon dating has provided reasonably consistent chronologies of cultures of the whole subcontinent, both in time and space. In recent years increasing attention has been focussed on the technological and economical aspects of different cultures. The remains of plants and animals and the cultural data are not only complimentary, but absolutely interdependent for interpretation purposes. The subcontinent with a wide range of climate from temperate winters to tropical summers, with monsoon rains varying in range from practically

nil to almost the highest in the World, offered variable circumstances to a variety of food grains and other plants represented in diverse cultural deposits. A rich data gathered, might be of some value in assessing the economical and ecological potential of the cultural settlements. Most of the reports are limited to a record of presence or absence of particular crops in various levels of stratified sequence. The crop remains have much information to give not only about the cultural level but also about the diffusionary traits of agriculture and likelihood of cultural intercourse. The crux of the approach is how conducive environmental conditions had been to spatial propagation of specific agricultural innovations in relations to the know-how of a particular human culture in the dark ages. But, in view of the progress of work on economic, social and technological aspects of diverse cultures, we have suffered the most with the dearth of botanical knowledge in the prehistoric times. The information, howsoever important it is, is inadequate and any realistic of the original extent at the individual sites must take account of possible gaps in our archaeobotanical record. Many archaeologists, until recent years, have not seriously looked for the plant remains. As a result, the potentially rich sites yielded too little to be convincing. Now floatation techniques promise to give us a much higher yield of material evidence than had been available in the past. Consequently, some new archaeobotanical evidences seem to offer not only a point of radical departure from the traditional picture, but also a body of firm empirical evidence against which theoretical models could be evaluated. The gaps in our knowledge are also due to the preservation of material by carbonization. A good number of plants are unlikely to have come in contact with fire and many fail to survive in identifiable form. Thus by means of synthesis of botanical information from a number of sites, general tendencies of the plant wealth in ancient economy should be established.

The contemporary local and regional variability in the culture has also been neglected. Environment and socio-economy are certain to provide valuable informations. The approach necessitates taking into consideration many other botanical evidence including the study of pollen, wild seeds and fruits, wood charcoals and other organic remains, thus giving an insight into the character of physical environment of individual cultural settlements. In recent studies wild seeds and fruits are being studied, but the informations on wood charcoal and cuticle remains are still inadequate. Wood charcoals are also only a fraction of the biological material and

we cannot attempt a reconstruction of the environment on the basis of them alone. They are, however, a component of fundamental importance when they are taken in an overall framework of flora in which all the other type of data are integrated. The habitats of tree taxa suggest a sectorial reconstruction of floral belt or associations in the light of modern information. Some quality woods are attested with the economic context.

In spite of all limitations, the basic framework of cultural plant economy has now been more precisely defined in space and time. Systematization of work that was so intractable a quarter of a century ago, has also proved that India and Pakistan constitute the region where crops and agricultural practices have their roots much deeper in the prehistory. Some of the finds have amazingly been found to date back seven or eight thousand years before the Christ.

Until recent past the earliest radiocarbon dates for domestic plants in the Indian subcontinent were for the cereals and other food grains found in late fourth millennium Afghanistan (Allchin, 1969) and at sites of the Indus Civilization of about mid-third millennium B.C. (Chowdhury, 1971). Recently the cereal remains of wheat and barley from Aceramic Neolithic settlement at Mehrgarh in Baluchistan (Jarrige & Meadow, 1980; Costantini & Biasini, 1985) and potsherds with impressions and carbonized grains of cultivated rice from Neolithic Koldihwa and Mahagara in the Belan Valley of district Allahabad in the Gangetic plain of Uttar Pradesh (Savithri, 1976; Sharma, 1980, 1985; Sharma, A., 1983; Sharma *et al.*, 1980), have amply demonstrated the earliest evidence of agriculture as early as sixth-seventh millennia B.C. The crops of wheat and barley which were supposed to have been imported from West Asia, have been demonstrated to be of a process of indigenous domestication in the north-western region of the subcontinent. The egalitarian social and settlement systems in Baluchistan have shown the gradual advancement right from the earliest Neolithic culture through various Chalcolithic stages which eventually led to the understanding of highly advanced Harappan economy. Contemporarily, the early history of agriculture through the examination of material from the Gangetic Valley, has provided an unequivocal record of the earliest cultivation of rice in the world.

Neolithic cultures in other diverse regions coexisted with Harappan and other Chalcolithic cultures, from the mid-third millennium to mid-second millennium B.C. Rich data on the plant wealth amply demonstrate that despite the knowledge of metal, Neolithic farmers could successfully exploit the land resource for sufficient

means of agriculture.

A number of new finds have added immensely to the economy of Harappans. Evidences from Punjab have shown that their economy was not shaped only by cultivating the annual crops, but they attained the know-how of an advanced horticultural practices to cultivate fruit trees, vegetables and ornamentals as well for adornment (Saraswat, 1988, 88-89, 1990-91). Discovery of ploughed-field at Kalibangan in Rajasthan is also unique in the world (Lal, 1970-71). There can be no doubt that it was of just on the same pattern as that followed by the modern farmers of the region for mixed cropping, and as such it is an extraordinary example of the longevity of Indian agricultural technology. Another instance of the same competence now suggests that the Harappan expansion into Saurashtra and Gujarat may have resulted from an awareness of the much greater potential of those areas for growing millets and other crops of wheat, barley and legumes, compared with the Indus Valley itself. Further, the data on plant economy of Harappans in western Uttar Pradesh during their cultural degeneration, has demonstrated the diffusion of crop economy into the Chalcolithic Gangetic Valley. It has also elucidated the connections between two cultures that was thought to be unrelated.

The striking feature of the pattern of plant records in Chalcolithic and Iron Age cultures of Ganga Valley and the peninsular India (2nd—I millennia B.C.) indicates extensive trade contacts. Crops of north-western region (alternatively called as Middle Eastern Complex) such as wheat, barley, field-pea, chick-pea, lentil, etc. spread during the second millennium B.C. throughout the peninsula and northern plains. Rice, the most important indigenous crop, is also found throughout, except in Saurashtra and Gujarat. Third group, including jowar-millet, finger-millet and pearl-millet, has their wild relatives in Africa. In default of their early evidences in Africa, they are regarded on the botanical evidences alone, as introduced in India. These three major groups of the food grains are well represented in the Indian archaeological record, over a wide area witnessing diverse environmental conditions. It can be surmised that artificial irrigation and other management practices may have made it possible to expand the agriculture systems into environmental zones where particular type of crops would have not been found. Conversely, artificial systems by the different cultural groups must have had changed the unfavourable conditions to favourable ones, for sufficient means of agricultural practices.

It is necessary to pause here for a moment to consider the potential complexity of the interaction

of processes involved in the development of agriculture in time and space. The situation is never static. Human interaction with ecosystems in the form of habitat modification and manipulation of gene pools does not stop with the transfer of crops and habitats into new environmental regions, but continues and likely leads to further significant changes and innovations. As a result, there may have been repeated transfers of crops and habitats which need not all be in the same direction but may have resulted in the return of highly modified forms back to an original region. As crops and habitats got shifted, there would have been continuing opportunities for feral and weedy varieties of crops to establish themselves. Such local populations must have constituted additional sources of genetical variability that contributed to further development of domesticates through interbreeding and backcrossing. Because of human communication and exchange, often over a long distances, the increasing number of populations of a single crop existing in different areas and under different environmental conditions, must have represented an ever increasing genetic pool for manipulation during the long course of the agricultural history. Given the complexity of this scenario, it should not be surprising that it is often exceedingly difficult to trace the history of particular crop and cultivation systems. In any event, it becomes clear that the empirical verification of the model of crop plants sketched on archaeological remains, demands a large body of data from different fields. Indian archaeology does not, at present, have such a body of data to precisely reconstruct the history of agriculture development. It would be particularly desirable to assess the bearing of the archaeological evidence against arguments put forward by geneticists and plant geographers.

A large number of seeds and fruits of wild and weed species recovered from various sites are of particular significance, not only to the actual determination but also for acquiring the state of soil conditions and the picture of ground vegetation around the settlements. Many plants may have arrived through the activity of man, albeit not necessarily intentionally. In association with crop remains, they may be taken as reliable evidence of the state of fields and serve significantly to sketch the perspectives of ecological potential of contemporary agro-ecosystems. So many weeds may have arrived along with the diffusion traits of agriculture from distant phytogeographic regions. From a number of settlements, weeds and other wild taxa have been reported. Owing to the gaps in our information, the systematic collection of these

remains in future would be of particular significance. Prehistoric man was dependent on wild plants for food, medicine, ceremonial and other requirements; infact these are still in use. Based on the economic models of present-day tribal and farming communities some conclusions can be drawn, which would be meaningful in prehistoric economy. Circumstantial evidences thus warn us not to assume easily that the wild and weed plants were of no economic importance.

It is not known when man began to use wood. However, a general belief is that wood was used for the first time during the Stone Age when man was on the look-out for a digging tool in search for food. Selection of various timbers for specific use and secondly, locating the forest sources from where quality timbers could be obtained, would have been the two aspects of timber utilization during prehistoric times. Use of Himalayan *Cedrus deodara* and *Dalbergia latifolia* of central India at Harappa for making coffin, is an unique example. From several other sites a number of quality woods have been found, but their specific use is difficult to work out. *Cedrus deodara* from Harappan Rohira in Punjab; *Pinus roxburghii*, *Cupressus torulosa* and *Cedrus deodara* from Iron Age cultures at Atranjikhera in Etah District, Uttar Pradesh; and *Pinus roxburghii*, *Mesua ferrea* and *Betula utilis* in Chalcolithic and Iron Age cultures at Sringerapur in Allahabad, Uttar Pradesh may be few examples among many others, which suggest that pre- and proto-historic men since much ancient times claimed priority for an efficient exploitation of this forest product from widely scattered regions.

Wood charcoal studies at Rohira in Punjab have brought an insight into the cultivation of grapevines by Harappans. Charcoals of henna (*Lawsonia inermis*) and parijat (*Nyctanthes arbor-tristis*) at the same site provide an information on the gardening activity of Harappans in Punjab. Further, the charcoal study at Narhan has brought to light the evidence of *Ocimum* sp., *Tinospora cordifolia*, *Strychnos nuxvomica*, *Santalum album*, etc. which are highly valued in the system of herbal medicines. Such evidences are of considerable significance in a prehistoric cultural economy of middle Ganga Valley.

Until very recently the existence of high level of sanitation, public hygiene, physical and chemical science and an advanced architecture and agriculture represented in archaeological sites, had been likely to be matched by a similar knowledge of medicine. Now, the systematic and intensive analysis of the bulk of plant remains carried out at the Birbal Sahni Institute of Palaeobotany, Lucknow from Narhan and

Khairadih on the bank of Ghaghra River in Uttar Pradesh suggests that during the first millennium B.C. a highly advanced medicinal system was in vogue. A collective evidence of drug-yielding plants represented by the remains of draksha (*Vitis vinifera*), tulsi or basil (*Ocimum* sp.), Kuchla (*Strychnos nux-vomica*), punarnava (*Boerhaavia diffusa*), emblic-myrobolan (*Emblia officinalis*) and sandalwood (*Santalum album*) from Narhan; and chebulic-myrobolan (*Terminalia chebula*), emblic-myrobolan (*Emblia officinalis*), jaiphal (*Myristica fragrans*), chiraunji (*Buchanania lanzan*) and bel (*Aegle marmelos*) from Khairadih (Saraswat *et al.*, 1990). This period from 1,000 B.C. to 200 B.C. is equated with the post-Vedic and buddhist era of history. All these plants are highly valued on the rational scientific basis in the indigenous medicinal system called as Ayurveda. It is also invariably true that medicines develop in any community or society only after a fairly high level of medical knowledge has already come up. The same must have been the case in the socio-economy of Indian cultures. Prior to first millennium B.C. the inadequacy of the local medicines must have been realized to meet out the growing needs of society. This realization was followed by action to import the much needed knowledge of a rational medicine from beyond the confines of the north Indian plains. The finds of medicinal plants also support this proposition about the interaction between north and south India, as well as the north-western region. Sandalwood was brought from south India, chiraunji from central India, and draksha or grapes and date were obtained from north-western India. Most interesting is nutmeg or jaiphal, which is native of Moluccas, Celebes and Sumatra Islands. The exploitation of resources is suggestive of ingenuity in economic and commercial activities between diverse cultural regions. This approach made through the archaeobotanical remains has for the first time explored the wisdom of ancient settlers in northern India to assess the advancement in medical knowledge based on factual evidences.

In our current approach we have been liable to forget what type of subsistence economy may have preadapted non-agricultural people to become cultivator? This question of prime importance is still awaiting an answer. The farmers and the hunters and food-gatherers manipulate their environment, deliberately as well as inadvertently. A survey of ethnographically documented hunting-and-gathering societies will show that virtually all of them interfere with their environments in a variety of ways, many of which result in some increase in the productivity of particular plant species. Food-gatherers act as

dispersal agents for plants and often look after the plants of particular interest to them, and also suppress their natural enemies and competitors.

The archaeological contexts for the earliest signs of domestication have been termed 'Mesolithic' in some areas. These settlements have yielded microliths or other stone blade implements and ground stone tools similar to Neolithic ones, and domesticated-animal bones (Gupta, 1979). Mesolithic folk were hunters and food-gatherers. Occurrence of a large number of querns, mullers, anvils and hammers indicate that they exploited the vegetal food resources (Sharma *et al.*, 1980). Camp sites of Mesolithic people at Mahadaha and Sarai Nahar Rai (Sharma *et al.*, 1980) present the picture of an incipient village settlement (Varma, 1984). These people knew pottery and devised ways for storage. Wild rice embedded in the lumps of burnt clay from Chopani Mando in the Belan Valley (Sharma *et al.*, 1980) and the grains of wild grasses, *Chenopodium*, *Portulaca*, rice (wild), etc. from Damdama in Pratapgarh District, Uttar Pradesh (Kajale, 1988) provide useful information on the exploitation strategies of wild plants by the Mesolithic men. Evidence of animal domestication comes from Bagor in Rajasthan and Adamgarh in Madhya Pradesh (Misra, 1973; Sankalia, 1974). Bones of domesticated sheep/goat and some cattle suggest that some headway had been made in this direction in Mesolithic times (Ca. 10,000-8,000 B.C.), prior to the commencement of agriculture in Neolithic culture. As agriculture developed incrementally from the stage of food-gathering, it is not possible to exactly define when it first occurred. It is, however, possible to decipher when the manipulation of natural ecosystems intensified rapidly in a region, which eventually led to the food-producing economy.

The historical reconstruction and the search for empirical evidence of botanical remains are considerably complicated. The point is not to propose a pat formula by which the development potential of a given cultural interaction with plant wealth can be assessed. Too many theoretical as well as empirical questions remain to be solved. Further work in the recovery and identification of cultural plant remains is likely to produce additional evidences to fill up the existing gaps in our knowledge.

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