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Tools and Tillage: Traditional Implements and their Role in Agricultural Systems of the Recent and more Distant Past in South Asia, with special reference to Bannu District (Pakistan)

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Abstract: This paper presents observations of traditional agricultural tools that were in use in Bannu District in recent times. The principal fieldwork was focussed on village Bharat where many old implements, mostly of wood, were brought to light, having been kept in storage since they were replaced by modern metal, often mechanized, versions. The roles of these implements in traditional agriculture and food production are considered alongside similar studies of traditional agricultural implements that have been made in other parts of South Asia. The ard-plough, an 'icon' of agricultural practice across Eurasia, receives special treatment. This leads on to a consideration of sources that might provide information about agricultural implements and practices in the more ancient past. The categories of evidence considered are ancient historical sources, artistic representations, and a diverse range of archaeological evidence. The long-term survival or persistence of many types of traditional agricultural implements is testament to how successful and well-adapted they were. They potentially offer useful and unique insights into present-day environmental issues, in particular the sustainability of agricultural production. Traditional agricultural implements are a vital cultural resource and a tangible link to the recent past. They should be preserved and displayed, to inform an increasingly urbanised society about past ways of life and how people coped with change.

Keywords: Traditional Agricultural Implements, Ancient Historical Sources, *Kṛṣi-Parāśara*, Rock Art, Ancient Agricultural Artefacts, Sustainable Tillage and Conservation, South Asia

Introduction

> '*First you have to get your fields ploughed. When that is done, you have to get them sown. When that is done, you have to get the water let down over them. When that is done, you have to get the water let off again. When that is done, you have to get the weeds pulled up. When that is done, you have to get the crops reaped. When that is done, you have to get the crop carried away. When that is done, you have to get it arranged in bundles; when that is done, you have to get it trodden out. When that is done, you have to get the straw picked out. When that is done, you have to get all the chaff removed. When that is done, you have to get it winnowed. When that is done, you have to get the harvest garnered. When that is done, you have to do just the same next year and the same all over again the year after.*'
>
> Mahanama introducing Aniruddha to the actions and rhythms of the farming cycle. Source: *Kullavāgga* texts, c. 5th Century CE (Gangopadhyay 1932: 42; Randhawa 1980: 361).

This charmingly written account of the principal events and sequences of the farming cycle encapsulates the breadth of knowledge and wealth of experiences that are universally and timelessly applicable to virtually all farming systems. Most of the operations described require specific implements or tools as well as skills in their use. In this paper, I seek to explore the types and variety of tools employed in the recent and more distant past in some traditional farming systems in South Asia, with special reference to observations made at Bharat village in Bannu District, Pakistan. We start with an outline of previous studies of traditional agricultural technology in South Asia.

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Studies of traditional agricultural implements in South Asia

In the last few years there has been an increase in research on traditional agricultural technologies in South Asia. One of the earliest is a survey of agricultural implements of India. In 1954 the Indian Council of Agricultural Research sanctioned a survey of indigenous agricultural implements on an all-India basis, to gather information about the design, construction, output, power requirements and general performance of the several types of indigenous implements used in the various parts of the country. The resulting State-by-State inventory (Raghavan 1960) is a monumental work impossible to summarise here. No doubt it has been helpful for decision makers seeking to adapt and develop India's agrarian infrastructure in the early years following independence, but the lack of any specific social and agricultural contexts makes it less useful for the purposes of the present paper. Das and Nag (2006) wrote a brief and very general review of traditional agricultural tools of India, which was largely concerned with the economic scales of their production. Since then, specific regional and more anthropologically embedded studies of agricultural implements and their roles in agrarian systems have been made. Each is referred to in specific instances in various parts of this paper, so here it will suffice to introduce them in chronological order of publication. Traditional agricultural implements used by dry land farmers in Tamil Nadu are reported by Karthikeyan *et al.* (2009). A similar study with tribal farmers in Odisha and West Bengal (eastern India) was made by Sarkar *et al*. (2015). The assemblage of agricultural implements of the Wokha tribal people of Nagaland (Singh *et al.* 2015; Singh and Devi 2020) is interesting for many reasons, including (in contrast with the other studies mentioned here) the absence of a plough. The agricultural implements employed in the harsh climatic region of Ladakh are considered by Ahmed *et al.* (2017). For Assam, the range of agricultural tools employed by the Bodo people is recorded by Brahma and Daimary (2017), while Langthasa *et al.* (2021) describe the diversity of agricultural hand tools used by tribal compared with non-tribal societies. Although many of these authors cite some earlier studies, especially that of Das and Nag (2006), they make virtually no use of them for comparative purposes. All have overlooked an important earlier study by Verma (1998) of traditional agricultural implements in Himachal Pradesh, northwest India. Lerche and Steensberg (1983), working further afield, describe an interesting range of agricultural implements (mostly ploughs) used in various regions of Iran.

Some records of agricultural implements and their uses cited here derive from incidental or selective observations, such as those of Dupree (1978) and Maletta and Favre (2003) in Afghanistan, and Noor *et al.* (2013) during ethnobotanical research in Gilgit–Baltistan (Pakistan). There are also studies of specific types of implements; for the purposes of this paper, mention will be made of Steensberg's (1971) study of drill-sowing equipment in southern India and the review of the *khurpa* by Mahias (1990). Accounts such as the examination by Parkes (2000) of the sustainable lifeways of the Kalasha people of Chitral (Pakistan) are less concerned with the implements of traditional agriculture as with the ecological relationships and consequences of traditional subsistence practices, although it would be valuable if someone were to extend the work by Parkes to include the agricultural implements employed in the successful, sustainable Kalasha farming system.

Most of the publications mentioned above contain a wealth of descriptive detail of a wide range of agricultural and related implements, including the local names of each type (some of which may have many local names, often relating to differences in size). To avoid overloading this text with excessive detail, it is intended to be selective in using information from these sources to compare with the traditional agricultural implements of Bannu District.

The present study: traditional agricultural technology in Bannu District

During a survey of village-based pottery production and potters' workshops in Bannu District in December 1991 (Khan and Thomas 2020), somewhat less structured observations

were made of other traditional technologies and crafts. These included craft activities and materials used for making ropes, mats, and baskets (Thomas 2022), and agricultural implements and their use. The principal focus for the study of agricultural implements was Bharat village, although observations of agricultural practices close by to the villages of Tathai Dheri, Sardi Khel and Takhti Khel were also recorded (Fig. 1).

In the afternoon of 20th December 1991, acting on their own initiative the villagers of Bharat assembled an array of traditional agricultural implements for us to see; they also demonstrated how they were used. Many of these implements were no longer in use and had been stored in good condition in various outbuildings belonging to different families in the village. The villagers clearly regarded these implements with pride as an important part of their cultural heritage and a tangible link to their forebears and ways of life that had rapidly and radically changed. I was permitted to photograph the implements and the demonstrations of how they were used; as this was something of a village 'occasion', everyone came wearing clothes that were quite unsuitable for labouring in the fields (as is apparent in some of the photographs). It being a late afternoon in December, the low light conditions and long shadows were not ideal for photography, but I hope the photographs selected for this paper are at least adequate for their purpose.

An outline of agricultural production in Bannu District

Farming in the Bannu basin today ranges from intensive double- and multiple-cropping systems in the irrigated areas to single-cropping systems in the rain fed (dry farming) areas which lie principally to the west and southwest of the region (Yaqub 1981; Thomas 1986, 2003). Within Bannu District, the *doab* between the Kurram River and the Baran *Nullah* is irrigated by a complex network of distributary channels feeding off the Kachkot Canal. This enables high levels of agricultural production. Important winter (*rabi*) crops are wheat and chickpeas (*gram*), along with barley, mustard, and vegetables which are sold in the *sabzi* (vegetable) bazaar in Bannu City. Sugar cane has become the most important cash crop (Khan 1983: 112); taking 12-18 months to grow, it is planted January to March and harvested December to February. Summer to autumn (*kharif*) crops are dominated by maize, followed by various millets, with some cotton and rice grown in areas where floodwater farming is possible (Khan 1983: 111). For example, just south of village Bharat the summer flooding of low-lying fields by the Baran *Nullah* allows rice to be grown. Today, farming is a year-round series of operations, involving the use of a diverse range of implements, some traditional others more 'modern'. Some larger-scale farmers, with large and contiguous holdings of land, are geared for market production and have adopted mechanization to replace the bullock-drawn wooden ploughs and harrows. Smaller-scale subsistence farmers, often with small and more dispersed holdings of land, were still using the full range of traditional agricultural implements at the time this study was made.

The first part of this paper describes the traditional agricultural implements used in recent years in Bannu District, in comparison with various implements used elsewhere in South Asia. The second part delves further back in time, examining a range of evidence for ancient agricultural implements and their use in South Asia.

I: Traditional agricultural implements used in the recent past in Bannu District and further afield

Implements from Village Bharat

The villagers of Bharat were very systematic in choosing the range of implements for display, which included those required at each stage of the farming cycle, from tillage of the soil through to harvest (Fig. 2). The caption to Fig. 2 identifies the various types of farming implements which are also listed in Table 1.

Draught Tillage Implements: Ploughs and ploughing

Arguably, the plough is the most 'iconic' of all agricultural implements. Ploughs exist in a wide variety of forms, but the most usual traditional

type of plough, which was used widely across Eurasia, is the wooden plough known as an 'ard' or scratch plough. The wooden plough (*hal*) in use in Bannu District until recent times was of this type.

A brief discourse on ards ('scratch ploughs')

Much has been written on early ploughs, in particular the history of the ard plough (e.g. Payne 1957; Manning 1964; Fenton 1964; Fussell 1966; Sherratt 1981; Reynolds 1982; Behre and van Lengen 1995). There is consensus that the ard plough originated in Mesopotamia and soon spread to Egypt in the 6th or 5th millennium BCE. The early ards of Mesopotamia were fitted with seed drills, and it is possible that the ard was first used to cover the seeds with soil rather than for soil preparation or tillage, which later became the principal function of the ard.

Rather than cutting and turning the soil to produce ridged furrows, an ard breaks up a narrow strip of soil by cutting a shallow furrow, usually little deeper than 15 cm. Ards are not suitable for clearing new land, for which hoes or mattocks are usually used. Cross-ploughing with an ard is often necessary to break up the soil, the ard being deployed to cut a series of parallel furrows at 90 degrees to the original furrows. Cross-ploughing is also effective at clearing annual weeds. The shallow furrows cut by an ard are perfectly

Figure 1. Google Earth™ satellite image of the Bannu basin, north-west Pakistan, showing the locations of Bannu City and the villages of Bharat, Tathai Dheri, Sardi Khel and Takhti Khel.

adequate for most cereals and the ard can be used to cover the seed in rows. The ard is most useful on light loamy or sandy soils, or steeply sloping fields where the soil is thin.

The structure of a simple ard is shown in Fig. 3A and the three principal types of ard (bow ard, body ard and sole ard) are depicted schematically in Fig. 3B. The appearance of individual ards can vary according to the size and shape of pieces of wood available for use in their construction. Ard enthusiasts (see plough references, above) see an 'evolutionary progression' in strength, stability and performance from bow, to body, to sole ard. The bow ard is the weakest and possibly earliest type, used for shallow tillage in dry, stony soils; it has been recorded in use in parts of Eurasia, including Iran and eastern India. The body ard, being sturdier and heavier for deeper tillage, was used more widely, including in Pakistan and India. The more stable sole ard became used very widely, although the three types have persisted into recent times.

The ard and its use in Bannu District and beyond in recent times

The traditional wooden ard used in Bannu is of sole ard type (Figs. 2, 4C), it being pulled by a pair of bullocks which were connected to the long beam of the ard by a double yoke around their necks (Fig. 4A, B, D). The handle of the ard was held by the ploughman and used to direct the line of the furrow cut by the metal share and to exert downward pressure to ensure a sufficiently deep furrow was cut (Fig. 4E, F).

Figure 2. Village Bharat: a diverse range of implements used in agricultural production. From back to front and from left to right in each row: back row *Sutta* (harrow), *Takta* (wooden irrigation dam) & *Zhagh* (yoke); next row *Hal* (plough); next row *Khairr* (a type of rake), *Thabur* (axe), *Pinzghashai* (literally a 5-pronged rake, although this one has 6 prongs), *Gantai* (pick), *Khuya* (wooden flat-bladed shovel), *Kaya* (mattock), *Yūm* (foot shovel), *Dabaliay* (large mallet), *Skaiya* (wooden winnowing fork) & *Belcha* (shovel); next row *Lareeka* (2 x small sickles), *Lair* (4 x large sickles), *Rambai* (large trowel) & *Thabur* (smaller axe); and front right *Spaita* (small trowel). Photograph by the author.

Ards from other regions

Verma's (1998) study of ards in Himachal Pradesh shows that a variety of types were employed in different areas (Fig. 5). One is of bow ard type (Fig. 5B), while the others are sole ards. Details of these types, and reasons for the differences between them, are given in the caption to Fig. 5.

Figures 6 and 7 depict some other ard-type ploughs and their use, as described in the captions to each (along with citations of sources). The ard from western Iran (Fig. 6C) shows an interesting variation of the sole ard morphology, there being an extra strengthening strut between the sole and the beam; in addition, the handle is inserted into the sole in front of the insertion of the beam. Elsewhere in Iran, such as Kerman in the southeast, can be found examples of a robust but simple bow ard (Fig. 6C). Even more robustly built is the ard from Ladakh (Fig. 6D), made of wood from the rather stunted willow trees that grow in the valleys of this harsh and mountainous region. The structure of this ard defies classification in the simple system described here (Fig. 3B); the sole is very blocky in appearance, which is exacerbated by the share not being attached at its front end. Very different from these is the ard used by the Bodo tribal people of Assam (Fig. 7). In this ard, the shoe, body and handle appear to be a single elegantly shaped piece of wood into which the beam is inserted, thus making it a body ard (Fig. 3B), but one of highly unusual appearance. The variation between all these ards is interesting, showing the choices made by the artisans who constructed them, the constraints on structure that different types of wood might impose, and differences relating to their intended use.

Ards are one way of tilling the soil in preparation for sowing seeds, but other implements, both drawn by draught animals and used manually, are also important for soil preparation.

Other Draught Tillage Implements

Bannu District, Village Bharat

There are two other bullock-drawn implements once used by the farmers of Bharat village, a type of harrow and a large rake-like implement. Both are used on soils which have been prepared by ploughing. The large and heavy harrow (*sutta*) is a

Table 1. Traditional implements associated with agricultural production and crop processing, village Bharat, Bannu basin.

Category	Implement type	Local name
Animal-drawn implements for soil tillage or preparation	Ard plough	*Hal*
	Yoke	*Zhagh*
	Spiked heavy beam harrow	*Sutta*
	'Bulldozer' rake	*Khairr*
Manual implements for soil tillage or preparation	Two-man 'traction' rake	*Pinzghashai*
	Foot shovel	*Yūm*
	Shovel	*Belcha*
	Large mallet	*Dabaliay*
Cultivation implements	Large trowel	*Rambai*
	Small trowel	*Spaita*
	Wooden irrigation dams (3 types/sizes)	*Takta, Darra, Tumbu*
General purpose implements	Axe, large & small	*Thabur*
	Pick	*Gantai*
	Mattock	*Kaya*
Harvesting implements	Large sickle	*Lair*
	Small sickle	*Lareeka*
Wooden winnowing implements	Winnowing fork	*Skaiya*
	Flat-bladed shovel	*Khuya*

wooden beam with many metal spikes (sometimes these can be of wood) hammered into its lower, working, surface (Fig. 2). The *sutta* is attached by ropes to a yoke which rests on the necks of the pair of bullocks. As the bullocks pull the *sutta* over the rough cloddy surface of the soil (Fig. 8), the combined weight of the implement and the spikes break the soil down into finer crumbs. On heavy types of soil the driver will stand on the harrow to increase its weight.

The other draught tillage implement is a particularly interesting object, being like a rake but with additional features; it is known locally as a *khairr* (Fig. 9). This complex implement is much more than a simple rake and here I describe this implement a 'bulldozer' rake because it has a similar function to a modern bulldozer, which has a large metal blade to push large quantities of loose material (soil, etc.) from one place to another. Similarly, the *khairr* has a large 'pushing' surface, although this is made of wood and basketry. It has a row of stout wooden pegs or 'teeth', that bite into the soil, mounted in a stout horizontal beam. Above this, the strong pieces of wood that at one end constitute the teeth continue up on either side of the main handle of the implement, where they are woven together with strong fibres to form a robust, flat piece of basketry, which is an integral component of the 'pushing blade'. This is an especially interesting and unique implement; there is nothing like it in any of the sources consulted for this paper.

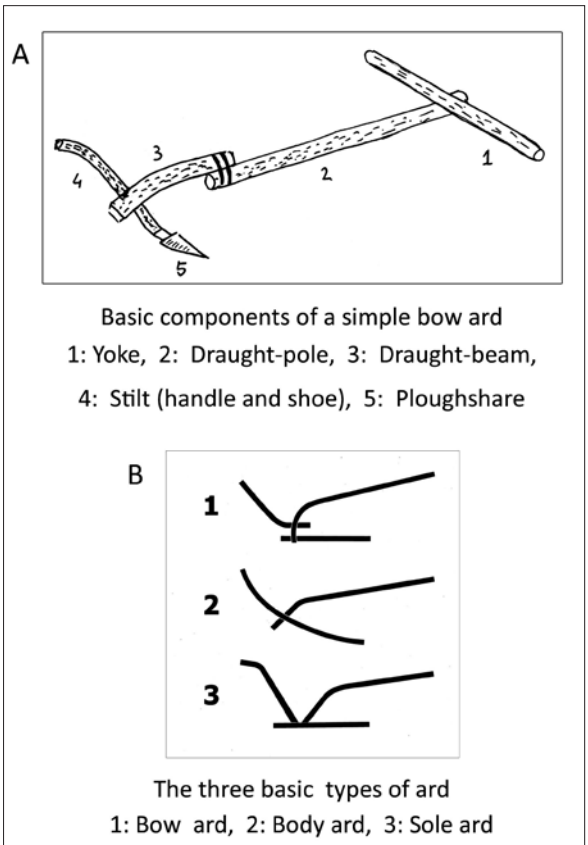

Figure 3. A: The components of a very basic ard, which can vary in different types of ard; for example, the draught pole and draught beam, shown here as separate pieces, may be replaced by a single long curved beam. Yokes can differ considerably in structure and complexity compared with the very simple one depicted here. B: The three main structural categories of ard. Sources: A: Wikimedia Commons; accessed 12th October 2023 at: AncientPlough.jpg (1176×585) (wikimedia.org). B: Wikimedia Commons; accessed 12th October 2023 at: File:Araire à mancheron unique - schémas.svg - Wikipedia.

Draught implements from other regions

Bullock-drawn implements for breaking up and levelling the soil are to be found in other parts of South Asia, Afghanistan and Iran. Sometimes these are heavy wooden boards or beams upon which the driver stands to add weight as he guides the bullocks (Fig. 10A, B). A more sophisticated harrow has a heavy wooden beam armed with stout wooden pegs, the implement being drawn by a pair of bullocks while the driver holds the handle (Fig. 10C).

Manually Operated Tillage Implements

Manual implements used in Bannu District, Village Bharat

An important implement used to build up soil ridges has the local name of *pinzghashai*. The Pashtu term '*pinz*' ('five') is used as a prefix because traditionally the implement has five teeth, although the one displayed by the villagers of Bharat had six (Figs. 2, 11). It is a two-man hand rake. One man pushes the teeth of the rake into the soil by the long handle, and the other pulls the rake and the soil forwards using a rope tied to the handle just above the beam (Fig. 11). The only similar implement found during the research for this paper is described by Lerche and Steensberg

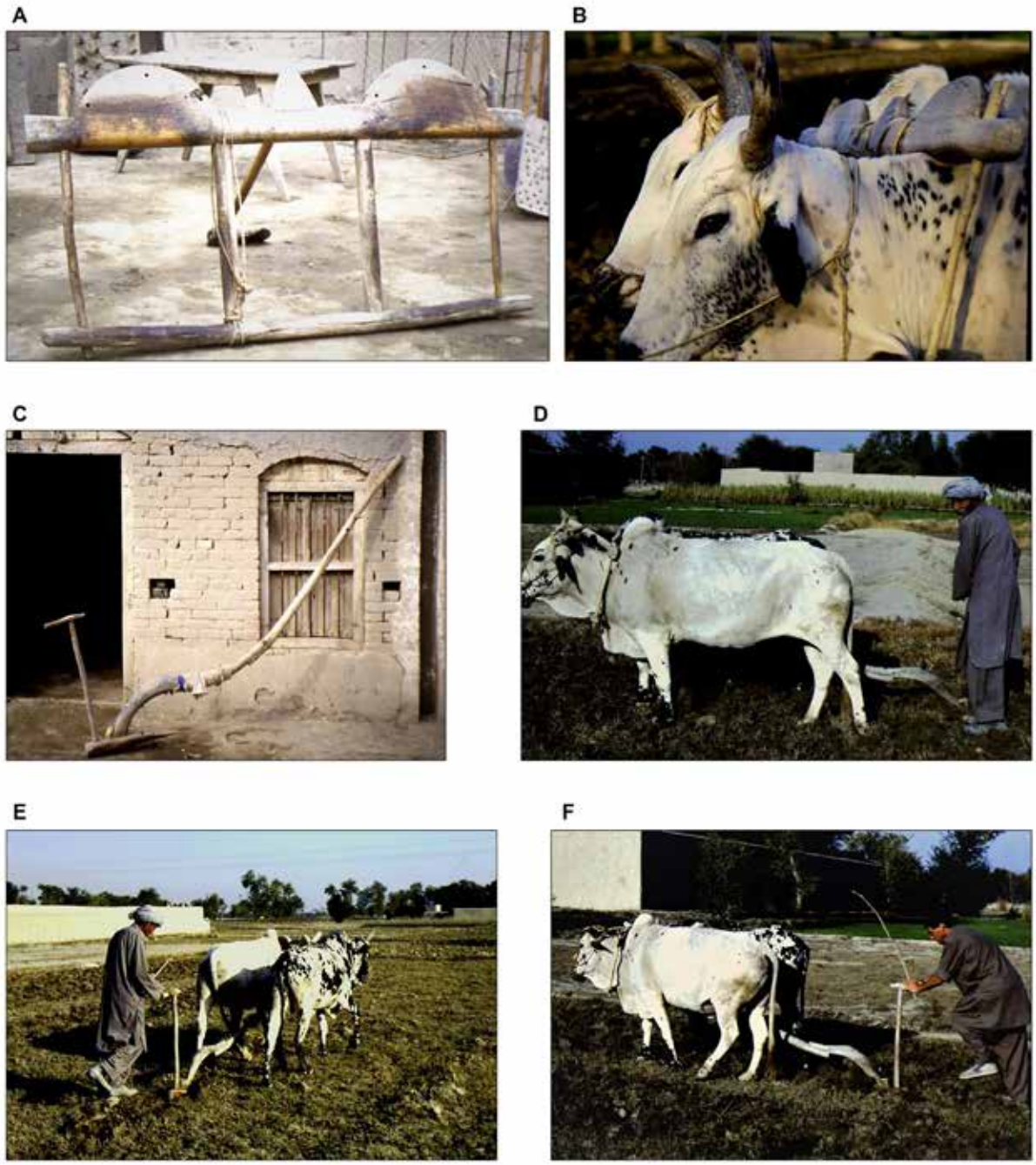

Figure 4. Plough and ploughing, Village Bharat. Left-hand column, A: a double yoke (*zhagh*) which is put over the heads of a bullock pair (B) and to which the long beam of the ard *(hal)* is attached (C). Right hand column, D: the ploughman holding the handle of the ard in preparation (E) to plough a furrow; F: a novice ploughman being led gently by a pair of bullocks. All photographs by the author, except (F) which was taken by Farid Khan using the author's camera.

(1983) as a 'toothed traction shovel' (see below); here I use the term 'two-man traction rake'. The implement is used to build up cultivation ridges, seeds or young plants being planted in the sides of the ridge. Water flows between the cultivation ridges close to the roots of the plants. It is especially used to prepare the soil for cultivation of sugar cane.

Two kinds of shovel are important tillage implements in Bannu District. One, the *belchā* (Fig. 12), is used for general digging and for piling earth into ridges. The other, the *yūm*, has a crossbeam for the foot of the user (Fig. 12). It is used for general cultivation, for digging up root crops such as turmeric (*haldi*), for digging water channels in fields, and for small scale tillage without the use of a plough. This latter use has historical resonance in two early observations from the British period in Bannu District, as follows:

> '*A peculiar feature in Bannu of the preparation of the soil for the seed is that in a large portion of the cultivated area, instead of the plough, manual labour is employed for turning up the soil. The implement used is a kind of spade called* kurza *and in Pashtu* yum *or* em. *It consists of a long handle above the height of a man, fixed into a spade which is heart-shaped and rather hollowed in front. A cross bar is fixed on the handle about a foot or a foot-and-a-half * from the point of the spade. The labour of turning up the soil with this rude implement is very great*'. (Gazetteer 1883-4: 135). * 30–45 cm

> *'It is a fact that, in general, the soil is rather more scratched than more deeply ploughed. In many low-lying areas in the District the soil around the villages is a stiff tenacious clay and the plough is not used at all. Instead, a large heart-shaped spade, worked by two men, one on either side, is used to turn the soil over to a depth of nine or ten inches* and each clod is subsequently broken up.*' (Thorburn 1876: 135-6). * 20-25 cm

While the Gazetteer's account seems to be accurate, that of Thorburn is perhaps a little confused. He describes a 'heart-shaped spade', which is surely a *yūm*, but then says it is worked by two men, which seems more like a *pinzghashai*.

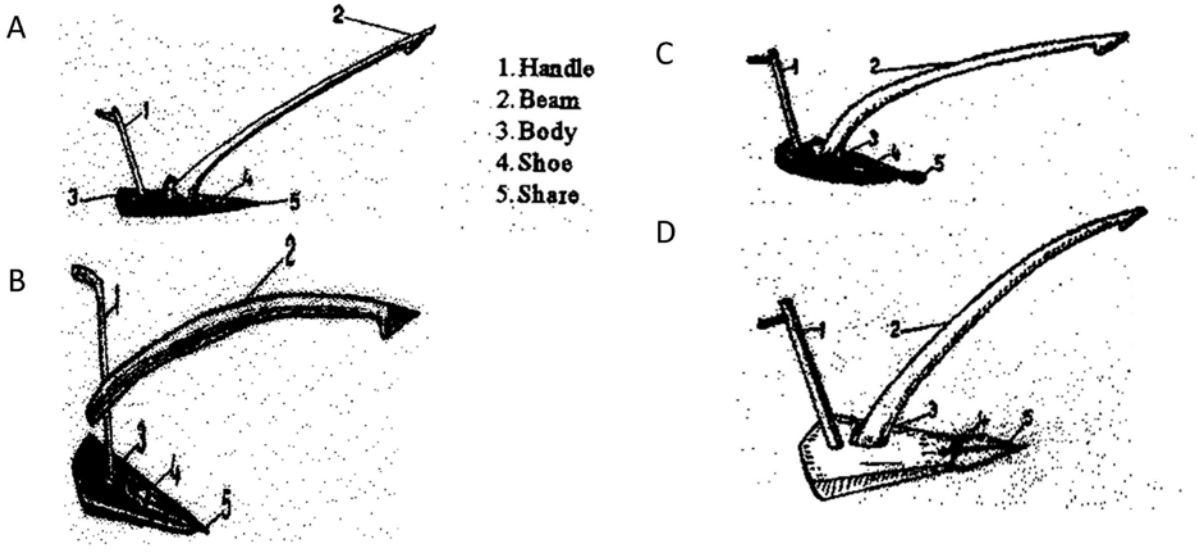

Figure 5. Different ard types, Himachal Pradesh (India). In some (a, b, c), the shoe and the body are in one piece which makes the plough more rigid and robust, enabling it to be used on gravelly and stony soils. In one type (b), the beam of the plough is joined to the handle instead of the body, which provides more clearance under the beam and facilitates easier passage over clods of soil and stubble. In areas with more sandy soils, the shoe and body are separate components (d), enabling replacement of the shoe when it is worn down by the abrasive action of the sand. From Verma (1998: figs 9.1a, b, c, d).

Quite possibly he or an informant observed both implements in use and subsequently they became conflated in the above account.

Finally, mention should be made of the *dabaliay* (Fig. 2), a very simple but effective implement (essentially a large, long-handled wooden mallet) which is used for breaking up clods of earth.

Some manual tillage implements from other regions

Lerche and Steensberg (1983) undertook studies of traditional tillage implements in the province of Kerman, southeastern Iran. Among the implements recorded is one known locally as a *panje* (Lerche and Steensberg 1983: 232-4), which they describe as a 'toothed traction shovel'; this is illustrated here in Fig. 13 (A, B). This implement is identical to the *pinzghashai* seen in the present study at Bharat village (see above and Fig. 11), which had been assumed by this author to be unique to the Bannu region until this Iranian example came to light.

Among other manual tillage implements widely used for levelling the soil are simple rakes, an example of a very conventional-looking wooden rake from Ladakh being depicted in Fig. 13C. Less conventional in appearance is the ladder-like implement (the *mwi*) used by the Bodo people of Assam (Fig. 13D). It is made of wood and bamboo and used for levelling the soil. Essentially it is a manual harrow which is pulled across the soil surface with a jute rope (Brahma and Daimary 2017: 67). We will make further reference to this implement later in this paper.

Spades and shovels are ubiquitous tillage implements employed throughout South Asia and adjacent regions. They occur in the lists of implements in all the published sources used here, although there is variation in the use of the term 'spade', which is often applied to mattock-like heavy 'draw hoes' resembling the *kaya* of Bharat village (Fig. 2). The villagers of Bharat said that the *kaya* was not used by them for cultivation (which is why it is listed as a 'general purpose implement' in Table 1), but rather for mixing mud-plaster for walls and roofs. Mallet-like implements for breaking down clods of soil are also widely reported in published accounts of agricultural implements of South Asia.

The digging stick, the simplest of manual agricultural implements, is absent from almost all the assemblages of implements discussed here (including Bharat village). The sole exception I have encountered are the digging sticks (*goda*) used by some tribal peoples in Assam (Langthasa *et al*. 2021: table 1). *Goda* are bamboo sticks about one metre long and pointed at one end. They are low tillage, high precision implements used to make

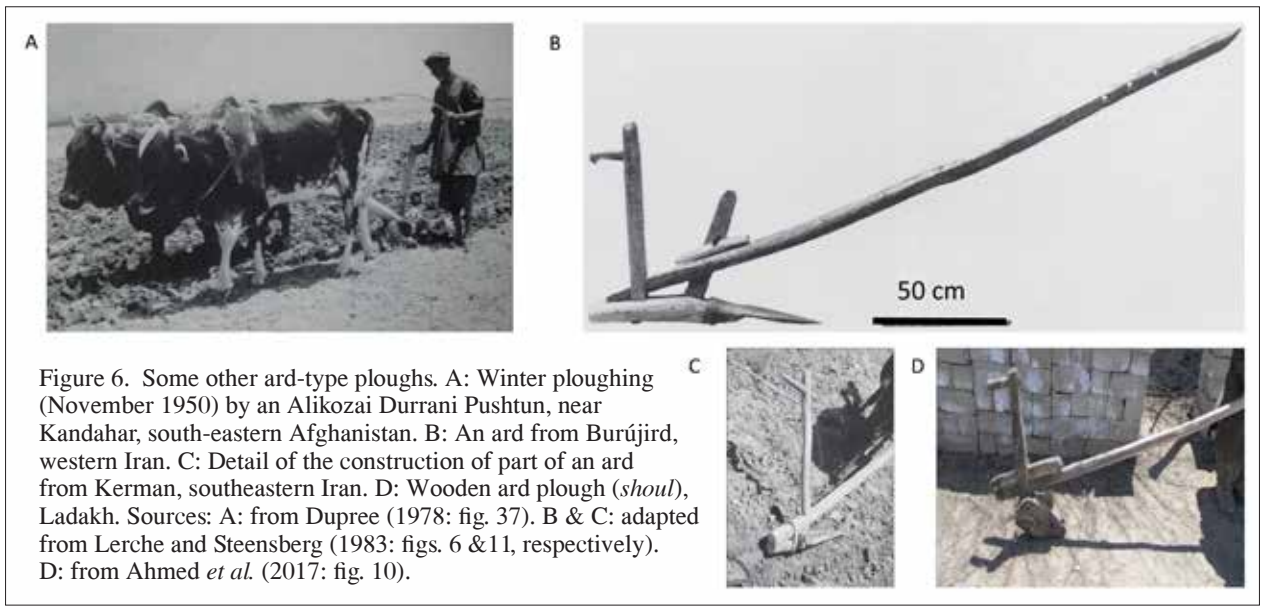

Figure 6. Some other ard-type ploughs. A: Winter ploughing (November 1950) by an Alikozai Durrani Pushtun, near Kandahar, south-eastern Afghanistan. B: An ard from Burújird, western Iran. C: Detail of the construction of part of an ard from Kerman, southeastern Iran. D: Wooden ard plough (*shoul*), Ladakh. Sources: A: from Dupree (1978: fig. 37). B & C: adapted from Lerche and Steensberg (1983: figs. 6 &11, respectively). D: from Ahmed *et al.* (2017: fig. 10).

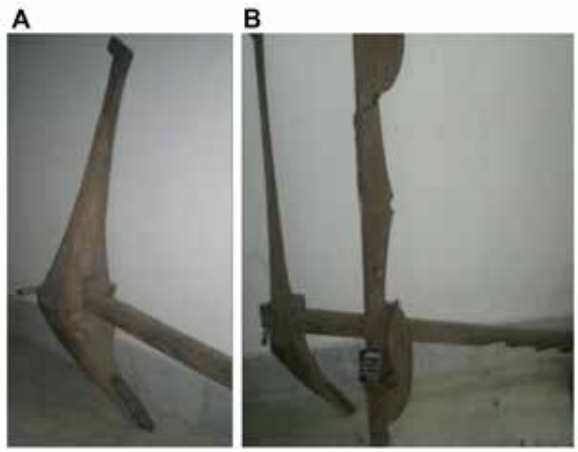

Figure 7. Ard plough of the Bodo people, Assam. A: Bullock-drawn wooden ard (*nangal*). The basic elements are the shoe, body, handle and beam. The handle of the plough is generally 0.6-1.0 m long. The iron share enables a ploughing depth of about 15 cm. B: The *nangal* ard with a yoke (*jungal*), which is made of wood or bamboo and measures about 1.5 m. From Brahma and Daimary (2017: figs. 5, 7).

holes in the soil into which individual seeds are dropped (Langthasa *et al.* 2021: 1095). Digging sticks are rather unsophisticated implements, but they are none the worse for that because they are entirely fit for purpose. They can be used for tillage and planting on difficult terrains and rock-strewn soils, when ards and other more complex implements would be unusable. Digging sticks have a long and honourable history of use, not only in agriculture but also by non-agriculturalists for digging up the edible roots and tubers of wild plants.

Accessory manual implements of Bannu District

From here to the end of this section of the paper, and with some exceptions, only implements relating to Bannu District will be described because all have exact analogs in most of the published inventories of implements of South Asia used in this paper; to include them all would lead to unnecessary and tedious repetition.

Implements used in cultivation

Two types of trowels are the principal hand-held implements used for cultivation in Bannu District: the *rambai* and the *spaita* (Fig. 2 and Table 1). *Rambai* (larger trowels) are used for weeding and for mixing the boiling juice of sugar cane in the preparation of *gur*. *Spaita* (small trowels) are used for diverse cultivation activities, including weeding and loosening the soil around, for example, garlic as it grows and for digging it up. Trowels like these occur in all the diverse assemblages of agricultural implements reported here. Despite minor variations in size and shape, all serve similar ranges of purpose. One variant, the *khurpa* has widespread use across northern and central India. It has been studied by Mahias (1990) who records the diverse ways in which it may be used. Both the *rambai* and the *spaita* of village Bharat fall within the range of forms that Mahias (1990) records for the *khurpa*.

Although technically not implements of cultivation, wooden panels used in irrigating crops might be mentioned here (Fig. 2 and Table 1). *Takta, darra* and *tumbu* are three names for the wooden panels of various sizes used by the villagers of Bharat to block water in irrigation channels to divert it onto specific fields. They are put onto the upstream side of two wooden pegs hammered into the bed of the irrigation channel.

Hand-held harvesting implements

Sickles are ubiquitous in assemblages of agricultural implements from across the length and breadth of South Asia, and beyond. There is often variation in shape, some having a crescentic cutting blade and others being only slightly curved. In Bannu District, and specifically in village Bharat, there are two basic sickles (Fig. 2 and Table 1): the *lareeka* (a small sickle) and the *lair* (a larger sickle), although there is minor variation in size, especially some blades becoming smaller according to the number of times they have been re-sharpened. Both are used for harvesting various crops but can also be used for digging up weeds or cutting wild grasses and canes.

Crop processing implements

Here we will be considering implements involved in the processes of threshing and winnowing the harvested crops. Threshing is the mechanical process by which the grains or seeds are freed

from the harvested plant materials (stalks, ears of cereals, heads of millets, pods of pulses, etc.). The resulting mixture of broken up bits of stalks, chaff, pods, seeds and grains is winnowed to remove as much as possible of unwanted plant debris, thereby concentrating the seeds or grains. After this, the required material is removed from the threshing and winnowing field to the domestic sphere, where it will undergo further refinement to yield the pure crop. These latter processes are not covered in this paper.

Threshing and winnowing in Bannu District and Village Bharat

Threshing is usually undertaken on a 'threshing floor', which is a cleared area in a field where the soil surface is hard and dry. A wooden post is hammered into the centre of the 'floor' (Fig. 14: bottom row) around which a tethered draught animal (usually a bullock or a donkey) will circulate, pulling a 'threshing sledge'. In Bannu District the threshing sledge is a '*sapella*' which, traditionally, is a thorny bush (a '*markharran*') with a wooden board on top for the driver to stand on. The version shown here (Fig. 14, centre row) has a metal frame upon which the *markharran* is placed and weighed down by rocks. A portion of the harvested crop is spread onto the threshing floor and the draught animal walks around in circles, pulling the weighted *sapella* which breaks up the stalks, heads or pods of the crop to release the grains or seeds.

Winnowing is undertaken using two implements: a *skaiya*, a winnowing fork with four curved wooden tines (Figs. 2, 14) which is used to turn over the harvested crop as it is being threshed, and a *khuya*, a flat-bladed wooden shovel (Figs. 2, 14) used during winnowing to turn over the threshed crop and to throw it up into the air to be winnowed by the wind.

Threshing and winnowing: some examples from other regions

During ethnobotanical research in the Astore Valley of Gilgit, Noor *et al.* (2013: fig. 1) observed a row of bullocks and *dzo* (hybrids between yak and cattle) circulating around a central post in a threshing floor, trampling the crop and breaking it up with their hooves (Fig. 15A). These investigators also highlight three tools, *bashan*, *fei* and *haroch* (Fig. 15A), used in threshing and winnowing, but they give no further information about them. Another purely illustrative example is Dupree's (1978: fig. 38) vivid photograph of Uzbek farmers in northern Afghanistan winnowing a threshed wheat crop (Fig. 15B) using a wooden fork and wooden shovel, which are similar to those of Bharat village and elsewhere in Bannu District, described above (Fig. 14).

From the recent past to more distant pasts

So far, we have examined the range of traditional implements employed for each of a series of agricultural operations, from soil tillage, to

Figure 8. *Sutta* in use, Village Bharat. Upper: *sutta* attached by ropes to the yolk resting on the necks of the bullocks; lower: *sutta* being pulled over the soil surface to break up clods of earth. Photographs by the author.

sowing and cultivation, to harvesting, and to the field-processing of crops. Attention now changes to seek evidence for agricultural implements and practices from more remote periods of time.

II: Agricultural implements in the ancient past

Here we consider two principal categories of evidence for ancient agricultural implements: ancient written accounts and archaeological sources. Each of these is a large topic and for the purposes of this paper it is necessary to be selective. The reasoning behind the selection of sources is to examine evidence of increasingly more ancient agricultural implements and associated practices from one category of evidence to the next, finally focusing on the specifically archaeological evidence for agriculture in the pre-Harappan and Harappan periods of South Asia.

Ancient South Asian Written Accounts of Agricultural Implements and Practices

The description of the farming cycle in the *Kullavāgga* texts, c. 5th century CE, is quoted in the Introduction to this paper. According to Gangopadhyay (1932: 41), the earliest reference to agricultural operations is in the *Rigveda* (c. 1500-1000 BCE): *'Fasten the ploughs, spread out the yokes and sow the seed on the field which has been prepared. Let the corn grow with our hymns. Let the scythe fall on the neighbouring fields where the corn is ripe.'*

In the *Śatapatha Brāhmaṇa* (c. 700-300 BCE) the basic agricultural operations are summed up as: ploughing, sowing, reaping and threshing (Gangopadhyay 1932: 41). When the crop was ripe it was cut with *sṛini* (sickles), bound into bundles and threshed out on the floor of the granary. The grain was separated out from the straw by a winnowing fan called *dhānyakṛi*, then measured in a vessel called *urdara*, and then stored in 'granaries' (*shivis*).

The *Kṛṣi-Parāśara* is a book on agriculture written in Sanskrit, the contents of which are usefully summarized by Rashid (2018: 226, fn 5). Maharishi Parāśara who, according to legend, lived more than 1500 BCE is sometimes credited with the authorship of the book, although it is probably a compilation of various sources of varying ages. It also exists in differing versions. Majumdar and Banerji (1960: v-x) discuss the age of the version of the book which they edited and translated, concluding that it is older than 800 CE, most probably 200-600 CE. Other scholars maintain that a later date, possibly in the middle of the 11th century CE, is plausible (Furui 2005: 151). There is continued debate about not only the age of the work but also its sociological implications, and complex linguistic and historical issues not directly associated with agricultural implements and techniques (Furui 2005; Wojtilla 2006). This is outside my sphere of knowledge, so the focus here will be on the agricultural evidence.

Gangopadhyay (1932: 64-5) relates Parāśara's description of the structure of the plough and its accessories and other implements associated with agriculture (summarized here in Table 2). Technically, the plough described is an ard and Raghavan (1960) observes that the morphology of ploughs (ards) used up to the modern era has not materially changed from those described by Parāśara. Majumdar and Banerji (1960: xiii) record the principal agricultural implements described in the ancient text (see Table 2); a similar range of ancient agricultural implements is recorded by Wojtilla (1991b: 532) for the version of the work that he translated. A curious implement, the *madika* (translated as 'ladder'), is among the implements identified by Majumdar and Banerji, who suggest that this scalariform implement was probably used as a harrow (Majumdar and Banerji 1960: xv, footnote 14). Majumdar and Banerji (1960: glossary, p. i) suggest that the ancient term *madika* is probably equivalent to *mai*, a Bengali word for a ladder-like implement used for levelling rice fields. An analogue from Assam, the *mwi*, was discussed above and depicted in Fig. 13D.

Another version of the *Kṛṣi-Parāśara*, the *Kṛṣiśāsana*, is a source consulted by Wojtilla (1991a; 1991b) and what follows is based upon his publications. The *Kṛṣiśāsana* is a manual of agriculture written in Sanskrit, compiled and translated (with a Hindi commentary) from ancient texts by Daśarathaśāstrin in 1909. Printed in Nagpur in 1920, it is a very rare text, to which Wojtilla was able to gain access. Along

with the text the work has simple sketches of the implements described, which are based upon detailed measurements given in an original ancient text. According to Wojtilla (1991a: 232), Daśarathaśāstrin's great merit is his interest in various types of ploughs and plough-like implements. Daśarathaśāstrin describes and illustrates a basic plough, which he calls 'the plough by Parāśara' (Fig. 16A). This plough can be equipped with a funnel placed behind the handle for use as a seeder-ard (Fig. 16B). At work it requires two men and two oxen linked to the beam of the ard by a *yugam*, an ancient type of yoke (Wojtilla 1991a: 204; Fig. 16C). The seeder-ard is especially interesting; this type of implement was observed in use in southern India by Steensberg (1971), who notes that this ancient method of drill-sowing was known in ancient Babylonia, as depicted on cylinder seals (Steensberg 1971: 242).

More could be gleaned from and written about these early written sources, but for the purposes of this paper I hope the above is sufficient.

Archaeological Evidence for Agricultural Implements and Practices in Ancient South Asia (i): representations in art

Here we outline some types of evidence for agricultural implements depicted in the ancient art of South Asia, principally in sculptures and paintings. The intention is to select examples from increasingly earlier periods, starting with the Early Historic period.

Representations in sculptures

Wojtilla (1989: 98-9) describes a statue, probably of the first century BCE, of the principal deity

Figure 9. Use of the *khairr* ('bulldozer' rake), Village Bharat. Top left: a *khairr*; top right: a *khairr* attached to a yoke by locally made ropes. On either side of the *khairr* is an ard (*hal*) and a *pinzghashai* (described in the text). Bottom left: a *khairr* harnessed up to a pair of bullocks; bottom right: the *khairr* ready for use. Photographs by the author.

of agriculture Balarāma holding an ard-type plough, although details of the implement are unclear. Some scenes of the life of the Buddha show representations of ard-ploughs, such as one of the second century BCE from Bodh-Gaya which shows an ard in which the stilt (handle) and ard-head (sole) are in one piece. This appears to be a 'body ard' (Fig. 3B.2) and is like those used in recent times in Uttar Pradesh, western Madhya Pradesh, and parts of north-western India (Wojtilla 1989: 99). A sculptural relief from Kavi in Gujarat, dating from the 6th century CE, depicts Balarāma holding an ard plough with a long beam and stilt or handle (Wojtilla 1989: 102). The body (ard-head and sole) have a stilt and a beam mortised into it, suggesting it to be a type of 'body ard' type (Fig. 3B.2).

Gandhara is renowned as a rich source of sculptural representations, although most of these are devotional in intent and relatively few portray more day-to-day subjects such as agriculture. Wojtilla (1989: 99-101) describes some sculptural scenes with representations of ard-type ploughs dating to the early centuries CE from Sahri Bahlol, Nimogram, Sanghao, and the Sikri stupa. All these ards have features in common: the ard-head continues in a horizontal sole, while the beam and stilt are fitted independently into this composite 'ard-head-sole' body, suggesting a form of 'sole ard' (see Fig. 3B.3). Wojtilla (1989: 101) notes that this type of ard is like those used in modern Kashmir and Himachal Pradesh, and I have seen similar ards in use in Bannu District and the Peshawar valley.

Depictions on coinage and seals

Wojtilla (1989) records two objects of interest here. A coin of king Agathocles, dated to the 2nd century BCE from Aĭ Khanoum, Afghanistan, bears a representation of the Hindu god Saṃkarṣaṇa (a form of Balarāma), with an ard-plough in hand. This ard looks like a sole ard; its central part is a little bent and a beam of proportional size is mortised into it (Wojtilla 1989: 98). The other object is a copper seal dated to the early first century CE depicting the Hindu god Śiva holding

Table 2. Ancient agricultural implements and components of implements according to Parāśara. After Gangopadhyay (1932: 64-5) and Majumdar and Banerji (1960: xiii) *

Implement	**Name by Parāśara**
The ard plough	*Hala*
Pole or beam of the plough	*Isa*
Yoke	*Yuga*
Sole of plough	*Niryola*
Iron plate fixing the share to the sole	*Solepāṣikā*
Handle for ploughman, fixed to the sole	*Halasthāṇu*
Pins of the yoke to fasten the bullocks	*Aḍḍacalla*
Piece of wood fixing the sole to the beam	*Ṡaula*
Hand-held stick to 'drive' the bullocks	*Paccani*
Ploughshare	*Phāla*
'Ladder' (probably a type of harrow)	*Madika*
Harrow	*Viddhaka*
Large hoe with 21 spikes	*Vidhaka*
Hoe	*Khanitra*
Sickle	*Sṛṇi*
Post in centre of threshing floor	*Melhi*

*See also Wojtilla (1989: 98, 102) who gives additional ancient terms for parts of the ard.

an ard-plough and a club (Wojtilla 1989: 101), although no details of the structure of this ard are given.

Representations in rock art

South Asia has a rich heritage of rock art. In Pakistan these occur most notably on rocks along the Karakorum Highway and in rock shelters in Swat. The Karakorum assemblages are at various places along this ancient route of pilgrimage and trade between Gandhara and the Silk Roads of East and Central Asia, as well as southwards in South Asia (Jettmar and Thewalt 1987). Many of the Karakorum paintings have a religious theme and few if any depict agricultural implements or practices. Some paintings in rock shelters in Swat, dating perhaps to the second millennium BCE, show complex scenes that Vidale *et al.* (2011) suggest might in some way be related to agricultural practices or rituals, although none depict specific agricultural implements or practices.

There are major clusters of paintings on rocks, in caves and in rock shelters in Central India, in particular Madhya Pradesh, which have been systematically studies by Neumayer (2013). He has also produced a valuable on-line resource of depictions featuring wheeled vehicles (carts, wagons, and chariots), along with some rare examples depicting agricultural practices (Neumayer 2016). Much of the rock art described by Neumayer (2013, 2016) is of the Chalcolithic period, which in this part of India dates from 2,000 BCE to 1,200 BCE (Dhavalikar 2002). Figure 17 shows activities relating to agriculture depicted in rock art, based on Neumayer (2016). In one, a bullock cart with solid wheels is pulled by two yoked bullocks led by a man (Fig. 17A, B). It is not clear this depiction relates directly to agriculture, but transport of agricultural products by bullock-drawn carts is attested widely across South Asia up to recent times (Kenoyer 2004, 2009). In another painting, two ploughmen with ploughs (which appear to be of 'body-ard' type), each drawn by a pair of yoked bullocks with humped necks, are shown on the right-hand side of Fig. 17C. To the left is a badly weathered chariot pulled by two animals (possibly horses) and with two charioteers, one wielding a 'battle' axe. In a particularly evocative scene ascribed to the 'Historic period' (Fig. 17D), a ploughman controls a pair of male draught animals (possibly horses) with a plough attached by its beam to a double yoke, all next to a cross-ploughed field.

Likely there are additional sources that I could have consulted, and more that might be written on the theme of agricultural implements and practices depicted in ancient South Asian art, but these are beyond the specific objectives of this paper.

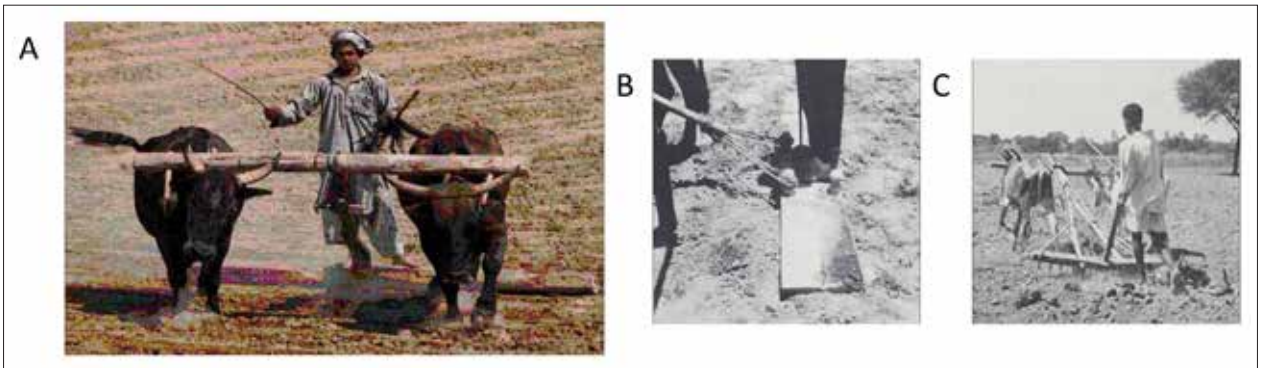

Figure 10. Some other bullock-drawn tillage implements. A: Passing a heavy wooden board (a *mala*), upon which the driver is standing, over the soil after sowing seeds of sesame and rain-fed melons, May 2003 (Baghdis, N.W. Afghanistan). B: A heavy board for levelling newly ploughed and sown fields, Kermán, southeastern Iran. C: Harrowing with a *haluve*, Tamil Nadu, India. Sources: A from Maletta and Favre (2003: fig. 9), B from Lerche and Steensberg (1983: fig. 13), and C from Steensberg (1971: fig. 2).

Archaeological Evidence for Agricultural Implements and Practices in Ancient South Asia (ii): excavated artifacts and other indicators

Here we will consider evidence from archaeological excavations and artefacts for agricultural implements and agrarian practices from the ancient past (Harappan and earlier) in South Asia. First, we consider what might be preserved.

Preservation of physical evidence

Most of the traditional implements discussed in the first section of this paper are made mostly of wood. It is probable that ancient agricultural implements were made mostly, if not wholly, of wood, with virtually no use of metal. The recent traditional implements observed and recorded at village Bharat had lain unused for many years but were in an excellent state of preservation. However, over longer periods of time, all would be subject to decay, as discussed by Thomas (2022: 18) and Thomas and Cartwright (2021: 1-2). Wood is a complex organic material composed principally of cellulose and lignin, along with a diverse range of minor components including hemicelluloses, polysaccharides, and lipids. These energy and nutrient-rich compounds are a valuable resource for a range of organisms including bacteria, fungi and various insects, the activities of which cause the physical and chemical biodegradation (i.e. decay) of wood. Wood is preserved in a relatively unaltered state only in particular environmental conditions in which biodegradation is inhibited, such as intense cold (preservation by freezing), very wet (preservation by waterlogging, which produces anaerobic conditions) or very dry (preservation by desiccation). Virtually complete ancient wooden objects, including ards of Bronze Age date, have been recovered from waterlogged peat bog deposits in various parts of northern and north-western Europe (e.g. Manning 1964; Fenton 1964; Behre and van Lengen 1995), the excellent preservation being aided by the organic acids, tannins, and polyphenolic compounds in these peaty deposits.

The preservation of ancient wooden agricultural implements is highly unlikely in the warm, aerobic, and dry (but rarely desiccating) deposits most commonly associated with archaeological sites in Pakistan and other parts of South Asia, and none have ever been reported. It is therefore necessary to look for less direct archaeological evidence for agricultural implements that were used in the past, starting with evidence for their use.

Ancient fields

In exceptionally rare cases, a settlement site might have been established on, or spread onto, a land surface that had been used for agriculture, and preserved evidence of that usage. A celebrated example from South Asia is the buried cross-ploughed field uncovered beneath Harappan levels at the site of Kalibangan, northern Rajasthan (Lal 1971; Thapar 1973), dating to approximately 2450 to 2300 BCE (Shinde 1987). The plough marks represent a grid of filled-in furrows running east-to-west and north-to-south and are indirect evidence for the use of an ard. A comparable cross-ploughed field depicted in rock art of the Historic period (Fig. 17D) is discussed above.

Evidence from artefacts (i): terracotta models

Objects in terracotta are commonly found at archaeological sites in South Asia from Neolithic times onwards and sometimes these have agricultural associations. A plough-like terracotta from the excavations at Mohenjo Daro (Randhawa 1980: 156) is one such example (Fig. 18A). The long beam-like extension and the rather stocky sole-like body suggest that this could be a model of an ard-type plough, although there is no evidence of a handle. If this object was, indeed, modelled on an ancient plough, it must have been a rather strange looking one, but perhaps no stranger in appearance than the ard in use in recent times in Ladakh (Fig. 6D), discussed above.

The terracotta model of an ard from the Harappan site of Banawali (Bisht 1982) is more convincing (Fig. 18B). According to Wojtilla (1989: 95) the beam and sole are combined; the beam being curved with a hole at the front end. The sole has a sharply pointed tip at one end and at the other, behind the insertion of the beam, there

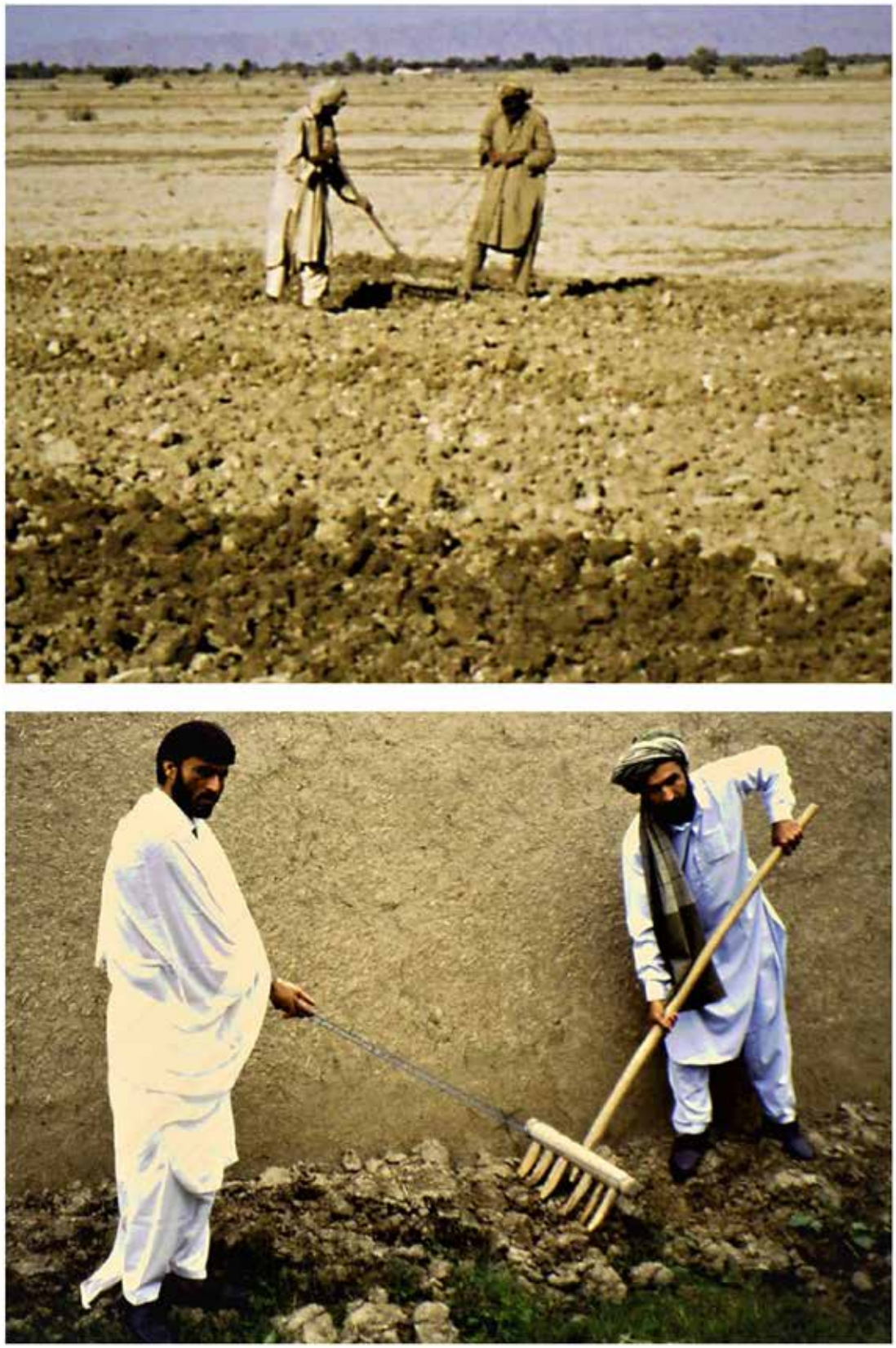

Figure 11. Use of the *pinzghashai* (two-man 'traction' rake). Upper: In use for making cultivation ridges in a field near Village Tathai Dheri, Bannu District (January 1978); lower: close-up showing mode of operation, Village Bharat. Photographs by the author.

Figure 12. Digging implements, Village Bharat. Left: a shovel (*belcha*) and foot shovel (*yūm*); right: demonstrating the use of a *yūm*. Photographs by the author.

is a hole for a handle. The implement represented by this model was probably of 'body ard' type (Fig. 3B), capable of cutting shallow furrows in the soil. Fragments of terracotta ploughs similar to the Banawali type (Fig. 18C) have been found at other Harappan sites (Possehl 1982).

Terracotta models of carts and wheels occur from as early as 3500 BCE at Harappa (Kenoyer 2004: 3). The early evidence for wheels, carts and wagons in South Asia, and their change or development over time, is discussed in depth by Kenoyer (2004, 2009). The connection between such vehicles and agriculture is rather indirect, although carts drawn by bullocks or buffaloes could have been used to transport crops between fields and settlements. Bullocks and other animals are frequently represented in terracotta models. The use of such animals for pulling carts and wagons could hint at their use in other forms of traction, such as pulling ploughs (discussed below).

Evidence from artefacts (ii): metal

In this section we are concerned with agricultural implements from Harappan and pre-Harappan times, so implements would have been made from wood with some components possibly of metal or stone (see next section for bone). The metal most likely to be used was copper and, less likely, bronze. Deshpande (1975: 51) described an elongated (c. 50 cm long) pick-like copper object (Fig. 18D), suggested to be a plough share, from the 'Copper Hoard' (Chalcolithic period) site of Kulgara, West Bengal (Fig. 18D). Shinde (1987: 217) notes that although the use of copper was known to the Chalcolithic people of central India and the Deccan, it was scarce and probably restricted to making small and delicate implements or ornaments such as beads and bangles. Shinde suggests the Chalcolithic farmers used wooden ards with shares of hard resistant wood, as in recent times in parts of central India and the Deccan. The large amount of copper in the object from Kulgara (Fig. 18D) would have made it very valuable and there are no marks of wear on the object as might be expected on a ploughshare that had been used. The deposition of this object in a Copper Hoard context alongside other objects of value and high status, such as copper 'battle' axes, suggests it might have had significance as an 'offering'.

Evidence from artefacts (iii): stone

Stone implements used to process harvested crops, such as milling vessels and grinding stones, are frequently found in archaeological deposits of many periods. These relate to processing activities within the settlement itself and not directly to any implements used where the crops were grown. It has sometimes been suggested that ground stone 'axes' might have functioned as plough shares, but this is unlikely for many reasons. The huge amount of effort required to shape, grind, smooth and then polish them would scarcely be justifiable, and certainly not necessary, for such a use. Also, they have insufficient length to be attached properly and securely to the sole of a plough. Finally, few if any show signs of wear compatible with being used as a plough share. Despite a long archaeological record of stone technology across South Asia, no convincing ploughshares made of stone have yet been reported. This contrasts with north-west Europe where, for example, Fenton (1964: 266-7 and fig. 1) describes stone plough

shares of Neolithic age from sites on the islands of Shetland and Orkney. These are roughly formed cylindrical bars of sandstone, tapering at one end and some 30-50 cm in length and tapering at one end; in these regards they resemble the copper object depicted here in Fig. 18D. However, one side of the tapered end of each sandstone bar, extending about 10 cm back from the tip, has been worn smooth (Fenton 1964: 267; Rees 1979), consistent with their frequent use as plough shares.

Struck lithics are another important category of stone implements. Chert blades and the microlithic tools made from them can be found in great abundance at many sites of prehistoric, Neolithic, and later date. In Pakistan, there is remarkable evidence from the site of Mehrgarh, Baluchistan, for the use of microliths as sickle blades (Fig. 19). They are composite tools, with a cutting edge made up of rows of chert blade segments mounted in wood and held in place with a mastic of natural bitumen. The wood has decomposed, but sections of bitumen with the embedded chert microliths have survived. These sickles are attributed by Jarrige (2008: 145) to Mehrgarh Period I (Neolithic).

A microscopic examination of the edges of the chert microliths in the Mehrgarh sickles would probably reveal specific signs of micro-wear and 'silica gloss', indicating their use for cutting the stems of cereals and other plants. Banerjee *et al.* (2018) review studies of blade tools from a wide range of Harappan sites, but mention no analytical investigations of micro-wear, use-wear, or silica gloss. They make occasional references to 'worn edges' of blades and suggest that the experimental study of lithic use-wear might provide important clues to how these tools were used in Harappan agriculture (Banerjee *et al.* 2018: 280). Clearly, this is an important research project waiting to be undertaken. Thanks to advances in microscopy, use-wear analysis of chert implements has developed further in recent years, with increased precision for identifying the types of plants they were used to harvest. For example, Ibáñez-Estévez *et al.* (2021) present a method for the study of early harvesting implements and practices, based on texture analysis of gloss on sickle blades seen by using confocal microscopy. Using this method, they claim to identify different plant harvesting activities (the cutting of unripe, semi-ripe and ripe cereals, reeds and other grasses), leading them to evaluate changes over the chronological period and sequence in which plant cultivation began and domesticated crops appeared in the Levant between 12,800 and 7000 BCE.

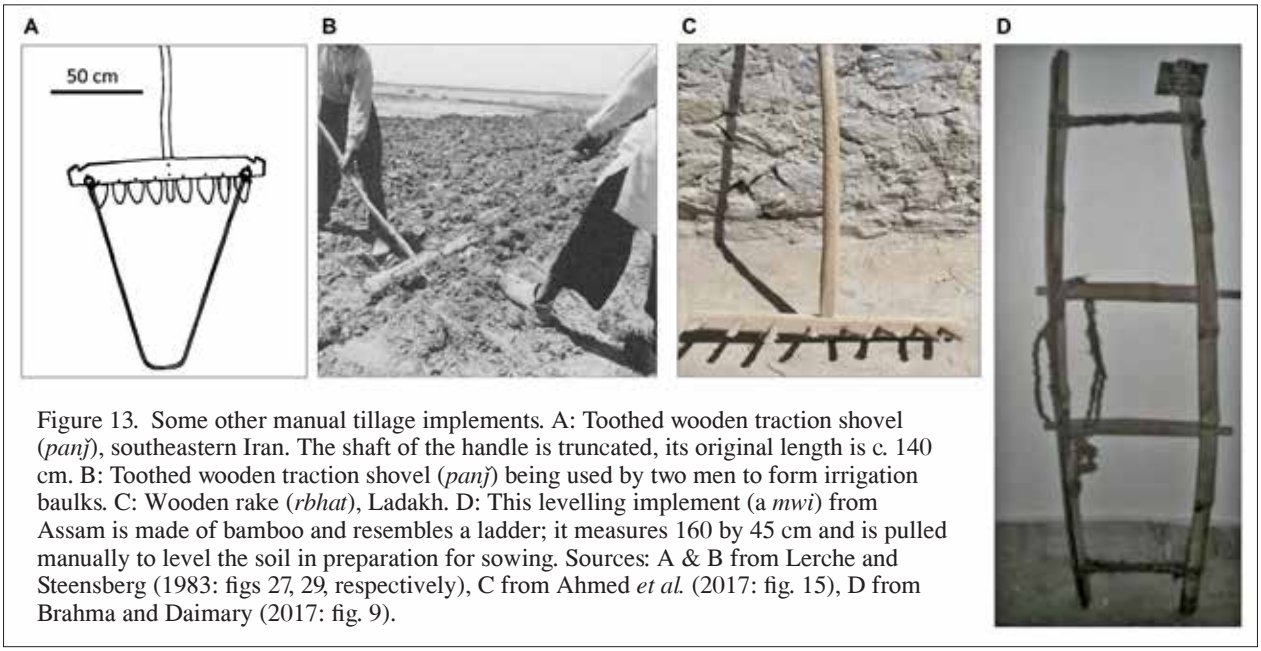

Figure 13. Some other manual tillage implements. A: Toothed wooden traction shovel (*panǰ*), southeastern Iran. The shaft of the handle is truncated, its original length is c. 140 cm. B: Toothed wooden traction shovel (*panǰ*) being used by two men to form irrigation baulks. C: Wooden rake (*rbhat*), Ladakh. D: This levelling implement (a *mwi*) from Assam is made of bamboo and resembles a ladder; it measures 160 by 45 cm and is pulled manually to level the soil in preparation for sowing. Sources: A & B from Lerche and Steensberg (1983: figs 27, 29, respectively), C from Ahmed *et al.* (2017: fig. 15), D from Brahma and Daimary (2017: fig. 9).

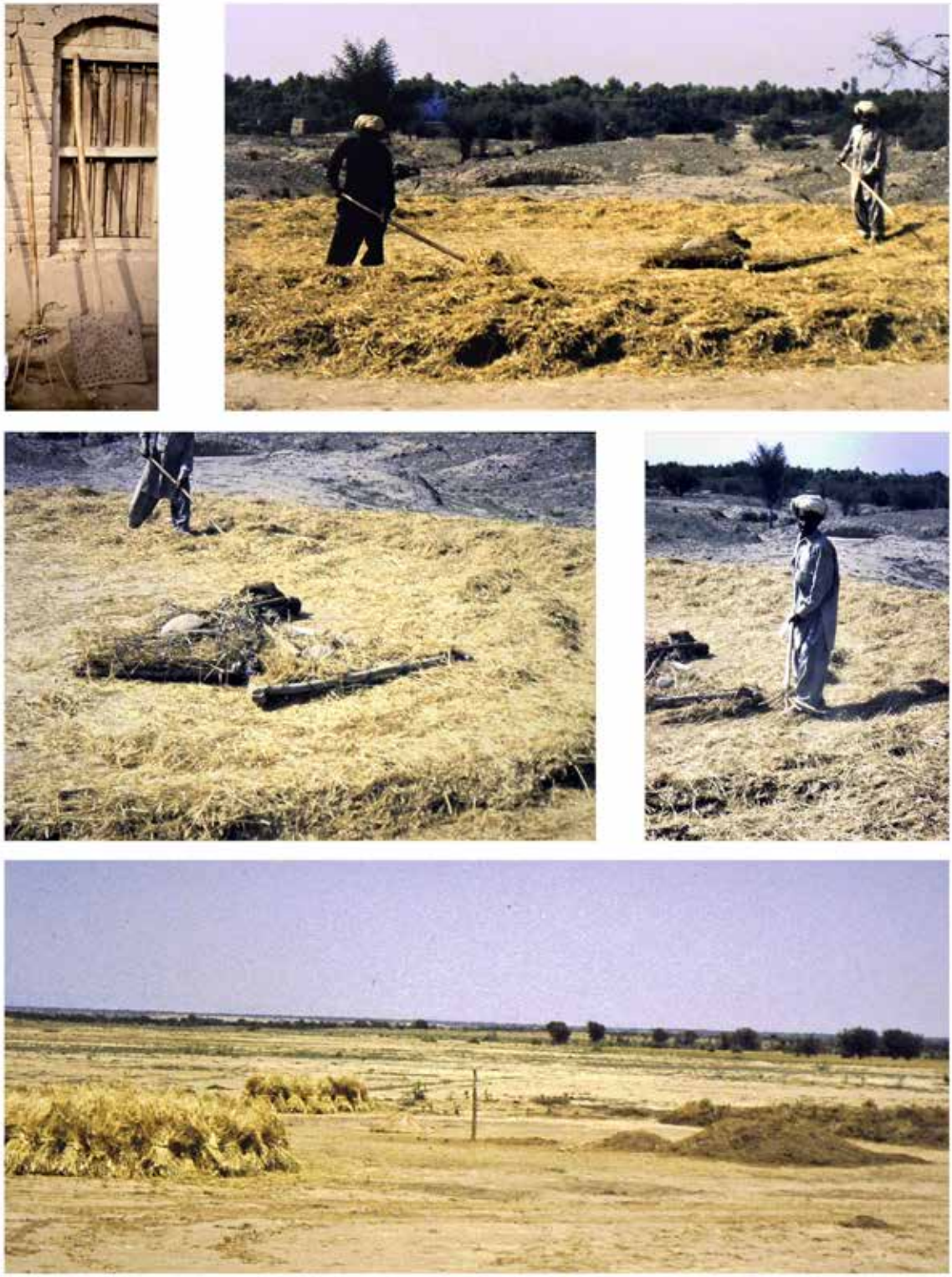

Figure 14. Threshing and winnowing. Top left: winnowing fork (*skaiya*) and winnowing shovel (*khuya*), Bharat Village. Top right: wheat threshing floor, north of Bannu City (April 1985). Middle left: close up of this same wheat threshing floor showing the threshing sledge (*sapella*) composed of a thorny bush (*markharran*) weighed down by large stones, plus the halter for attaching the sledge to a bullock. Middle right: the same wheat threshing floor showing the winnowing fork or *skaiya* in use. Bottom: chickpea (*gram*) threshing floor near Village Takhti Khel, Bannu District (April 1985); note the central post to which a bullock would be attached to pull the threshing sledge around in circles. Photographs by the author.

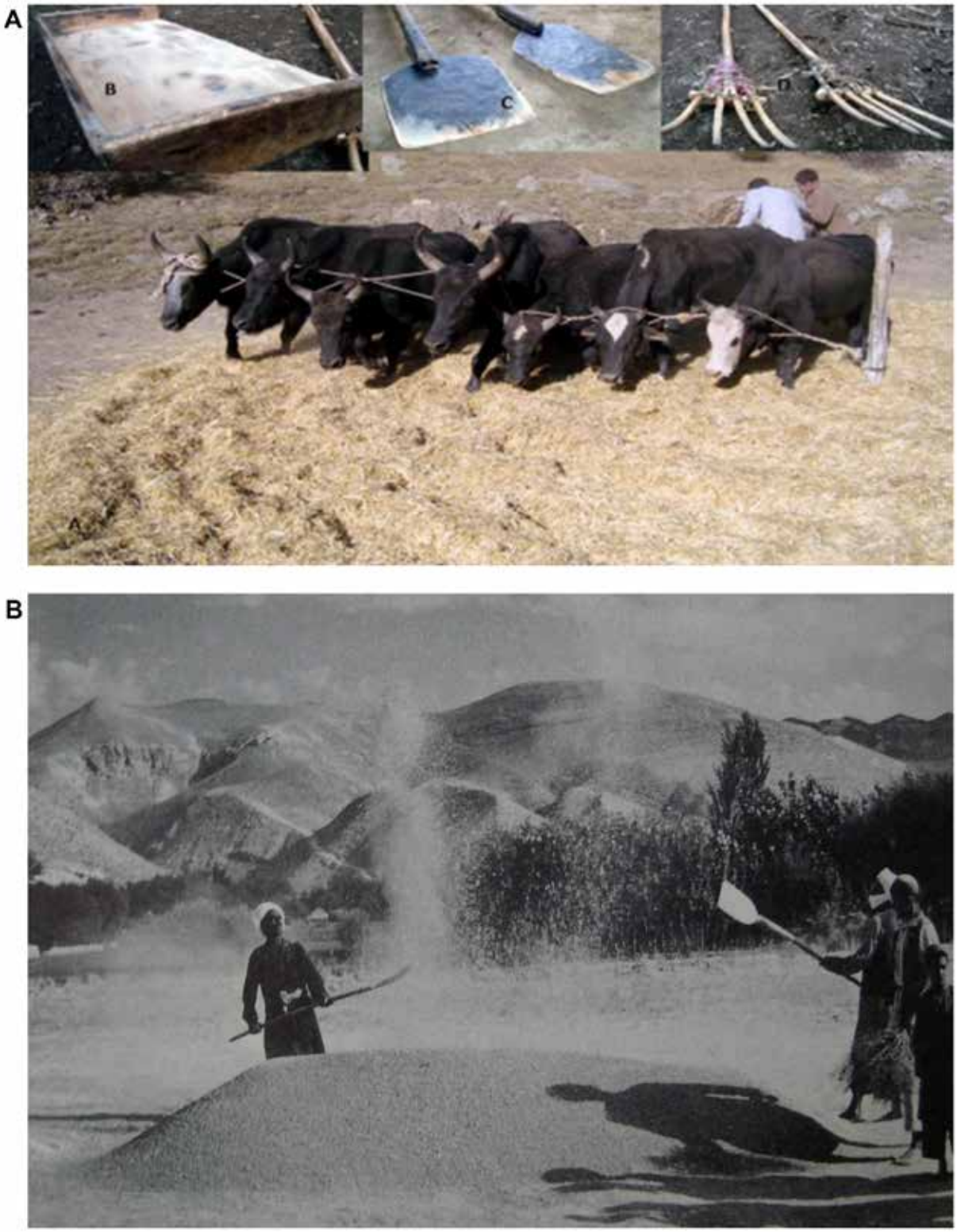

Figure 15. Threshing and winnowing. A: Traditional agricultural techniques and tools, Astore Valley, Gilgit. Lower: Bullocks and *dzo* being used for threshing. Upper: traditional wooden tools (from the left: *bashan*, *fei* & *haroch*) used in threshing and winnowing. B: Uzbek farmers winnowing wheat with a wooden fork and wooden shovel, northern Afghanistan (August 1969). Sources: A: from Noor *et al.* (2013: fig. 1), B: from Dupree (1978: fig. 38).

Evidence from zooarchaeology (i): artefacts of bone and antler

Animal bones are among the most abundant types of material found during archaeological excavations; their study being known as 'zooarchaeology'. Some bones may show signs of having been used as implements, although these are rarely associated with agricultural activities. However, Shinde (1991) describes two implements from the Chalcolithic period farmstead of Walki in Western India, which he suggests might have been used in agriculture. One is a modified bovine shoulder bone (scapula), made into a triangular artifact (Fig. 20) which Shinde (1991: 212) suggests was a plough share. The side edges of this implement have long parallel wear marks; the underside has no wear marks, possibly indicating this surface was protected by a wooden sole. The other implement is a piece of deer antler about 35 cm in length (Fig. 20) which has been deliberately hollowed-out and cut obliquely at one end (Shinde 1991: 213-4). Its exact function could not be determined but Shinde suggests it might have been used as a seed drill. Producing this enigmatic antler 'tube' would have involved a considerable amount of painstaking work, suggesting the object had considerable 'value'. This is not to suggest it was something other than a seed drill, although in recent times tubes of bamboo have been used for this purpose. Other implements made from deer antler were recovered during excavations at the Chalcolithic period site of Inamgaon, Maharashtra (Fig. 20). These are identical hoes or picks (Shinde 1987: 219 and fig. 8) which make effective use of the original structure of the antlers from which they were produced.

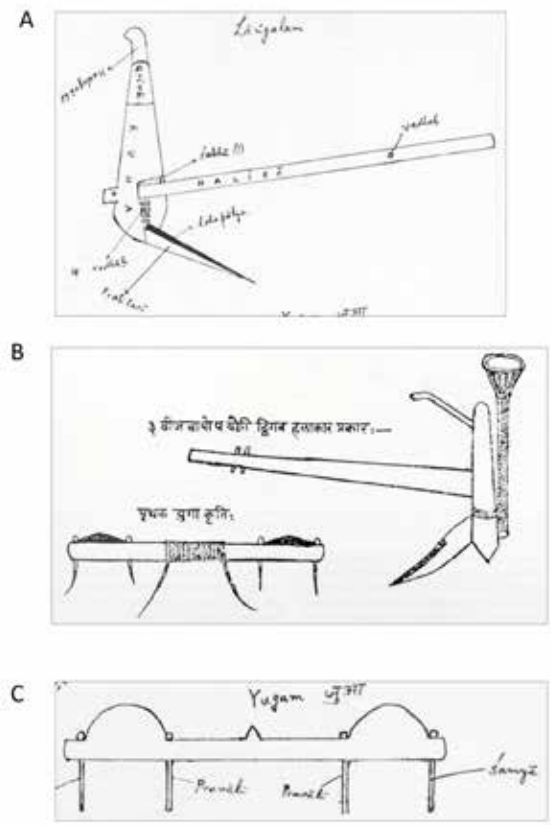

Figure 16. Ancient ploughs of Parāśara. A: The ard-type plough described by Parāśara in the *Kṛṣiśāsana* manual of agriculture. Details of this ard, including dimensions of components, are given by Wojtilla (1991a: 232); the beam (*halisā*) measures 96 cm in length. B: Plough with sowing equipment. C: Yoke for two draught animals. Figures adapted from Wojtilla (1991a: figs. 2, 3).

Evidence from zooarchaeology (ii): ancient animal husbandry

The evidence here is rather indirect as far as agricultural operations are concerned: if it can be shown from analysis of their bones that animals in the past were probably used for purposes of traction, it is likely they were used to draw agricultural implements such as ards and harrows (in addition, perhaps, to wheeled vehicles such as carts and wagons). The evidence used is of two types: establishing the age at death of male cattle and seeking evidence of joint pathologies that might be linked to heavy work such as traction.

The harnessing of cattle is a major factor behind the economic development of early farming societies. Sherratt (1981) and Halstead (1996) observe that the earliest use of ploughs must be linked to the use of animals for traction and other forms of work. Williamson and Payne (1959: 234-6) note that bullocks are preferred to cows as traction animals because they are stronger and, in the case of male zebu cattle, have a more pronounced hump on the neck and more developed muscular tissues in that region, which aids their traction power and reduces injuries that might be caused by the yoke. Male cattle are

usually killed at a young age because as mature bulls they are aggressive and unmanageable. Animals that have been castrated are easier to handle, but if done too early it will affect the physical development of draught animals. In villages in Pakistan, farmers castrate male cattle at the age of two or three years (Hanjra 1994: 282). Based on such knowledge of animal husbandry, evidence from zooarchaeological assemblages that some male cattle were kept alive well into adulthood could suggest they had been used for traction (Halstead 1996: 302). This is a perfectly reasonable assumption with which to proceed, but there are problems. Foremost is identifying older males in assemblages of bones from archaeological sites. Preservation needs to be good and the most appropriate skeletal elements for sexing cattle must be present. Then there is the tricky question of estimating the age of death of any males identified among the bones, a complex technical issue which cannot be considered here.

Cattle forced to undertake heavy work experience stresses and strains to which they are not naturally accustomed. This can lead to pathological developments in the bones, most especially near the joints ('arthropathies') in the limbs. As part of a wide-ranging study of the past use of animal power for a range of economic activities, with special reference to the Indus Civilisation and the site of Harappa, Miller (2003, 2004) studied the bones of cattle for evidence that these animals might have been

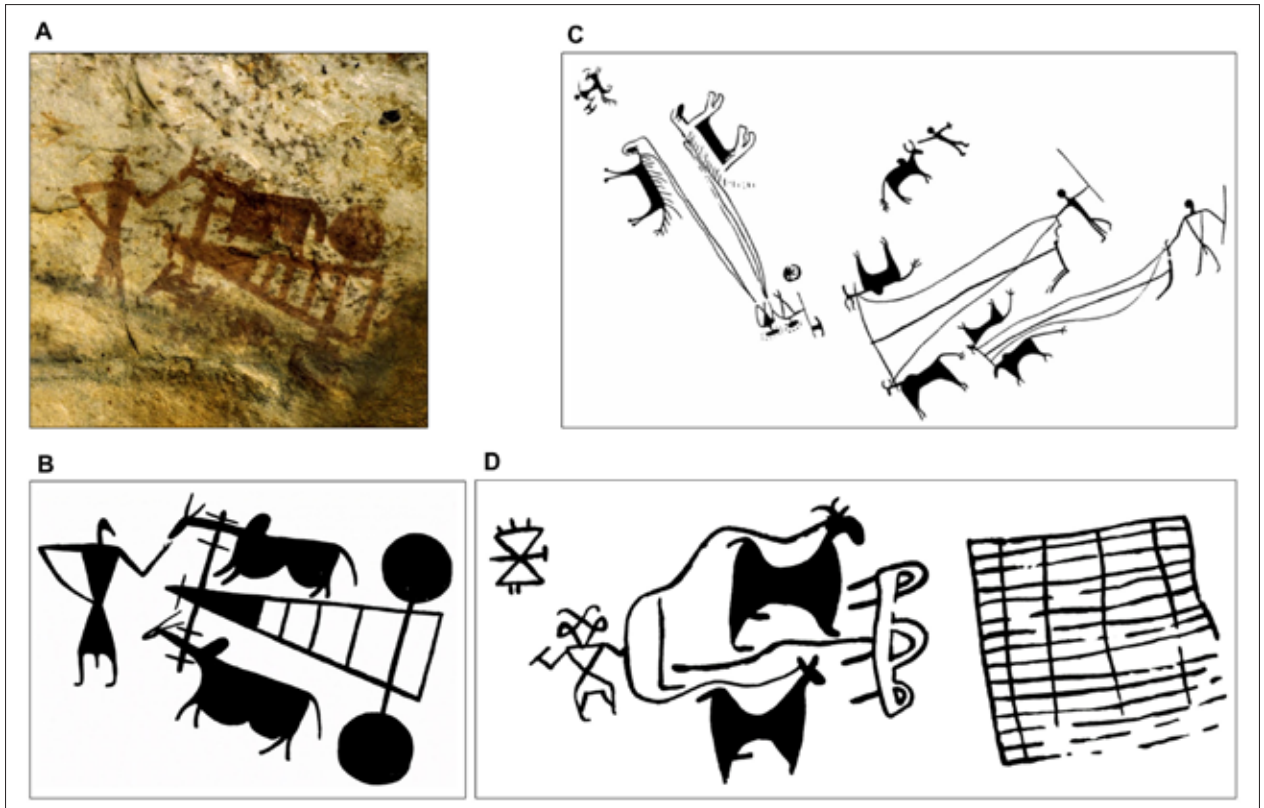

Figure 17. Rock art from Madhya Pradesh, India, depicting a bullock cart and ploughing. A & B show a cart with solid wheels pulled by two yoked cattle led by a man. Location: Asan River (Madhya Pradesh) and of Chalcolithic age. C: A horse-rider (top left), a chariot drawn by two horses (badly weathered, but one spoked wheel is evident), and two ploughmen with ploughs, each drawn by a pair of yoked cattle. As Neumayer (2016: caption to C10) notes: depictions of ploughmen are probably the rarest theme pictures in Indian rock art. Location: Chhatur Bhoj Nath Nulla (Madhya Pradesh) and of Chalcolithic age. D: A ploughman, his pair of oxen and a double yoke, all in front of a ploughed field. According to Neumayer (2016: caption to C10a), the theme of this painting is unique in Indian rock art. Location: Lakhajoar (Madhya Pradesh) and of the 'Historic' period. Figures adapted from Neumayer (2016: figs. C07, C10, C10a).

used for traction. Miller examined both modern comparative specimens of the Punjabi 'Sahiwal' breed and archaeological specimens from the site of Harappa, focusing on the 1st, 2nd, and 3rd phalanges of the fore and hind limbs. She found that in modern cattle it can take two to four years for the effects of traction work to show in the foot bones of cattle (Miller 2003: 289). In the archaeological material, pathologies that could have been caused by traction work were found in 17% of 1st phalanges, 13% of 2nd phalanges and 21% of 3rd phalanges, with variation in the frequencies of pathologies between different phalanges of the fore and hind limbs, although pathological lesions were slightly more prevalent in the fore limbs (Miller 2003: 291).

Recent studies of cattle bones from archaeological sites illustrate the potential and problems of using joint arthropathies. Using a recording system based on Bartosiewicz *et al*. (1997), Holmes *et al.* (2021) investigated possible draught cattle using a large data set of bones from mediaeval sites in England. They found a correlation between sex, body mass and lower limb bone changes. Changes in hindlimb elements were highlighted as the most useful indicator of draught use. In another study, Kamjan *et al*. (2022) examined palaeopathological features in the lower limbs of *Bos* from the Neolithic site of Çatalhöyük in Turkey. They found such bone changes in, especially, the fore limbs but did not observe any clear correlation between the severity

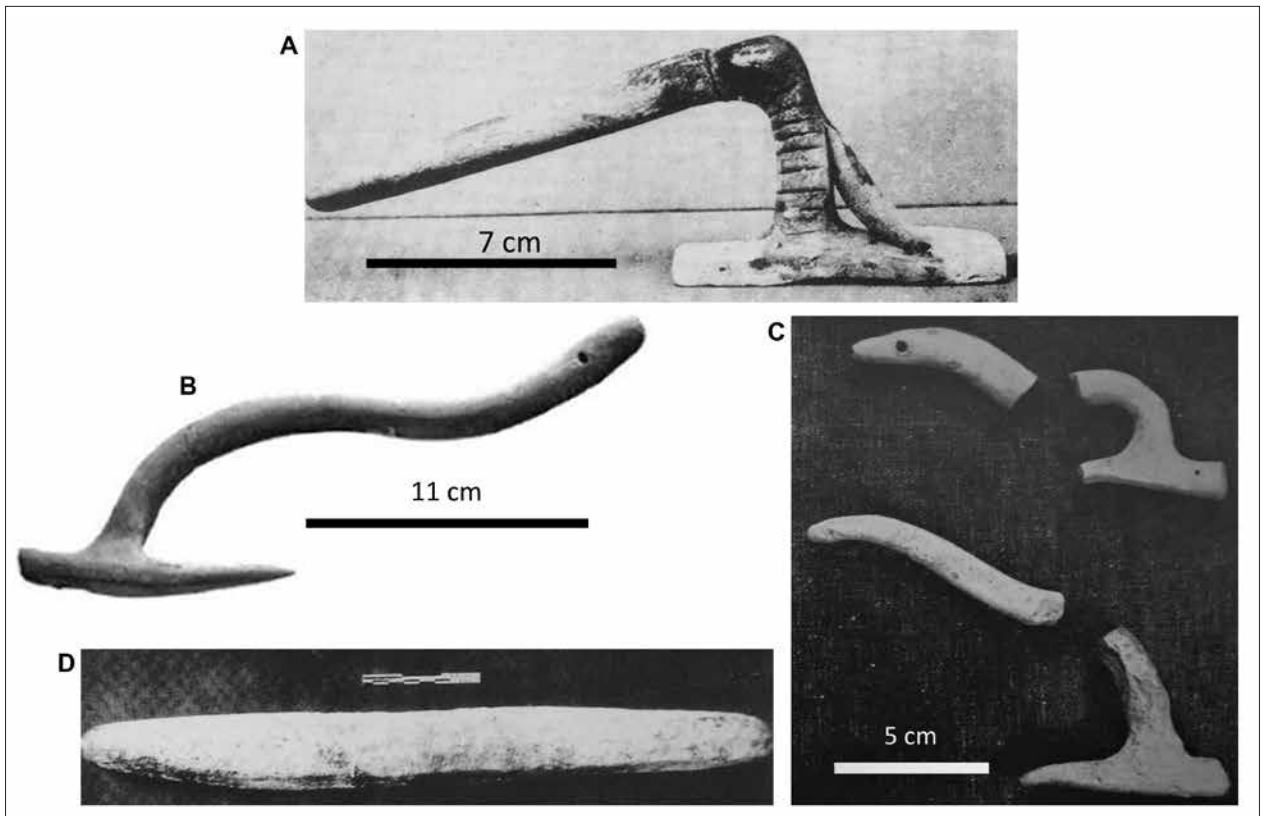

Figure 18. Archaeological evidence of early ploughs, South Asia. A: Plough-like terracotta from Mohenjodaro. The long beam-like extension and the plough sole-like body suggest that this is a model plough, although there is no evidence of a handle. B: Intact terracotta model plough from the site of Banawali (Haryana, India), there is no evidence of a handle. C: Fragments of terracotta ploughs from Mature Harappan sites. D: An elongated (c. 50 cm long) pick-like copper object, possibly a plough share, from a Chalcolithic period 'Copper Hoard' site, Kulgara, West Bengal. Sources: A: adapted from Wojtilla (1989: fig. 2), based upon Randhawa (1980: fig. 78), B: downloaded 4th August 2023 from 'Agriculture in Harappan Civilization' at: http://infoindianhistory.blogspot.com/2017/10/agriculture-in-harappan-civilization.html, C: adapted from Possehl (1982: pl. 7.8), D: adapted from Deshpande (1975: pl. LXV.B).

of the pathologies and either cattle survivorship (age at death) or the size of animals. Clearly, there are differences in the findings of these two studies in relation to pathologies showing up in either fore or hind limbs, which probably relate to differences in how the animals worked. How much work a pair of bullocks can do when pulling a heavy agricultural implement depends on a range of factors, most particularly the physical condition of the animals, their experience (particularly of working alongside each other), the nature of the soil, what equipment is pulled (plough, harrow, cart, etc.), and the competence of the driver (Williamson and Payne 1959: 234-6).

Johannsen (2005: 46) notes that strategies for draught exploitation are highly variable and to focus on survivorship of male cattle can be misleading because from the age of about two years, both male and female cattle are potential draught animals. He also highlights another misconception: that young animals are difficult to train as draught animals. Ethnographic studies show they can easily be trained if teamed with older experienced animals, suggesting it might be easy to obtain or replace draught animals (Johannsen 2005: 47). Keeping single-purpose draught animals into old age might not be the best option. Bartosiewicz *et al.* (1997: 119) make the point that keeping of male cattle for draught purposes is often characterised by early castration followed by only moderate use as working animals, this allowing them to 'fatten up' for early slaughter. A male animal might be used for draught purposes and then slaughtered at an early age while the meat quality is still high. In consequence, draught animals may be virtually 'invisible' in zooarchaeological assemblages (Johannsen 2005: 47).

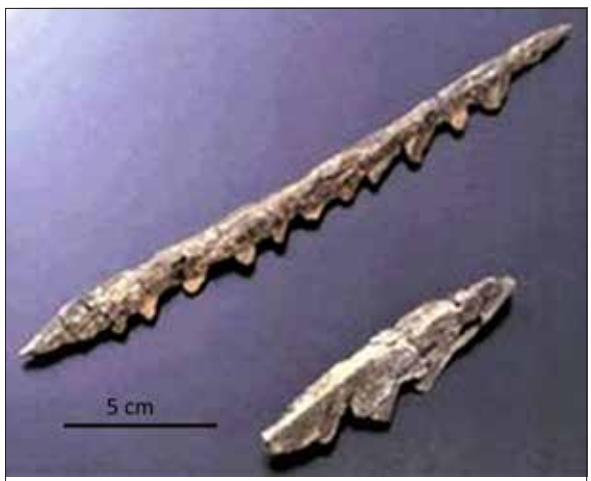

Figure 19. Mehrgarh chert sickles of the Neolithic period. The original sickles would have been of wood (since decomposed), with chert blades held in place with natural bitumen. Source of image: https://in.pinterest.com/MugdhaSharma/mehrgarh/ (accessed 3rd August 2023).

Evidence from archaeobotany

Plant remains recovered from archaeological deposits can yield information not only about crops grown but also harvesting methods. Survival of such organic remains is a problem and, in most archaeological sites, seeds and grains will only survive if they have been charred by fire. Harvey and Fuller (2005: 739) note that microscopic phytoliths offer an alternative or additional method of analysis because they are durable in most environments, regardless of whether plant parts are preserved by charring.

Archaeobotanical research aimed at reconstructing former agricultural practices faces a basic problem: how can the analysis of samples obtained from on-site domestic areas be used to make interpretations about past off-site activities (Cappers 2006: 429). Cappers suggests this dilemma can be resolved in part if the reconstruction of agricultural practices is based on ethnographic research and experimental archaeology. Pioneering work using such approaches was undertaken by Hillman (1973) who studied traditional crop-processing activities in remote villages in Turkey, taking samples of crop residues at each stage, which enabled him to relate the composition of each sample to a specific processing activity. Applying this to assemblages of charred plant macro-remains (grains, seeds, chaff, husks, stalks, etc.) from different archaeological contexts, he was able to infer various aspects of past crop husbandry (such as cereal harvesting methods, cutting heights, and the type of threshing) and subsequent on-site processing (principally winnowing and sieving). Hillman's work was later developed in a more quantitative way by Jones (1987). More recent

research, for example that of Harvey and Fuller (2005), seeks to use phytoliths to investigate crop processing because different parts of a crop (stalks, leaves, chaff, grains) have differing forms of phytoliths. As exciting as this research may be for understanding harvesting and post-harvest crop processing, less can be learned about agricultural implements and pre-harvest activities such as tillage, planting, and cultivation.

Concluding comments

In the first main section of this paper, we examined the range of traditional agricultural implements once used by the farmers of village Bharat and compared them with agricultural implements recorded in a number of different studies across South Asia. There are some common themes that link many of these studies:

- They are mostly concerned with subsistence farming practices rather than production geared for markets.
- Land holdings are small, often fragmented and sometimes located on steep and rocky terrains which are difficult to cultivate with large heavy machines or implements.
- There is a low level of crop productivity, so there is low risk-bearing ability.

Traditional agricultural implements are tried, tested, and trusted to do the job of producing a sufficiency of food, year after year. If it works, why change it – especially if to do so involves a significant element of risk? As Hudson (1987: 9) says: *'An important reason for the poor adoption of new techniques is the inability of the subsistence farmer to take risks. The essence of farming is trying to improve the odds in the gamble against weather, pests, and disease. The peasant has no risk capital to gamble with, so his whole strategy is geared to safety.'* And very successful this has been, for thousands of years.

All the traditional agricultural implements considered here have an important feature in common: their use involves low-intensity tillage and minimal disturbance of the soil. In consequence, the systems employing such implements are highly sustainable. In recent years there has been an upsurge in research into more sustainable ways of farming, especially those which limit negative impacts of tillage on the vital soil resource. Carter (2005) presents a useful review of conservation tillage, including variants such as reduced tillage, minimum tillage and no tillage. Conservation tillage provides benefits for agricultural systems through soil conservation, including reduced soil erosion, enhanced storage or retention of soil organic matter, and improvement of soil quality at the soil surface. In an evaluation of the potential of conservation

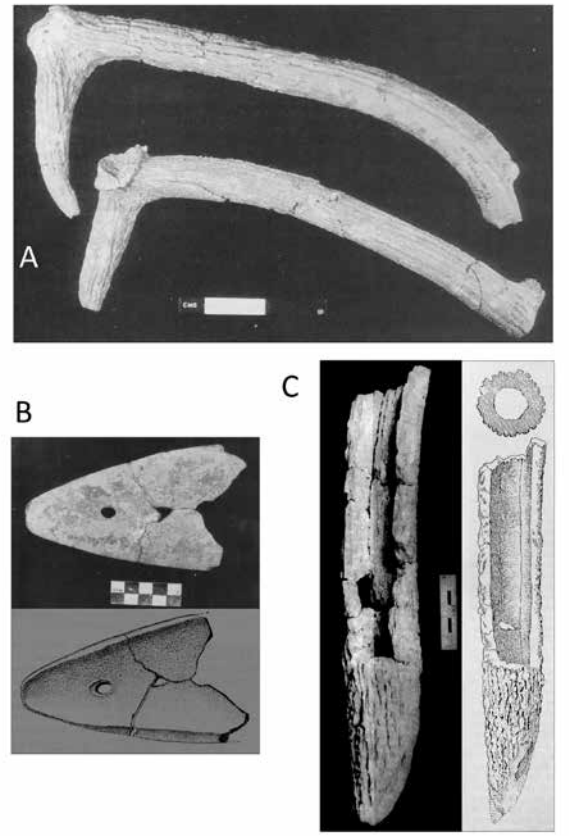

Figure 20. Implements in bone and antler from Chalcolithic period sites in Maharashtra (India) that might have been used for agricultural purposes. A: Antler hoes or picks from Inamgaon. B: Photograph (upper) and drawing (lower) of a worked bovine scapula from Walki, described as a bone ard plough share. C: Photograph (left) and drawing (right) of a deliberately hollowed-out deer antler from Walki, suggested to be a seed drill. Sources: A: Shinde (1987: fig. 8), B: Shinde (1991: figs. 1, 2), D: Shinde (1991: figs. 5, 4).

tillage for sustainable agriculture in parts of Africa, Fowler and Rockstrom (2001) emphasize the importance of indigenous knowledge and urge less use of introduced 'European' agrarian technologies, such as the mouldboard plough and hand hoe, which cause damaging soil inversion. However, in some farming systems the practice of less intensive tillage might have longer-term negative results. For example, Baig *et al*. (2013) found that although farmers in the rainfed (*barani*) farming areas of Pakistan practice shallow tillage to increase organic matter, water conservation and weed control, in the long term such shallow ploughing causes the development of a hardpan beneath the plough layer. This hardpan reduces rainwater infiltration and restricts the root development of rainfed crops and Baig *et al*. (2013: 42) suggest that in such agricultural systems, it is deep tillage that helps loosen the soil, increases infiltration and recharges water resources deeper into the soil profile, thereby helping to conserve moisture in the soil.

Many of the implements we consider here, from village Bharat and farther afield, are 'low tillage' in terms of their impact on the soil. This is especially so for ards, which merely scratch a shallow furrow into which the seeds are dropped. Ards can hardly be expected to contribute to the levels of crop production needed to sustain present-day populations, but perhaps the lessons they offer can help inform the design of new, less tillage-intensive, types of farming machinery.

Despite trends towards increasing use of modern agricultural machinery in Pakistan, a relatively recent survey by Ali (2014) found that across the whole of Khyber Pakhtunkhwa Province some 60% of farmers were still using traditional agricultural technologies, while only 15-20% had access to mechanised harvesters and 10% used combine harvesters (i.e. combined harvesters and threshers). Surveys of farming practices in Peshawar District by Sanaullah *et al*. (2021) showed that 44% were using traditional farming methods and equipment.

We have been concerned here with 'traditional' agricultural implements and allied farming systems. 'Traditional' as used in an agricultural context has been defined by Delamarre (1972: 135) as 'what remains from or is ascribed to the past in present-day societies'. Traditional forms of farming, and associated implements are fast disappearing yet should be preserved and recorded as vital elements in the history of that most important innovation of humankind: agriculture. Knowing about traditional agriculture also brings to mind the work of the people who worked in this way and the craftspeople who made the implements (Delamarre 1972: 137). Museums have important roles to play here. The villagers of Bharat village were certainly proud of their farming heritage as embodied in the traditional implements they so carefully curated in their houses. The display of these implements they laid out for us (Fig. 2) would have been a credit to an open-air agricultural museum. Higgs and Drake (1972: 140-1) suggest that agricultural and folk museums can play two important roles. First and foremost is to record the changes that take place in society, technology, ideas, and traditions to ensure that future generations have a link with their past. The second is to teach people about techniques and methods: agricultural museums provide comparative collections which allow people to see how farming practices are carried out, how traditional methods worked, and possibly how they might be improved. To achieve this will not be easy; first it will be necessary to overcome the perception that museums are concerned only with the past.

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