Strategies for the Utilisation of Secondary Animal Products in the Sutlej–Yamuna Divide, 3200–1200 BCE: An Ethnoarchaeological Perspective

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Abstract

This paper examines the possible use of animal secondary products in the subsistence economy of the Sutlej–Yamuna Divide, focusing on transport, agricultural labour, dairying, and wool production. In animal husbandry, secondary products are those obtained from living animals without killing them, including traction, milk, and wool. These products may have helped past societies to produce surpluses and to use animals as renewable sources of energy and materials, making them important for reconstructing subsistence strategies. The study analyses published zooarchaeological data together with artefactual and ethnoarchaeological evidence from the Divide. It combines faunal datasets with plough and yoke models, toy cart frames and wheels reported in excavation reports, and field observations of ploughing, carting, dairying, and sheep and goat herding among present-day communities in the same landscape. These observations serve only as comparisons, not as direct evidence of the past. Cattle (*Bos indicus*) and water buffalo (*Bubalus bubalis*) receive particular attention because, as large bovids, they were better suited than sheep and goats for traction and heavy work. Horses are absent from Early and Mature Harappan assemblages and appear only in small numbers in Late Harappan and Painted Grey Ware contexts. The evidence is indirect, and its strength varies by activity. Cattle dominate the faunal record throughout the period, and the evidence is consistent with their use for traction and transport. Dairying is possible, probably at a small scale. Wool use is plausible but is the least securely supported. The findings are presented as possibilities supported by converging lines of evidence.

Keywords: Secondary Products Revolution, Zooarchaeology, Sutlej, Yamuna, Harappan, Protohistoric Culture

Introduction

V. Gordon Childe (1936) first discussed the Neolithic, or Domestic, Revolution. This term became significant in archaeology, and many researchers worldwide began looking for markers directly associated with the primary uses of domesticated plants and animals. In 1981, however, Andrew Sherratt (1981: 262) highlighted an important aspect that previous work had overlooked: the secondary use of animals. This identification led to the development of the term 'Secondary Products Revolution' (SPR), which implies that animals were used for additional purposes. This secondary utilisation of animals was an important factor in the development of Old World societies and eventually transformed Neolithic European society (Sherratt 1983: 90–104). According to Sherratt, these new technologies led to higher population densities and more complex subsistence patterns (Sherratt 1983: 90–104).

This may be supported by the observation that, over time, humans began to conceptualise their surroundings more analytically; animals were therefore used for more purposes than meat and were regarded as a 'walking larder' of labour, food, fuel, and clothing (Clutton-Brock 1989: 1–7). A simple framework equates the SPR with domestication alone, but the SPR is more than domestication: underlying principles make it a more complex process (Sherratt 1983: 95).

Flannery (1965) discusses the relationship between agricultural communities and goat herders near the Zagros Mountains and the Assyrian steppes, arguing that local populations integrated animal herding and cereal cultivation into a diversified food-production system. This argument sparked debate among scholars of agriculture and pastoralism about the geographical and economic models of the time. Sherratt subsequently suggested that, in the Old World, agricultural societies went through two phases of agricultural development. In the hoe-cultivation phase, technology and transportation relied on human muscle power, and animals were kept mainly for meat (Sherratt 1981: 262–263). During this phase, the Old World was heavily forested, and carnivore pastoralism was based on meat production (Chang and Koster 1986: 101). In the second phase, both plough cultivation and pastoralism utilised animals as a source of energy (Sherratt 1981: 262–263). According to Sherratt, animals began to be used for secondary products in the second phase because forests diminished and pastures increased (Sherratt 1981). However, the carnivore-and-dairy pastoralism model offers an unclear picture of the ecological and economic conditions of pastoralism and early food production (Chang and Koster 1986: 101). These models cannot be understood solely in terms of environmental and ecological conditions; culture and technology must also be considered, because animal domestication is a cultural process (Clutton-Brock 1989: 20–21).

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In the Levant and the Near East, early herders preferred small bovids, *i.e.*, goats and sheep, over cattle during 8000–6000 BCE (Davis 1987: 140–142). Data from Ali Kosh, Ganj Dareh, Bus Mordeh, Jericho, Beidha and Ain Ghazal support the hypothesis that people preferred small bovids over large ones (Crabtree 1993: 222–223); for the domestication of large bovids, *i.e.*, cattle, the eastern Mediterranean and North Africa have been identified as the earliest centres of domestication around 7500–6800 BCE (Crabtree 1993: 223).

Before considering the study area, i.e., the Sutlej–Yamuna Divide, it is necessary to examine the Neolithic levels of Mehrgarh, which reveal evidence of agricultural domestication and animal husbandry from 6000 BCE onwards. Period IA at Mehrgarh shows faunal remains of wild and domesticated small bovids such as goat, sheep, gazelle, and blackbuck, with a very low presence of cattle (Patel and Meadow 2017: 284–290). Animal domestication in Period IA at Mehrgarh shows similarities to patterns seen in the Levant and the Near East. However, later periods at Mehrgarh show an increase in cattle remains (Patel and Meadow 2017: 284–290). This makes Mehrgarh the only site in the Indian subcontinent that provides evidence of the transition from exploiting wild fauna to animal domestication (Patel and Meadow 2017: 297).

From 3200 BCE onwards, faunal data from the Sutlej–Yamuna Divide show that domesticated goat, sheep, cattle, pig, and water buffalo were present from the start. The only difference between the Divide and Mehrgarh was a greater emphasis on domesticating large bovids (including water buffalo) in the Divide. This suggests that, by the fourth millennium BCE, species that had spread beyond their wild ranges had been fully domesticated in the Divide; this shift may have been due to herder movement or trade. It further suggests that society in the Divide during the fourth millennium BCE was ready to shift from animal herding alone to more advanced uses that exploited secondary products, i.e., traction, milk, dung (Figure 1), and wool. This hypothesis is supported by the extensive artefactual and zooarchaeological material available from individual sites in the Divide, discussed in more detail below.

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Figure 1: Heap of cow dung used as fuel on open land near the mound in Rakhigarhi (Photo by Author).

Regarding the use of animal secondary products in the Divide, I first consider cattle (*Bos indicus;* cow/ox) and water buffalo (*Bubalus bubalis*). These large bovids had a wider range of uses than small animals such as goats and sheep because they were better suited for traction and agricultural production. In contrast, other draught animals such as the horse were absent in the Early and Mature Harappan phases of the Divide. In the Late Harappan and Painted Grey Ware (PGW) cultures, however, horses were present at sites such as Bhagwanpura, Burj, Karsola, and Mirzapur, although with a very low number of identified specimens (NISP) in the faunal assemblages (Abhayan and Joglekar 2012; Sharma 1996; Sharada 2018). Thus, the economy of the Sutlej–Yamuna Divide would have benefited from domestic animals such as cows, oxen, and water buffalo, as well as small animals such as sheep and goats, which provided transport, agricultural labour, dairy products, and textiles. Miller argues that 'the control and distribution of animal secondary products are hypothesised to have been important factors in the processes of urbanisation and social differentiation in Harappa' (Miller 2003: 302). Accordingly, this study aims to understand the utilisation of animal secondary products in the Divide, including not only traction but also dairying and wool production.

Drawing on published faunal analyses from fifteen sites in the Sutlej–Yamuna Divide and surrounding areas, especially Sharada's (2018) detailed work on Girawad, Farmana and Mitathal, together with artefactual evidence for ploughs, yokes, toy carts, and wheels, and my

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own ethnoarchaeological observations of ploughing, manuring and carting in the modern landscape, this study re-examines how secondary animal products collectively underpinned subsistence strategies in the region between 3200 and 1200 BCE.

Methodology

All faunal data in this paper come from published zooarchaeological reports; I did not re-examine skeletal material. The core dataset is the detailed study of Harappan faunal assemblages in Haryana by Sharada (2018), which provides NISP by taxon (Table 1), age profiles and sex data (from epiphyseal fusion and tooth wear), withers height estimates (Table 2), and observations on skeletal stress for Girawad, Farmana, Mitathal, and associated sites. These are supplemented by faunal reports for additional Early, Mature, and Late Harappan and Painted Grey Ware assemblages from the Sutlej–Yamuna Divide, including Burj, Karsola, Bhirrana, Rakhigarhi, Ropar, Masudpur, and other sites (Abhayan and Joglekar 2012; Deshpande-Mukherjee 2010, 2012; Deshpande-Mukherjee et al. 2016; Joglekar et al. 2013, 2018, 2019; Nath 1968; Sharada 2018; Sharma 1996; Uparthana 2011). For each site and phase, I extracted the relative abundances of major domestic taxa (Tables 1 and 3) and, where possible, the proportions of juvenile, sub-adult, adult, and old individuals among bovids as published by the original analysts. I then reorganised these data to focus explicitly on their implications for secondary products, i.e., the retention of mature and old animals for labour and milk, the relative importance of caprines and their potential for wool, and the marginal but persistent presence of pigs. In parallel, I systematically reviewed excavation reports for sites in the Divide that have yielded artefacts related to secondary products, particularly toy cart frames and wheels, plough and yoke models, and other evidence for wheeled transport and plough agriculture. I compared these finds with my own ethnoarchaeological observations at and around these sites, where traction, dairying, and wool production continue to play a role in subsistence. I documented modern ploughs, neck yokes, bullock carts, and sheep- and goat-herding practices in the villages of the study area to understand how different cart types, yoking arrangements, and herd structures translate into specific patterns of skeletal stress and secondary-product use. I then used these ethnoarchaeological insights as a comparative framework to interpret the archaeological faunal and artefactual record in terms of traction, milk, and wool.

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Common Name	Biological Name	Early Harappan (3200–2600 BCE)							Mature Harappan (2600–19			
		Girawad (EH)	Bhirrana (EH)	Farmana (EH)	Kunal IA (Pre-H)	Kunal IB (EH)	Burj (EH)	Masudpur (EH)	Rakhigarhi (EH)	Farmana (MH)	Ropar (MH)	Bara (MH)	Bhirrana (MH)
Cattle	*Bos indicus*	7.60%	P*	3.05%	**12.20%**	**14.20%**	P*	P*	**44.61%**	6.48%	**56.20%**	**67.82%**	P*
Buffalo	*Bubalus bubalis*	1.96%	P*	0.48%	—	2.29%	P*	P*	3.63%	0.59%	**11.70%**	6.05%	P*
Cattle/Buffalo (broad)	*Bos/Bubalus*	**77.05%**	P*	**73.91%**	**34.30%**	**51.50%**	P*	P*	**27.13%**	**79.21%**	—	—	P*
Goat	*Capra hircus*	0.04%	P*	—	—	1.60%	P*	P*	**12.02%**	0.32%	4.24%	0.34%	P*
Sheep	*Ovis aries*	1.05%	P*	0.32%	—	1.37%	P*	—	1.81%	0.20%	5.55%	**10.07%**	P*
Sheep/Goat (broad)	*Ovis/Capra*	3.49%	P*	**12.07%**	7.73%	5.49%	P*	—	—	**12.17%**	—	—	P*
Pig	*Sus domesticus*	0.04%	P*	0.32%	—	4.81%	P*	—	1.53%	0.14%	5.55%	5.83%	P*
Dog	*Canis familiaris*	0.04%	P*	—	—	0.46%	—	—	—	0.22%	**15.66%**	—	P*
Cat	*Felis catus*	—	—	—	—	—	—	—	—	0.22%	—	—	—
Horse	*Equus caballus*	—	—	—	—	—	—	—	—	—	—	—	—
Ass/Donkey	*Equus asinus*	—	—	—	—	0.23%	—	—	—	—	—	—	—

Table 1. NISP (%) of domestic mammals in the Sutlej–Yamuna Divide (3200–1200 BCE) (Abhayan and Joglekar 2012; Deshpande-Mukherjee 2010, 2012; Deshpande-Mukherjee et al. 2016; Joglekar et al. 2013, 2018, 2019; Nath 1968; Sharada 2018; Sharma 1996; Uparthana 2011)

Values are % of total identified assemblage (NISP) per site | P* = Present, no NISP % available; — = Not reported; EH = Early Harappan; MH = Mature Harappan; LH = Late Harappan; PGW = Painted Grey Ware; Pre-H = Pre-Harappan. Colour intensity: dark red ≥50% • brown ≥10% • green ≥1% • blue <1%.

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Site	Phase	Mean Cattle Withers Height (cm)
Rakhigarhi	Early Harappan	**108.45**
Girawad	Early Harappan	**112.43**
Masudpur	Mature Harappan	**122.00**
Ropar	Late Harappan / PGW	**118.10**
Mitathal	Late Harappan / PGW	**112.00**

Table 2. Mean cattle withers height (after Sharada 2018).

Common Name	Biological Name	Early Harappan (3200–2600 BCE)								Mature Harappan (2600–1900 BCE)						La	
		Girawad	Bhirrana (EH)	Farmana (EH)	Kunal IA	Kunal IB	Burj (EH)	Masudpur (EH)	Rakhigarhi (EH)	Farmana (MH)	Ropar	Bara	Bhirrana (MH)	Lohat	Masudpur (MH)	Bhagwanpura LH	Bha
Cattle	*Bos indicus*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Buffalo	*Bubalus bubalis*	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Cattle/Buffalo (broad)	*Bos/Bubalus*	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—	✓	✓	✓	—	
Goat	*Capra hircus*	✓	✓	—	—	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	
Sheep	*Ovis aries*	✓	✓	✓	—	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	
Sheep/Goat (broad)	*Ovis/Capra*	✓	✓	✓	✓	✓	✓	—	—	—	—	—	✓	—	—	—	
Pig	*Sus domesticus*	✓	✓	✓	—	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	
Dog	*Canis familiaris*	✓	✓	—	—	✓	—	—	—	✓	✓	—	✓	—	—	✓	
Cat	*Felis catus*	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	
Horse	*Equus caballus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Ass/Donkey	*Equus asinus*	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	

Table 3. Major Domestic mammal taxa from Sutlej–Yamuna Divide 3200–1200 BCE (Abhayan and Joglekar 2012; Deshpande-Mukherjee 2010, 2012; Deshpande-Mukherjee *et al.* 2016; Joglekar *et al.* 2013, 2018, 2019; Nath 1968; Sharada 2018; Sharma 1996; Uparthana 2011)

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Limitations of the evidence

The reconstructions proposed in this paper are constrained by several limitations inherent in the available evidence. First, the zooarchaeological record for the Sutlej–Yamuna Divide is fragmentary and unevenly reported. Some sites provide detailed NISP, age, and size tables, whereas others offer only broad taxonomic lists or qualitative observations of pathologies, making inter-site comparisons imperfect. Recovery methods and sampled areas also vary across excavations, and fine screening was rarely employed, potentially biasing assemblages towards larger elements and taxa. Second, many skeletal changes relevant to secondary-product use, such as *exostosis* on *phalanges* and *metatarsals*, may result from age, body weight, or general mechanical stress, as well as from traction; pathology alone therefore cannot establish specific uses. Third, important aspects of secondary-product exploitation, notably dairying and wool production, often leave only indirect signatures in the faunal record. Ideally, biomolecular analyses, such as lipid-residue or isotope studies, would complement these interpretations, but they are not yet available for most sites in the Divide. Accordingly, the interpretations advanced here are probabilistic and exploratory, based on the

convergence of zooarchaeological, artefactual, and ethnoarchaeological indicators. They are intended to encourage further discussion rather than provide a definitive reconstruction.

Discussion

I. Traction Activities

The earliest evidence of traction in the Bronze Age Old World emerged from scholarly interest in the technological development of the wheel and wheeled transport. Researchers such as Sherratt (1981), Piggott (1983), and Childe (1951) examined the use of large draught animals (cattle and horses) for traction and agricultural production in Europe and the Near East (Figure 2).



Figure 2: Impression of a cylindrical seal depicting a two-handled plough (ard) with a sowing funnel, Akkadian period (third millennium BCE) (after Sherratt 1981: 267).

As Sherratt (1981) discusses in his work on the Old World, plough marks and vehicle pictographs in Mesopotamia date as far back as the fifth millennium BCE. Draught animals were initially used for agricultural purposes, and their use later expanded to transportation with the advent of wheeled vehicles.

In the study area, artefactual material – particularly that associated with agriculture and transport – can help identify traction-related uses. Archaeological evidence for traction-related activities includes carts, ploughs, and yokes, as well as cart ruts on streets and plough marks in fields. Artefacts

such as terracotta toy carts, wheels, ploughs, and yokes can help clarify the use of animals in agriculture and transportation.

I.1. Traction in Agriculture

Archaeological findings, including terracotta plough and yoke models and plough marks, provide evidence for traction in agricultural activities. At Banawali, in the Sutlej–Yamuna Divide, a terracotta plough model dating to Period II, which corresponds to the site's Mature Harappan period, has been reported (Figure 3; Dangi and Hitoshi 2016: 22).



Figure 3: Terracotta model of a plough from Banawali (after Dangi and Hitoshi 2016: 22).

A careful examination of the plough reported from Banawali indicates that it belongs to the crook 'ard' type, which is typologically similar to ards discovered in northern Europe and dated to around the third millennium BCE (Sherratt 1981: 268), as shown in Figure 4.

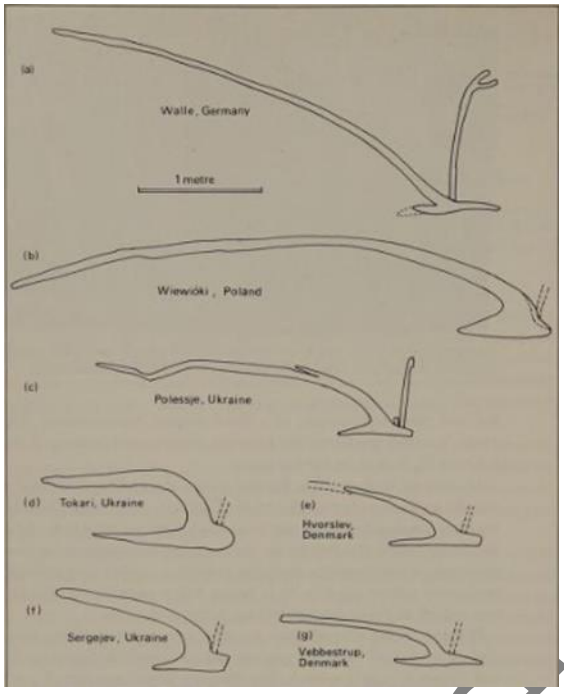


Figure 4: Ards of crook type from Northern Europe (after Sherratt 1981: 268).

However, during my fieldwork, I observed that farmers now use tractors for cultivation. Interviews with village elders in the Divide indicated that, in the past, they cultivated their land using either a crook-ard plough (Figure 4) or a bow-ard plough (Figure 5).

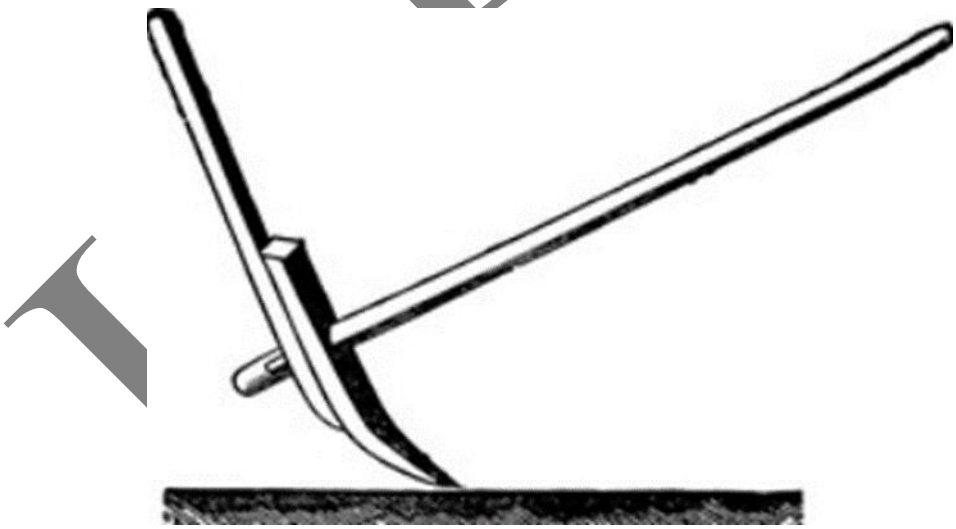


Figure 5: Modern bow-ard plough (Drawing by Author)

Another significant discovery associated with ploughing is the evidence of a ploughed field at Kalibangan (Figure 6; Thapar 1975: 28).

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Figure 6: Kalibangan: furrow marks in the southern half of the trench, belonging to an Early Harappan field (after Lal et al. 2003: Pl. XXI: 98).



Figure 7: Furrow marks in a modern field in Ropar (Photo by Author).

Kalibangan is not located within the Divide but lies close by, to the south. This ploughed field revealed furrows associated with the Early Harappan context (Thapar 1975), and similar furrow marks are visible in the present-day field at Ropar (Figure 7). The photograph was taken in December 2023, after landowners had sown Kharif crops.

In addition to the plough, researchers recovered a terracotta yoke from the Mature Harappan context at Banawali, as shown in Figure 8 (Dangi and Hitoshi 2016: 22).

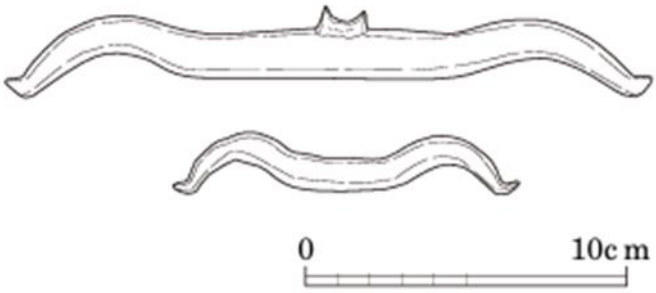


Figure 8: Drawing of a terracotta yoke from Banawali.

This neck yoke is slightly curved on either side and resembles a single horizontal crosspiece made from heat-treated, bent wood. It may have been used in agriculture and transport, with a plough or cart attached, to cultivate the land or to carry goods. Figures 9a and 9b show modern-day yokes used in Punjab and Haryana.

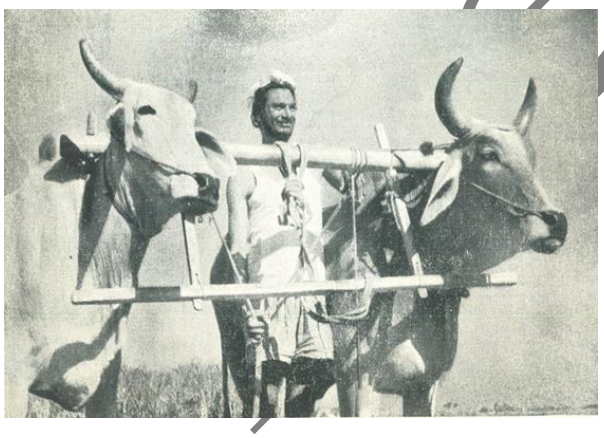


Figure 9a: A double neck yoke used for ploughing in Punjab in 1950 (Randhawa 1960)



Figure 9b: A single neck yoke used for pulling a cart near Mitathal (Photo by Author)

Apart from the terracotta plough and yoke models, no other artefactual evidence related to the use of animals in agricultural production has been found within the Divide. This evidence comes only from

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the urban site of Banawali (Dangi and Hitoshi 2016). Other sites, such as Rakhigarhi, have not yielded any direct artefactual evidence of agricultural traction implements. Nevertheless, faunal studies in the Divide have reported pathological changes in the anterior limb bones and cervical vertebrae of an adult bovid (Sharada 2018). Pathological changes in modern oxen are more pronounced than those observed in oxen in the past because land is ploughed more deeply today and therefore requires greater force (Miller 2003: 277).

I.2. Traction in Transportation

Terracotta remains of toy carts and wheels have been recovered from Nausharo (Figure 10; image available on the Harappa.com website), Banawali (Bisht 1993a, 1993b), Rakhigarhi (Lal 2002: 30), Farmana (Shinde et al. 2008: 92–109), Bhirrana (Rao et al. 2004: 20–34), Masudpur, Bahola (Singh et al. 2013: 32), Mitathal (Bhan 1975: 92), Mirzapur (IAR 1972–73: 20), Ropar (IAR 1954–55a: 9–11), Rohira (IAR 1982–83: 65–66), Sanghol (Sharma and Sharma 1982), and Balu (IAR 1984–85: 20), across Early Harappan, Mature Harappan, and Late Harappan levels in the region.

A) Toy Carts

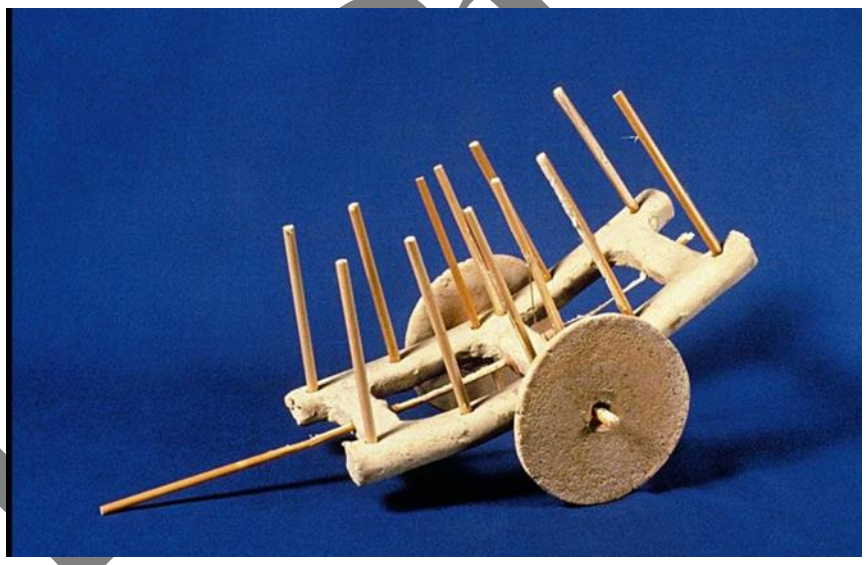


Figure 10: Toy cart frame from Nausharo reported by Jarrige (1990).

The cart models recovered from the Divide are two-wheeled, single-hub, with some having double perforations in the centre and others having single perforations at all four corners. The types of two-wheeled carts suggested by Miller (2003: 276) include:

i) Solid Box without Side Rails (Figure 11)

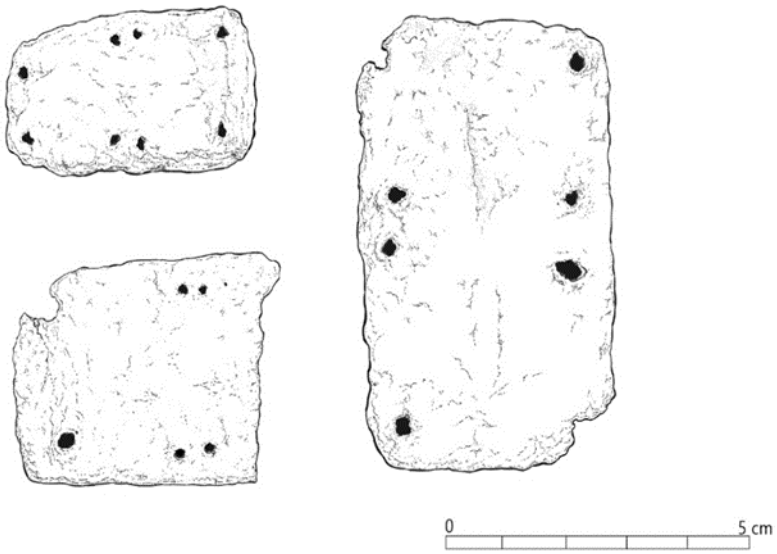


Figure 11: Solid-box cart without side rails from Farmana (Shinde et al. 2008: 94, modified by the author).

ii) Solid Box Carts with Sides (Figure 12)

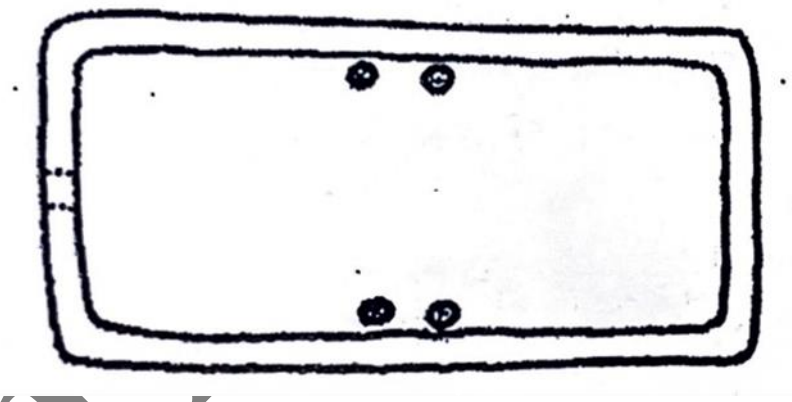
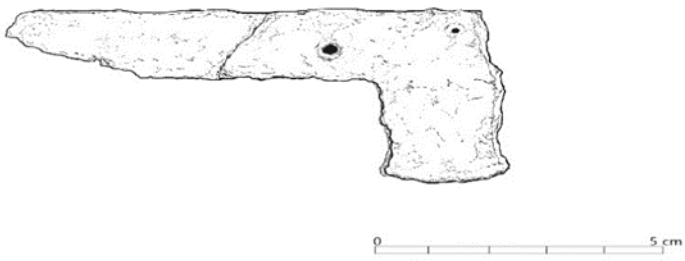


Figure 12: Solid box-type cart with sides (after Miller 2003: 276)

iii) Hollow Box Carts (Figure 13)



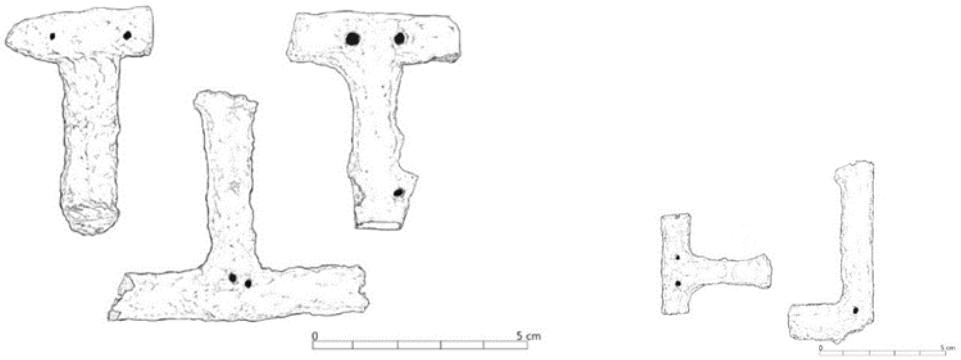


Figure 13: Fragments of a hollow box-type cart from Farmana (Shinde et al. 2008: 94, modified by the author)

Overall, cart types in the Divide showed little variation and were similar to those found at sites in other regions during the Harappan period. Cart remains from Farmana, Rohira, Banawali (Figure 14), and other sites within the Divide included solid box types, both with and without rails, as well as hollow box types.

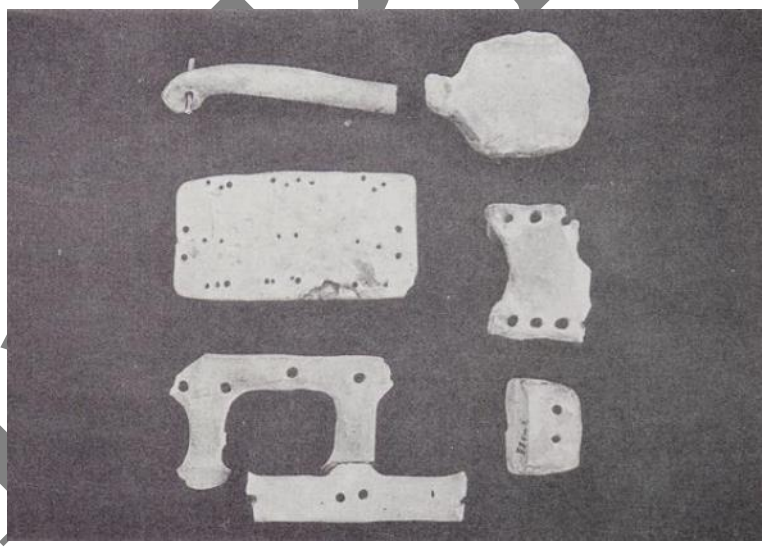


Figure 14: Solid box, solid box with sides and hollow box types from Banawali (after Bisht 1993a: 119, Plate 10.24).

According to Miller (2003), 'The animals which were used to pull light weight carts tend to have less pathology than animals with heavy weight carts. Animals pulling 2-wheeled carts are expected to have more pathologies than four-wheeled wagons.' Today, two-wheeled carts pulled by a single animal using a single neck yoke are commonly observed in the study area (Figures 15a and 15b).



Figure 15a: Solid box type with side rails and two wheels at Mitathal (Photo by Author)



Figure 15b: A two-wheeled cart in Masudpur used to transport dry and green grass as fodder for their animals. (Photo by Author)

B) Wheels

Initially, archaeologists recovered terracotta wheel remains from Mohenjo-daro (Marshall 1931: 554) and Chanhu-daro (Mackay 1943: 162–163). On this basis, Wheeler (1962: 74) concluded that the Indus civilisation used solid cart wheels. In the Sutlej–Yamuna Divide, 16 of the 21 sites have yielded terracotta toy wheels: Bahola, Bhirrana, Balu, Bhagwanpura,

Banawali, Farmana, Karsola, Kunal, Lohat, Mahorana, Masudpur I, Masudpur VII, Mitathal, Mirzapur, Rakhigarhi, and Sanghol, dating from 3200–1200 BCE (Lal 2002: 30, 72–73; Joshi 1993; Bisht 1993a, 1993b; Shinde et al. 2008: 92–109; Rao et al. 2004: 20–34; Singh et al. 2013: 32; Bhan 1975: 92; IAR 1972–73: 20; IAR 1984–85: 20). The terracotta toy wheels recovered from these sites are solid, single-sided, and either with or without a hub (Figures 16a, 16b, and 16c).

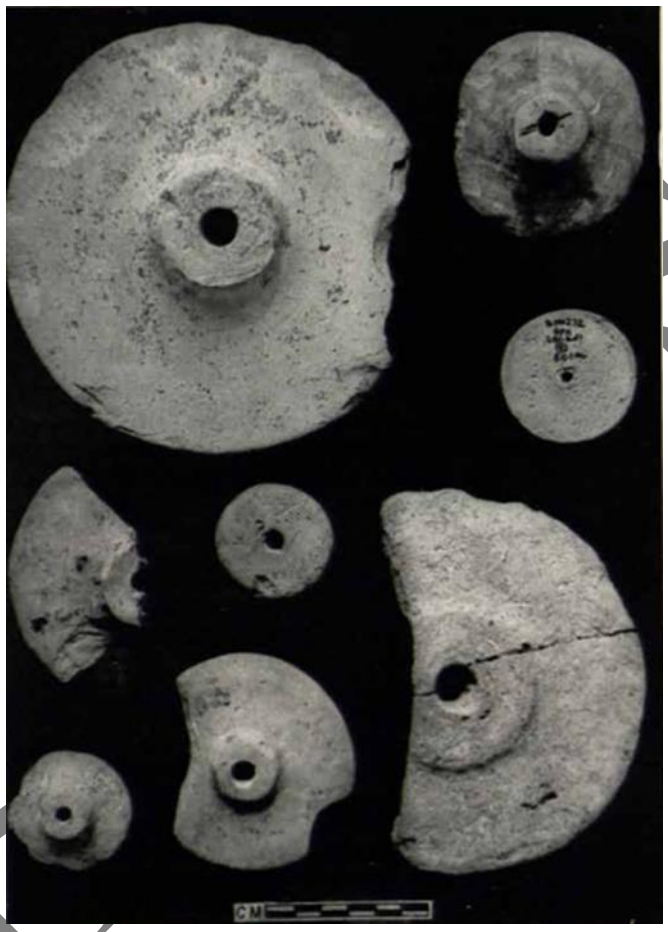


Figure 16a: Terracotta simple disc wheel with and without a hub from Bhagwanpura (after Joshi 1993: Plate XXXVI).

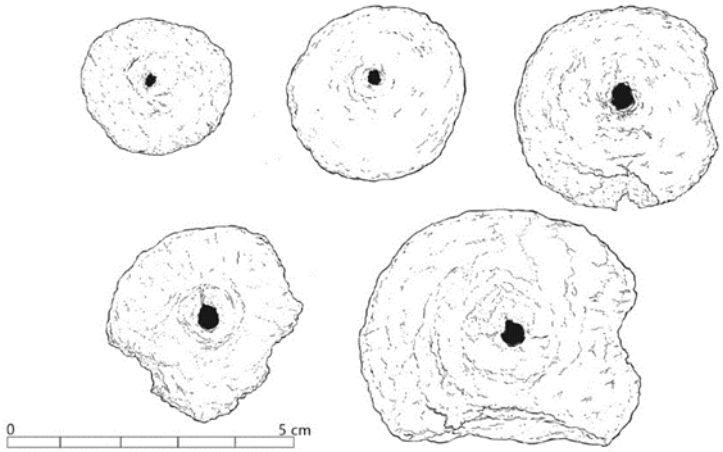


Figure 16b: Terracotta simple disc wheel with and without a hub from Farmana, modified (after Shinde et al. 2008)



Figure 16c: Painted terracotta wheels with hubs from Banawali and Rakhigarhi (after Lal 2002: 72–73).

Toy wheels from the Early Harappan period were cruder and smaller, whereas those from the Mature Harappan period were more refined and varied in size. At Bhirrana, four types of toy cart wheels have been identified: wheels with painted spokes, painted representations of solid terracotta toy wheels, wheels with spokes in low relief, and plain toy wheels (Rao 2005: 61). Painted spoked toy wheels have also been found at Banawali, Rakhigarhi, and Mitathal (Rao 2005: 61). Plain solid wheels found at other sites likewise suggest the use of solid wheels on carts for traction.

C) Axle

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Published data indicate that no axles have been discovered during excavations at sites in the Sutlej–Yamuna Divide. However, based on the vertical holes and central brackets on toy cart frames, I infer that two-wheeled carts had a single axle and four-wheeled carts had two axles.

D) Harness

Direct evidence for animal harnessing is lacking, but animals were probably controlled by ropes tied around their necks, as is still the case today (Figure 16b).

The presence of the above traction activities can be assessed using the faunal samples. The continuity observed among these remains is the presence of large bovids from 3200–1200 BCE. These bovid species included cattle and buffalo, which were probably used mainly as draught animals for agriculture and transport. Careful analysis of the faunal assemblages showed that the percentage of cattle exceeded that of buffalo at the sites. This suggests that people in the Divide preferred cattle over buffalo as the primary draught animal. According to Sharada (2018), cattle bones had 'taphonomical widening of the distal end of the *metapodia*, *pedosis*, and *exostosis* of the proximal ends of the third phalanges is seen at several sites, suggesting heavy physical stress due to traction and movement'.

II. Dairying

Dairying is a complex strategy for utilising animals. It involves raising, breeding, and managing animals to produce milk and other dairy products. This activity differs considerably from extensive pastoralism, in which animals roam freely and graze in open pastures. In dairying, by contrast, animals are kept in controlled environments and provided with appropriate feed, primarily to maximise milk production. These practices are ancient and have been integral to many civilisations.

The Neolithic Revolution intensified the domestication of both plants and animals. Scholars such as Valerie Porter (1996), in *Goats of the World*, argue that the goat was among the first animals domesticated in the Fertile Crescent during the eighth millennium BCE, because its wild ancestors were easy to tame and it had relatively modest fodder requirements. The Fertile Crescent was better suited to domesticating small bovids than larger ones (Porter 1996).

The earliest evidence of pastoralism in the Indian subcontinent comes from Mehrgarh, where communities shifted from hunting towards pastoralism. Wild species represented in the faunal assemblages indicate the potential for a transition to domestication. During the aceramic Neolithic period at Mehrgarh, the later phase saw a decline in the domestication of small bovids

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relative to larger ones. These large bovids, such as humped cattle, are represented not only in zooarchaeological remains but also in images and figurines from the fifth and fourth millennia BCE in the Old World. Around the same period, Sherratt (1983) reports a pictorial representation from the Uruk period depicting cattle milking. This indicates that milking was known, and Sherratt suggests that the practice may have begun much earlier (Sherratt 1983: 94).

However, no similarly direct representation has been identified in the Sutlej–Yamuna Divide. Accordingly, artefactual, zooarchaeological, and archaeobotanical evidence is used to investigate dairying practices in the region.

The excavations in the Divide yielded faunal assemblages dominated by domestic animals (cattle, sheep, goat, buffalo, and others). Cattle and buffalo were ubiquitous, appearing at 100 percent of the sites studied from 3200–1200 BCE (Table 1). Joglekar et al. (2013), Sharada (2018), and Sharma (1996) report that cattle bones accounted for more than 90 percent of the combined cattle and buffalo bones at these sites during the study period. These faunal data suggest that cattle were the preferred species, and their use exceeded that of buffalo, possibly because they were easier to rear.

To assess whether the stock was local or mixed, I draw on the inferences made by Sharada (2018): 'The variability in height of the cattle was higher in the Early Harappan phase, with the tallest being 124 cm… the shortest 92 cm…. This variability declined in the Late Harappan phase because of interbreeding of the livestock,' which suggests that local indigenous cattle were preferred. These local cattle also varied in age, as shown by remains of young, mature, and old individuals in the Divide. Older females and males without cut marks (Joglekar et al. 2013: 262–267) are consistent with uses other than meat, such as milking or traction. This does not constitute proof. Old animals could also have died naturally or been kept for breeding or dung. Cattle typically first calve at about three years of age and then lactate for much of their adult lives, so a milking herd should include many mature females. A full age and sex breakdown would be required to test this properly.

An analysis of the archaeobotanical data reveals plant remains of C3 and C4 grasses, along with horse gram, all of which could have been used for human consumption and as animal fodder (Lightfoot et al. 2020). Their use as fodder can be inferred from crop-processing strategies, in which grains are processed to make them suitable for consumption. Phytolith studies in the Divide by Bates et al. (2017) indicate that processing occurred at both household

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and central levels, depending on crop type (i.e., Kharif or Rabi). Processing these crops produces 'chaff' as a by-product, which has multiple uses, including animal fodder and fuel. The substantial calcium content in animal bones from the Late Harappan and PGW phases at Bhagwanpura (Joshi 1993: 146) may indicate that ample fodder sustained herds over several years.

It is possible that the same group of people who practised agriculture also managed animals and reared them for milk and other uses. During my fieldwork at Mitathal, Farmana, Masudpur, and Rakhigarhi in Haryana, and Ropar in Punjab, I studied animal management among present-day villagers using participatory methods. Marginal landholders there rely on the same people for farming and animal rearing, whereas large landowners and dairy-farm owners employ specialised labour for each. Milking can be done on a small or large scale depending on fodder, breed and labour. These observations serve only as a comparison and cannot show how labour was organised in the Bronze Age.

Lipid analysis of pottery vessels from Rakhigarhi, Masudpur and Farmana has identified dairy fats, but in very low concentrations (Suryanarayan et al. 2021). This indicates that dairy products were part of the diet, but the low concentrations point to limited or occasional use rather than heavy dependence. Therefore, the archaeobotanical and zooarchaeological evidence suggests that dairying was part of subsistence patterns in the Sutlej–Yamuna Divide from 3200 to 1200 BCE. However, its scale can be established only through more in-depth study of plant remains, animal bones, and lipid analysis.

III. Wool Production

The wool economy in the Sutlej–Yamuna Divide warrants investigation, as this may help determine whether animals were used for textile production. Sheep are the animal associated with this economy, with the earliest references from the Near East (Greenfield 2010: 29–54), where sheep played an important role in pastoral communities. The Near Eastern landscape is well suited to raising sheep. Domesticated sheep are believed to derive from Ovis orientalis (Meadows et al. 2005: 494–501), a non-woolly, hair-coated sheep. Wool shearing is likely to have begun thousands of years after non-woolly sheep developed into woolly sheep. Genetic change does not occur overnight; it requires sustained breeding and interaction in a controlled setting. This suggests that in the early phases of sheep domestication, people used sheep not for wool but for their meat or milk.

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It is also important to recognise that shearing sheep is a highly specialised activity requiring specific tools and skilled individuals. Mesopotamian civilisation offers valuable insight into wool production, as wool became a major fibre in its textile industry by the late third millennium BCE (Breniquet and Michel 2014). The trade in woollen textiles was a significant economic activity, as evidenced by trade texts. This study examines wool-related activities in the Divide by analysing faunal remains, tools, and representations on pottery and seals.

The proportion of sites in the Divide yielding sheep remains ranges from more than 80 per cent during the Early and Mature Harappan phases to 100 per cent during the Late Harappan phase (Rana 2025: 108–129). These data may indicate increased domestication from the Early to the Late Harappan phase, as well as changes in sheep-rearing practices. They also show that sheep formed part of the subsistence strategy in the Divide from 3200 BCE onwards, although their use varied over time. Their utilisation could be examined through osteological analysis, but such data are largely missing for the Divide. At the earliest levels, bones from young animals bearing charring and cut marks suggest that sheep were primarily consumed for meat during the Early Harappan period in the Divide. However, remains of adult animals have been reported at various sites in the Divide during the Mature Harappan, Late Harappan, and PGW periods (Rana 2025: 162). This aligns with a shift toward secondary products such as milk and wool, although the consumption of mature animals as meat cannot be ruled out. Sheep bones make up a very small share of the assemblage, making it difficult to say how wool-related labour was organised. The depiction of Zackal (woolly) sheep on a seal from Mohenjo-daro (Hermanns 1952: 166) suggests that woolly sheep were known during the Harappan period. Botanical evidence for flax and cotton provides insight into textiles in the Indus Valley (Fuller 2008: 1–26) and suggests that plant-fibre weaving could have been practised.

Terracotta spindle whorls from Rakhigarhi (Nath 2019: 3–10) show that yarn was spun. Measuring the weight and size of whorls can indicate the type of fibre spun, which might support the hypothesis of wool use. Timbers such as deodar, shisham, kikar, neem and bamboo have been reported from the Divide (Saraswat and Pokharia 2003), so wood suitable for looms was available, though this does not show that looms were used.

Conclusion

The artefactual and zooarchaeological data from the Divide suggest that animals were used for purposes beyond meat. The activities considered here are ploughing, transport, dairying and

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wool production. The evidence for each varies in strength, and the interpretations below are possibilities supported by several lines of evidence, not firm conclusions.

Large bovids were present at all fifteen sites studied and accounted for the largest share of animal remains from 3200 to 1200 BCE. This indicates that cattle were the primary large domestic animal in the Divide. This is consistent with their use for traction and transport, and possibly for milk, though presence alone does not show how they were used. Artefacts linked to ploughing are far fewer than those linked to transport, such as terracotta toy carts and wheels. This may be because ploughs were made of wood, which rarely survives, and the absence of finds does not imply an absence of use. The ploughed field at Early Harappan Kalibangan shows that ploughing was practised from that period. It does not show which animal pulled the plough. Cattle, and to a lesser extent buffalo, are the likely candidates, given how common their bones are. Horse bones are very few and come from only four sites of the Late Harappan and PGW periods, so horses were probably rare, and their role in traction cannot be judged from these remains. The smaller number of buffalo bones suggests buffalo were less common in the herds, but this evidence cannot determine why.

Both small and large bovids were reared. Adult animals from the Mature and Late Harappan periods are consistent with milk use, and the low levels of dairy fat in vessels point in the same direction. Together, they suggest that dairying was possible, probably on a small scale. They do not show that it was continuous or large-scale.

Sheep use appears to have changed over time. In the Early and Mature Harappan phases, sheep remains were reported from more than 80 per cent of sites, mostly of young animals, with few adults. In the Late Harappan phase, all sites reported sheep, including adults. This pattern is consistent with a shift in how sheep were used, though the use of mature animals for meat cannot be ruled out. Wool use is plausible but is the least securely supported of these conclusions. Whorl weights, fibre or residue analysis, and clearer age data would be needed to test it.

Overall, the evidence indicates continuity in cattle dominance across the period and a probable change in how sheep were kept. Traction and transport are the best-supported secondary uses, dairying is moderately supported, and wool is the least well supported.

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