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Contextualizing Ancient Indus Agricultural Strategies: Archaeology and Lessons for Today's Sindh

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Abstract: *The current research is conducted to explore accelerating agricultural trends in Pakistan by analyzing ancient Indus agricultural strategies and role of green revolution technology. Increasing population of the country demands increasing production of food self-sufficiency and this can be resolve through the concept of green revolution. In general, the green revolution depend on the use of machinery for cultivation and harvest, on large-scale agricultural enterprises with access to credit (often from foreign investors), government-supported infrastructure projects, and access to low-wage agricultural workers (Wright, "Down slope and North", p. 38). In contrast of the concept green revolution, range of crops and variable strategies including multi cropping were used to feed different urban centers in ancient Indus. This has important implications for our understanding of the development of the earliest cities in south Asia, particularly the organization of labor and provisioning throughout the year (Feeding ancient cities in south Asia, C. A Petrie, J. Bates, T. Higham , R.N Singh) Another aspect from the agricultural strategies in Ancient Indus is that, In ancient Indus change in agricultural strategies suggest that it was result of cultural change. It is urged that there was decline in traditional crops which feed the large population centers, at the same time as the emergence of new agricultural techniques and crop plants that spurred the development of local, independent communities. Although explanations for these disruptions in agricultural base tend to be regional in nature, they point to widespread causes such as tectonic movement or changes in river patterns, resulting in flooding and sedimentation. Crop failure would have been followed by settlement abandonment. Population dislocations, disrupted trade networks and new agricultural strategy would have then produced new, localized political units (steven weber),Thus by the fusion of these both concepts agricultural trends in Pakistan can be accelerated.*

Keywords: *Indus Civilization, Agriculture, Multi-Cropping, Environmental Adaptation, Resilience, Overlapping Rainfall System, Inundation, Green Revolution Technology*

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Introduction

Agriculture is the practice of cultivating plants and livestock. Agriculture was the key development in the rise of sedentary human civilization, whereby farming of domesticated species created food surplusesthat enabled people to live in cities. The history of agriculture began thousands of years ago. After gathering wild grains beginning at least 105,000 years ago, nascent farmers began to plant them around 11,500 years ago. Pigs, sheep, and cattle were domesticated over 10,000 years ago. Plants were independently cultivated in at least 11 regions of the world. Industrial agriculture based on large-scale monoculture in the twentieth century came to dominate agricultural output, though about 2 billion people still depended on subsistence agriculture (Wikipedia). Agriculture is very important in Sindh with cotton, rice, wheat, sugar cane, bananas, and mangoes as the most important crops. The largest and finer quality of rice is produced in Larkano district.(Gazzetter of sindh). Agriculture has a great impact on the economy of country leading to development and growth. During ancient time of Indus civilization agriculture was practiced. Now a days, the discoveries and revolution of new agricultural system has Introduced many new methods in term of new hybrid varieties, new agricultural machineries, water sprinkle systems, seed distribution system that gives the qualitative and quantitative yield per acre. Due to adoption of new technologies in Sindh has increased the yield per capita and increased the economy of Pakistan. Sindh province has urban and rural areas. Fifty percent population is living in Sindh and it contributes 30% of country's GDP. Hence, this study has a wide scope in depth in direction of agriculture and country's economic growth. (Fatima Tehseen)

Research Objectives

- To understand Concept of multi cropping and adaptation to variable environment in ancient Indus
- To know about the variation of crops usage in ancient Indus
- To explore modern trends of agriculture boosting up agriculture in Sindh

Significance of Study

It is of mere important to contextualize ancient Indus agricultural strategies in order to look at up the archaeology of agriculture in Indus civilization because it might tell us about the Agricultural strategies including multi cropping, adaptation to environment and feeding urban centers, which issignificant lesson for today's sindh and will help out for future agricultural strategies to be adopted by sindh.

Limitation of Study

The research study covers various fields to study on and use of the other expertise to work on the Agricultural strategies in Ancient Indus. It merely covers Archeology for its ancient significance. The Scope of study also limits to the Agriculture, Plant Sciences and the novel concept of GRT (Green Revolution Technology) also.

Research Methodology

The method to execute this research work is data collecting at first hand, through the secondary source which is searching and reading books, excavation reports as well as research articles and research papers available on Internet and different libraries across country and primary source of data collection has been done through visiting some Indus Civilization sites and museums containing recovered cultural heritage from Indus civilization.

Findings and Analysis

The Cultural and Environmental Context of Indus Valley Civilization

The Indus civilization was one of the great early complex societies of the old world, and during its urban phases (ca 2600- 1900 Bc), it spanned large parts of modern Pakistan and India. Present knowledge indicates that there was a constellation of four or five particularly large Indus settlements, which usually described as cities (mohen jo daro Harrapa, Rakhigarhi, Dholavira, and possibly Ganeriwala). The inhabitants of these cities produced, used and traded distinctive type of material culture, including painted pottery and figurines that were presumably made locally, and jewelry, standard weights and stamp seals that were made from raw material typically obtained medium and long- rang sources. In a landscape dominated by rural settlements, Indus cities appear to have been the exception rather than norms. The substantial distances between the major centers (at least 280 km) have been used to suggest that each controlled vast hinterlands, it is, however , also probable that large and medium sized settlements played an important and perhaps, independent rather than subordinate role in both interactive processes and socio- economic control structures. To some extent, the pattern of material evidence seem at the city –sites has also been observed at large, medium and small settlements and there has led to the suggestion that there was marked uniformity in some aspects of Indus material culture. While similarities between some cultural elements have been emphasized, variation in material and human behavior has been acknowledged. The variation is particularly evident in subsistence practices, settlement systems and the production and use of particular categories of material cultures, most notably figurines and ceramic vessels.

It has been recognized that there is considerable variation in climate, hydrology, and ecology across the extensive area in which Indus settlements are found. Environmental factors undoubtedly placed specific constraints on cultural behavior and the choices open to the inhabitants of the various Indus regions and it is arguable that comprehending the ways in which human interacted with diverse and potentially changing environments over time and across space is critical for understanding the rise, floruit and decline of Indus urbanism. So the both human and natural factors considered important in terms of Indus decline, but some have argued that there is no conclusive evidence to show that there is any difference in annual rainfall patterns between 6000Bp and the present. (kenoyer 1997; 2008, possehl 1997; 2008). While other have posited climate change as the primary cause for the collapse and/or transformation of Indus civilization. Scholars now have detailed reconstruction of river shifts in Sindh, which demonstrate the movement of the main Indus channel between 4000 and 2000 BC. Also the reconstructions and investigations provide the impact of drying of the ghaggar/hakra river, which is often equated with the "lost" sarwasti river. In northwest india connections between climate change and river shift have been mooted, and it also been posited that neotectonic process have been a factor in reshaping hydrology.There has also been only limited attention to proxy evidence for ancient climate that is proximate to the Indus zone and/or can be connected directly to the archaeological record. Climate has been long considered an important parameter for understanding the Indus civilization, starting from marshall's suggestion that there has been a significant decrease in rainfall since the Indus period. Furthermore, when climate has been involved as a critical driver of social change, there has been a reliance on distant climate proxy data sets for support. A range of climate proxy data is certainly available from various locations in the subcontinent, particularly from dry lakes in Rajesthan.

Indus civilization spanned a large and environmentally diverse area, it is unlikely that climate change would have had identical or area comparable effects in all regions, similarly, hydrological shifts that may have been divesting in one area might have had no direct impact on others or may have

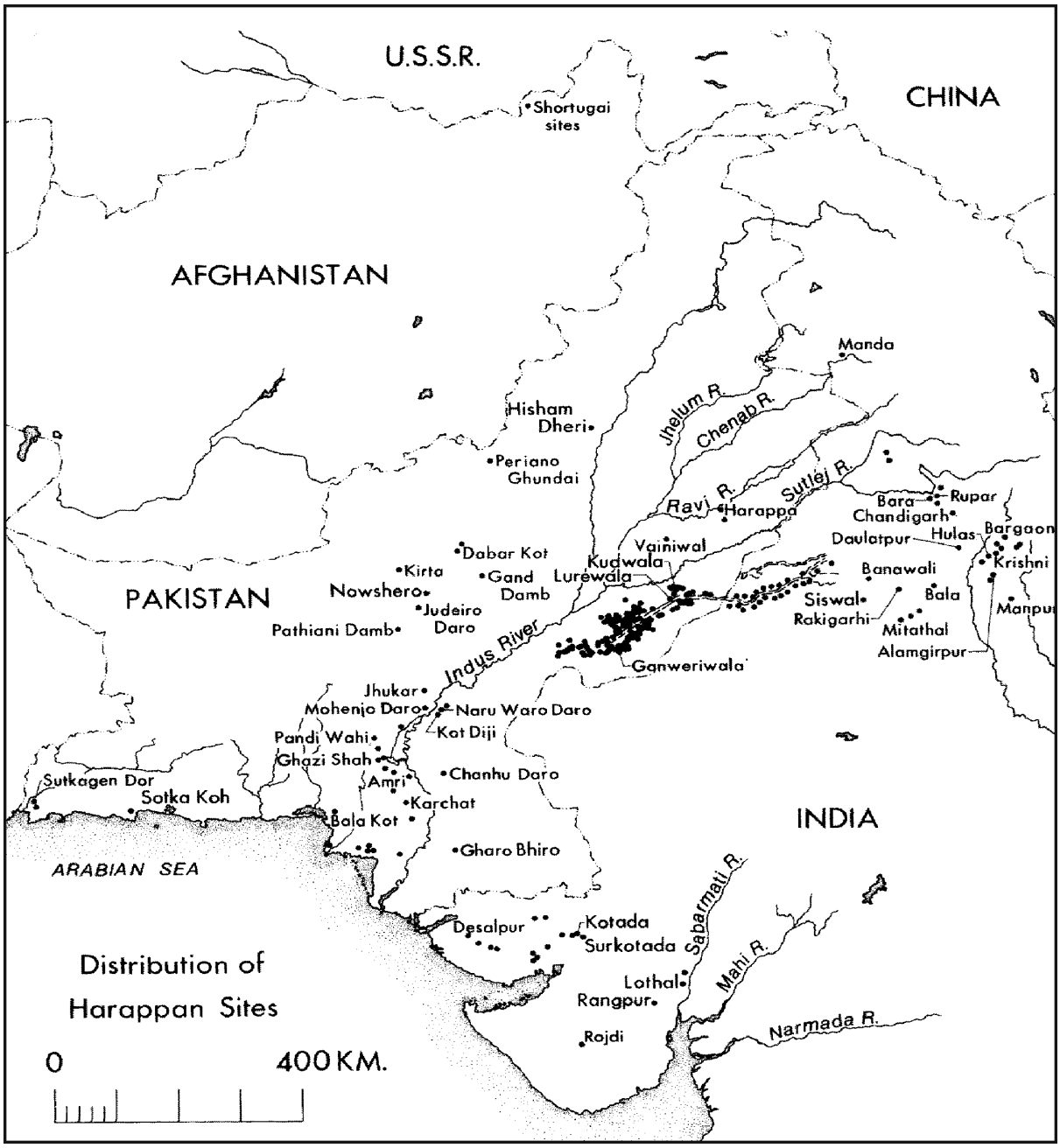

Figure 1: The location of Harappa, Rojdi and other Harappan sites in northwestern South Asia.

Source: Possehl & Raval 1989; Weber 1991).

been beneficial. Furthermore, human behavior was likely already adapted to ecological regimes that are intrinsically variable between seasons and between years. Comprehension of the interrelationships between past and climate and environment and human actions and reactions can result only from integrated approaches and collaborative research projects that seek to identify the inter connections between archaeological evidences, and the evidence for climatology, hydrology, sediment logy and even ethnography, which are fundamentally interrelated but are too often treated as independent data sets. Thus it is another dimension of research to know about the human environment interactions and their relationship to process of cultural transformation.[1]

Multi-cropping

What is Multi-Cropping?

Multi-Cropping is a term developed by agronomists that can refer both to growing crops in multiple seasons and to growing more than one crop in a single season. Multi cropping is the production of two or more crops per year on the same land. Multi cropping is these distinct from mono-cropping and mono-culture, where one crop is grown on the same plot for one or more year respectively. The principal patterns of multi- cropping were first defined by Andrews and kassam, who divided it into two forms, sequential multi- cropping and intercropping. The first refer to the growing of crops in sequence on the same area of land in the space of one year, during which the succeeding crop is planted after the preceding crop has been harvested. Farmers thus manage one crop in one parcel of land at one time. Andrew and kassam further, subdivided sequential multi-cropping as follow:

1. Double Cropping: growing two crops in sequence
2. Triple/quardruple (etc) cropping: growing three/four crops in sequence
3. Ratoon Cropping: Cultivation of regrowth from stubble / roots following intial harvest

How Cropping and Multi- cropping are identified Archaeologically?

Archaeology rarely provides direct evidence for cropping practices in the past. Occasionally fields have been identified the exposures of such features is not typically the objective of excavation. Analysis of plant remains can identify the crop and associated plant species found at excavated sites, but the plant remains that survive in the archaeological record are typically either discarded residues or material that has been preserved accidentally through waterloggging, desiccation, mineralization or carbonization. Importantly the material that is recorded from closed or open contexts within an archaeologically settlement does not necessarily provide a direct analogue for cultivation practices in the fields. Furthermore, human actions, such as the post – cultivation mixing of crops, can obscure the evidence for actual cropping practices before deposition, and post- depositional mixing can obscure things further. Nonetheless, several attempts have made to differentiate cropping strategies archaeologically, particularly in parts of Europe, ancient near east and Mesoamerica. In contrast these examples of mono-cropping, or inter – cropping to grow more than one crop in one season, South Asia and particularly Indus civilization- provide us with an opportunity to examine the dynamics of cropping system that incorporate both the growing of more than one crop in one season and the growing of crops in more than season .

Indus Subsistence and the issue of Multi-Cropping

The urban phase of the Indus civilization (2500-1900) has long been characterized as a flourishing, culturally integrated and complex society with a number of distinctive attributes , including , major urban settlements or cities surrounded by substantial fortification walls, and/or built on platforms; house; drains; and walls made of mud and/or fried bricks , and a distinctive material culture assemblage produced using a range of complex crafts production techniques, however, there has been increasing recognition that these was a degree of cultural and geographical variation across, the zone occupied by Indus populations and numerous authors have proposed that there was regional variation in subsistence practices (Petrie, 2017). From the beginning of Indus research, the issue of seasonality and single or multiple season cropping has been highlighted. Early excavations at the urban settlements of Mohen jo

daro, for example , revealed evidence of the exploitation of wheat, barley and field pea , all of which would have grown with support of late summer inundation resulting from Himalyan snowmelt and monsoon rain in the regions to the northwest , complemented by winter rain (Petrie, 2017). Thinking primarily about the areas of Baluchistan and Sindh, (Fairservise, 1997) subsequently hypothesized that winter or rabi cultivation was the norm for the Indus region. It has however, long been argued that summer or kharif cultivation also important (Weber, 1991). Excavations at the Indus siteof rojdi in gujrat quantitavely demonstrated that there was more to Indus cereal exploitation than wheat and barley, with the discovery of sequence of occupation dominated by summer crops, particularly. The Archaeobotnical evidence from these Indus sites in gujrat was subsequently used to support a model of winter/rabi cropping in the core and summer /kharif cropping in the 'periphery' where the periphery was regarded as and not representative of the situation across the Indian civilization as a whole (Fuller and Madella, 2002) also suggest that 'core' areas practiced more intensive agriculture, whereas populations in the summer cropping areas utilized more extensive system. It is now clear that there is a range of data suggesting that model of winter/rabi core and summer/ kharif periphery is too simplistic. Since the 1980, it has been argued that Indus population emerged in multi cropping, particularly in the areas of northwest india where it might have helped to buffer risk. Excavation at Harrapa have revealed evidence of the exploitation of crops grown in two seasons with an apparent increase over time in summer crops alongside continued use of winter crops , and this led to argue that a complex multi-cropping strategy is evident in all periods of occupation. (Weber 2003).

Differentiating Indus Cropping Strategy

Archaeobotincal remains have been recovered from only 55 of the 140 plus Indus settlements that have been excavated and systematic flotation and full publication assambalges remains extremely rare. The available archaeobotnical evidence demonstrate the across the entire Indus zone, farmers grew a wide range of crops, including cereals, pulses, oilseeds, fibres and fruits , with crops of each major type being grown in summer and winter it is important to note however that variation in the distribution of rainfall and thus the supply of water in general means that it was not feasible to grow all of those crops in all of regions occupied by Indus populations has suggested that in central Punjab, water supply for Indus farmers is likely to have come primarily from inundation (produced by a combination of snowmelt and run-off from the Indian summer monsoon) and direct rainfall, while additional water was probably obtained via small scale irrigation or well lift irrigation. It is likely that these water supply mechanism were used across the Indus zone, at differing levels of intensity, depending upon local environmental and climatic conditions (Petrie 2017) . it is not yet possible to reconstruct the distribution of winter and summer rainfall across the Indus zone throughout the third millennium BC. However modern instrumental rainfall data suggests that some of the areas inhabitated by Indus populations are likely to have received direct winter rain, some probably remained direct summer rain, some will have received direct rain from both systems and others are not likely to have received direct rain from either (Miller 2015).

Furthermore, the steepness of the rainfall gradients means that there was likely difference in the quality of direct rainfall that was received, with most areas receiving relatively limited direct rainfall have been suggested that variation in local environmental conditions, vegetation, rainfall and water supply would have necessitated distinctive adaptation for summerfull farming in different regions, including strategies relying on either winter crops like wheat or barley or summer crops like millet in some areas or combination of summer and winter crops. Thus the variation in water supply across the Indus zone has implication for the dynamics of cropping.

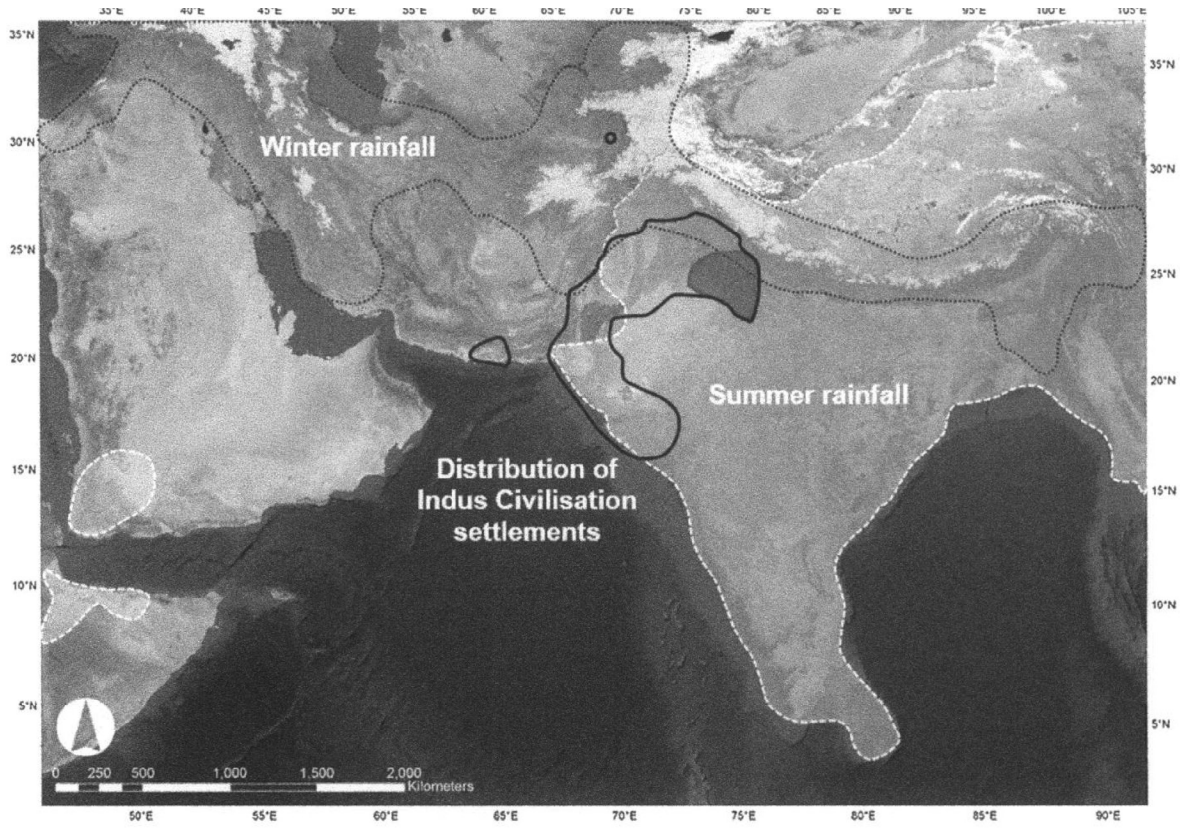

Figure 2: Distribution of Indus Civilization settlements in relation to the environmental and climate context of northwest south Asia

Table 1: Major winter (rabi) and summer (kharif) from Weber 1999, table 1; 2003, table 5.2; Fuller 2016, tables 4.3, 4.5)

Winter (rabi) crops Summer (kharif) crops

Cereals

Barley (Hordeum vulgareA Rice (Oryza cf. sativa) A
Wheat (Triticum sp.) ASignal grass millet (Brachiaria ramosa) A
Sawa millet (Echinochloa colona) A
African finger millet (Eleusine coracana) A
Proso millet (Panicům miliaceum) A

little millet (Panicům sumatrense) A
Kodo millet (Paspalum scrobiculatum) A
Pearl millet (Pennisetum glaucum) A
Foxtail millet (Setaria italica) A
Yellow foxtail millet (Setaria pumila) A
Sorghum millet (Sorghum bicolor) A
Pulses
Lentil (Lens cf. culinaris) A Black bean (Vigna mungo) A
Pea (Pisum) AJ? Mung bean (Vigna radiata) A/P
Chick pea (Cicer) A/P Moth bean (Vigna acconitifolia) A
Sweet pea (Vicia/Lathyrus) A African gram bean (Vigna cf. trilobata) A/P
Horse gram bean (Macrotyloma cf. uniflorum) A **Oilseeds**
Linseed/flax (Linum usitatissimum) AMustard (Brassica) A/P
Sesame (Sesamum indicum) A

Fibres

Linseed/flax (Linum usitatissimum) A Cotton (Gossypium arboreum) A/P
Hemp (Cannabis) A/P
Jute (Corhorus) A/P

Fruits

Cucumber/melon (Cucumis) A

Longer lived perennial fruits

Jujube (Zizyphus) P Date (Phoenix) P
Grape (Vitis) P

A indicates annual and **P** indicates perennial plant . A/p indicates a plant that can be either. We have separated our longer- lived perennials here as they are not strictly winter or summer crops, though they do flower at specific times.

Variation of Crop Usage in Indus Zones

It is typically assumed that Indus cities were provisioned by crops grown in their immediate hinterlands (e.g. Wright 2010: 127). The nature of the relationship between Indus urban centres and the settlements in their hinterland regions has not yet been the focus of significant research, however, and issues of provisioning have typically been discussed on the basis of evidence from the urban centre alone (cf Petrie in press).

Mohenjo Daro

Only limited archaeobotanical work has been carried out at the Indus urban centre of Mohenjo- Daro, and what has been done, was conducted on hand-sorted samples collected during Sir John Marshall's excavations in the 1920s (Marshall 1931). The grain seeds recovered included free-threshing wheat and barley (Mackay 1931; Luthra 1936). No summer crops have yet been reported from the site.

Harappa

The urban city-site of Harappa in central Punjab (Pakistan) is arguably the most important Indus settlement in archaeobotanical terms as it has a protracted sequence of occupation and systematic sampling for archaeobotanical analysis has been carried out over many seasons (Weber 1999, 2003). The archaeobotanical assemblage from Harappa shows that from the pre-urban Early Harappan period onwards the agricultural strategies at this Indus urban centre were dominated by the winter cereals wheat and barley, combined with the exploitation of some summer crops such as millet (*Panicum* sp.) (Weber 2003). This material has been used to support the suggestion that over time there was an increase in diversity, and a broadening of the agricultural strategy at Harappa through the evolution of a "complex multi-cropping strategy" (Weber 2003: 181), which conforms to Vishnu Mittre and Savithri's (1982; also Chakrabarti1988: 95) proposal that Indus populations practiced some form of multi-cropping involving both winter and summer crops. It is important to acknowledge, however, that the published evidence for cropping in two seasons at Harappa suggests that summer crops were a significant, but relatively minor component of the assemblage. Comprehension of the importance of summer crops is complicated by the fact that statistics on the frequency and proportions of individual crops are not yet available, though there has been some discussion of quantities in several publications. For instance it has been noted that "tens of thousands of small millet seeds" (Weber & Fuller 2008/09:

79), or that "over 10 000 little millet seeds have been recovered from Harappa" (Weber & Kashyap 2013: 4). The total number of seeds from the site has been variously estimated at "nearly 150,000" (Weber & Fuller 2008/09: 79) or "hundreds of thousands", so even at the most optimistic estimate, millet may have only comprised *c*.13.33% of the entire assemblage. The proportionally minor role of millet is also emphasised by the statistics on crops that have been published. Summer cereals, specifically millets, initially had a ubiquity of 9% in the Early Harappan period, and increased to appear in 19% of Mature Harappan and 47% of Late Harappan samples (Weber 2003: tab. 5.3a). However, these summer cereals only equate to 2% of the overall charred crop assemblage in the Early Harappan, a 4% in the Mature Harappan and a 7% in the Late Harappan periods (Weber 2003: Table 5.3c). Although it is clear that both summer and winter crops were being exploited at Harappa, it could be argued that the relatively low proportions of summer crops do not actually indicate extensive multi-cropping. This reconstruction is supported by Miller's (2006) observation that the winter crops were clearly the most important staple at Harappa throughout the urban phase, and that it is only after the urban phase that the use of summer crops, and hence multi-cropping, becomes a major contributor to the crop assemblage.

Modern Trends of Agriculture Boosting up Agriculture in Sindh (GRT)

By adopting the Indus agricultural strategies another one of the most important trend which can boost up the agriculture in sindh is Green Revolution Technology. The key elements of the revolution include: 1) Use of the latest technological and capital inputs, 2) adoption of modern scientific methods of farming, 3) use of high yielding varieties of seeds, 4) proper use of chemical fertilizers, 5) consolidation of land holdings, 6) Use of various mechanical machineries.(Wright Angus , 2012). The transition from traditional agriculture (in which inputs were generated on-farm) to Green Revolution agriculture (which required the purchase of inputs) led to the widespread establishment of rural credit institutions. Smaller farmers often went into debt, which in many cases resulted in a loss of their farmland. The increased level of mechanization on larger farms made possible by the Green Revolution removed a large source of employment from the rural economy. The new economic difficulties of smallholder farmers and landless farm workers led to increased rural-urban migration. The increase in food production led to cheaper food for urban dwellers. According to a 2021 study, the Green Revolution substantially increased income. A delay in the Green Revolution by ten years would have cost 17% of GDP per capita, whereas if the Green Revolution had never happened, it could have reduced GDP per capita in the developing world by half (*Gollin, Douglas; Hansen, Casper Worm; Wingender, Asger Mose (2021).*

Conclusion

The economy of Indus valley civilization was based upon agriculture as well trade. Commerce was important and there links from overseas places. With the rivers surrounding their area, the land was fertile and they used to cultivate many crops such as Barley, wheat, melon seeds and oil crops like sesame, mustard and dates. These were traded by farmers with the other people. Agricultural strategies adopt by Indus valley civilization played key role for successful agriculture which simultaneously boosted up Indus valley civilization economy. In ancient Indus change in agricultural strategies suggest that it was result of cultural change. It is urged that there was decline in traditional crops which feed the large population centers, at the same time as the emergence of new agricultural techniques and crop plants that spurred the development of local, independent communities. Although explanations for these disruptions in agricultural base tend to be regional in nature, they point to widespread causes

such as tectonic movement or changes in river patterns, resulting in flooding and sedimentation. Crop failure would have been followed by settlement abandonment. Population dislocations, disrupted trade networks and new agricultural strategy would have then produced new, localized political units (steven weber), Thus the Contextualized Indus agricultural strategies and its fusion with green revolution is lesson for today's sindh.

Note

1. Adaptation to Variable environment and resilience to climate change , cultural anthropology , volume 58, February, 2017.

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