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The emergence of early agriculture in the Horton Plains, central Sri Lanka: linked to late Pleistocene and early Holocene climatic changes

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Introduction

Agriculture can be defined as the cultivation of domesticated plants and animals for use by human societies. Agriculture promoted the sedentary communities (e.g. permanent villages) to establish and develop stratified societies (e.g. towns and cities) that included specialized and dedicated groups such as governors, administrators, farmers, religious leaders, philosophers, craftsmen and artisans. In south Asia, the plant and animal domestication and its development was a gradual transition which took place in several geographical regions and chronological settings, *via* the north-western parts. This transition was from hunting and foraging to early farming communities. This appears to have occurred in Baluchistan since 9000 BC, Indus valley 3500 BC, eastern part of India 2400 BC, the Indo-Gangetic plains in north India 8500 BC, central India 5500 BC, western India 2500 BC, southern India 2800 BC.[1-9] In south-eastern Asia (e.g. New Guinea), the earliest known evidence shows that plant exploitation and some forms of cultivation (e.g. starch-taro and banana) had been carried out on wetland margins since 8200 BC.[10] Archaeo-botanical evidence indicates that the earliest farming activities (i.e. rye cultivation) in the Euphrates valley, south-western Asia, have been dated to 11 000 BC.[11] Rice cultivation has been dated to 12 000 BC in the middle Yangtze River valley, East Asia.[12] In the new world, the proof of domesticated *Cucurbita* sp. that came in the form of preserved phytoliths has been dated to 8000 BC.[13]

It is obvious that the origin of agriculture did not appear as an abrupt transition in one place, it was a gradual diffusion into most other parts of the world. New research conducted during the last two decades, suggests that there were several possible regions (locations) of origin of agriculture in the world. The variety of archaeological evidence and environmental changes reported from different parts of the world support the theory of multi-centred origins of agriculture.[5, 7, 14] The agricultural practices appear to have a considerable age in India, starting from the late Pleistocene and the early Holocene. However, it is somewhat obscure, because the data on the origin of agriculture in the Indian subcontinent

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are still too inadequate to lead to a coherent detailed agricultural history. Archaeological evidence of Neolithic settlements (i.e. close to agrarian culture) has been found in the form of stone axes and associated domestic plant and animal remains, collected from cultural layers at several archaeological sites (e.g. Mehrgarh) in south Asia, dating from the seventh millennium BC (9000 cal yrs BP). In the subsequent period (i.e. 7000-4000 BC) in Mehrgarh area, mud-brick architecture was developed and domestic wheat, barley, cattle, sheep and goats have been exploited in an aceramic Neolithic context. Evidence of early agriculture was supported by the finds of microlithic and ceramic industries, associated with Mesolithic cultures of hunting people, fishermen and pastoralists or people practising some form of agriculture in several sites in India (e.g. Balathal, Koldihawa and Bagor). The site Koldihawa and Mahagarha, located in the Gangetic Valley, India has yielded evidence of rice cultivation together with ceramics industries dated between 7000 and 6000 BC.[15]

Recent investigations at the sites, Lahuradewa and Sanai Tar in the Indo- Gangetic Plains have yielded evidence of early forms of agricultural activities (i.e. slash-and-burn cultivation) through the presence of *Cerealia* pollen and microcharocal since 13 000 BC, and the evidence of rice cultivation in association with rice paddy field diatoms and direct archaeological finds (e.g. pottery) were found since 6500 BC.[16, 8, 17]

The World Meteorological Organization (WMO) recently reported that the number of serious hydro-meteorological disasters has doubled during the past decade suggesting that climate has played a critical role in the evolution of human societies. Recurrent droughts, desertification and floods are seriously threatening the livelihoods of nearly 1/6th of the global population. In South Asia, considerable failures of agriculture (e.g. repeated crop failures and reduction of agriculture-surpluses) are closely linked with the occurrence of seasonal and annual droughts and floods. The most impressive civilizations in the world (e.g. Egypt, Mesopotamia, Indus and Ganga) were located along the banks of the perennially flowing Nile, Tigres-Euphrates, Indus and Ganga respectively. It has been suggested that water availability led to the rise of the civilizations which subsequently flourished for a long period. On the other hand, the collapse of civilization (e.g. Akkadian: 2200 BC, Classic Maya: 800 AD, Mochica: 500 AD and Tiwanaku: 1000 AD) appears to have been linked with multi-century scale climatic shifts.[18] It is very obvious that the impact of severe climatic changes has strongly affected a large portion of the world population in the recent past, as well as the historic and prehistoric societies. In the Indian subcontinent, the origins of agriculture have been closely linked to climatic changes, according to known records.[7, 14, 19-24]

With these climatic changes as a background, human societies have taken a series of prominent steps into agriculture, civilization and subsequently into urbanism.[2, 3, 26, 27] The climatic changes are an important factor to be considered when discussing the earliest human societies and their niche in the environment. Changes in climate have altered the way people lived in the environment and affected the productive resources, e.g: plant communities, soil fertility and animal husbandry.

The origin of agriculture appeared in South Asia between 13 000 and 8000 BC, indicating the beginning of the neolithization. This process coincided with the fluctuation in both warming (i.e. increasing humidity) and cooling (i.e. increasing dryness) climatic trends.[28, 21, 23, 14] In general, the agricultural practices which followed during the early Holocene were associated with a humid climate.[23, 24, 21, 14] Singh[20] reported that the climatic conditions between 6010 cal yrs BP (4719 BC) and 5000 cal yrs BP (2577 BC) were optimised, i.e: wet, promoting the rise of the Indus civilization. An opposing viewpoint has been given by Enzel[22] suggesting that this time period corresponded to a dry phase, not suitable for the growth of the Indus culture. Flooding and sedimentation in the later part of the Indus civilization (2000-700 BC) were caused by changes in climate resulting in a declining pattern of crops, e.g: *Triticum* sp. and *Hordeum* sp., and shifts in the river systems.[29] Giving attention to the palaeo-climatic reconstruction in South Asia, Shinde[30] has suggested that dryer climatic conditions have forced both humans and animals to settle down in the congenial environment which led to the rise of domestication of plants and animals as indicated by Childe.[31] Palaeo-monsoon dynamics have played an active role on socio-techno-cultural and political dimensions of Sri Lanka (Premathilake in press). There are several investigations from other parts of Asia, which show the connection between climatic change and origins of agrarian communities during the Late Quaternary. Neolithic settlements in the desert of Arabia were abandoned between 3600 and 3200 BC.[28] In South West Asia (Iraq), systematic cereal cultivation (*Secale cereale*) started before the end of the Pleistocene *ca.* 13 000 cal yrs BP, i.e: around the beginning of the Younger Dryas.[11] The climatic conditions at this time have been characterised as dry and cold. The start of rice cultivation in eastern Asia (i.e. China) occurred between 12 000 and 11 000 BC and disappeared between 11 000 and 8000 BC.[12] These two events coincide with warmer/wetter conditions and the Younger Dryas respectively. Multidisciplinary investigation at Kuk Swamp in the Highlands of Papua New Guinea show that some form of agriculture arose independently between 8220 and 7910 BC and intensive wet land cultivation occurred between 4950 and 4440 BC, coinciding with wet climatic conditions.[10] Wet rice cultivation has been dated to 5000 BC in Thailand.[32, 33] It is interesting to note that some of the classical theories (i.e. Oasis hypothesis) of origin of agriculture leading to settled communities, forwarded by Childe,[31] are still of high value. However, the close link between human settlement and climatic changes has lessons for today, as reported by scholars in science. Based on all the above facts, however, it is difficult to conclude that a consensus has been reached by the scholars regarding climatic change and the origin of agriculture. Therefore, the attempt of this paper is to give an account on the early evidence of agriculture in the form of palaeo-ecological findings in the Horton Plains, central Sri Lanka, and its links to climate change and archaeology.

Previous approaches to prehistoric subsistence strategy in Sri Lanka

Sri Lanka is an island in the Indian Ocean hosting prehistoric human settlements from *ca.* 0.2 million years to the beginning of the historical period at *ca.* 500 BC.[26] The stratified archaeological data on prehistoric subsistence strategy in Sri Lanka indicate a hunting and gathering economy based on resources from existing flora and fauna. Stone artefacts assigned to prehistoric occupations have been recovered from the coastal deposits near Pathirajawela, dated to *ca.*

125 000 yrs BP by OSL.[34, 35, 26, 27] Alluvial deposits from the intermediate uplands near Lunugala have been dated to 80 000 yrs BP by TL. Evidence of Mesolithic settlements on the island has been recorded in the form of stone artefacts, together with osteological and archaeo-botanical remains collected in several sequences in cultural layers in cave sites, radiocarbon dated to 37 000 yrs BP.[26, 36-38] Detailed physical anthropological studies of human bone materials indicate close genetic affinities of early humans from as early as 16 000 BC with the recent *Vaddha* aboriginal populations of Sri Lanka.[39, 36, 40] These prehistoric humans are known to have achieved microlithic tool-making ability at 31 000 yrs BP in most of the areas in the country, i.e. on the damp and cold high plains, e.g: Horton Plains, and also in the arid lowlands. They occupied small areas in temporary camp-sites while moving from place to place in an annual cycle of foraging for food (i.e. mobile). Predecessors of the *Vaddha* aboriginal communities in various parts of the lowland areas in the Dry zone are thought to have produced the cave art. Ethnographers have interpreted these as part of the diversified prehistoric social life-style of the aboriginal people. Indications for ceremonial activity related to mortuary practices have also been found from some of the investigated cave sites. Possible indications of domestic dogs have been found from several Mesolithic camp sites.[26] A radiocarbon-dated pollen-analysed sequence from the Horton Plains (>2000 m a.s.l.), central Sri Lanka indicated major land-use changes since 5500 BC.[41] The result from this study revealed that climatic variations ranged from semi-arid to humid conditions and that the area hosted a prehistoric human habitation including grazing, slash-and-burn and possible evidence for rice cultivation. In the lowland areas (<900 m a.s.l.), tentative evidence of domesticated cereals (i.e. type of millet) is available from a cave at *ca.* 5000 BC. The earliest evidence of the Early Iron Age culture including horse breeding, iron production, and paddy cultivation found at Anuradhapura (<300 m a.s.l.) ancient city of the country has been dated around 900 BC.[26]

Site environment

The Horton Plains area (6°47'-6°50' N, 80°46'-80°51' E) in the central highlands of Sri Lanka was designated as a National Park in 1969 for the preservation of natural montane eco-systems and habitats (Fig. 1). The area is characterised by a rolling landscape with mires, plains, forested hilltops, grassy slopes, precipices, brooks and waterfalls. Located at *ca.* 2100-2300 m a.s.l., it covers an area of ca. 3160 ha. Tributaries of several major rivers in Sri Lanka, e.g: Mahaweli, Kelani, and Walawe, originate from the Horton Plains serving as important water catchments. The bedrock of the Horton Plains was formed during the Archaean and has under-gone uplift because of folding and compression. Lateruplift was due to vertical tectonic epiorogenesis.[42] The bedrock of the area mainly consists of highly metamorphic rocks belonging to the charnokite metasedimentary series, largely granetiferous gneisses, quartz and granulites.[43] In general, the bedrock is covered with up to 1 m of organic-rich soil. The present day weather condition of the Horton Plains ranges from extreme wet to dry. During the driest period in February, the mean daily temperature is 12°C and the night temperature drops to 5°C.[44] The rainfall, which averages about 2150 mm per year, is determined to a great extent by the south west monsoon (SWM), which reaches its peaks in June to August. The north east monsoon (NEM) brings considerably less precipitation in December. The

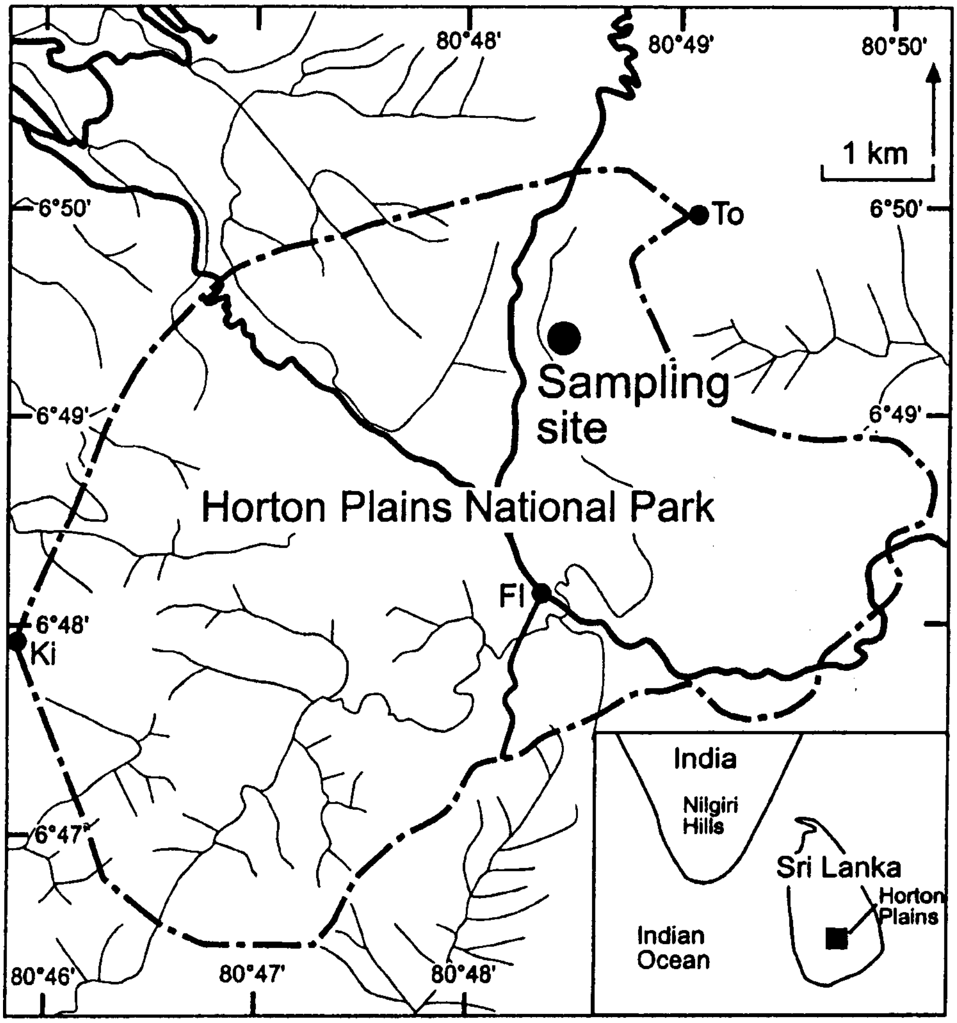

Fig. 1. Location of the Horton Plains National Park in central Sri Lanka (park boundary is marked by the dashed line). Thin lines mark the major drainage patterns. Thick lines indicate major roads. RC = road cut. Fl= Farr's Inn bungalow. Mountain peaks : To = Totupola (2351 m a.s.l), Ki = Kirigalpotta (2398 m a.s.l).

vegetation of the area mainly consists of upper montane rain forest (UMRF) and grasslands. 50% of the plant species identified in the area are endemic to Sri Lanka (Fig. 2).

Coring, material and methods

The mire selected for litho-, bio- and chrono-stratigraphic investigations is located in a 2 km long valley with a north-south orientation. The valley sides are steep and bedrock out-crops are occasionally found. The eastern side is dominated by wooded hill tops, and the western side by grassy slopes. The ground vegetation consists mainly of grasses (Poaceae), sedges (Cyperaceae) and dwarf bamboo (*Arundinaria densifolia*). The lithostratigraphy of the mire was investigated using a Russian peat corer by means of 36 corings along transects (diameter 5 cm). The bedrock is often highly weathered, resulting

Fig. 2. The southern part of the valley selected for litho-, bio- and chrono-stratigraphic investigations in the Horton Plains, central Sri Lanka. *Arundinaria densifolia* (dwarf bamboo) dominates in the lowermost parts while montane grasslands cover the valley slopes.

in kaolinite. At the coring site, the kaolinite is covered with sandy clay and silt containing some organic matter. These two minerogenic units are interpreted as sediment, i.e: the particles have been subject to transportation by surface run-off. The overlying sequence is a mixture of reworked clastic particles and decomposed sedentary plant material, e.g: from Poaceae (grasses), and humus. This type of accumulation is referred to as peat. In general, the thickness of the peat in the valley does not exceed *ca.* 3 m, except at the sampling site where it was 525 cm. Preliminary classifications of the sampled core were performed in the field, while detailed determinations were made in the laboratory on the basis of macroscopic and microscopic observations. The methods employed are pollen and spore, siliceous microfossil, organic carbon, stable carbon, environmental mineral magnetic analysis together with radiocarbon, dating in peat and sediment sequences collected.

Radiocarbon-dating

Fourteen bulk samples were collected from the core and dated at the Ångström Laboratory, Uppsala University, Sweden, by the AMS technique.[45] In addition, three samples were collected from a road cut (RC) about 1 km NW of Farr's Inn (Fig. 1) and dated by the conventional technique at the Laboratory of Isotope Geology, Museum of Natural History, Sweden. Rootlets and pieces of unknown wood were removed manually before the dating process. In general, the dates were performed on the NaOH soluble fraction (SOL), except for the upper-most one at 80 cm depth and one of the dates from the road cut. The latter dates were made on the insoluble fraction (INS). Ages are stated with $\pm \sigma$ and a normalization of $\delta^{13}C$= -25 per mill against PDB was carried out. The half-life ($T_{1/2}$) is 5570 years. Calibrated ages are according to Stuiver.[46]

Evidence of early cereal cultivation and the late Pleistocene-early Holocene climate in the Horton Plains

The palaeo-ecological data obtained from the Horton Plains can contribute to the discussion regarding the early stages of the independent origins of agriculture in the south Asian region. Semi-arid climatic conditions between 22 000 and 16 550 BC, as indicated by the xeophytic vegetation, suggest an extremely weak south-west monsoon resulting in very low rainfall. Siliceous microfossil and organic carbon data support this interpretation well. This climatic condition observed in the bottom of the Horton Plain sequences can be correlated with the earth precessional effect and the maximum extent of glacial conditions in high latitudes. The palaeo-ecological evidence also clearly indicated that floral diversity severely decreased at the peak of the Last Glacial Maximum (LGM). The vegetation composition deduced from the pollen data of the Horton Plains indicate that a mobile life-style prevailed among the hunter-foragers. It is possible that this way of life could have dominated owing to the low carrying capacity of the island's rain forest during the LGM.[26] Probably, plant cultivation did not start before 16 500 BC and this can be explained from the facts that LGM climate (semi-arid) were extremely unfavourable to agrarian settings in the environment. In southern Asia, the climate and vegetation were most favourable between 15 500 and 14 000 BC for the initial steps that led to the domestication of crops.[47] It is clear that incipient management of barley and oats occur around 15 500 BC in the Horton Plains as evidenced by pollen and other multi-proxy records (e.g. phytoliths, diatoms, stable carbon isotope, organic carbon, total carbon, environmental mineral magnetic). The semi-humid event between 15 600 and 14 000 BC corresponds to incipient management of cereal plants (oats and barley). The pollen evidence also indicates herding, possibly of *Bos* sp. and supportive indications are (1) forest clearance/ burning, (2) grazing, (3) pastures, (4) the presence of a characteristic edible plant, (5) a cultivated shrub, (6) various types of disturbed fields, e.g: patanas, (7) enhanced anthropogenic erosion as indicated by the initial increase of the values in magnetic susceptibility parameters (8) and high percentages of microscopic charcoal particles. These observations can be interpreted as the result of the initial stage of slash-and-burn activity. It is interesting to note that the beginning of incipient plant management did not take place until climatic conditions were favourable, but, it was being progressed since the transition from glacial to post-glacial conditions (16 500-15 600 BC), possibly terminal LGM. Subsequently, with the presence of fan-shaped phytoliths, which morphologically appears to have linked with *Oryza* sp. (cultivated rice), cultural pollen and a high amount of microcharcoal are indicative of human occupation and some type of agricultural activity (i.e. slash-and-burn) continued by 13 000 BC diversifying the prehistoric subsistence pattern. These processes were under the relatively dry climatic condition (14 000-11 600 BC), as evidenced by clear reduction of rainforest pollen records. Thus, it is reasonable to assume that the hunter-foragers had acquired the techniques and practices, at least to some extent, to convert the wild plants into domestic ones surviving to climatic changes as early as 15 500 BC. However, it does not point to the start of agricultural activities.

The evidence of early form of agricultural activities found in the Horton Plains do not appear to have got isolated at the regional level and similar type of evidence in the form of cultivated pollen and other proxies is available in the Indian subcontinent. The site, Lahuradewa, has yielded evidence in the form of *Cerealia* pollen and microcharcoal indicating some kind of basic forms of agricultural activities, defined as slash-and-burn cultivation since *ca.* 10000 BP.[8] In the regional level, it is obvious that such basic forms of agricultural activities progressed with the climatic fluctuations (repeated occurrences in dry and wet climatic conditions). This situation (i.e. change in the climate) resulted in long term drying and short term humid trends, which brought humans together in regions where water remained, leading to the need for increased food production, gradually decreasing mobile life styles.[48] The Horton Plains, having very prominent water catchments of the several major rivers in the country, was an ideal geographic area for prehistoric humans to engage in the agricultural experiments. Several other basic premises for the origin of agriculture are available, e.g: diversified natural habitats (the location where these plants occur in wild forms, woodlands, grasslands, rainforest). The presence of sharp geometric microlithic tools clearly indicates that the area was occupied by Mesolithic population with the wild cultigens of the cultivable grasses.[14] Mesolithic people may have collected seeds of the wild cultigens and utilized them for their food requirements, gradually adapting to the climatic change, especially to the long term dry conditions that prevailed. This process resulted in the changing of cultigens from wild to domestic ones giving advantages to formulate the first step to settled communities with incipient cultivation and herding of *Bos* sp. in the area.

The activities mentioned above were periodic in character until 11 000 BC. Thus, the prehistoric humans could have already started a primitive form of cultivation in the Horton Plains when they engaged in a hunter-forage life style. It is interesting to note that there is a substantial time lag of *ca.* 4500 years (15 500-11 000 BC) between the incipient cereal plant management and systematic cultivation, i.e: relatively larger fields during the late Pleistocene. During this time lag, the prehistoric humans (i.e. Mesolithic communities) apparently developed sufficient techniques and practices for plant domestication in the Horton Plains. Evidence indicates that the semi-humid climatic condition (15 600-14 000 BC) was followed by a step-wise strengthening of climatic amelioration, characterised by humid (12 600-10 000 BC), per-humid (8200-7900 BC) and hyper-humid (at 6700 BC) climatic conditions. This progressive trend was interrupted by two relatively dry climatic conditions again, as evidenced by pollen and other proxy data. It is really interesting to note that the beginning of systematic cultivation occurred when the climatic condition was significantly favourable in the Horton Plains, as well as in other areas in the Indian subcontinent since 11 000 BC. Repeated occurrence of dry climatic conditions probably forced many of incipient farmers in the Horton Plains, central Sri Lanka, to adapt new farming strategies, i.e: systematic cultivation. The East Asian sites (e.g: Xianrendong in China) have yielded evidence of rice-based subsistence patterns in human life-style between 12 000 and 7 000 BC.[49-51, 12] In south-western Asian sites (e.g. Abu Hureyra) in Euphrates and Ghaba Valley in northwest Syria, remains indicate systematic cereal cultivation at *ca.* 11 000 BC.[52, 11] Between 10 300 and 9500 BC, Tell Mureybit in the Euphrates valley has provided evidence for domestic wheat cultivation. Slightly younger remains of domestic cereals have been identified at several sites in south-western Asia[53] (Iraq). In addition, pollen and charcoal records in the highlands of Indonesia indicate anthropogenic disturbances since 11 000 BC, which may correlate with the spread of agricultural innovation in lowland Papua New Guinea.[54, 55] The emergence of the early stage of agriculture closely linked with the climatic changes (see introduction). It is clear that the abrupt climatic changes influenced the incipient agriculture in a complex way in different parts of the world during the Last Termination. Thus, a similar kind of early agricultural base appears to have established in the Horton Plains. The climate in the Horton Plains became much warmer and wetter at 11 000 BC, when the first evidence of systematic cultivation is observed. Between 11 000 and 6 000 BC, rapid and relatively large changes in $\delta^{13}C$ values, increase in total organic carbon (TOC), nitrogen (N) and carbon/nitrogen (C/N) ratios, indicate major anthropogenic disturbances in the vicinity of the site studied. These are probably related to deforestation and runoff changes in connection with field cultivation.[56] Between 8 000 and 7 000 BC an abrupt increase in fan-shaped phytoliths, derived from of cultivated *Oryza* sp. in association with the progressive trend in humid climate clearly indicates that rice agricultural activities has rapidly progressed, and it presumably culminated around 6 700 cal yrs BP coinciding with the hyper humid climate in the Horton Plans while oats and barley agriculture has decreased as evidenced by multi-proxy records.[57, 14] It is assumed that these warm and humid climatic conditions were ideal for the rapid growing of wild rice, e.g: *Oryza eichingeri*, *O. nivara*, *O. rhizomatis* (only in Sri Lanka), and *O. rufipogon*, which occur in the present vegetation in the country, and that wild species may have played a major role as the prototypes in the domestication of rice converting from wild to domestic ones in such degree with respect to the continuous processes of cultivation. It is really interesting to note that rice was first grown as a dry land crop (i.e. 13 000 BC) and then it was gradually adapted to wet lands around 8000 BC. With the improvement of monsoonal rainfall, intense agricultural activity probably started since 11 000 BC in the mountainous valleys in central Sri Lanka and in the Gangetic Valley in India; and the early Holocene (8000-5000 BC) witnessed the spread of well developed agriculture in both geographic areas (including Horton Plains, Lahuradewa Koldihawa and Mahagarha), as well as in the Indus system (Mehrgarh).[58-63, 3, 8] The new archaeological evidence (e.g. pottery, cultivated rice grains) found from the Gangatic Valley (i.e. Lahuradewa) suggests that the rice growing cultures appear to have been established by 6,500 BC, and associated with high rainfall as evidenced by pollen, phytolith, $\delta^{13}C$ and microcharcoal records.[14] Furthermore, it can be believed that Shinde[30] and Gupta[64, 65] have made a nice compilation based on palaeo-climatic and archaeological records in the Indian subcontinent, the Arabian Sea and the Tibetan plateau, suggesting that proliferation of early civilization and beginning of agriculture in north-western India were closely linked to the strength of south-west monsoon during the early Holocene. Therefore, it is reasonable to assume that rice cultivation could have established as a staple crop in the Indian subcontinent (Sri Lanka and northern part of India) as early as 6500 BC. However, the direct archaeological evidence (e.g. pottery) has not yet been found at stratigraphical contexts in the Horton Plains due to lack of systematic excavations, but a considerable amount of surface pottery fragments which are said to be generally considered as the characteristic of a much earlier period than the megalithic early Iron Age in character, have been found. Considering all the above facts, it is clear that an independent development of the 'beginning of agriculture' in the Horton Plains, central Sri Lanka was closely linked to the step-wise strengthening of the south-west monsoon and the rice cultivation which is associated with the monsoon optimum at 6700 BC.[14]

Conclusion

The history of climate, vegetation and land-use since 22 000 BC has been constructed for the Horton Plains, southern central part of Sri Lanka. Xerophytic vegetation, i.e: dry forest, predominated until 16 500 BC, indicating weak south-west monsoon (SWM) rains. The upper montane rain forest expanded from 16 500 BC as a result of warming. A first period of strengthened SWM appeared at 15 500-14 000 BC (Semi-humid). A second period of strengthened SWM appeared at 11 600-10 500 BC (Humid). A weak signal of the Younger Dryas event was traced to 10 200-8900 BC. A third period of strengthened SWM appeared at 8200-7900 cal yrs BP (Per-humid). Dry climatic conditions occurred among the semi-humid, humid and per-humid climatic events. The SWM culminated at 6700 BC.

The late Pleistocene and early Holocene climatic amelioration favoured the development of cultivation. The Horton Plains and its surrounding area was home to nomadic people who followed the SWM rains that turned the dry forest into montane rain forest. Incipient cereal plant management together with slash-and-burn techniques started around 15 500 BC. The first possible evidence of cultivated rice (*Oryza* sp.) is found around 13 000 BC, and the systematic rice cultivation appears to have progressed between 8300 and 6500 BC. The cultivation of *Avena* sp. (oat) and *Hordeum* sp. (barley) started around 11 000 BC. This gradually decreases, coinciding with the progressive trend in rice cultivation. The beginning of cereal agriculture in the Horton Plains, central Sri Lanka, was closely linked to the step-wise strengthening of the SWM, and the repeated occurrence of dry spells, probably forced many of incipient farmers in the Horton Plains, central Sri Lanka, to adopt systematic cultivation. The new evidence of an earlier stage of agriculture from the Horton Plains is of great significance for the Indian subcontinent. The present study demonstrates that there were several independent centres for initial agriculture in the region. Aridification began at 6500 BC, followed by severe arid conditions between 3400 and 1600 BC.

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