The Evolution of Agriculture, Food and Drink in the Ancient Niger River Basin: Archaeobotanical studies from Mali and Benin.

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Submitted towards a PhD in Archaeology

I, Louis Champion confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

Abstract

This doctoral thesis examines the evolution of the agricultural and food economies that supported the communities that gave rise to complex societies in West Africa, as well as the agricultural systems that sustained the succeeding polities around the Niger River Valley. One of the major goals of my thesis was to reconstruct the evolution of food and beer systems, including both production and consumption. The aim of my thesis goes beyond simply documenting the arrival of new practices or new crop taxa. It also addresses the consumption practices that these crops gave rise to, and how they became embedded in the social, economic, political and environmental history of past African societies.

The time period covered by this research (from 2000 BC. Until Today) witnesses climatic fluctuations, with continual oscillations between dry and humid phases. Many social changes also occurred during this period. One of the most important modifications in the African landscape, during the first and second millennium AD, is the growth of the West African states and empires, such as those of Ghana and Mali, as well as various Songhay polities. The extension and maturation of these political entities likely impacted on local agricultural systems, urbanization, and trade networks. The history and peopling of West Africa, and particularly in the Niger River area, is connected to issues of food consumption and social organisation. Indeed, we also have to study the ethno-historic framework of the area.

This research includes an analysis of archaeobotanical material recovered from sites located in North Benin and Mali. The 13 sites from Benin were excavated for the 'Crossroad of empires' ERC project during three field seasons (2012-14). As for the samples from Malian sites, 4 were recovered by Kevin MacDonald during excavations in the 1990s, Sadia in Dogon country was excavated by the APA Swiss project in 2010-11 and Togu 2A excavated by Daouda Keita (Université des sciences Socials et Géstion, Bamako, Mali) for the Markadugu Project led by Nikolas Gestrich from the Frobenius Institute (Frankfurt, Germany).

Impact Statement

The primary anticipated impact for this research will be West African archaeology and tropical archaeobotany. My results and discussion will contribute to the creation of practical resources that can be used by future researchers, such as my taxa identification guide of African taxa. There is also the potential for the application of some of the research themes that emerged in this research regarding native African crops, agricultlure and environmental conditions in the past to modern issues surrounding sustainability, conservation and resilience today. Issues facing vulnerable areas in Africa today include climate change and examining past climatic patterns and human adaptation and change in the past may help mitigate some of the worst effects today.

As there is a paucity of new archaeobotanical data from Africa in the current literature, each new project, including this one, adds considerably to our understanding of native African domestication trajectories including the spread and diffusion of different native and introduced crops by different peoples along with the incorporation of later introduced crops from other regions including New World taxa. .

Food and drink is one of humanity's biggest concerns and preoccupation. In fact, most of our energy is spent fuelling nutritional needs, tastes and culinary practices. Yet, so far, such an important issue remains poorly studied in the archaeological record. In particular, our knowledge of African food practices is still very basic, in comparison with other, better studied, areas such as the Near East. One of the main aims of this research project was to improve our understanding of African cooking traditions and their evolution over time. To this end, the archaeological evidence was studied in conjunction with ethnographic observations, participation, survey questions to better understand the development of African culinary traditions.

I was active in local knowledge exchange during my field work in Africa as I was involved in training local colleagues in Africa how to sample, collect and process archaeobotanical samples and explained the relevance and importance of archaeobotanical analyses.

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As shown in Figure 6.7, the analyses suggest some changes through time. However due to the small volume of soil floated, some caution is applied. Still we can observe frequency changes within the tree and shrubs remains: 40% in phase A which shrank during phase B to ≈15%), and totally vanished in phase C (Figure 6.7).

Acknowledgements

As with every culinary recipe, this thesis is the result of the slow evolution between the chef, the ingredients and all the steps of preparation in between. Every element, even down to the smallest, and perhaps particularly the smallest constituents, have an important role to contribute to the greater whole. In this sense, I would like to thank everyone who has assisted me in the preparation of this meal.

First, the entire recipe was done under the wonderful assistance and supervision of Master Chefs, Dorian Q Fuller, Kevin MacDonald, Chris Stevens, Henry Wright and Alison Crowther.

Also, it should be acknowledged that preparation and cooking takes time and for this I would like to thank my friends and colleagues in the Archaeobotanical Research Room (306) and Lab at UCL and team members of the "comparative Pathways to Agriculture, ERC project (awarded to DD Fuller ERC Grant Agreement 323842) who have supported me throughout the years of my researching including : Chris Stevens, Ellie Kingwell-Banham, Charlene Murphy, Alison Weisskopf, Cristina Castillo, Michèle Wollstonecroft, Phil Austin, Sue Colledge, Amanda Leon, Leilani Lucas, Lara Gonzalez Carretero, Anne Sommieres, Rita Dal Maretllo, Hanna Sosnowska, Julian Grray Vazquez and Dorian Q Fuller. And also my others friends from UCL including Hannah Page, Andrew Reid and Phillipa Ryan. And my brothers Laurent Nieblas, Nicolas Nikis, Vincent Vanderheyden, my Dogon uncle and Mayor of his town: Elin Tessougué, my Benin sister Lucie Smolderen, my swiss sister Céline Grognasse Cervera and my mother Bernadette Cuvelier and father Raymond Champion.

The main ingredients of this thesis were, of course, the archaeobotanical samples; without them, this research would not have been possible.

Thus, thanks to Anne Haour and the entire Crossroad of empires ERC Project (awarded to A Haour ERC Grant Agreement 263747) team for their assistance and samples from Benin. I also want to thank Sam Nixon and Carlos Magnavita who taught me the basics of flotation. Moreover, I would like to thank in particular Alexandre Livingstone Smith for all his wonderful energy and help in the field and in general. It is also true that everyone from the teams I worked with made their own individual contributions to the projects and I thank each one of them for their presence, help and support, advice, words of encouragement and so many others intangible aspects that leads to the creation of a positive excavation project atmosphere. In this regard I would like to thank: Olivier Gosselain, Alexandre Livingstone-Smith, Didier N'Dah, Nadia Khalaf, Carlos Magnavita, Mardjoua Barpougouni, Paul Adderley, Caroline Robion-Brunner, Richard Lee, Djimet Guemona, Victor Brunfaut, Nicolas Nikis, Obarè Bagodo, Paulo Farias, Veerle Linseele, Lucie Smolderen, the villagers of Tintin, the workers, and the drivers Alain and Valere. Also, I want to give a special thanks to all the villagers and inhabitants of the Dendi region who were so gracious and kind to us.

The second half of my samples came from Mali and for this I need to thank Kevin MacDonald, Cecilia Capezza, Nikolas Gestrich, and the Swiss team (APA laboratory, University of Geneva) Anne Mayor, Eric Huysecom, Sylvain Ozainne, Marie Canetti, Céline Cervera, Luis, Thomas, David, Maria, Carol, Katja, Seb, and the Dogon technicians who help with the excavation and flotation.

After the creation of the base, you need to add some spices and condiments, which are so important for the taste and flavour of your dish. In this case- tomatoes and onions. In Benin, every day three children, Leni, Badgi and Fadalou came to the excavation site to offer us fresh tomatoes and onions grown by them. Thanks to them we had fresh food every day. What a great pleasure! The chili is Chris Stevens's contribution. Chris taught me so much regarding developing and strengthening my ideas that I now have a much stronger tasting meal thanks to him.

Of course, each ingredient has to be correctly identified and so I want to thank all the persons involved in the creation of the UCL reference collection, both past and present, including Gordon Hillman, David Harris, Sue Colledge, Mary Anne Murray, and Sandra Bond and careful, ongoing curation by Amanda Leon. I would also like to thank the staff at Frankfurt University's Africanist archaeobotany laboratory, including Katharina Neumann, Alex Höhn and Barbara Eichhorn, who kindly allowed me to use their amazing reference collection and also thanks for their wonderful comments and advice on my research.

Of course, in a recipe the cooking pot itself has a huge impact on the final taste. Just like for the porridge preparation I had to make pots: a big one for the porridge and a smaller one for the sauce, thanks to my metaphorical sauce pot, the entire archaeological team from the museum of Central Africa in Tervuren (MRAC Belgium)

including Els Cornelissen, Nadine, Alexander, Alice, Olivier, Ali, Josiane, and Pierre de Maret, who gave me the opportunity to provide some extra flavour.
A good meal is not a good meal without beer or wine to wash it down. Thus, even the smallest drop of a great vintage makes everything better. This drop can be credited to the excellent conversations, usually around several glasses of beer, with Andrew Reid, Roger Blench, Mark Horton, Nicole Boivin, Sylvain Ozainne, Katie Manning, Nik Gestrich, Sarah Walshaw, Daphne Gallagher, Jed Kaplan, Laurent Lespez, Aline Garnier, Charline Bouchaut, Valentin Vydrin, Oliver Pryce, Henry Wright, Paul Lane, Pierre de Maret, Phillipa Ryan and Raymond Champion.

During this lengthy preparation, it is nice to have some helpful tasters along the way. Thus, it is thanks to Chris Steven, Charlene Murphy, Michèle Wollstoncroft, Dorian Q Fuller, Sarah Walshaw, Kevin MacDonald, Nicolas Nikis, Ellie Kingwell-Banham and Laurent Lespez that the contents have been much improved.

And, finally, I would like to thank my three supervisors, Chris Stevens, Kevin MacDonald and Dorian Fuller again for all their hard work and patience. Thank you.

Thank you very much!

I hope that this meal has not been over- or under-cooked and will suit the reader’s particular palate, maybe you can enjoy it with a nice beer (African or not) or a glass of Bisap.

I wish you “*bonne appétit*” and thank you.

1. Introduction - Research Questions and Data Set

1.1 Introduction

This doctoral thesis examines the evolution of the agricultural and food economies that supported the communities that gave rise to complex societies in West Africa, as well as the agricultural systems that sustained the succeeding polities around the Niger River Valley. One of the major goals of this thesis is to better understand the cultural evolution of early African food traditions, and their role in the rise of empires and states, through an analysis of the archaeological and archaeobotanical record and by bringing data from new excavations to this record.

The analysis of the archaeobotanical remains collected during the course of this thesis come from the Niger River Basin (specifically Benin and Mali) and are oriented towards developing a better understanding of plant food traditions and cultivation through time. These archaeobotanical data pre-date historical records and provide the first empirical evidence for the use of major crops, especially cereals, including pearl millet, fonio and African rice, as well as other food plants in these regions. The sequence of shifts in crop repertoire can in turn be linked to broader social and economic developments in the region. Notably, some of the most important modifications to the African landscape occur in the first millennium BC and then later during the first to second millennia AD, during is the growth of the West African states and empires, such as those of Ghana and Mali, as well as various Songhay polities and the Kasar Haussa. The domestication, spread and relationship of the major African crops, for example, African rice, fonio, pearl millet and sorghum, to the rise and establishment of these political entities then forms a major focus of this thesis. In turn, the extension and maturation of these political entities no doubt involved many changes (e.g. social, cultural and economic) that impacted on previously established local agricultural systems, urbanization, and trade networks.

Food and drink form the foremost prominent concerns of all societies. In fact, the majority of human energy is spent fuelling nutritional needs and tastes. Yet, thus far, these issues have not been significantly addressed in the literature on African prehistory.

In particular, there is much research still to be done regarding our knowledge of food practices throughout the continent.

The Niger River is second only to the Nile in length in Africa, and plays host to dense populations of agriculturalists in West Africa that supported polities in historical times. This is also the region to which the origin of the Niger-Congo language family, including its Bantu offshoot, is attributed. Furthermore, the Niger River contributes an essential part of the agricultural development of the whole region. The river brings water and additional fertilizer (alluvial sediments) that increase and facilitate agricultural productivity. It can be considered as a natural hydraulic system, which depends of the seasonal rising and falling of the river waters, the "crue" and "décrue", resulting in the natural flooding of the river. Usually today the principal crop planted before the flood is rice, but in the Inland Niger Delta the agricultural exploitation of the "décrue" zone is given to millet and sorghum cultivation (Harris 1976).

The sub-humid and semi-arid Sahel, and its traditional agriculture is characterised by a complex system of long term fallow and seed-cultural flood-water farming systems and stands in contrast to the forest zone to the south where vegecultural systems prevail (Harris 1976). Firstly, a Long-Term Fallow system in the region today and historically comprises of relatively frequent shifting of the fields or plots. Secondly, the seed-culture system is located within traditional agricultural areas where the dominant crops are seed-reproduced. The research area today is represented by the most widespread of the subtypes of farming systems in the Sahel, the Sorghum-Millet system. This sub-type is associated with numerous secondary crops, such as groundnuts, beans, rice and manioc, that latter being the only root crop in this zone (for more detail see Harris 1976).

Despite a wealth of ethnographic and historical research, archaeobotanical evidence for the development of agricultural systems, based on both ancient West African crops, like *Pennisetum glaucum* (L.)R.Br.[1], *Vigna unguiculata* (L.) Walp. and *Oryza glaberrima* Steud., *Digitaria exilis* (Kippis) Stapf., and crops introduced to the Niger Basin, such as *Sorghum bicolor* (L.) Moench. and *Gossypium* L. sp., has remained limited. In

[1] Recent Taxonomies issue want to rename as *Cenchrus americanus* but in order to avoid any confusion, I will continue to use the well-established *Pennisetum glaucum* nomenclature.

particular the role of multiple crop systems, that included both wet (rice) and dry (millets) crops, remains to be directly documented archaeobotanically.

In order to address the question of the relationship between agriculture and the rise of complex societies, I have chosen an area that encompasses parts of modern Mali and Benin centring on the Inland Niger Delta and Middle reaches of the Niger Valley. Here recent archaeological work has uncovered sites relevant to understanding the development of early West African complex societies and importantly has made possible the collection of archaeobotanical samples.

Without omitting other analytical tools developed in this domain, such as modern botanical and genetic studies of crops, the core data underpinning this thesis focuses on ancient plant remains and the archaeological contexts from which they come from. Carbonized macro-remains of plants are the most common form of evidence to provide information for early crops and agriculture, and they provide an empirical, if fragmentary, record of past crops, agricultural systems and food plants.

The basis of the investigation of the changing role of agriculture in the period from the second millennium BC to the second millennium AD, during which we see the rise of the first West African states and Empires, comprises an analysis of 470 archaeobotanical samples from 5,867 litres of soil recovered from 19 sites located in North Benin and Mali within the Niger River Basin (Figure I.2). The 13 sites from Benin were excavated for the 'Crossroad of empires' ERC project (see below) during three field seasons (2012-14). As for the samples from Malian sites, 4 were recovered by Kevin MacDonald during excavations in the 1990s, Sadia in Dogon country was excavated by the APA Swiss project in 2010-11 and Togu 2A excavated by Daouda Keita (Université des sciences Socials et Géstion, Bamako, Mali) for the Markadugu Project led by Nikolas Gestrich from the Frobenius Institute (Frankfurt, Germany). These sites cover four time periods. The earliest two sites, Windé Koroji (WKO) in Mali and Alibori SIII in Benin, date from the second (WKO only) and first millennia BC. The second time period is covered by six sites, one Malian (Sadia) and five in Benin (Tintin, Birnin Lafiya, Kantoro, Pekinga, Alibori SII) from the mid-first millennium AD until the mid-second millennium AD. The last time period encompasses the second part of the second millennium AD (after 1500 AD) with the sites of Gorouberi, Kozoungou, Kargi, Guenezeno and Madekali. The time period covered by this research, covering more than four millennia (from 2500 cal. BC. to the present day), and witness several phases of climatic fluctuation, with continual oscillations between dry and humid phases (see below).

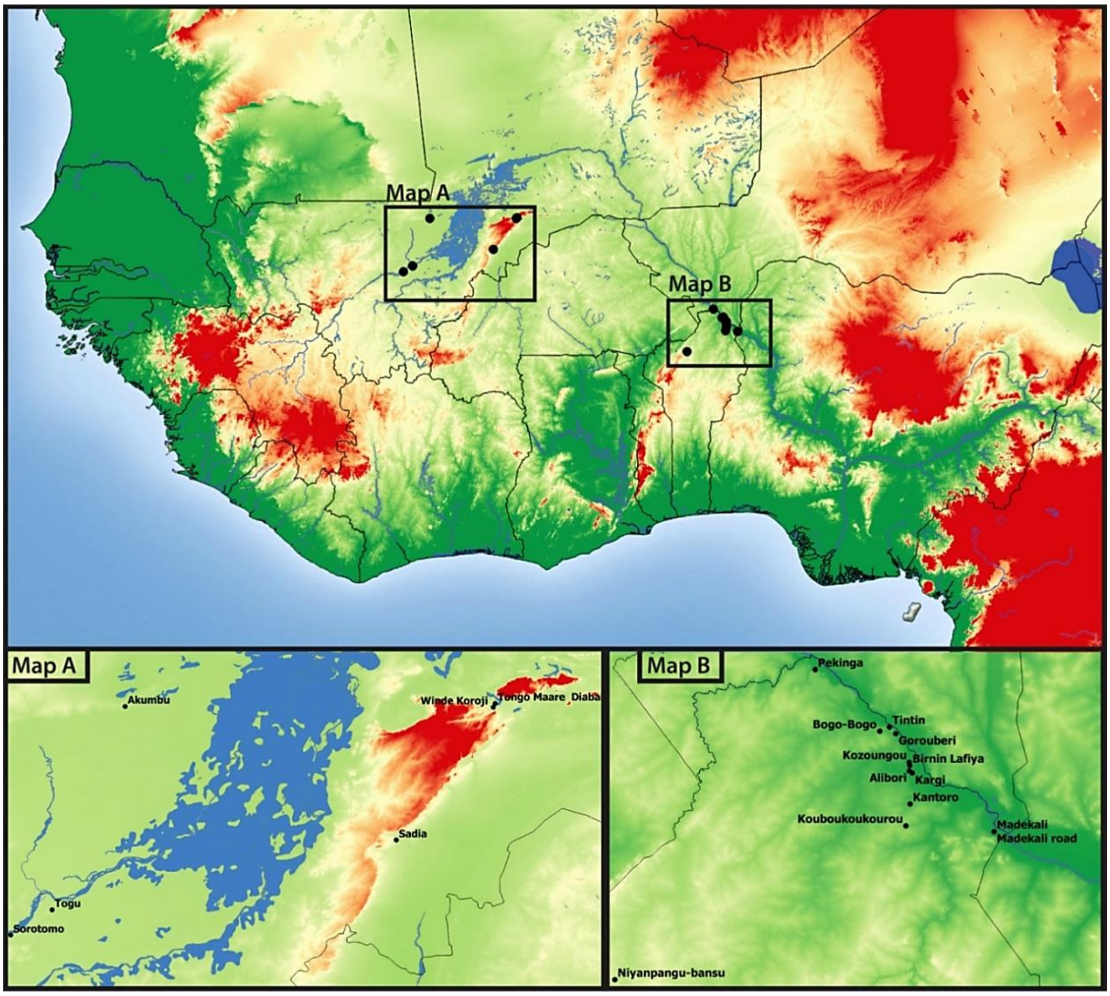

Figure 1.1 Research areas, Location of the archaeological sites. Map A: Sites in Mali; Map B sites in North Benin

The new data analyzed in this thesis will contribute to the major aim of filling in the broader patterns of agricultural evolution in West Africa. Currently, the available data comes from 31 sites that are older than 100 BC and some 64 sites from the first or second millennia AD (Figure 1.8). These allow us to summarize the distinct, but inter-related histories, of crop use across the major biomes of West Africa. Early grain farming in West Africa was based on the spread of pearl millet among agro-pastoralists. Over time farming systems diversified and supported increasing sedentism with additional grains crops (rice, fonio, sorghum), grain legumes (especially *Vigna unguiculata*), and various tree crops, mostly with oily seeds (oil palm and cotton)

Evidence from the Tilemsi Valley suggests that pearl millet domestication was well underway by 2500 BC (Manning and Fuller 2014). Further west, in Mauretania, impressions of domesticated pearl millet occur in pottery by 1500 BC (Fuller et al. 2007). Finds in Senegal, Mali, Burkina Faso, Benin, and further south in central Nigeria (the Nok Culture) indicate pearl millet cultivation was well established quite widely in West Africa by the later second millennium BC (Champion and Fuller 2018 a, b; MacDonald et al. 2017; Kahlheber et al. 2009; Eichhorn and Neumann 2014). Another key element of agricultural diversification is the domestication and spread of African rice (*Oryza glaberrima*) and fonio (*Digitaria exilis*). From the final centuries BC rice and fonio cultivation, together with urbanism, increased in the Inland Niger Delta and began to spread downstream (Murray 2007a, McIntosh 1995). At present there is no archaeological evidence for the dispersal of rice westwards into the Senegal, Guinea highlands and coastal regions, or to its subsequent diversification into southern and northern Guinea groups, suggested by geographical genetic structure (Meyer et al. 2016, Gallagher in press), as well as by historical linguistic data (Fields-Black 2008). The medieval era, represented by Islamization, saw the commencement of widespread trade in grain and the production of cash crops. This was already evident before the end of the first millennium AD at Essouk in north-eastern Mali, with evidence for cotton and imported wheat and sorghum (Nixon et al. 2011), as well as wheat and cotton from Dia (Murray 2007b). Cash crop production and grain trade became increasingly enmeshed into the economic exploitation of labor, including enslavement and the slave trade. Slave and food trade was intensified by the increased frequency of European trade ships that sought both food supplies and slaves from the West African coast to support European wealth creation, for example via sugar starting 15th century AD (e.g. Mintz 1985; Carney and Rosomoff 2011, Champion and Fuller 2018a,b).

The extension and maturation of West African political entities likely impacted on local agricultural systems, urbanization, and trade networks. The history and peopling of West Africa, and particularly in the Niger River area, is connected to issues of food consumption and social organisation. Indeed, we also have to study the ethno-historic framework of the area. Naturally the main areas of this research, the upper Niger Valley, the middle Niger with Niger Inland Delta in Mali (IND), and the Niger bend with Dendi (region of North Benin), have both similarities and distinct differences. One of the main differences is the position of the Dendi area in relation to the normally posited frontiers of the main empires and other polities.

1.2 Geography, Ecology and Climate evolution

Despite the fact that the arid West African climate is one of the most variable and unpredictable in the world (Koechlin 1997:12-18), this section aims to provide a brief overview of our current understanding regarding climate fluctuations during the second half of the Holocene period for the Inland Niger Delta and the Dendi area.

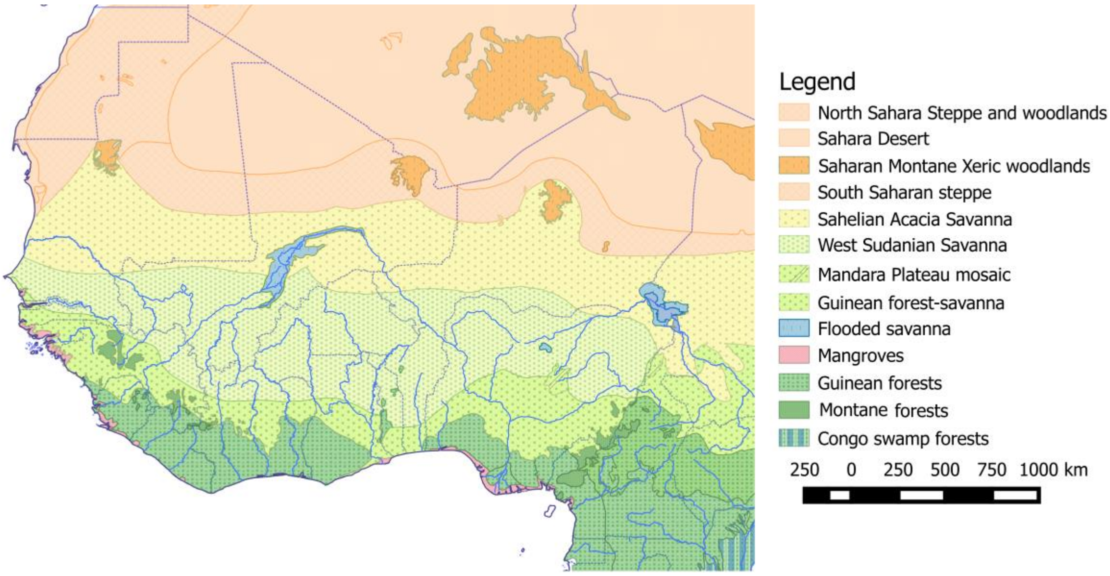

Figure 1.2. Map of modern potential vegetation zones of western Africa. The zonation of this map were derived from GIS-shape file of Terrestrial Ecosystems of the World (Olson et al 2001; World Wildlife Fund 2017), with zones grouped into broader categories in line with White (1983).

The research focus of this thesis centres on the Niger River Basin, located in the border region of the Sahel area. The source of the Niger originates in the Guinean forest, an area characterized by high rainfall, then flows northwards across the Guinean forest-savanna, then eastwards through arid Sahel dunes and then finally southwards to the sea through the Nigerian Mangroves. During this long journey, the Niger River transverses our research area; the West Sudanian Savanna, the Sahelian Acacia Savanna and the flood plain savanna of the Inland Delta (see zonation in Fig.I.1 and Fig I.2). All of these areas possess a large alluvial floodplain that offers a rich area for settlement and agro-pastoral activities, bordered by semi-arid grassy woodland Savannah. The climate of both zones is similar to and characteristic of the West African Sahara/Sahel sub-desert area with low rainfall levels varying from 1000 mm to less than 100 mm (Olson et al 2001, Andersen et al. 2005, Gallais 1967). Data for this thesis were collected from three different parts of the Niger River Basin: the Upper Niger, the Inland Niger Delta and Lake District (IND), and lastly beyond the middle Niger Bend in Benin (Figure 1.3).

The Upper Niger River Basin

The Niger is formed of an extensive network of steep-sloped streams located in the high plateau of Guinea. Over the first 40 kilometres, the river drops some 300 metres, before reaching the Malian border the river passes through rapids and after, before reaching the Inland Delta, the flatness of the terrain is only broken by some lateritic buttes. In this last area diversified agriculture is only possible in the alluvial plain. The Guinean region where annual rainfall is greater than 1200 mm, has a transitional tropical climate (Andersen et al. 2005).

The Inland Niger Delta (IND)

This region lacks well-established watershed limits, and can range from 30,000 square kilometres during periods of low water to 80,000 square kilometres during periods of high water. It is a large alluvial plain filled with various Quaternary and recent deposits. In terms of rainfall the IND, can be split in two regions; firstly, the area around Mopti (Niger Valley, Bandiagara escarpment, the Seno plain), characterized by semiarid tropical climate with 300-750 mm of annual rain; secondly, the Timbuktu region with a semiarid desert climate with 150 to 300 mm of rain distributed over three to four months (Andersen et al. 2005).

The Middle Niger

The archaeological sites of Dendi in Benin, investigated in this study, are located on the south bank of the Middle Niger. This part of the Niger River collects three watercourses draining the northeast regions of Benin; The Mekrou, Alibori and Sota. As with Mopti region in the IND, the Dendi region has around 300-700 mm of annual rainfall. On the opposite bank, in the Republic of Niger, three Wadis ‘flow’ directly into the Niger River from the Sahara, the Dallol Foga, Dallol Bosso (Azaouâk) and Dallol Maouri (Andersen et al. 2005). From at least the 18th century AD these Dallol were used by trans-Saharian Caravans to reach Benin and the southwestern African trade network (cf. Chapter 2 and the Wangara from Dendi) (Brégand1998).

The “Dallols and Wadi” region within the Niger River Basin was important for the origin and diffusion of pearl millet agriculture. A Wadi or a Dallol is a channel of a watercourse that is dry except during periods of rainfall, The Tilemsi valley, in Mali being a good example. The Tilemsi has provided the earliest evidence for domesticated pearl millet (Manning and Fuller 2014). Currently this region is formed of old contributories of the Niger coming directly from the Sahara but due the desertification many are not flowing any more. This zone is characterised by a desert climate with less than 150 mm rainfall (Manning et al 2005, Andersen et al. 2005).

In all locations, rainfall seasonality is similar with a three to five month humid season with a rainfall peak around the month of August and a dry season from November to April (Figure 1.4) (Andersen et al. 2005, Olson et al 2001, Gallais 1967). The Niger inundation is a major phenomenon in the IND and throughout the entire valley. The Inland Delta acts as a sort of sponge which distributes the floodwaters below ground, while the IND, in contrast, swells and then gradually releases the inundation downstream (Figure 1.4). Due to the reduction of the slope across the length of the delta, from 6cm per km to 1 cm/km, inundation and flood peak progression is both delayed and spread out during its movement downstream, as a result, the downstream floods are naturally regulated. As shown in Figure 1.4, the flood peak has a different timing according to one's location in the valley. The upper Niger's flood peaks is in October (Point (1) in Figure 1.3 and Figure 1.4), in the IND (3) it occurs in November and below the delta (4) in December. Thus along the river, the flood peak progresses 60 km a day upstream and 5 km a day downstream (Gallais 1967). One thousand kilometres away, in Benin (5), the IND still has a strong influence on inundation levels. However, unlike in Mali, there are two flood peaks during the same inundation event. The first peak is due to the local rainfall, towards the end of August, creating a local flood peak. The second peak can be attributed to the Malian flood peak progression, described above, generating a second peak around February (Figure 1.4 point (5)) (Andersen et al. 2005, Olson et al 2001, Gallais 1967, Rouch 1950). Thus, the combination of the Niger River inundation, and the IND, has a significant influence on the hydrology of the area, by creating an extended the period of flooding. The presence of this fresh water for nearly the entire year is a major asset for local populations and agricultural production (see Chapter 5). Regulated and long-lasting, the flood waters provide a predictable and reliable water source and alluvial soil fertilization suitable for cultivation in the months following the flooding peak.

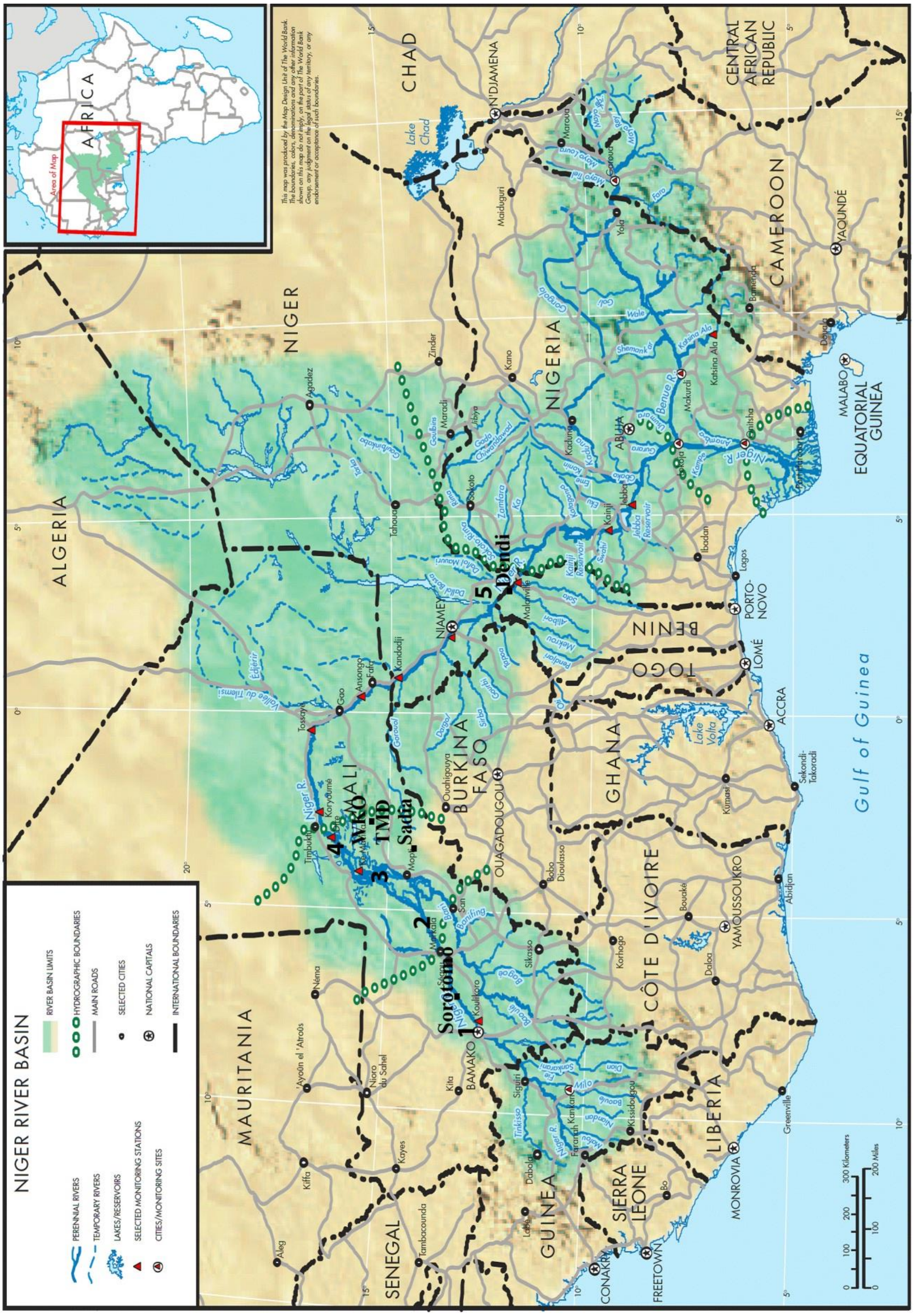

Figure 1.3. Map of the Niger river basin, indicating the archaeobotanical study sites and areas of flood discharge. TMD/WKO (abbreviation for Tongo Maaré Diabal and Windé Korodji & Dendi). The numbers (1 to 5) indicates the location of river discharge records shown in Figure 1.4. (Transformed from Andersen et al. 2005:71

Among the populations that benefit from this seasonal flooding are the nomadic herders, the Peulh/ Fulani, who bring their animals to the water and graze them on the available burgu grass (Gallais 1967; Gestrich 2013). Burgu (*Echinochloa stagnina*) grows in the Niger's deep waters (cf. Chapter 5), as a lush, competing weed of flood rice (*Oryza* sp.) cultivation (Gallais 1967, McIntosh 1995). The presence of large numbers of cattle today in the area, totalling over 2.5 million for both Benin and IND, provides manure on the hoof for soil fertilisation, weeding, and natural ploughing, especially on the poor soil of the lower valley. Today, this lower valley is sometimes reserved inter-annually as a grain gift from growers to herders (Figure 1.5) (Gallais 1967; de Bruijn & van Dijk 1995; Van Driel 2001). During the dry period (after the harvest), the flood plains are used by pastoralists for grazing cattle and during the humid season (after the flooding) they are used for '*décrue*' agriculture (e.g. Sorghum (*Sorghum bicolor*) cultivation) or rice cultivation during the flooding. The phased system of flooding, of rising and falling, '*crue*' and '*décrue*' respectively, can be considered as a natural hydraulic system driving land use and agricultural production on a long-term seasonal schedule, which creates an unpredictable chaotic year to year calendar. Usually the principal crop sown before the flood is rice, both African rice (*Oryza glaberrima*) and Asian rice (*Oryza sativa*), but in the Inner Niger Delta the agricultural exploitation of drier '*décrue*' conditions has forced them to turn toward millet (*Pennisetum glaucum*) and sorghum cultivation during long lasting low flooding conditions (Harlan 1969; Harris 1976).

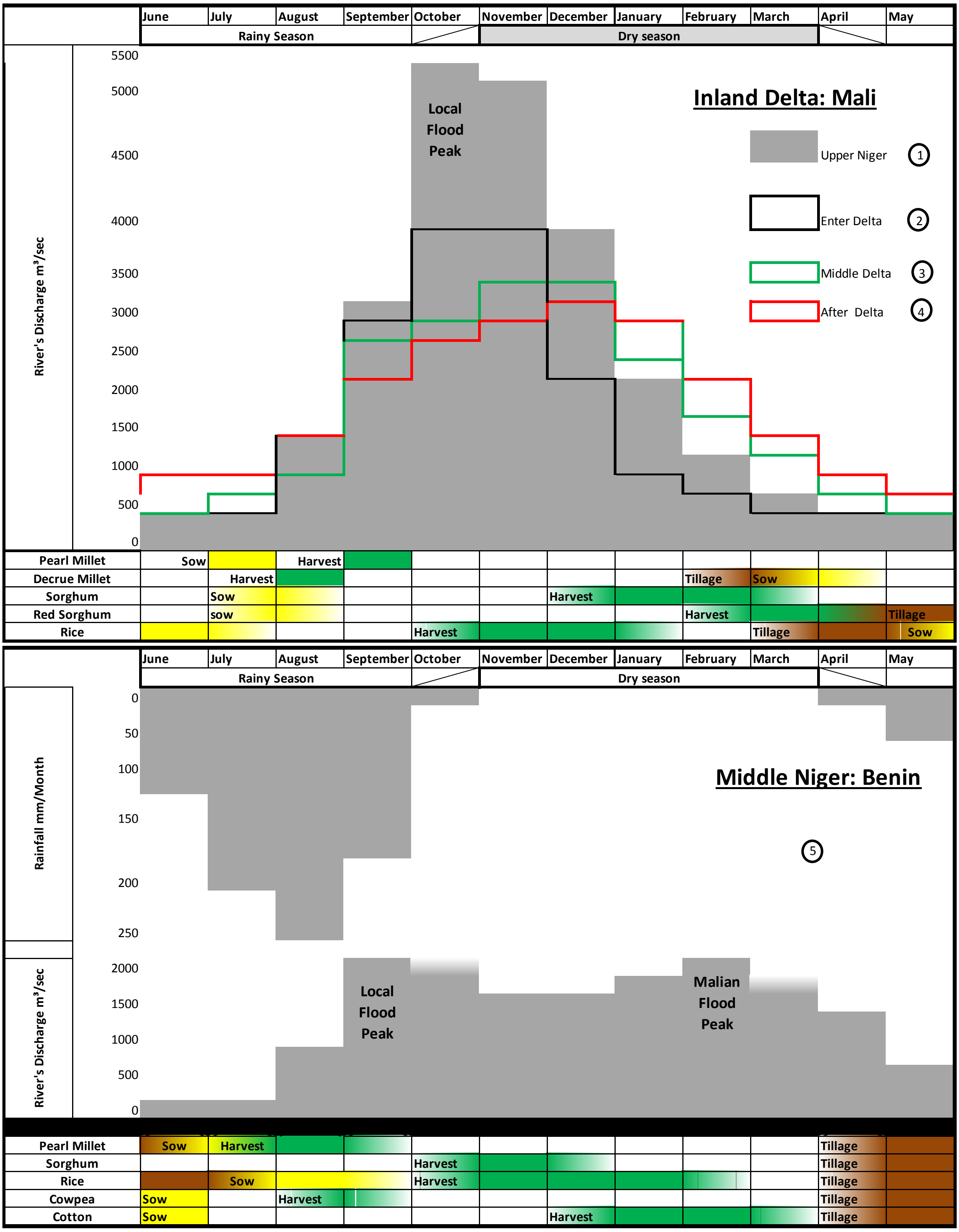

Figure 1.4. Schematic representation of the rainy and dry seasons including Niger River flood progression (Average flood event) and main crops seasonality. Numbers 1 to 5 correspond to the geographical location of Niger River discharge record show in Figure 1.3 (Adapted from Gallais 1967; 1984; Rouch 1950; McIntosh 1995; Van Driel 2001)

In what is now modern day Mali and Benin, annual rainfall and river floods have a major effect on the landscape. This complex hydrology facilitated the formation of a mosaic of natural ecosystems made up of different niches created over various time spans (i.e. millennially, centenary, decennially and annually) based upon the seasonality of moisture and total available water. Each of these niches is characterised by specific vegetal ecotypes (Figures 1.3 and 1.4). Thus, these ecological niches provided opportunities for human settlers to exploit a wide diversity of wild resources. This long coexistence (over 4,000 years) between wild plants and peoples, in such rich natural environments, resulted in the development of a wide range of cultivation practices. Indeed botanical, archaeological, genetic and palaeoenvironmental studies have demonstrated that many different innovations in subsistence strategies occurred in this region due to the presence of these unique environmental niches; including multiple plant domestications within western Africa, which can divided broadly into two packages: those from the drier open savannah/Sahel and those of the forest margin savannah, (Harlan 1992; Fuller and Hildebrand 2013). Without human specialization to this specific landscape, defined in this thesis as specialized perceptions and agencies for known set of ecological conditions and associated landscape, as opposed to *spécialités artisanales* — craft specialization, societies cannot master the complexities of this rich but highly diversified moving and unpredictable landscape (McIntosh 2005:109)

The majority of archaeological sites in Benin are located along the flood plain of the river valley (Figures 1.3 and 1.4). Both sites from Mali, Tongo Maaré Diabal and Windé Korodji (TMD and WKO respectively), are located at the edge of the Inland Niger Delta. However, very strong flooding events still reach these sites and they share similar geomorphological features with those sites on the higher valley edge

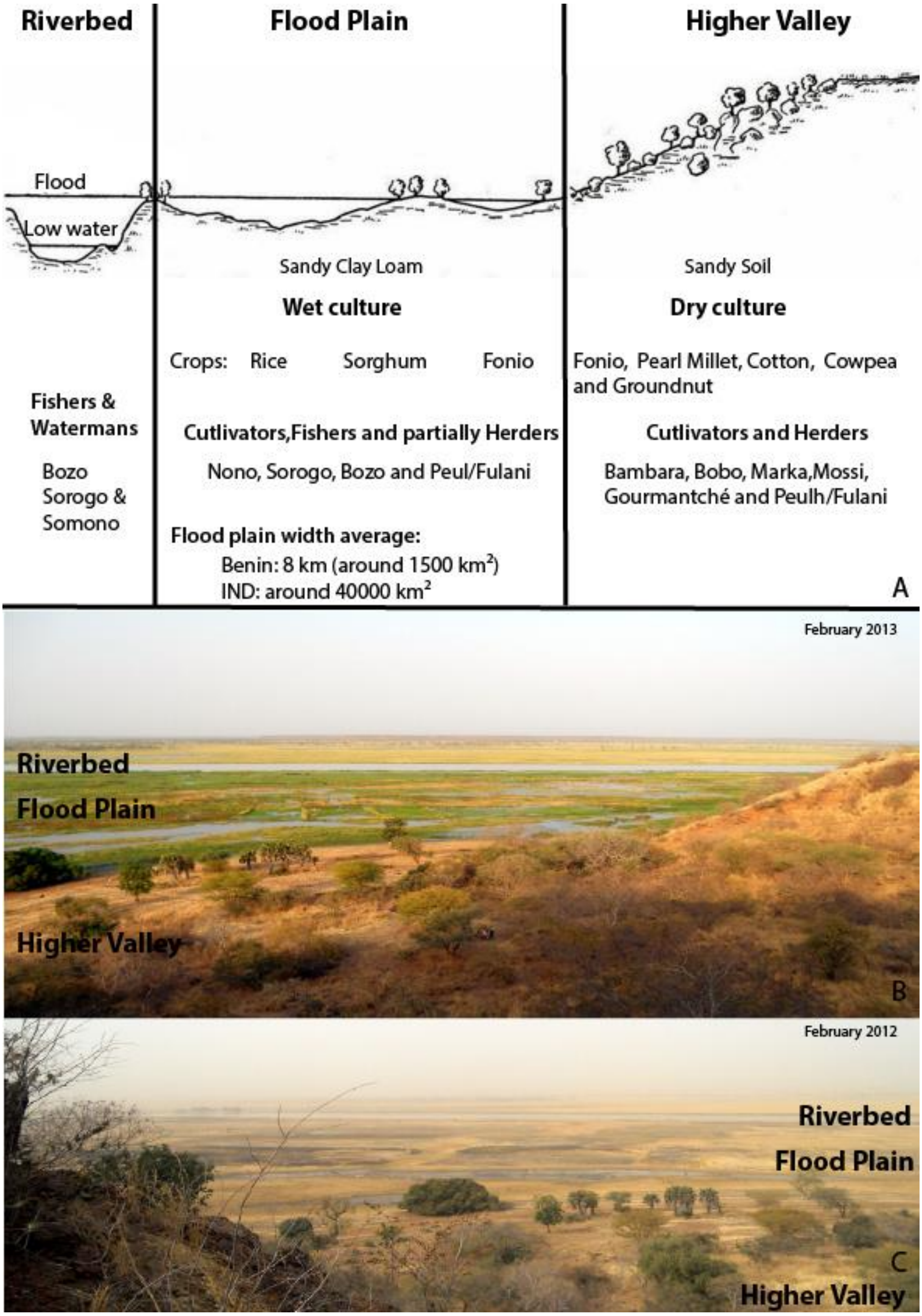

Figure 1.5. **Niger River Valley showing the association of different soils, crops and peoples**: a) Cross section of the Niger River Valley *(redrawn from Gallais 1959; 1967 and Van Driel 2001); b, c) photographs, b) taken in February 2013 and c) taken in February 2012, illustrate the flooding and low water periods. Taken exactly one year apart, they illustrate the dramatic role of the inundation: the absence of the flooding in 2012 created a difficult drought year for the local population. Photo© Champion

Climate evolution (paleo-environment)

Our knowledge of the past climate oscillation in the Sudanian-Sahelian zones remains weak. Indeed, very few paleoclimate and palaeoenvironmental data are available for continental West Africa to reconstruct the climate changes during the last 4 millennia. The most precisely dated sequence comes from Lake Chad (Maley 2015), over 1000 kilometres to the east, and from archaeological observations in the IND (McIntosh 1998, 2005). However, these data are critical because the first ones are ancient, but the dating remains disputable, while the second one comes from archaeological observations (settlement), but without any complementary palaeoenvironmental research. More recently, new research conducted on the tributaries of the Niger (Yamé River; Lespez et al., 2011; Garnier et al., 2015; Garnier and Lespez, submitted) and Senegal River (Faleme River, Davidoux et al., submitted) offers potentially local data on the paleo-hydrological changes for the Middle and Late Holocene. Nevertheless, these studies are still ongoing and no synthesis is currently available, and for this reason this thesis mainly utilizes the data coming from previous research summarized by McIntosh and Maley (2015) to give a general chronology of the climate changes of the studied area during the late Holocene.

Today's West African Savanna landscapes are inherited from vegetation dynamics that are greatly influenced by human activities and climate changes over the past millennia. The climate change from the Early-Holocene (6200 BC) results from the continually fluctuation of the inter-tropical converge zone (ITCZ) boundary, also called the monsoon frontline from the Arabic word, '*mawsim*' = season, having tropical vegetation associated with this type of tropical rain belt. However, in West Africa the maximum rainfall levels are not directly connected to the tropical rain belt, but are also influenced by the strong westward migrating mesoscale fluctuations of the African easterly jet of the mid-troposphere (Mohr and Thorncroft 2006, Nash et al. 2016). The West African monsoon rainfall system arises mainly from the thermal circulation caused by the contrast in temperature between the Atlantic Ocean and the Sahara. The Sahelian tropical rainy convergence is unimodal, whilst the Guinean intertropical is bimodal. The intertropical oscillation of this seasonal convergence drives the distribution of the precipitation in all of tropical Africa (Casey 1998, Nguetsop 2004). It rains during the boreal spring and autumn over the Guinea Coast and during the summer over the Sahel (Nash et al. 2016). Based upon the proxy data (palaeo-lake levels, pollen cores, and archaeological flora and fauna datasets) we can analyse and summarize the climatic changes over time for this part of West Africa. Around the mid Holocene the general palaeo-climatic patterns for West Africa can be characterized as very humid with the bio-climatic zone situated hundreds of kilometres north of their present locations. This period ends around 3000 BC and is followed by increasingly arid conditions until *circa* 300 BC (Figure 1.6). From 300 BC to 300 AD the climate has been classified as unstable and on average was drier than in previous periods. Due to a gradual increase in humidity, the first millennium AD is marked by shifts in the vegetation zonation northwards. Around 1100 AD the aridity returned until around 1500 AD when the rainfall levels increased again to previous levels. Finally, the modern climate "stabilised" around 350 years ago (Ballouche and Neumann 1995, Ballouche 2001, Dueppen 2013, Maley 2015 Mayor et al. 2005, Nguetsop 2004).

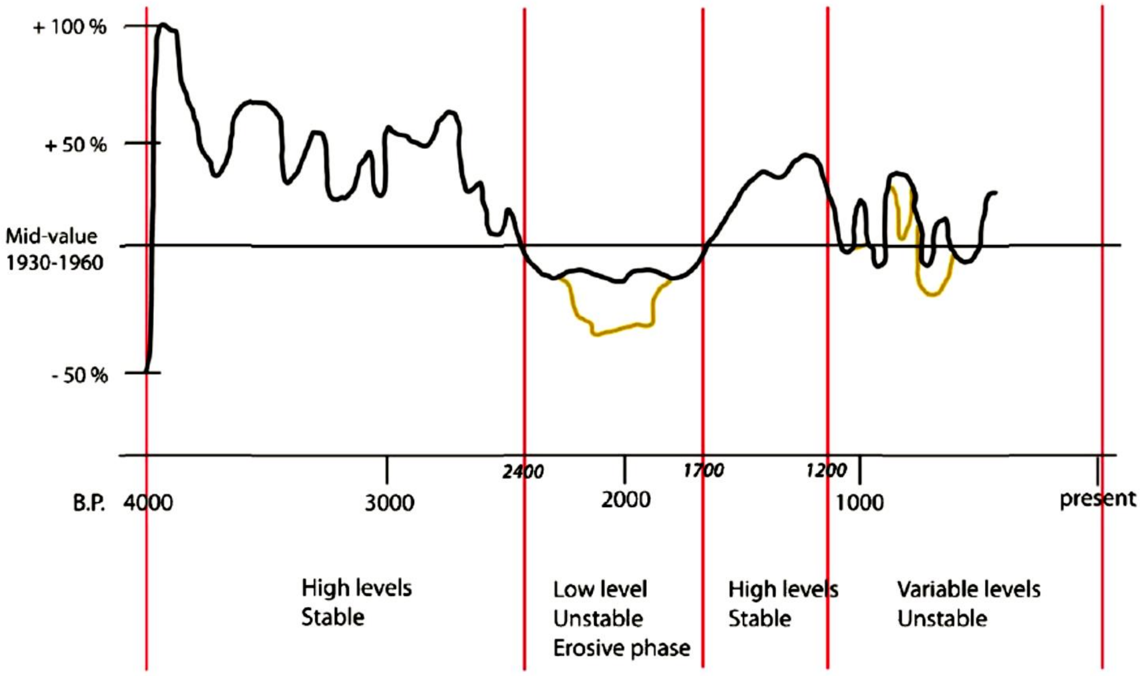

Figure 1.6. Niger River Palaeo-climatic phases during the Late Holocene 2000 BC (4000 BP) to present (Maley 2015 adapted from McIntosh 2005).

Inland Niger Delta and Seno plain – Climate evolution for Mali

According to McIntosh (2005:73) "*the arid West African climate is the world's most variable and unpredictable*". Discrepancies appear at times between precipitation levels on the IND and the volume of the Niger River: precipitation in the high valley in the Sudano-Guinean bimodal climatic zone is not correlated with the unimodal Sahelian IND. Thus, sometimes even if the IND climate is arid, as it was in the 17th century, the Niger River could still have very powerful flood events.

As shown in Figure 1.7 variations in the Niger River influx have continuously oscillated between wet to dry conditions. Between 4500 and 2100 BC the climate was dry and quite unstable in terms of precipitation levels. This era was followed by a long, unstable period (2100-500 BC) composed of very rapid oscillations in temperature and precipitation. Dune winds along with flooding events transformed many geological features including lakes that over time disappeared or were transformed into swamps. The period from 300 BC to 300 AD is characterised by an unstable, dry climate with the desertification of the Azawad (in the north of the IND). This system was followed by a wet optimum with higher precipitation levels than previous periods. The optimum humid conditions are thought to have been reached around 1000 AD. After this peak, the climate deteriorated quickly with very rapid oscillations, often within less than 30 years, between large flooding events to severe drought episodes. Around 1450 AD Lake Chad was completely dry and the Niger River had a very unstable flow rate with some very large flooding leading to extensive erosion within a very arid and dry landscape (McIntosh 1998, 2005; Maley 2015).

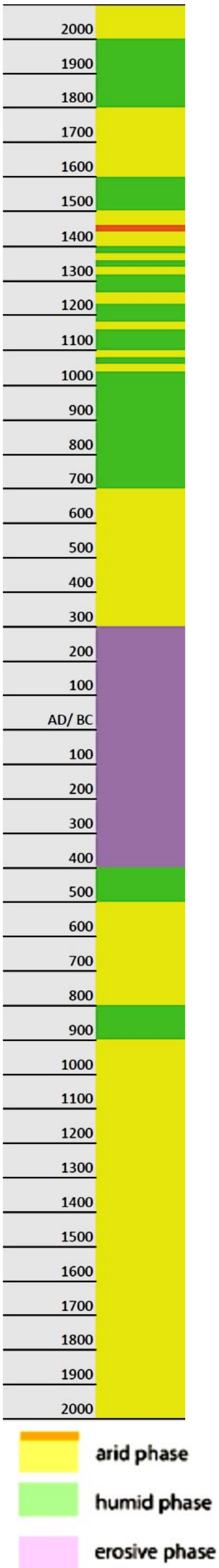

Figure 1.7. Table for the Late Holocene chronology in the Inland Delta. Adapted from McIntosh 1998; Mayor 2005; Maley 2015.

Dendi – Climate evolution of North Benin

Due to the lack of direct palaeoenvironmental data for the Dendi to date, it is difficult to assess and interpret the climatic evolution in the area over time. But as discussed previously, the current Dendi areas hydrological conditions depend on the Niger River flood flowing from the IND, and the local rainfall, which created the two flood peaks (see Figure 1.4). Thus, without direct empirical data, we have to assume that the hydrologic and climatic evolution in the Dendi area was more or less similar, but perhaps less extreme when compared with that of the IND.

As suggested by Ballouche and Neumann (1995), since the first millennium BC the agro-pastoral human activities may have played an important role in the vegetation history of West Africa. This human impact may have also influenced or even masked the natural effects of climatic change (Ballouche 1995).

All the conditions mentioned, including the current ecology and chaotic climate fluctuations, have changed over time and created '*a mosaic landscape, of micro-ecologies tightly linked to an almost infinitely-variable local climate*' (trans. R Vernet in McIntosh 1998:69) that defies detailed interpretation.

1.3 The current Status of Archaeobotany in Africa

As archaeobotanical data from Africa are still very rare, each new project has the potential to substantially improve our understanding of vegetation change and evolution on the continent. Beyond traditional archaeobotanical data, archaeological studies devoted to early food production and consumption in other areas of world, have introduced new analytical tools and methods, and we are presently within the eve of major developments in the archaeology of food, and my thesis therefore will make a significant contribution to this growing field. As such, this is an original approach that will bring a new and innovative multi-dimensional dataset to studying the evolution of culinary practice, distinctions between savannah and forest food crops, and to understanding agricultural, culinary and drinking systems in West Africa.

Archaeobotany is a mutli-disciplinary field combining botanical studies to archaeological contexts and materials. In a nutshell, archaeobotany's goals are to investigate the interactions between human societies and the plant world in the past, from the botanical remains preserved in archaeological sites, including the environment people exploited and the foods they extracted from it. Archaeobotanical research in Africa has tended to be less widely practiced than in many other parts of the world, and systematic archaeobotanical sampling is still only incorporated into a minority of archaeological field projects in Africa. Nevertheless, there is considerable potential for archaeobotany to contribute to a holistic understanding of Africa's past. But much of West Africa remains *terra incognita* in terms of archaeobotany, despite the fact that modern botanical evidence indicates several crops were domesticated there, including pearl millet (*Pennisetum glaucum*) in the dry north, African rice (*Oryza glaberrima)* in the riverine wetlands, and cowpea (*Vigna unguiculata*) in the forest margins. As put by Harlan some decades ago: "*Studies on the origins of indigenous African agriculture have been much neglected. […] The research in Africa remains inadequate and too unsystematic to provide more than a tenuous outline of events."* (Harlan 1992: P.59) and by Harris: " *I am struck not only by the relative paucity of the archaeological evidence presented, but also, and with greater concern, by the fact that tropical Africa has not seen the impressive advances in archaeobotanical investigation that have taken place in Asia and the Mediterranean region"* (Harris 1996:P.202). Unfortunately, 25 years later, the African continent remains poorly studied. Indeed, even the most recent synthesis about African archaeobotany, “Archaeology of African Plant Use” (Fuller et al. 2014), presents the same “depressing” diagnosis (Figure 1.8)

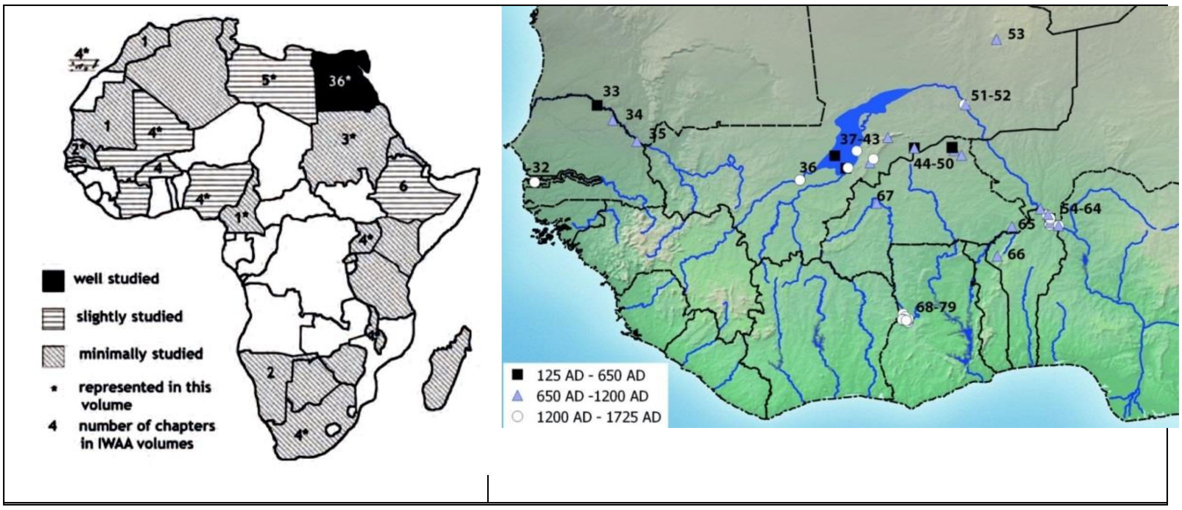

Figure 1.8 Map of the general distribution of archaeobotanical studies in Africa. Countries are shaded on the basis of how well-studied they are in four grades (Blank = No studied). Reproduced from Fuller et al. 2014b)

Over the course of the Holocene, especially during the middle and later Holocene (from 6000 to 2000 years ago), much of Africa converted to agricultural production. However, Africa only came to be considered a region of agricultural origins over the past half century, or so, but research into this transition has tended to lag behind work on other continents. In the 1850s, Alphonse de Candolle (1806-1893), a French-Swiss botanist, identified for the first time crop species as potentially originating in North Africa, such as sorghum that he — wrongly — saw as originating within Tropical Africa, and dispersing into Egypt and then India. He also cited ‘eleusine’, finger millet, as a potential native of Ethiopia. About rice he cited Strabo *“Strabon qui avait vu ce pays [l’egypte] ne dit pas que le riz fut cultivé de son temps en Egypte, mais que les Garamantes le cultivaient, et ce peuple est considéré comme ayant habité une Oasis au midi de Carthage »* (de Candolle 1886 : 310). The first scholar to consider Africa as a major centre of plant domestication was Nikolai Ivanovich Vavilov in 1926. This agronomist, who dedicated his work to Alphonse de Candolle, thought that there were eight “centres of origin”, geographical areas, in the world where domestication took place (Figure 1.9). One major centre of crop origins Vavilov identified was the conjectured Abyssinian centre localised in North-east of Africa (mostly modern Ethiopia). Since then a succession of agronomists and anthropologists has evolved the concept of domestication centres. In the 1950s, Portères distinguished two types of domestication centres he referred to as primary and secondary centres. Within Africa, he distinguished "primary agricultural cradles" as centres of genetic diversification that became foci of agricultural civilizations (Portères 1950, 1980). The American anthropologist Murdock (1960) argued that West African agriculture was distinctive and should be added to the list of centres of crop origins. Harlan, a pioneer in the study of crop wild progenitors in Africa, developed a theory of agricultural “non-centres”, which he applied to Africa (Figure 1.10 ; Harlan 1971, 1976 and 1992). For him, when a restricted geographical area cannot be defined for the origin of domestication of one particular plant, but from a much wider expanse zone was involved in early exploitation and domestication, he regarded the latter as a “non-centre”. “*And even today, African agriculture is still often a mosaic of crops, traditions and techniques that do not reveal a centre, a core, or a single place of origin* “(Harlan and Stemler 1976). However as it has become clear that even in the so-called focused centres of origins, such as the West Asian Fertile Crescent, the origins of crops was a mosaic of different crops in different sub-regions, and evolutionary processes of domestication were slow processes of selection from the wild, with ample time for gene flow and movement of early crops geographically. Therefore, Harlan’s notional contrast between a centre and a non-centre is less clear-cut. In addition, it has come to be suggested that the domestication of key African species was focused in restricted parts of their wild ranges, and that sub-regional packages of domesticates can be defined. On this basis Fuller and Hildebrand (2013) outline five regional centres of crop origins in Africa (Figure 1.12), with at least four of these that are recognized as distinct centres of domestication in global syntheses (Larson et al. 2014). Each of these areas has specific staple crops, but details about the domestication processes for many of them are still lacking. Currently there is good evidence for the domestication and dispersal of pearl millet and sorghum, however African rice and fonio domestications are less understood and remain currently unresolved (Figure 1.12).

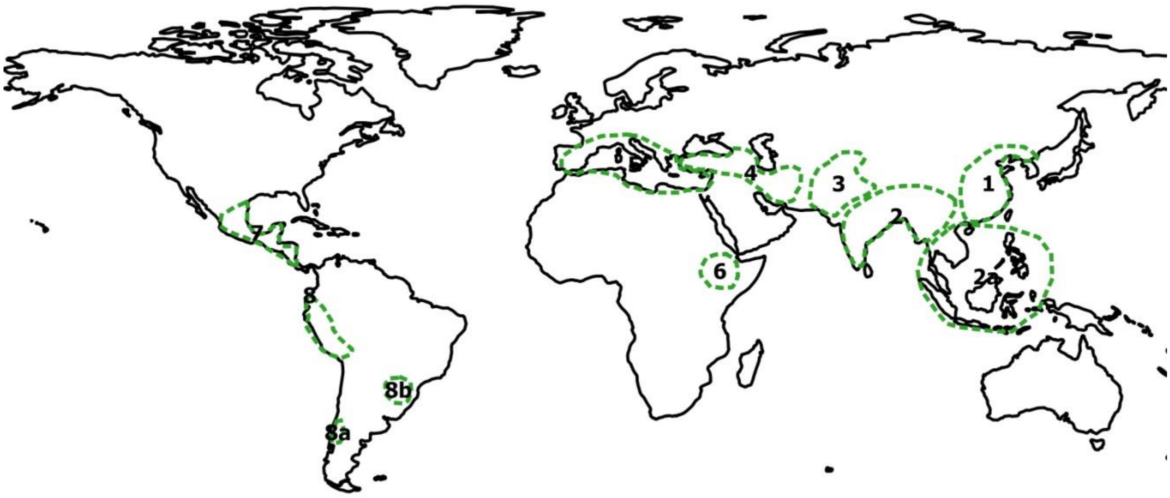

Figure 1.9 The eight agricultural origin centres for Vavilov. There is one in Africa (point 6) around Abyssinia

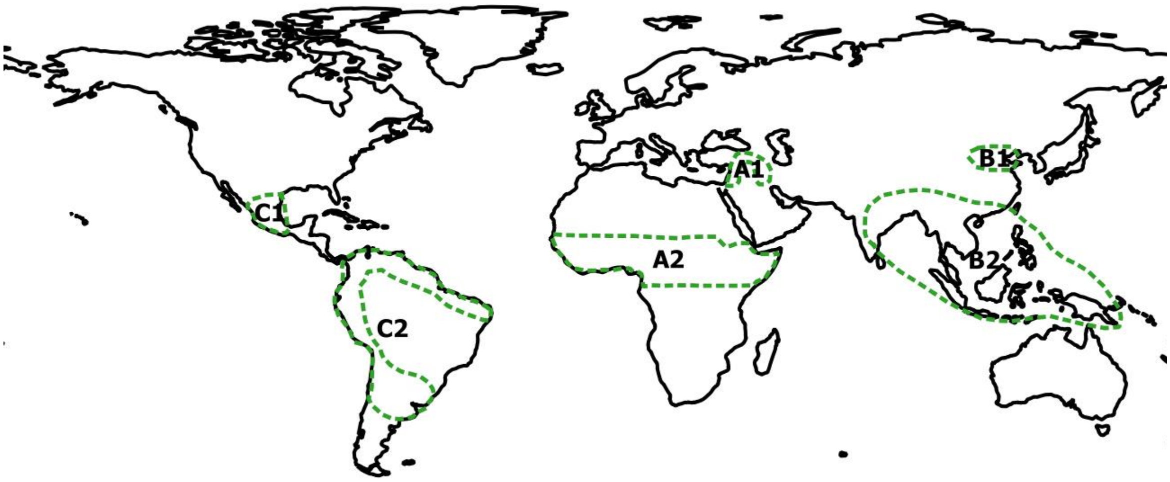

Figure 1.10 The three centres and three "non-centres" of Harlan. The Zone A2, in Africa, is an extended belt from west to east.

Botanical studies through the 1960s-1970s, by Harlan and colleagues, clarified the distribution of wild progenitors of many African crops, and highlighted a distinction between three ecological zones; the Guinean forests, the west Sudanian savanna, and the Sahelian Acacia savanna (see zonation in Figure 1.2). The southern Guinean forest zone, or its margins, was source region of tubers (e.g. *Dioscorea cayenensis* Lam., *D. dumetorum* (Kunth) Pax), oil palm (*Elaeis guineensis*), and a more northerly open woodland savanna zone (Sudanian) was the source area of African rice (*Oryza glaberrima*), cowpea (*Vigna unguiculata*), Bambara groundnut (*Vigna subterranea* (L.)Verdc.), and the fonio millets (*Digitaria exilis, Brachiaria deflexa* (Schumach.) C.E.Hubb. ex Robyns). Pearl millet origins were inferred to lie beyond this zone, further north in the Sahelian zone (Harlan 1971, 1992; Harris 1976; De Wet 1977; Fuller and Hildebrand 2013).

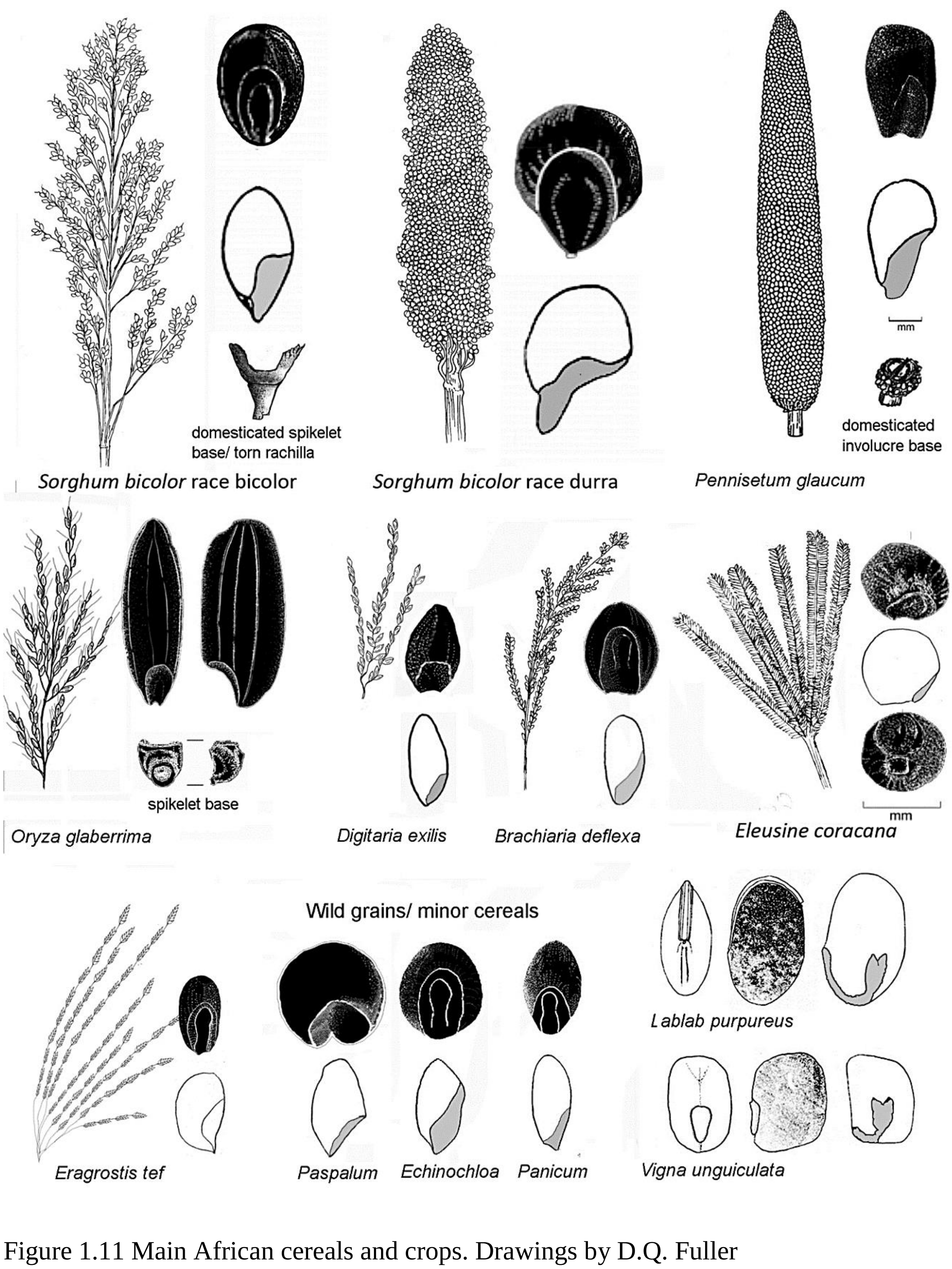

Figure 1.11 Main African cereals and crops. Drawings by D.Q. Fuller

More recently, archaeological and botanical studies have revealed evidence for a large number of different regions of independent domestications around the world. Among the twenty-four possible centres of early cultivation now recognized, at least five are in Africa (Figure 1.12; Purugganan and Fuller 2009; Fuller and Hildebrand 2013). The two sets of data used for this research come from two of these five areas; the West African Sub-Sahara/Sahel, and the West African savannah and woodlands. The potential areas of domestication include two situated in the research zone covered within this thesis; the West African Sahara/Sahel and the West African grassy woodlands (Fuller & Hildebrand 2013). Wild pearl millet is present in the West African Sahara/Sahel (Figure 1.12, (1)). Also providing clear evidence for pearl millet domestication is the lower Tilemsi Valley sequences from Mali dated to 2500 cal. BC to 1700 BC (Manning et al. 2011; Fuller and Hildebrand 2013; Manning and Fuller 2014). The second area is directly linked to the West African grassy woodlands and the Niger Valley. This ecological area is home to fonio cereals (*Digitaria exilis*, *D. iburu*, *Brachiaria deflexa*), cowpea (*Vigna unguiculata*) and African rice (*Oryza glaberrima*) (Figure 1.11, Figure 1.12, Figure 1.13; Fuller and Hildebrand 2013).

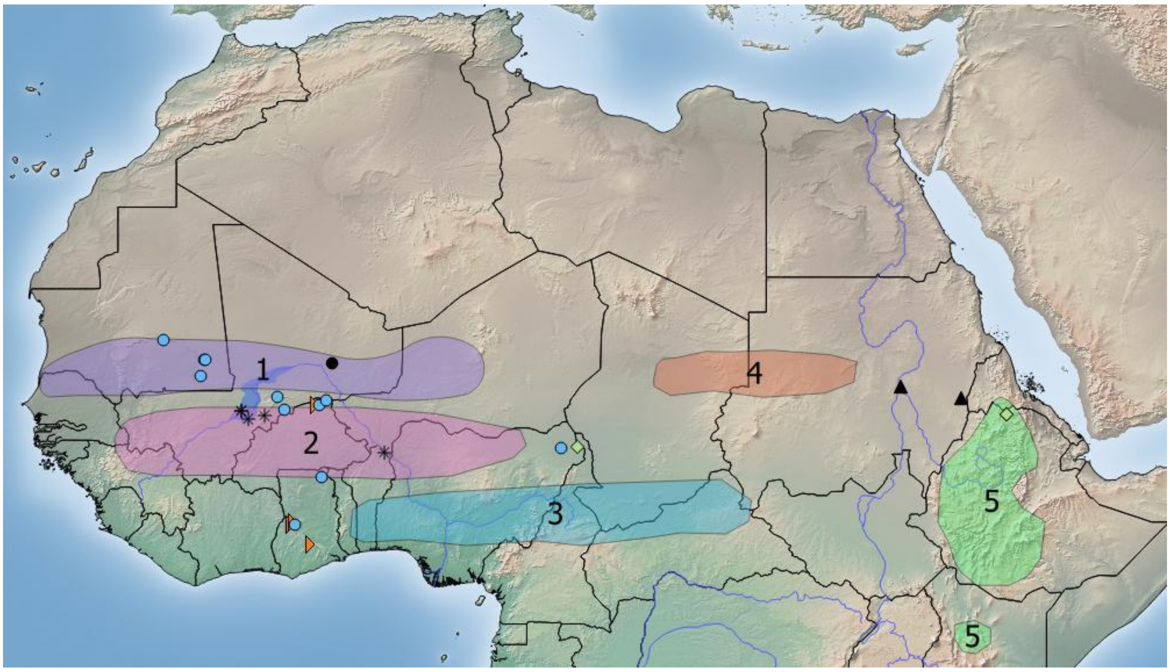

Figure 1.12 Probable geographic locations of the five centres of indigenous crop domestication in Africa, on a topographic base map. Modified From Fuller and Hildebrand 2013

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Latin Name	Common name	Early Evidence
(1) West African Sahara/Sahel		
Pennisetum glaucum	Pearl millet	Tilemsi Valley (Mali) ~2500 BC Mauretania and Ghana ~1700 BC India by ~1700 BC
Citrullus lanatus	Watermelon	Southwestern Libya back to ~4000 BC
(2) West African grassy woodlands		
Digitaria exilis	Fonio	Niger River Bend ~400 AD Senegal ~500 AD
Brachiaria deflexa	Black Fonio	*Brachiaria* sp. finds along the Niger River and Senegal from ~500 AD
Oryza glaberrima	African rice	Dia (Niger Bend) 800 BC
Vigna unguiculata	Cowpea	Ghana ~1700 BC; Probable India ~1700 BC
Vigna subterranea	Bambara groundnut	Nigeria ~500 BC
Macrotyloma geocarpum	Kersting's groundnut	?
Adansonia digitata	Baobab	Burkina Faso ~1000 BC
Hibiscus cannabinus	Kenaf	?
(3) Forest margins of West/central Africa		
Dioscorea cayenensis	Yam	
Plectranthus rotundifolius	Hausa Potato	
Elaeis guineensis	Oil Palm	Used by hunter-gatherers in Ghana >4000 bc;
Cola nitida and C.acuminata	Kola Nut	
(4) East Sudanic grasslands		
Sorghum bicolor	Sorghum	In India by 1700 BC
Lablab purpureus	Hyacinth bean	In India by 1700 BC
(5) Uplands of Ethiopia		
Eragrostis tef	T’ef	Northern Ethiopia ~500 BC
Eleusine coracana	Finger millet	Northern Ethiopia and Nigeria ~100 AD
Also Enset, Yam, Noof, Coffee…		

Figure 1.13 Summary of major indigenous African plant domesticates (Modified from Fuller and Hildebrand 2013:511) Numbers refer to areas in Figure 1.12.

Pearl millet is the common English name of the main cultivated millet of West Africa (*Pennisetum glaucum*), which is important throughout the savannas of Africa, as well as in South Asia. Pearl millet was domesticated in West Africa sometime before 2500 BC. The earliest archaeobotanical evidence for pearl millet comes from a group of sites located in the Lower Tilemsi Valley, Mali, which date to between 2500 and 2000 BC (Manning et al. 2011) Early agriculture in western Africa was focused on pearl millet, alongside domesticated livestock. Pearl millet spread quickly east through the Sahel and overseas to reach India around 1700 BC (Fuller 2003). In western Africa pearl millet spread gradually, reaching southern Ghana and the Lake Chad region by ca 1500 BC (see Chapter 7 this study; D'Andrea and Casey 2002; Zach and Klee 2003). It was during this period of initial dispersion that cowpea (*Vigna unguiculata*) appears to have been domesticated as an addition to agriculture, evident from finds in Ghana at 1700-1500 BC and from the Nok Culture around 800 BC (D'Andrea et al. 2007; Franke 2016; Figure 1.11; Figure 1.12; Figure 1.13). Currently the co-cultivation of cowpea and pearl millet is common in agricultural practice. Indeed *Vigna unguiculata* has better development under the shade of the pearl millet (Kahlheber 2004; Höhn and Neumann 2012).

Sorghum bicolor seems to have been domesticated for the first time in an area bordering the eastern Sahara (Harlan 1971, 1992; Fuller and Stevens 2018). Ceramic impressions in eastern Sudan document the presence of a large proportion of domesticated-type seeds dating 3500-3000 BC at the site of Kasm al-Girba 23 (Winchell et al. 2017). After 3000 BC archaeobotanical evidence is limited, but sorghum populations cultivated near Kassala, Sudan at ca. 1800 BC still show a mixture of wild and domesticated morphology (Beldados et al. 2018). Sorghum became widely grown throughout the Nubian Nile valley from Meroitic times onwards, i.e. from ca. 2400 BP (Fuller and Stevens 2018). The earliest sorghum in West Africa comes from the Alibori site in North Benin more than 2500 years ago (this study). Free-threshing caudatum may have evolved in the Sudan region and spread through Saharan oases or the Sahel around 2000 years ago (Pelling 2005; Fuller and Stevens 2018).

African rice, *Oryza glaberrima*, is thought to have been domesticated from a wild progenitor, *Oryza barthii*, around 3500-2500 years ago. Portères placed the original domestication in the Inland Niger Delta of Mali (Portères 1959). Currently, with the exception of the site of Juffure, dated to 1650-1900 CalAD in Gambia (Gijanto and

Walshaw 2014), all the sites with domesticated African rice come from the Niger Valley, so the antiquity of the western groups of rice is problematic. Currently, the domestication of African rice (*Oryza glaberrima* Steud.) remains problematic, with the earliest evidence for domesticated rice in the Iron Age, before 400 BC at Dia in the Inland Niger area (Murray 2005). Other evidence for domesticated rice is more recent, but it had spread down the Niger River as far as Benin (Birnin Lafyia) by AD 300 (this study, Champion and Fuller 2018)

Other crops of West African origin are less understood. For example, fonio (*Digitaria exilis*) is a widespread small-grained cereal (Figure 1.11), often producing a crop on marginal soils and poor rainfall, but its origins remain obscure. Currently, the timing of fonio domestication is unknown. However, Portères suggested that it was probably domesticated in the Inland Niger Delta (Portères 1959, 1976). It's geographically widespread, but patchy distribution, could be taken to imply that is was once more continuously distributed and might therefore be of great antiquity (e.g. Blench 2006). However, finds have been strikingly absent from most archaeobotanical studies of either Neolithic and Iron Age sites, leading to the alternative hypothesis that it was a late, secondary domestication associated with diversification of agriculture during the era of urbanization in the region (this study; Champion and Fuller 2018).

Moreover, comparative ethnography and historical linguistics has inferred an indigenous West African vegeculture complex, focused around yams (*Dioscorea cayanensis*, *D. dumentorum*), but including several forest tree fruits, such as cola nuts (*Cola* spp.), African olive (*Canarium schweinfurthii*), African plum (*Dacryodes edulis* (G.Don) H.J.Lam.), and Mobola plum (*Parinari curatellifolia* Planch. Ex Benth.). These trees and tubers have a deep antiquity among Niger-Congo speaking groups, at least as far back as Proto-Benue-Congo, several proto-language grades prior to the emergence of proto-Bantu, and thus inferred to go back to perhaps 2000-3000 BC (Blench 2006; Bostoen 2014). Unfortunately there remains no archaeological hard evidence, such as from charred yam parenchyma or starch on ancient tools, that confirms the antiquity of yam cultivation. Among the tree fruits, use of oil palm is widely documented on archaeological sites back to the Late Stone Age, ca. 3000 BC (D'Andrea et al. 2006), with use of *Canarium* evident from 4000-5000 BC at a rock shelter in Cameroun (Lavachery 2001).

African agriculture, however, does not rely on endemic crops only, but has also incorporated major crops originating in Asia and the Americas, Historical sources are quite revealing about the uptake of American crops, such as maize and cassava, over the past ~500 years (McCann 2005, Carney and Rosomoff 2011; Gallagher 2017), but the earlier introduction of tropical Asian crops likely occurred during prehistoric times and require archaeobotanical approaches. In general these arrivals from tropical Asia connect to discussions of globalization processes around the Indian Ocean Trade, which are best documented in eastern and southern Africa starting from ca. AD 750, at which point some Asian grain crops, including Asian rice (*Oryza sativa*) and mung bean (*Vigna radiata*) became crops on various East African islands, around the same time that Asian (Austronesian) cultural traditions (and people) established agriculture in Madagascar (Crowther et al. 2016, Boivin et al. 2014).

What is striking from these data is the absence of early finds of African rice (*Oryza glaberrima*), fonio millets (*Digitaria exilis, Brachiaria deflexa*), and sorghum, all grain crops important in the traditional agricultural diversity of western Africa.

With regards to agricultural, farming, and food systems, the development of rice systems and the domestication and the spread of African rice, is currently understudied; but, is one of the most important agricultural innovations in the region. The antiquity of rice farming systems and how such systems developed or how widespread they were is totally unknown. Today African rice (*Oryza glaberrima*) is being replaced by the Asian species introduced to Africa around the middle of the 16th century AD by the Portuguese (Linares 2002). The presence of rice fields (African rice fields) is documented by the Portuguese on arrival on the African coast in the 15th century: In 1446 the chronicler Gomes Eanes de Azurara states, *"They found the country covered by vast crops, with many cotton trees and large fields planted with rice…"* (Linares 2002:16360). In 1506-1510, another writer remarks that *" this land is rich in food, to wit* ***rice****, millet and beans, cows and goats, chickens and capons and numerous wines and other food products"* (Valentim Fernandes cited in Linares 2002). Thus, African rice was an important part of the agricultural food systems in the past, yet today it is rarely grown and when it is, (e.g. the Jipalom in Senegal) it appears to be used only in rituals (Linares 2002). Moreover Portères suggests the centre of *Oryza glaberrima* domestication is in the Inland Niger Delta (Portères 1962, 1976); however, the archaeological knowledge of the origins of African rice is too poor at this time to confirm his hypothesis. To date, only eight African archaeological sites have provided evidence of domesticated rice (Murray 2004; Morris 2013).

1.4 Research questions

The present contribution reports archaeobotanical findings from northern Benin and Mali, along the Niger River basin, which provides new evidence for the diffusion of such crop diversity into West African savanna agriculture. In addition, we report evidence for adoption of cotton cultivation, and use of a number of tree fruits.

This project has three primary aims:

(1) Characterizing the nature of agriculture and cooking practices within the Niger River Basin

My dissertation study area is located in the Niger River Basin region. The first step in this endeavour will be to define the economic balance and contribution of cereals, pulses, tubers and wild foods in the diet of people within and around the Niger River Basin. To support these archaeobotanical data I incorporate comparative analysis relating to linguistic reconstruction of terms relating to plants, genetic analysis of the origin of crops and botanical knowledge of those plants.

(2) Studying the evolution, spread and impact of Key Economic Taxa such as Fonio, African rice, Pearl millet and Sorghum.

A second aspect of the thesis is to examine the evolution and spread of different varieties of key economic taxa, in particular fonio, African rice, sorghum and pearl millet. This will aim to identify and study the impact of key taxa varieties on agrarian societies and on the development of West African polities. How pre-existing crops, such as pearl millet and sorghum (along with other crops such as fonio) associated with agro-pastoralists, became also integrated within emerging, increasingly complex polities, e.g. early states, kingdoms and empires. Was rice the prime mover? Or was it through the development of new systems incorporating sorghum, pearl millet, fonio that were more important? Or a mixture of both. Were these crops incorporated into single systems in which sedentary farmers cultivated them all? Or were agro-pastoralists who were still relatively mobile supplying sorghum and pearl millet to these early empires, but with sedentary farmers reliant on rice farming the more important element?

For pearl millet, I will look for evidence of two potential trajectories of domestication (Champion and Fuller 2018), as well as post-domestication trajectories of adaptation to wetter and drier environments.

From historical accounts we know African rice was important, but was it associated with the start of West African polities? Was it cultivated before them and hence might be seen as part of their development? Or was rice farming a response to the existence of these polities, originating from outside the area in which these polities arose? Perhaps a sign of increasing trade networks and demands for increased food production? Further, how widespread were these systems and did they expand through time?

In that concern, I want to examine how the spread of these key crops impacted the development of societies in the Middle Iron Age, particularly examining the degree in which these societies became more crop focused and/or more sedentary.

(3) In studying the signature of food complexes, we can also study links between the origins of kingdoms and empires and the appearance and rise of certain foods.

How have agricultural systems worked to provide a basis for West African urbanism? Can we use archaeobotany to characterise the food production that underwrote the rise of urbanism and kingdoms in West Africa? How is urbanism in tropical Africa supported in terms of a food production base? Can specific crops be related to the process of urbanisation of West Africa?

2. The Peopling of West Africa

2.1 Mali

The natural conditions, rich arable land and pasture, of the Niger Valley are suited to a wide range of food production techniques. Traditionally subsistence practices such as fishing, millet or rice cultivation and transhumant pastoralism have been linked to specific ethnic groups (Gallais 1967). Within the Inland Delta (IND), at the centre of the Middle Niger region, more than ten major ethnic groups are present. The Middle Niger represents a cultural crossroads between the three main African linguistic phyla (Niger-Congo, Nilo-Saharan and Afroasiatic) – an area that was sparsely inhabited before 4500 BP (MacDonald 1998). By 2000 BP, due to the arid climatic conditions (Figure 1.7) and the significant contraction of the IND, the initial population had to get along with aridity-driven waves of migration arriving from the north and east (MacDonald 1998).

The initial IND population formed by fisherfolk is well attested by 4000-5000BP (the 'Kobadi Tradition', cf. Chapter 7 this study and see MacDonald 1996; 1998; Raimbault and Dutour 1989). Around 3500-3000BP, in the northern Delta, these fisherfolk populations were joined by agro-pastoralist groups derived from the Tichitt tradition to the northeast (MacDonald 1998; 2013; 2015b). At the same time, in the Gourma region to the south, the site complex of Windé Koroji (c. 3635 ± 90 BP to 3115 ± 195 BP) is a good example of regional cohabitation between the pre-existing Kobadi tradition and a new agro-pastoral tradition that may result from a south-westerly migration by the Tilemsi Valley's occupants (Chapter 7 and MacDonald 1996; 1998; Gaussen 1988).

Modern oral traditions claim that the autochthonous IND inhabitants were ancestors of the Bozo fisherfolk (Gallais 1967; MacDonald 1998). The origin of the Bozo is still controversial, possibly descending from the autochthonous IND fisher population or alternatively inter-mixed with waves of migrants arriving from outside the region. Before the introduction of Islam, oral tradition attested the coming of the 'Nono' from the north. In recent history, the Nono (a Soninke sub-group) have been, along with the Marka (Islamicized Soninke and Malinke), the rice cultivators of the IND (Gallais 1967). Nono origins are linked to the proto-Soninké Tichitt-Oualata diaspora from the Sahel to the IND (Cf. Munson 1980). Both they and the Bozo speak forms of Soninke dialect. MacDonald (1998:57) explains this by positing a language switch by the proto-Bozo to that of Soninke immigrants, noting that: "*In other words, it is possible that before the 'emptying' of the Sahara (c.4000BP), a single Niger fisherfolk substrate existed (the Kobadi tradition) which was then acculturated along different parts of its length by incoming Niger-Congo speakers.*" Indeed, linguistic information indicates a relatively recent split between Soninke and Bozo (c. early first millennium BC) (Dwyer 1989, Figure 2.1).

Together Bozo fisherfolk, with later former-slave Somono fisherfolk, and Nono/Marka rice agriculturalists form the foundation of Middle Niger settlement and subsistence. But what of other groups?

As stated by Gallais (1967: 114):

La clef de la distribution ethnique dans le Delta [et en Afrique] n'est pas un partage en aires, mais dans le liens spécifique qui unit l'homme d'une ethnie et un élément du milieu naturel: l'eau dormante du marais ou celle des petites marigots pour le Sororgo, le fleuve pour le Somono, l'étage des rizières pour le Nono, le sol sableux pour le Bambara, la combinaison toggué-bourgou pour le Peul. [In the IND, the ethnic distribution key is not the sharing in area, but the specific link between people and natural niche: still water and swamp for the Sororgo, River for the Somono, rice paddy for the Nono, sandy soil for the Bambara, toggué-Burgu [Settled island surrounded by burgu grasses, *Echinochloa* sp.] *combination for the Peulh (Table 2-1)]*

Table 2-1 Relation between ecological niches, human practices and population groups.

Specific ecological niches ↔	Specific human practices ↔	Specific population groups
Flood plain	Fishing	Bozo, Sorogo
Paddy	Wet cultivation ("Décrue")	Nono, Bambara
Higher valley	Herding, Dry cultivation	Peulh, Bambara

One of the most idiosyncratic Middle Niger peoples are the Peulh/Fulbe/Fulani[2] herders. The Fulani are animal producers, mainly of cattle, who live in a nomadic way with seasonal camps (Gallais 1962; 1967; Van Driel 2001). As stated by Gallais, they have a large variety of specificities including multiple dialects of the same language and they are proud of their identity (Gallais 1962). The Fulani are a strong example of an

[2] The three names are designated the same group of people. Peulh is the French name, Fulbe is the English name (that also could designated the language) and Fulani is the Hausa name.

ethnic group linked to specialised activities. For the agriculturalists this ethnic subsistence link is not so strong but is still present and techniques used can be distinguished from one group to another. Indeed, even if Bozo and Somono are both fisherfolk, they use two different modes of fishing techniques which link to their cultural traditions. The Bozo fish in low slow water, while the Somono are more deep water fishers. In terms of differing techniques, one uses boats and big nets (Somono), the other small water reservoir fishing with fish traps and snares (Gallais 1962; 1967).

The border between cultivator and herder economies can be crossed sometimes. Thus sometimes Peulh cultivate some pearl millet and cultivators can have some cattle. Nevertheless, particular agricultural techniques are often linked to specific ethnic groups of cultivators. Examples include the Nono (Soninké, Marka) who are specialists of wet culture (rice) and the Bambara, the dry agriculture specialists of millet in sandy uplands.

Table 2-2 Population group and Linguistic affiliation in the Inland Niger Delta (based on Bedaux 2005)

Ethnonym	**Language**	**Linguistic classification**
Peul	Fulfulde	Niger-Congo, Atlantic-Congo, Atlantic, North, Fula
Sarakolé	soninké	Niger-Congo, Mande, West, North-West, Soninke-Bobo, Soninke-Boso, Soninke
Soninké	soninké	Niger-Congo, Mande, West, North-West, Soninke-Bobo, Soninke-Boso, Soninke
Nono	Soninké	Niger-Congo, Mande, West, North-West, Soninke-Bobo, Soninke-Boso, Soninke
Bambara	bamanakan	Niger-Congo, Mande, West, Central, Manding, Bamana.
Marka	marka	Niger-Congo, Mande, West, Central, Manding, Marka-Dafin.
Bozo	boso	Niger-Congo, Mande, West, North-West, Soninke-Bobo, Soninke-Boso, Boso
Somono	bamanakan	Niger-Congo, Mande, West, Central, Manding, Bamana.
Bwa (Bobo-Oulé)	bobo	Niger-Congo, Mande, West, North-West, Soninke-Bobo,
Arma-Songhay	songhay	Nilo-Saharian, Songhay, South
Dogon	dogon	Niger-Congo, dogon

2.2 North Benin

Throughout my North Benin study area, the *lingua franca* is Dendi (Nilo-Saharan family, Songhay group, southern branch) (Table 2-2). As with Hausa, the same term is used to designate both a language, a region and population. The Dendi people are historically heterogeneous, fruit of the successive arrivals and various subsequent group alliances. Without prejudging the historical complexity of these terms, which can mask a greater diversity, the inclusion of language classification elements may provide useful information about population dynamics and plausible geographical areas of related cultural traditions in the past.

Table 2-3 Population group and Linguistic affiliation in the Dendi area (North Benin). Courtesy of O.P.Gosselain.

Ethnonym	**Language**	**Linguistic classification**
Dendi	dendi	Nilo-Saharian, Songhay, South
Songhay	songhay	Nilo-Saharian, Songhay, South
Zarma	zarma	Nilo-Saharian, Songhay, South
Gourmantché = Gourma	gourmantchéma	Niger-Congo, Atlantic-Congo, Volta-Congo, North, Gur, Central
Baatombu = Bariba = Bargantché	baatonum	Niger-Congo, Atlantic-Congo, Volta-Congo, North, Gur, Central
Mokole = Mokolantché	Mokole	Niger-Congo, Atlantic-Congo, Volta-Congo, Benue-Congo, Defoid, Yoruboid
Peul	Fulfulde	Niger-Congo, Atlantic-Congo, Atlantic, North, Fula
Tchenga = Tyenga = Nyango	Kyenga	Niger-Congo, Mande, East, Busa
Boko = boo	boko	Niger-Congo, Mande, East, Busa
Hausa	hausa	Afro-asiatic, Tchadic, West

Due to their geographical location at something of a “crossroads”, the Dendi cultural identity is more complex and differentiated than of those groups in the Middle Niger. Languages in the Dendi region include speakers of all three main West African language classes; Afro-Asiatic, Nilo-Saharan and Niger-Congo. Even within the Niger-Congo main group, the language groups of the Dendi region are split into very different sub-groups (Table 2-3). While in the Middle Niger, the situation is less complex, the populations are mainly Mande (a single sub-group of the Niger-Congo macro-family) (Table 2-2)

Western Africa is linguistically diverse, which reflects the region’s cultural history over the course of the Holocene. The region is mostly occupied by the language groups in the highly diverse Niger-Congo macro-family, but Nilo-Saharan and Chadic (Afroasiatic) speakers are also present, as are a number language isolates such as the Bangeri Me in Mali (Vydrine 2009,Blench 2006).

The **Niger-Congo** phylum has more languages than any other in the world[3] including Bantu, Fulani (Peulh) and Mande family speakers in West, Central and Southern Africa (Figure 2.1). Niger-Congo languages form a large territorial block with a great homogeneity (in contrast to the Nilo-Saharan phylum). This suggests a more recent expansion following the steady, if gradual, spread of more sedentary agricultural populations (Blench 2006).

The **Afroasiatic** phylum includes Arabic, ancient Egyptian and Hausa in West Africa (Figure 2.2). Its classification and history are by far the most controversial of the language phyla of Africa (Blench 2006). The origin of Afroasiatic languages is located in southwest Ethiopia with the Cushitic centre and the Omotic speakers. For Ehret (1987) and Blench (2006) the proto-Cushites and the proto-Omotic were pastoralists who cultivated wild *Tef* cereal.

The extreme fragmentation of the **Nilo-Saharan** Phylum can in part be attributed to the disruptive effects of the slave trade across Africa but more probably it can be attributed to the high mobility of small groups moving freely and following favourable climatic or ecological conditions (Figure 2.3) (Blench 2006). The dispersion of the Nilo-Saharan began in East Africa (North Soudan) and moved to the Middle Niger (The Songhay) by the Lake Chad area following linear features such as waterways (Figure 2.4) (Blench 2006; MacDonald 1998, Drake et al. 2010).

[3] According to the most recent estimation around 1514 languages are related to the Niger-Congo phylum (Blench 2006).

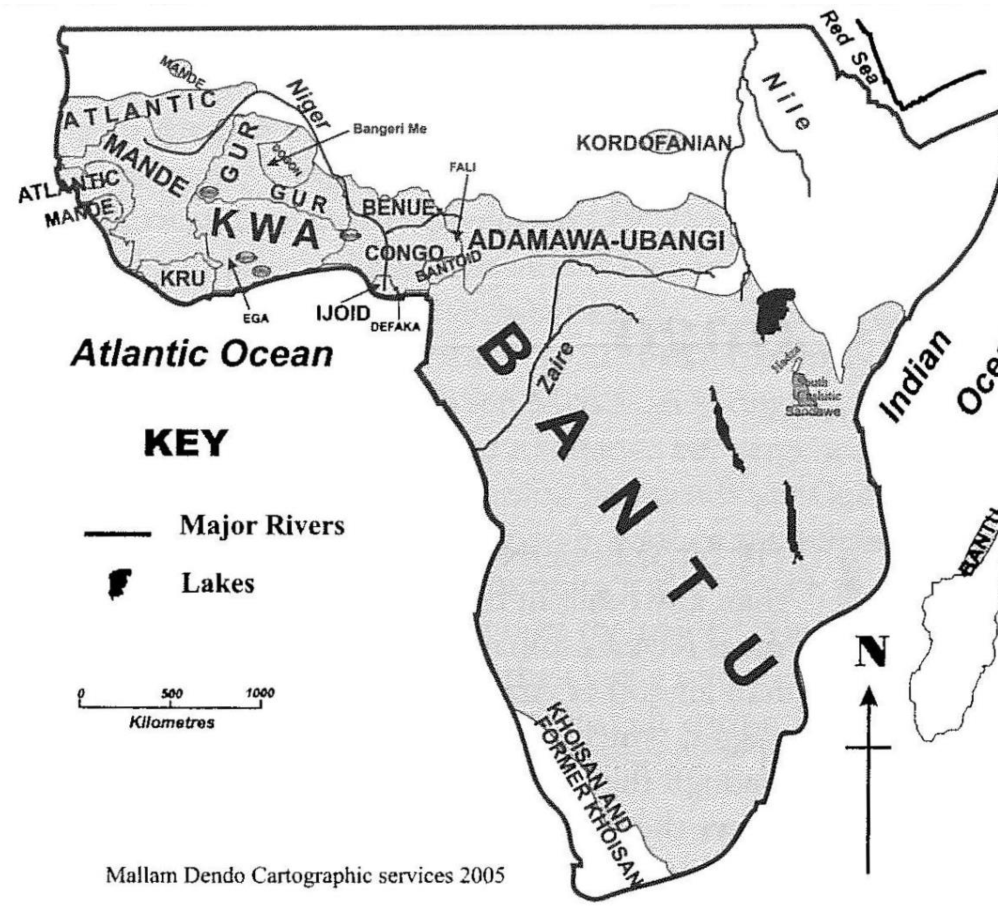


Figure 2.1. Distribution map of the Niger-Congo languages. Reproduced from Blench 2006:110

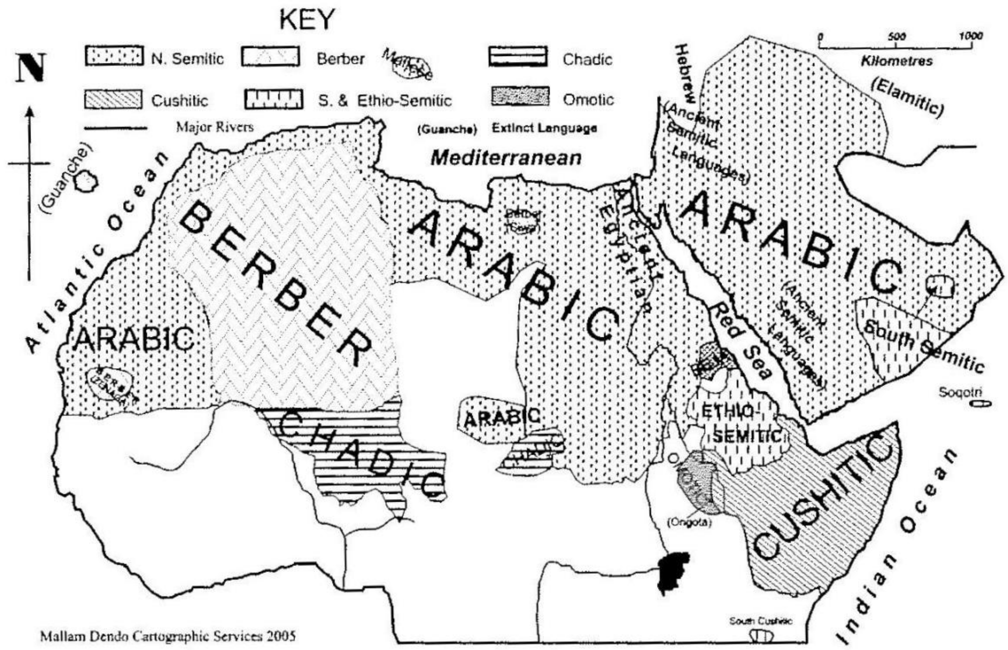


Figure 2.2. Distribution map of the Afroasiatic languages. Reproduced from Blench 2006: 140

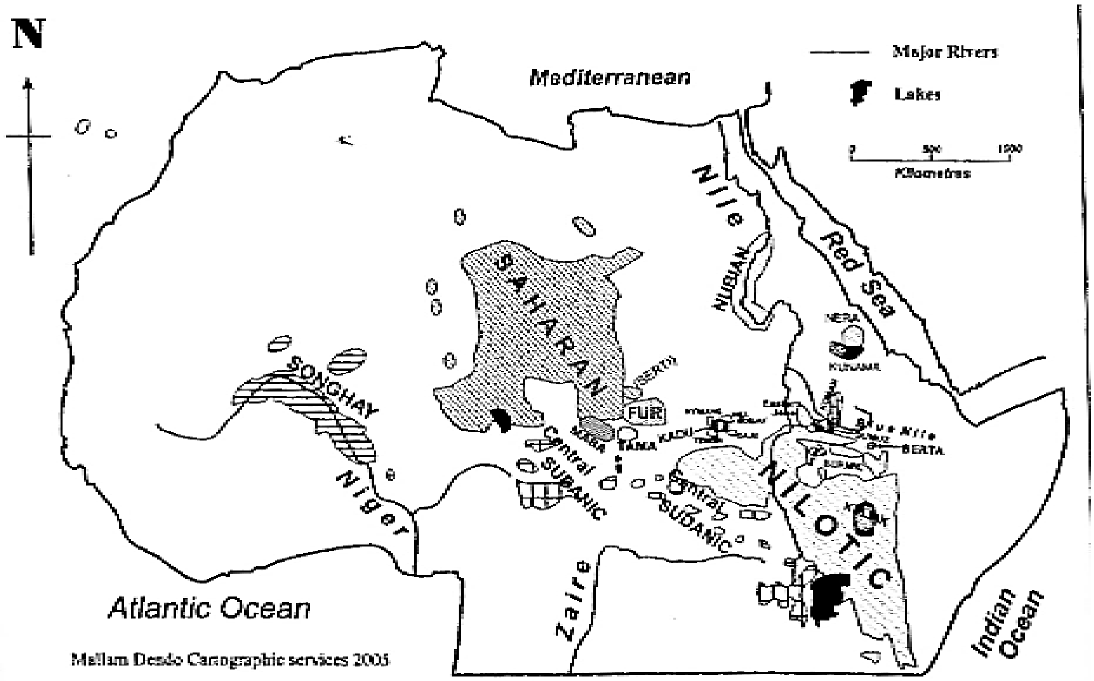


Figure 2.3. Distribution map of the Nilo-Saharan languages. Reproduced from Blench 2006: 96

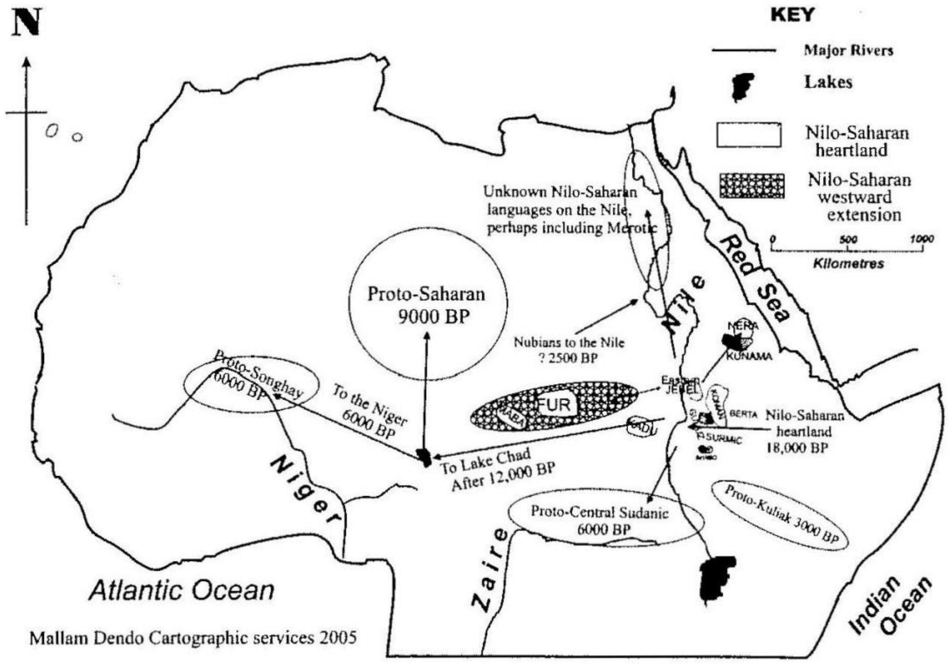


Figure 2.4. Diffusion of the Nilo-Saharian languages in Africa. Reproduced from Blench 2006:107

2.3 Political entities

This section discusses the different political entities that influenced history and geographic boundaries examined in this dissertation.

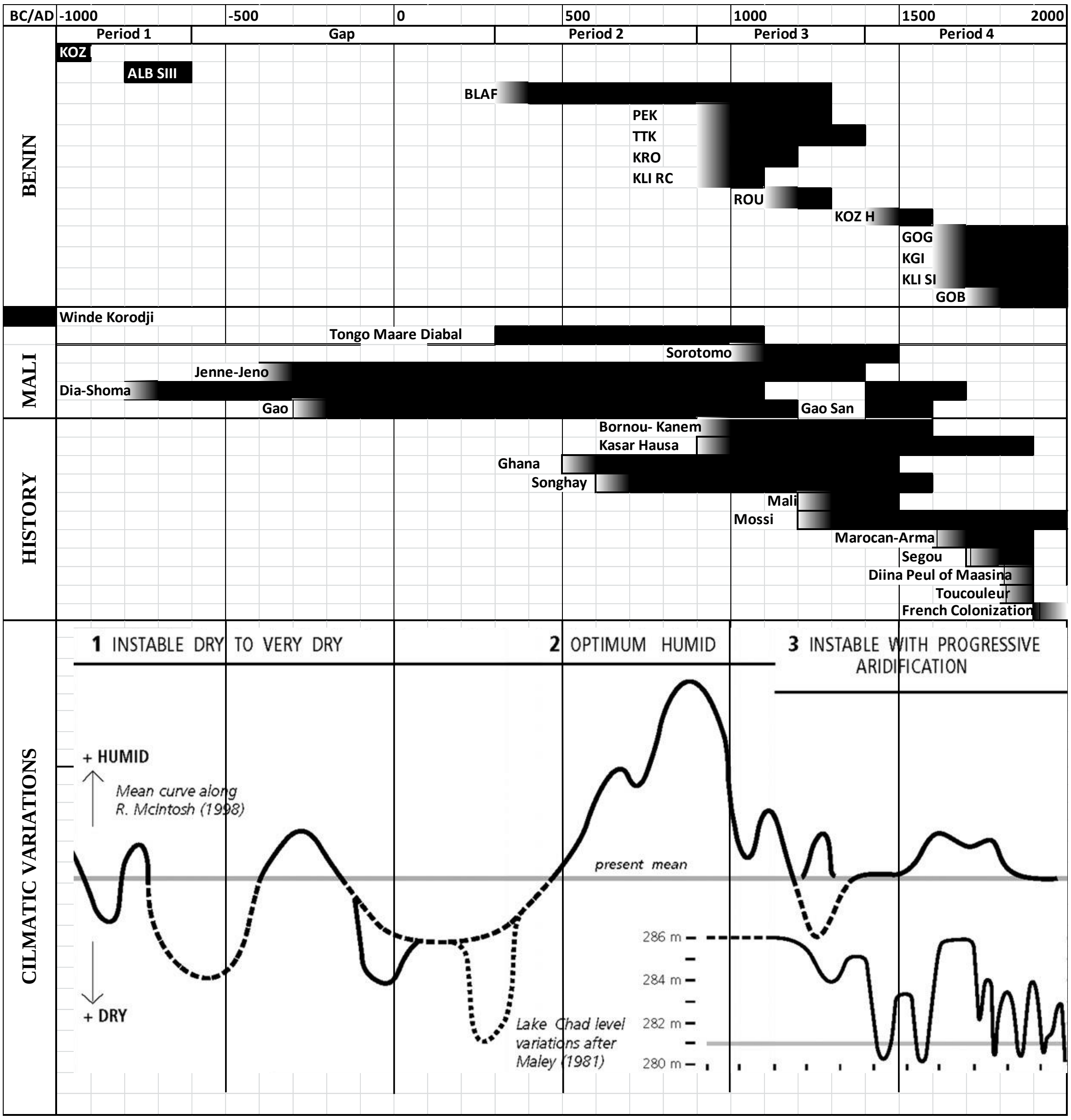


Figure 2.5 Schematic table of the archaeological sequence of the 14 sites sampled in this research. This diagram also includes the timeline of the main political entities in West Africa and the four main sites with archaeobotanical remain from the Inner Niger Delta. Climatic variation from Mayor 2005.

As described above, while ecological niches contributed to the settlement patterns and location of different populations, the rise of major West African political entities also demarcated populations. The establishment of commercial routes throughout West Africa and the Sahara (the gold and slave trades), and the taxation and security of these routes, were the preoccupation of a series of regional polities. Since the second half of the first millennium AD (and maybe even before) gold production and exchange was common in the Niger Valley. The gold mines were located around Bambuk in the upper Niger Valley (modern southern Mali), in Sirba (modern southern Niger), and in other smaller localities (Lange 1994; Devisse 1972; Tourte 2005). Initially, the term Wangara designated the Bambuk gold country but progressively this became an ethnonym that referred to the gold sellers. The Wangara are an off-shoot of the Soninké population (see above) (Brégand 1998; Lovejoy 1978; Insoll 2003). In the Niger basin, the prosperity established by this trade encouraged the development of West African political entities such as the empires of Ghana (5th?-12th century), Mali (13th-15th century) and Songhay empire (9th?-16th century, and Kawkaw antecedents). At the same time, the Lake Tchad region followed a comparable historical scheme. Based on trans-Saharan trade control, the Kanem – Bornu kingdoms (7th-17thcentury) rose in the area (Lange 1994; 2004; Insoll 2003). And at least, around the same period (9th-19th century) and just between the two areas mentioned above, the *Kasar* Hausa also emerged as a social political force (Grégoire 1991; Hamani 1994; Lange 2004; Tourte 2005). However unlike the Middle Niger which had several large political entities (Ghana, Mali, etc…), the North of Benin was, according to traditional historical reconstructions, never directly contained in any of these entities but always on their periphery. As Anne Haour's ERC project "*Crossroads of Empires"* implies, the Dendi area is seen as a major crossroads near the frontiers between the political entities of West Africa without being directly part of those polities. A crossroads is, by definition, a place where different peoples, and populations, arrived from different places with their own cultures, skills, and hence created a very complex area. Figure 2.5 summarizes in a time line the succession of the West African states, while the approximate geographical extents are illustrated in Figures 2.6-2.8.

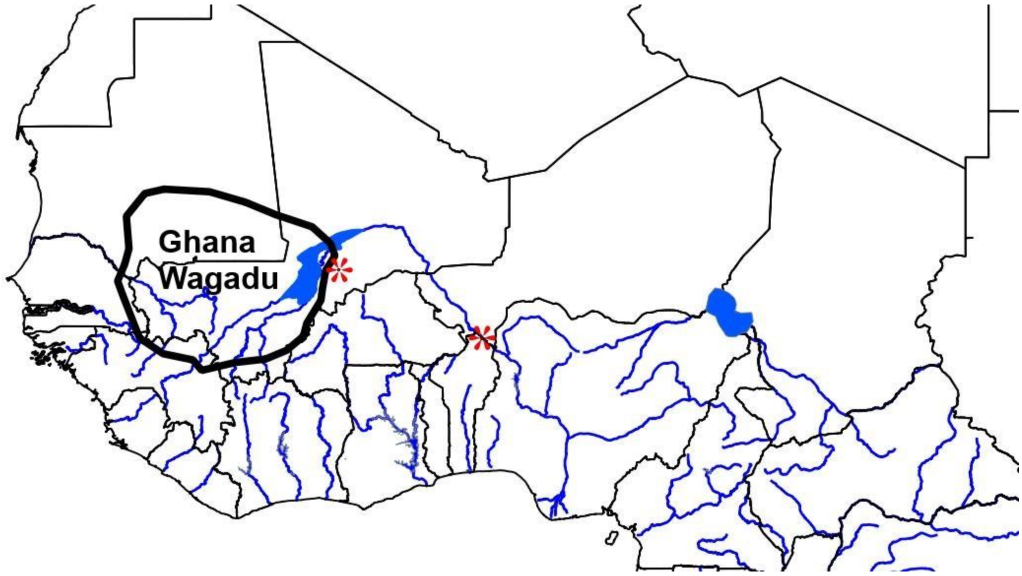


Figure 2.6 Sphere of influence of the empire of Ghana.

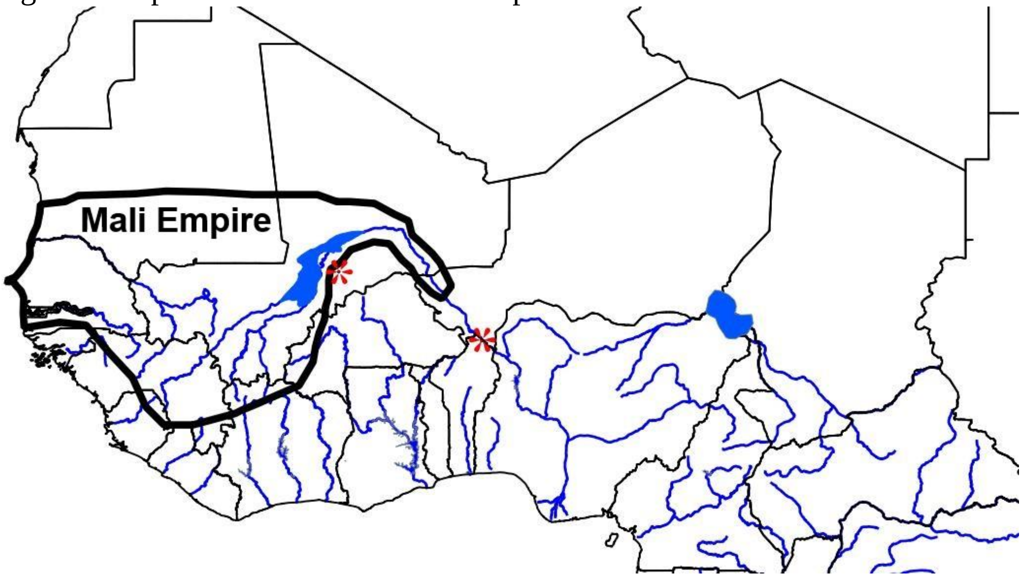


Figure 2.7 Sphere of influence of the Mali Empire.

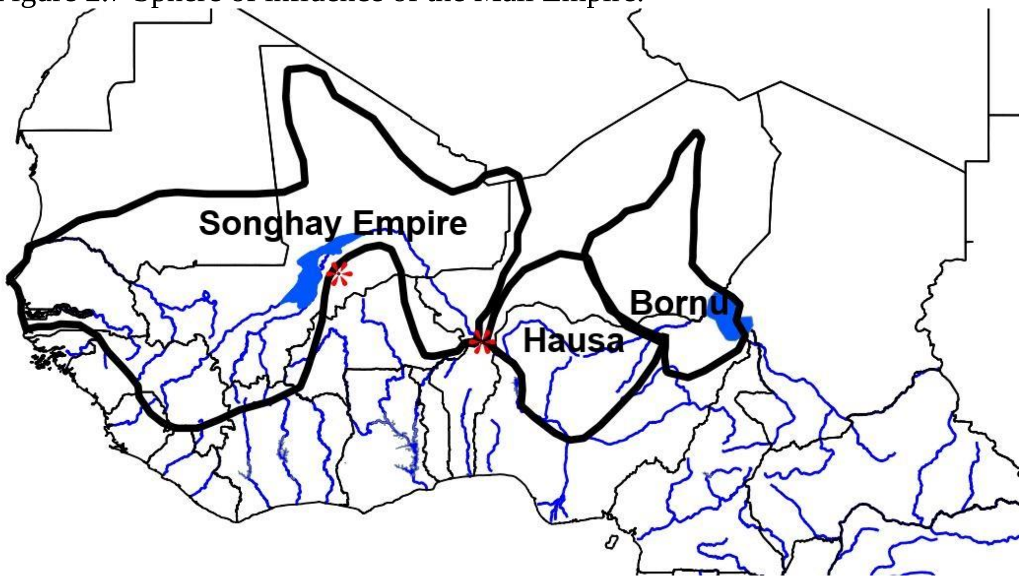


Figure 2.8 Sphere of influence of the Songhay Empire, the Kasar Hausa and the Bornu Kingdoms.

2.3.1 The Empire of Ghana/Wagadu (5th? – 12th)

The Empire of Ghana, or Wagadu, is the first documented West African polity formed of an alliance of smaller political entities – an 'empire' (Figure 2.6). Following Arabic sources, and archaeological evidence of settlement, Ghana probably dates from at least AD 500 (MacDonald 2013). Traditionally, archaeologists have considered Koumbi Saleh (south Mauritania) as the Ghana's capital but both the site's excavated sequence and contradictory historic sources do not support this assertion. The foundation of Ghana is directly linked to the Soninké people, and its oral history is preserved in their traditions (MacDonald 2013; Mayor 2011; 2005; Cuoq 1975). From the 11th century AD, climatic change and Muslim Almoravid invasion contributed to the progressive decline of the empire (Mayor 2011; 2005). The Almoravids gradually took control of Ghana's trade entrepots and trade routes. During the 13th century AD another commercial shift appeared in the area. Indeed with the rise of Empire of Mali, the trans-Saharan routes initially controlled by Ghana moved east. All these factors contributed to the final collapse of the Ghana Empire during the 12th century AD (MacDonald 2013; Mayor 2011; 2005; Cuoq 1975). The collapse of Ghana created a wave of population movements, mainly the Soninké diaspora, along the Niger and Senegal rivers (Mayor 2005).

2.3.2 The Kingdom of Kawkaw and the Songhay Empire (9th? – 16th)

Further to the east, the hegemony of the kingdom of Kawkaw began around the 9th century AD centred on the site of Gao ancien (MacDonald 2013; Mayor 2011; 2005; Insoll 1997; 2000). The site was developed by the proto-Songhay (Nilo-Saharan people, Figure 2.4 and Figure 2.3). During the 13th century AD, dynasties shifted from the Dia to the Sonni and the Askya (Mayor 2005; 2011). At the end of the 15th century, different conflicts between the Mali Empire with Toucouleurs, Tuaregs and the Mossi kingdoms, and the growing military power of the Songhay, allowed Sonni Ali Ber to conquer the Middle Niger (Figure 2.8). At the death of King Sonni Ali Ber, the Askya warriors controlled and extended the limits' of the Empire from the Atlantic (West) to Agadez (North) via the Kasar Hausa Border (East) and also the Dendi. (Mayor 2011; 2005; MacDonald 2013; Gallais 1967; Cuoq 1985). The "*Tarikh el-Fettach*" chronicle describes the Songhay Empire's organisation during the 16th century, and mentions the cultivation of rice in the Dendi area. Indeed the Dendi, one of the borderlands of the empire, had to produce for the Askya one thousand *sounnou* of rice per year (one *sounnou* is approximately 250 litres) (Houdas 1913: 179-181). At the end of the 16th century the Songhay were defeated by the Moroccan army, the last Askya survivors were pushed to move into the border of the falling empire, and particularly in the Dendi area in North Benin (Houdas 1913; Lange 1994).

2.3.3 Mali Empire (13th -15th)

According oral traditions, the Mali Empire was founded by Sunjata Keita (reigned 1235-1260). The Empire stretched from Gao to the Atlantic Ocean (Figure 2.7). The Malinke people ("the people of Mali") are directly related to the Mali Empire (MacDonald 2013; Mayor 2011; Levtzion 1981). As described by Ibn Battuta (an explorer who travelled in the empire during the 14th century) the empire of Mali was totally safe and its commerce was very well developed (Levtzion 1981). Those conditions were suitable for the expansion of the Wangara traders.

2.3.3.1 The Wangara

As already mentioned, the Wangara families derived from the Soninké (Mande, Niger-Congo) and were involved in gold and other commerce (Brégand 1998; Lovejoy 1978; Insoll 2003). Currently, the Wangara remain a strong community well-established in Borgou, a region very close of Dendi in North Benin (Figure 2.9 & Figure 2.10) (Brégand 1998). From the 12th century (and probably even before) they gradually dominated the commercial organisation of West Africa. They administered caravan cities from the Lake Chad to the upper Niger and were associated with all the main political entities: Ghana, Mali and Songhay but also Kasar Hausa and Bornu-Kanem as well (Figure 2.9 & Figure 2.10) (Brégand1998). In Benin, oral tradition links the archaeological sites of Birni Lafia, Tintin, Madekali and Kantoro to a Kumate or Tyenga origins. The Kumate and Tyenga were Muslims and merchant families who were probably part of the Wangara group (Gosselain *pers.com.*). It is noticeable that every archaeological site from North Benin that produced evidence of African rice (*Oryza glaberrima*) remains are by oral tradition linked to the Mande (Soninke/Wangara) population diaspora along the Niger River (Gosselain *pers.com.*). Like the Nono and Marka in Mali, the Mande diaspora in the Dendi seems to have been originally driven by African rice cultivators.

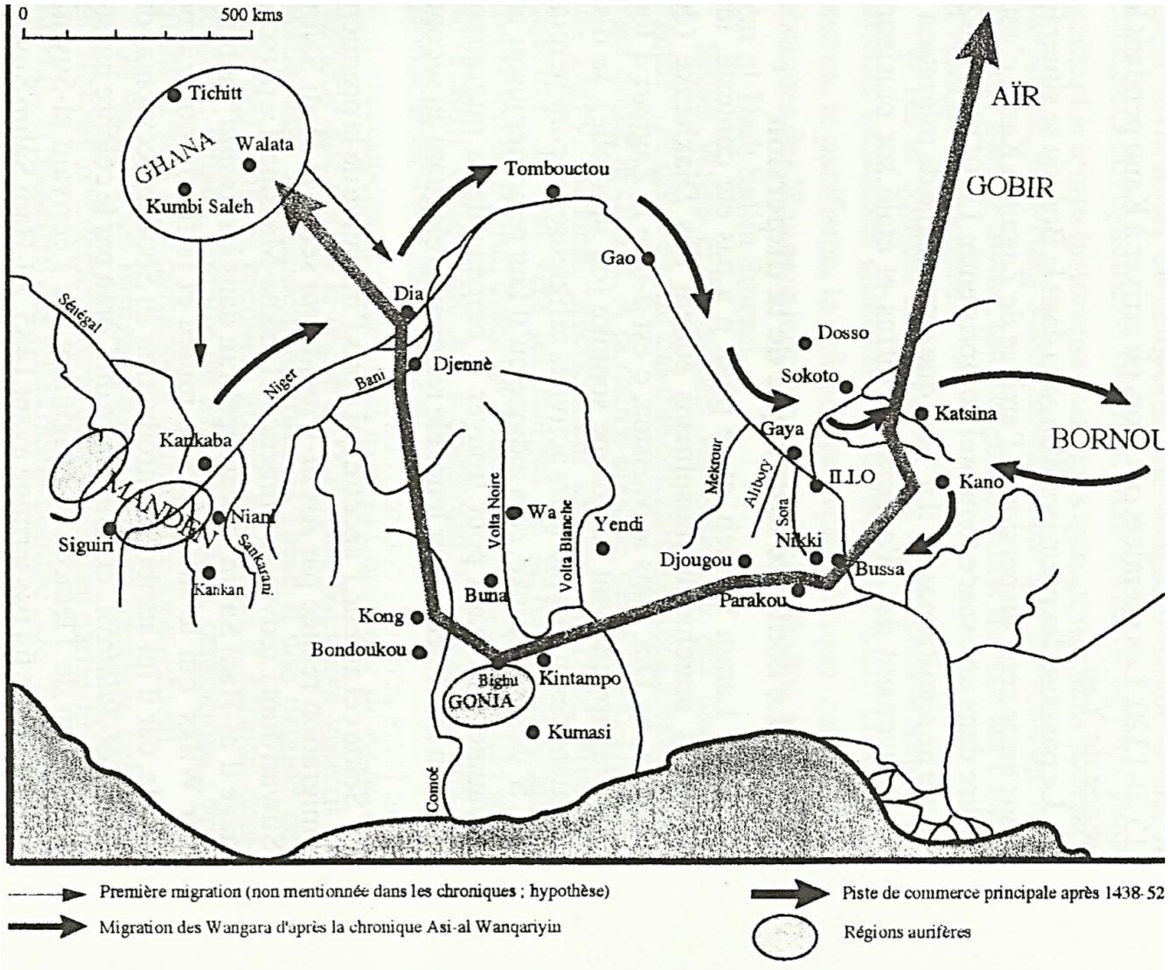


Figure 2.9 Wangara migrations and main trade roads. Reproduced from Brégand 1998: 33

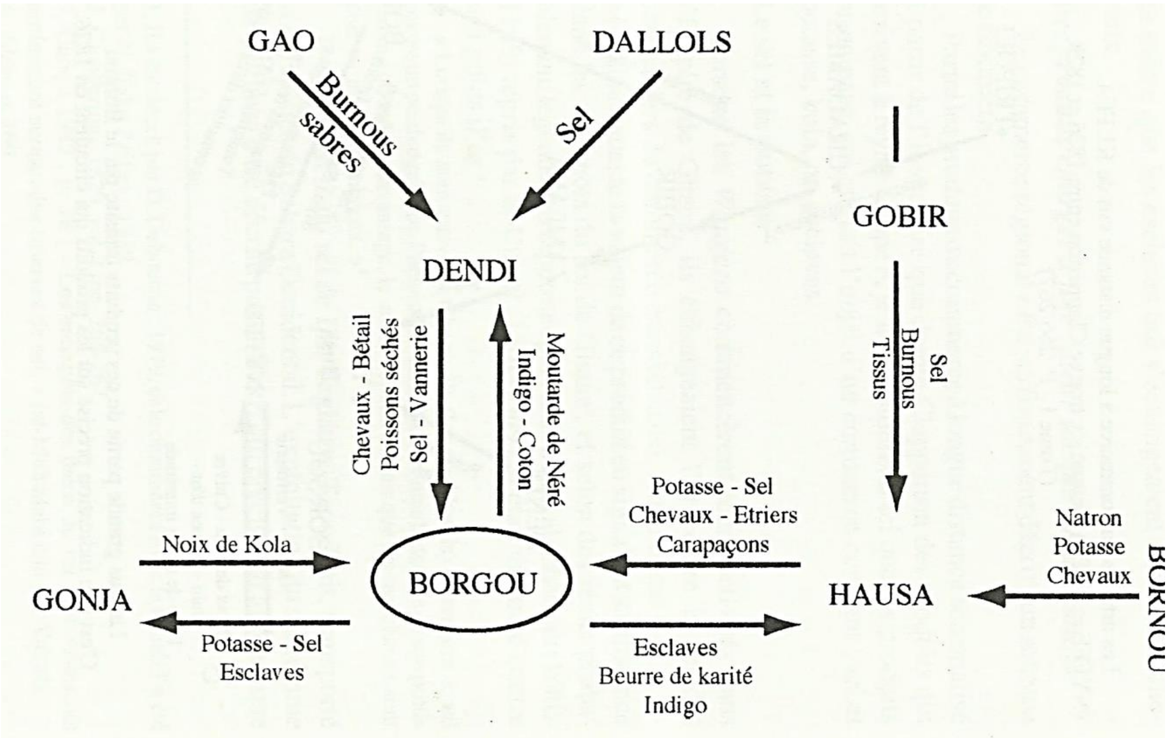


Figure 2.10 The commercial exchange dominated by the Wangara. Reproduced from Brégand 1998:64.

2.3.4 Kanem-Bornu (8th-18th)

Further east, in the Lake Chad area, during the 8th century, the Kanem Kingdom emerged from a nomad group, the Zaghawa who came from Darfur. They quickly controlled the commercial routes; they sold slaves and ivory to the north in exchange for horses, books, beads, textiles and salt from the South (Insoll 1997; 2000; Lange 1992). By the end of the 11th century during the Islamisation of Kanem, the Zaghawa lost the kingship but the kingdom stayed a strong entity. During the 12th and 13th centuries, Kanem controlled the commercial routes between the Lake Chad and the Mediterranean Sea (Moniot 1970). Between the 14th and 15th century, internal revolts push the kings of Kanem to move to the Bornu, the occidental province of the kingdom. From Bornu, they rebuilt a new kingship and during the 16th and 17th century they controlled all of the area with their powerful military armed with horses (Figure 2.8). The Bornu and the Kasar Hausa were linked by political and commercial alliances creating safe exchange routes (Figure 2.8 & Figure 2.11) (Insoll 1997; 2000; Lange 1992; Moniot 1970).

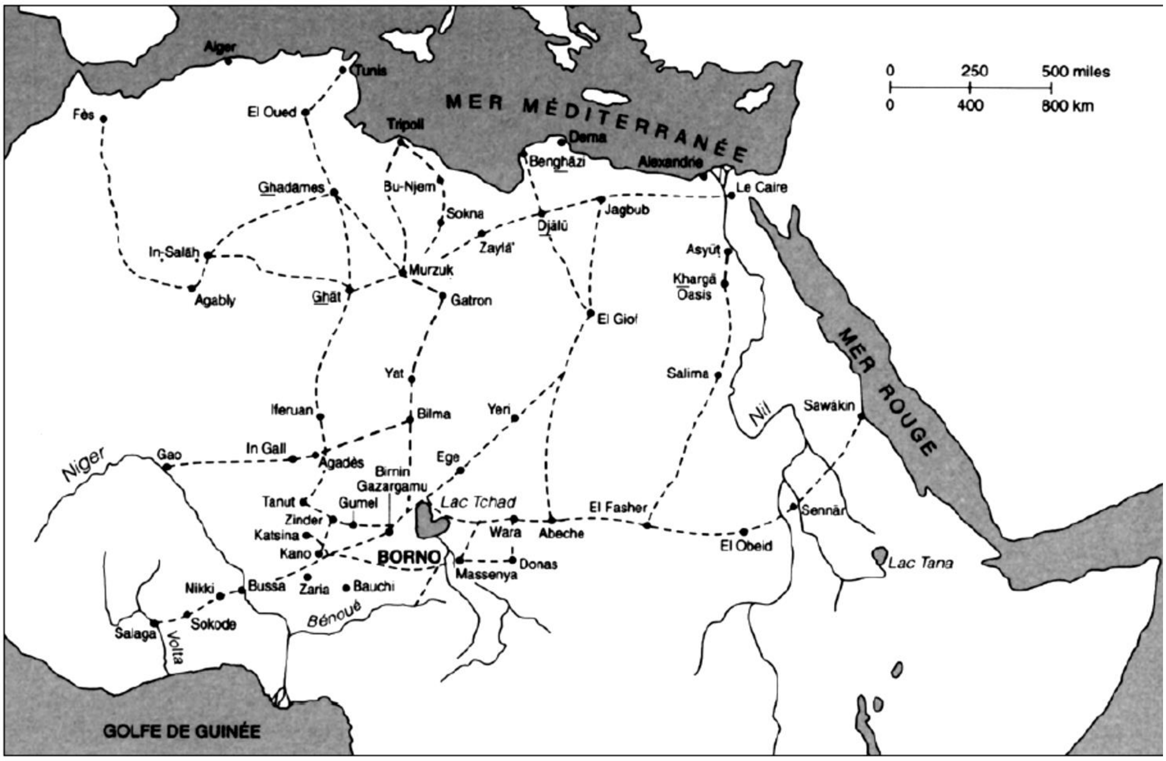


Figure 2.11. Commercial routes in the 17th and 18th century that linked the Bornu [=Borno] with North Africa and Egypt. Reproduced from Barkindo 1999:563

2.3.5 The Kasar Hausa (10th – 18th)

The origin of the Hausa is still controversial; some researchers claim that they came from the north escaping conflict with the Berbers. Others proposed that the Hausa originated from the Aïr mountains in North Niger and they moved south for more favourable ecological conditions (Smith 1970). John Sutton suggested that the Hausa came from agricultural Chadic groups that looked for new fertile fields (Sutton 1979). The Hausa were both agriculturists and traders. They controlled the Kola nut commercial routes from the modern state of Ghana to Katsina and Kano (two important Hausa cities). From the 15th century until the 19th, the Hausa dominated all inland West Africa's slave exportation (Figure 2.8 & Figure 2.12) (Moniot 1970; Insoll 2000; Coquery-Vidrovitch 1985). In the 18th century, the Kasar Hausa was progressively subsumed by the Sokoto Caliphate.

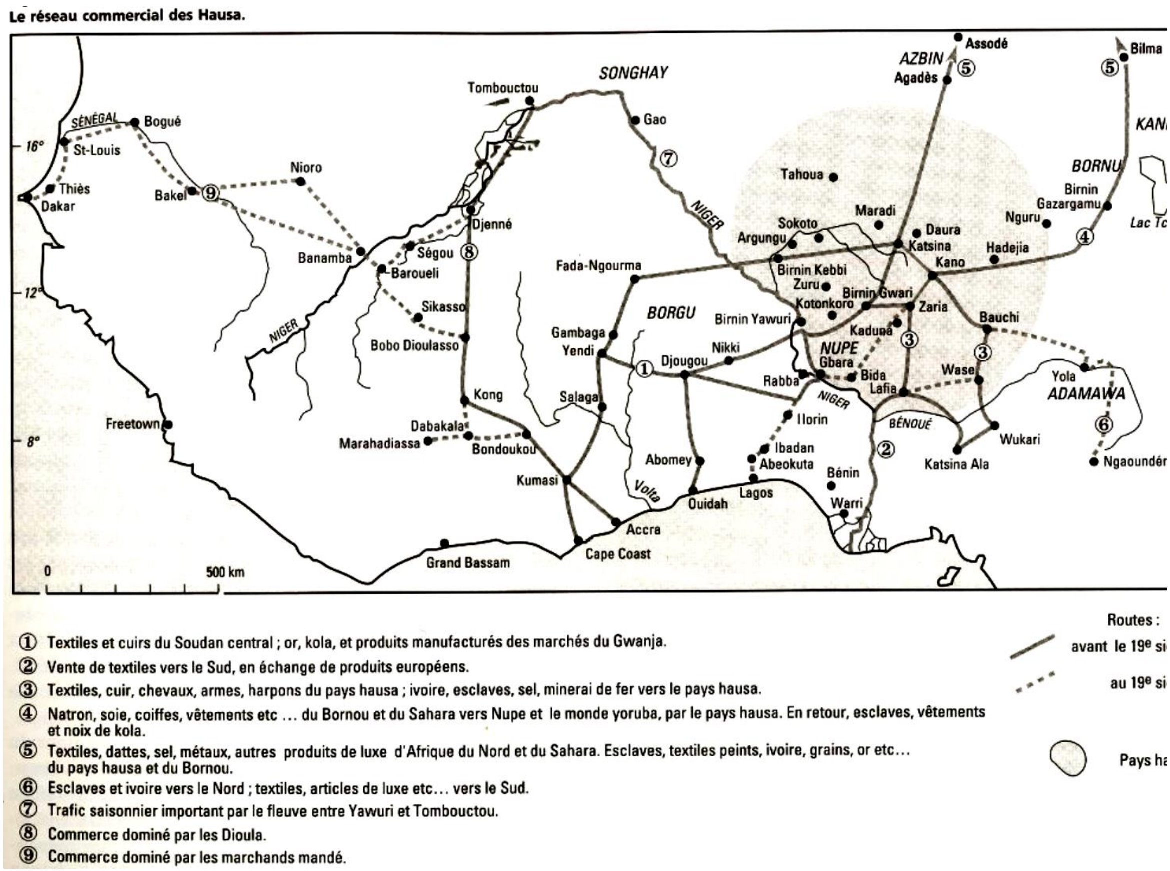


Figure 2.12. Commercial Network of the Hausa (reproduced from Hamani 1994:193)

2.3.6 Conclusions

To conclude, West African political entities shared similar goals: the control of the Trans-Saharan and inter-regional commercial routes. The West African Empires and Kingdoms have to be seen as economic powers using the foundation of valuable natural resources to develop economic alliances with others groups and extending webs of trade through all the Sahelian area. In that sense, the borders of each state has to be understood as moving zones of influence rather than a defined border. This mobility probably also applies to capitals, which are too often seen as singular, static cities during the kingdoms/empires period. As stated by MacDonald (2013: 840):

"*The capitals of both Mali and other Mande states may have been relatively mobile, shifting location at ruptures between dynasties, or even between rulers (Conrad 1994).* […] *Overall, the archaeology of the West African empires has been largely limited to attempts at locating capitals and gauging the degree and timing if their participation in trans-Saharan commerce. True archaeologies of the economies and settlement structures of such entities are only beginning.*

To take up this quest for a more complete economic understanding of the West African polities and empires, an understanding of the subsistence production that underpinned demography and provided surplus that could support trades, militaries and elites is needed. The archaeobotanical studies of this thesis aim to contribute an empirical basis to reconstructing such economic underpinnings.

2.4 Urbanism and social complexity in West Africa

The origin and development of West African polities is intimately related to the notion of complexification and urbanisation, but as stated by Roderick McIntosh (2000:19) "*Middle Niger urbanism does not conform comfortably with the expectations of urban archaeologists around the globe*".

Urbanism, and urbanization, are a complex and convoluted phenomenon centred on increasing social complexity studies. Debate over the nature of their complexity results from multifaceted definitions, sparked by many different researchers who are each expressing their own point of view, their personal 'gut feeling' about urbanism and state development within Africa. Here, I will present an overview of the main academic approaches on urbanisation but as once stated *"coming up with a definition of urbanisation that neatly encompasses all of the case studies is impossible […].The Urban footprint is not a reliable measure as very different constraints operated […]"* (Mattingly and MacDonald 2013:67).

Urbanism is a concept that many research domains (e.g. geographers, sociologists, anthropologist, architects, archaeologists) have engaged with. Such studies can be considered in two broad approaches. Firstly, a trait list approach based on classical European sociological and archaeological literature. This approach focuses on the city as forming the definition of the urban centre (e.g. Childe 1950) and on the fact that city and urbanism are linked concepts of urban/rural interdependence (e.g. Weber 1958). *"Cities thus served as central places with articulated systems. Functionalism built upon a trait-list approach by examining how traits integrated a complex system, emphasizing relationships and political economy over particularism such as writing"*(LaViolette and Fleisher 2005: 329).

Following such evolutionary and Eurocentric theories, early West African polities and African urbanisation cannot be readily recognised as necessarily "urban". The evolutionary approach to urbanism was instrumental in early discussions of the ancient city. The classic definition of the city was set by Gordon Childe (1950): large in size (e.g. 10-15 hectares); with a high population density, organised into groups of specialists; controlled by a centralized power of hierarchy and bureaucracy. This system, for maintaining cities, is based on: surplus production; a system of taxation;

monumental building; an organized labour force; long distance trade; and state organisation that included a bureaucracy and a military apparatus.

But, as stated by S Walshaw (2005:8): *"This list-based characterization has been critiqued by Africanist scholars because it fails to recognize many of Africa's indigenous urban systems (see LaViolette and Fleisher 2005 for a detailed review). Many African cities successfully arose without the hierarchical organization, public monuments, or writing systems traditionally associated with urbanism (Fletcher 1998; McIntosh 2000; McIntosh and McIntosh 1993). Examples of such cities are Jenné-jeno (McIntosh and McIntosh 1980, 1984, 1993), Benin (Connah 1975), or Great Zimbabwe (Garlake 1973; Huffman 1972; Pikirayi 2001)".*

Classic hierarchical states (e.g. Pharaonic Egypt, Mesopotamian city-states: Edwards 1998, Fuller 2003; Maisels 1998; Trigger 2003) hold economic power by accumulating agricultural surplus that is stored in centralized granaries; these both support peasantry through bad years, and specialists (craftsmen) on a permanent basis. Also land grants to temples support them and maintain ritual power that is beholden to the state. The Meroitic State operated on a similar, but much reduced, local scale. Maintaining its empire instead through trade in prestige commodities produced in urban centres or acquired from abroad (Egypt/Rome) in exchange for localized wealth controlled by the state (gold, ivory and incense trade, cotton, and slaves). Some of the latter were "cash crops" which then fed into wealth economies and "wealth finance" e.g. cotton (Edwards 1998; Fuller 2003, 2014).

The functional, trait-list approach, rests upon the belief that urbanism was a universal process, the natural outcome of increasing social complexity linked to increasing population density. Bringing with it a contrasting negative evolutionary model that concludes urban systems without hierarchical order are deemed less complex and "primitive". Further, in many cases, urban systems became synonymous with hierarchical social formations (LaViolette and Fleisher 2005). However, as exemplified by cases in Africa (e.g. R. McIntosh 2000; Vansina 1999), and in South America (e.g. Feinman 2000), this approach does not work for many regions in the world. Thus it pushes academics working in such regions to search for definitions of urbanism and other pathways that led to urbanisation. In Africa, a huge diversity of societies gave birth to an equally huge diversity of urbanisation processes, i.e. the emergence of large population centres, from micro-states to macro-states, and other systems of more or less self-organized societies clustered across an urban landscape. As stated by J. Vansina: *"Many pathways towards growing complexity in terms of size of population, size of area, and institutions were involved, and these did not necessarily generate only kingdoms but many other types of political formations. Hence evolutionary theory has no predictive value and should not be used by archaeologists to extrapolate a sequence of developments towards greater centralisation"* (Vansina 1999:169).

The effects of both approaches (hierarchical/trait list and heterachical/egalitarian) on the classification of archaeological sites are well summarised by Gary Feinman on his studies on South-American polities.

Table 2-4 Features of Heterachical and hierarchical urbanism (After Feinman 2000:43)

	Conforming features
Egalitarian or Heterachical formations	Rarity of princely burials Similar residential setting Damped household access differentials Lack of identifiable "rulers" Intra-settlement social segmentation
Chiefly/ Hierarchical polities	Monumental public construction Amassed labour effort Multimodal settlement pattern Central storage Restricted access to ceremonial features Specialised production and labour divisions Select differences in access/burial Large aggregated populations Surplus

Food production and Urbanism

One of the first key features used to explain the hierarchical organisation and the rise of city or state is the production of an agricultural surplus that could be stored and fed to non-food specialists or traded. This surplus is controlled and managed by a central state or administration around few large protected stores located in the city. This system has been documented in many regions around the world and especially in Mesopotamia where farmers were giving grain to the city-state as tax. Those grain taxes were then redistributed as rations (to a labour force), trade goods, or tribute (Figure 2.13.a; Walshaw 2005; Damerow 1996).

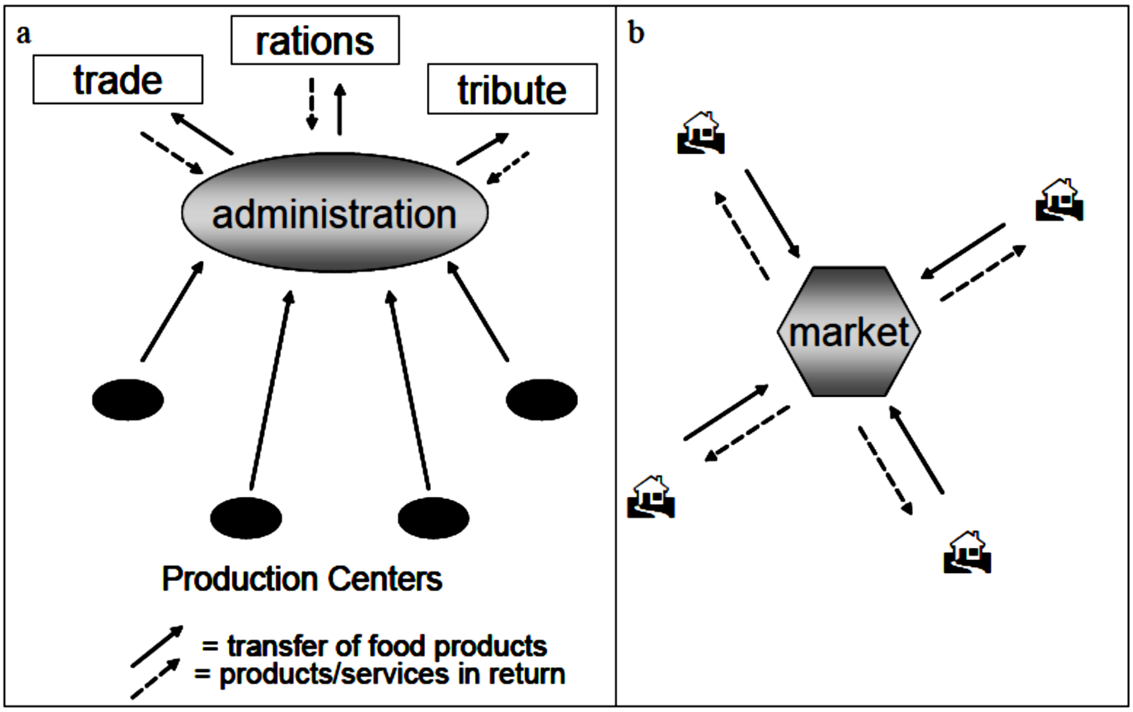


Figure 2.13 Schematised models of possible urban food production system: (a) centralized production and distribution; (b) household production and distribution. (Walshaw 2005:11)

However, different systems potentially exist and have been explored for Africa. For East Africa, Sarah Walshaw (2005:12) suggested *"that under productive environmental conditions and with the use of iron tools, Eastern African farming households could have produced sufficient surplus to permit trade of agricultural products, as indicated by ethno-historic documents concerning the Swahili (Horton and Middleton 2000:29). Therefore, at the level of the household or small-hold noted elsewhere for its productive potential and managerial efficiency (Netting 1993), the "African mode of production" becomes an economy in which the total surplus produced by individual farms supports a market-based trade economy. Such a system need not be centrally controlled to function effectively for all participants, although undoubtedly individual families could have gained inordinate wealth and possibly status. This household production system is schematized in Figure 2.13b. Individual households are responsible for the growth, harvest, and processing of crops, with families trading surplus food products in market contexts with a minimum of administrative intervention, perhaps only that necessary for market function. Furthermore, households trade for products or services that benefit them directly, such as pottery, tools, cloth, food, or medicine. This contrasts sharply with the classic model of centralized, direct control over collective production (e.g., Wittfogel 1957) depicted in Figure 2.13a, where the farmer is likely not provided the same trade opportunities as the administration".*

Such a system, as outlined by Walshaw, is comparable to the heterachical system potentially in place in West Africa. In both systems, centralized and household production, should generate a specific archaeobotanical signature. Centralized systems depend on a hierarchical control of communal labour, whereas household production will take place around the house by family members. The most differential point is the location of grain storage; hierarchical systems will lead to the construction of large administration controlled stores. At the opposite end of the scale within household-based production systems processing waste will be dispersed among households and middens throughout the community. Each household could potentially mobilize small surplus food products that will be used in market exchanges (Walshaw 2005).

Table 2-5 Characteristics of centralized food production system versus household based food production (after Walshaw 2005:15)

Variable	**Centralized food Production**	**Household food production**
Grain Storage	Protected stores located in urban contexts	Many small dispersed stores located in domestic contexts
Pre-storage processing	Large-scale, centralized	Small-scale, widely dispersed
Control of stores	Administrative bodies	Household head or members
Location trade goods	Concentrated among the administration and elite	Dispersed among domestic contexts

Urbanism in West Africa

The debate on urbanization and social complexity in West Africa is encompassed within the work of two researchers; Roderick McIntosh and Kevin MacDonald, and both have taken quite different approaches to the question of how urbanism arose within West Africa. MacDonald argues for the **hierarchically or state generated** nature of Niger valley urbanism, built on the sovereign will of a political power (MacDonald 2013, MacDonald and Camara 2012). Whereas, McIntosh has emphasized the **heterachically self-generated** origin of middle Niger societies, derived from his 'Pulse Model' theory (McIntosh 1993, 1998, 2005).

The state-generated – hierarchically generated – landscape (MacDonald)

Looking for an explanation behind the origin of Middle Age West African States (Empires and Kingdoms; e.g. Ghana empires) MacDonald's arguments are based on the classical urbanism functionalist approach, that urbanism is linked to the formation of states, *"in this view, states might exist without cities, but cities will not come into existence in the absence of a centralized state policy (H. Wright 1977)*" (Laviolette and Fleisher 2005:327). Traditional arguments have generally been based on the work of Weber (e.g. Weber 1958) and /or Childe (1950) that cities, and by extension the state, are built on the sovereign will of a political power. "*Weber characterizes the city as the artefact of the will of a despot and as an arena for a pre-existing, exploitative economy and social structure based around control of agricultural labour*" (Weber 1958, *Economy and Society vol. 1 241-3* in Gallagher & McIntosh 2015:190).

For the middle Niger, Kevin MacDonald has distinguished two types of urban development during the Middle Age, the *Markadugu* and the *Fadugu.* The *Markadugu* settlements are seen predating the state and existing outside of a state that kept them as a "hen who laid golden eggs" in a semi-autonomous way, that endured for a thousand years, such as Dia or Jénne. In comparison, the *Fadugu* has a shorter existence on the order of ten to a hundred times shorter (MacDonald 2013, Mattingly and MacDonald 2013, MacDonald and Camara 2012).

- *Fadugu, Dendugu* and *Cikebugu* and the state-generated landscape

The state generated landscape included three settlement types. All those settlements were slave driven. Firstly, the *Fadugu*, the town of the King or *Fama*, was a short term town, serving either as a capital or a location for secondary royal courts, occupied for only a single reign and abandoned at any crack within the succeeding dynasties. As an example, through the century and half of Segou existence, six capitals have been identified through academic research (MacDonald and Camara 2012). From 1712 to 1861 Segou was a West African historical state, whose towns were populated by peoples who have been categorized as slaves. Whether cultivators or soldiers, they were controlled and owned by elites. Secondly, the *Dendugu* were cities created by the king for his sons or for the station of military garrisons commanded by the son or members of the nobility. Finally, the *Cikebugu* are agricultural hamlets inhabited by slaves or serfs (who self-subsist). Normally, the *Cikebugu* was composed of a *Gwa,* a slave agricultural production unit, associated with military supervision garrisons, the *Tata.*

- The *Markadugu* and the "eternal landscape"

The Marka, meaning "those who pray", is a loose ethnonym used mainly by Islamized Soninke. The Marka towns or Markadugu are simultaneously ancient "eternal cities" regarded as ancestral to all Mande civilisation, with its secret animist traditional sorcery, and new eternal "holy cities" with officially revealed truths of Islamic scholarship. By their characteristics as 'holy' or 'eternal', most of these Marka towns were considered as supernatural and as such required neither protection through walls nor standing armies, also a few were established as major colonial centres. Those cities also had 'long established agricultural hinterlands' (MacDonald and Camara 2012: 175), which means the grains stored were gathered into the cities, much as expected in the classic definitions of urbanism (Childe 1950; Maisels 1998). Captives gathered from areas in the further reaches of the hinterland were enslaved by washing out of their identity and sold in these *Markadugu*. From an archaeological point of view, long-lived *Markadugu* settlements resemble mounds, i.e. tells, with deeply stratified occupation deposits of 5 to 7 m, whereas state generated towns that were shorted lived often reached only a maximum of one metre stratification, and present no visible relief within the present-day landscape. This is used by MacDonald as an argument for the relative archaeological "invisibility" of the Sahelian capitals. For MacDonald the best well-known examples of *Markadugu* are the archaeological sites of Jenné-jeno and Dia, along with later Timbuktu.

The self-generated landscape (R. McIntosh)

Roderick McIntosh (2005) proposed that climatic fluctuations acted as pulses that pushed societies toward self-organising clusters, stimulating the development of urbanism within the Middle Niger: the self-generated construction of the landscape. For McIntosh urban centres within West Africa developed organically and gradually, whilst maintaining a horizontal distribution of "power" between groups of specialists that lived in symbiosis. McIntosh's theory is based on his interpretation of the Jenné-jeno archaeological site within such systems. Jenné-jeno was probably the first West African site to have been recognised as an urban centre, although earlier sites, such as Dia or sites from the Tichitt tradition, present some urban (or at least proto-urban) features.

McIntosh has proposed a heterarchical urbanisation of Inland Niger Delta cities. His proposition is based on the absence of any kind of centres or elite (status) indications, such as citadels, differentiation in buildings, burials, etc. Roderick McIntosh has suggested that Jenné-jeno was a heterachical society where the power was shared between specialist groups (McIntosh R 1998). Susan McIntosh suggested: *'that by AD 1000 there was a fairly developed, well-established urban hierarchy centred on Jenné-jeno'* (1995:394). In 1987, Crumley was the first to consider the concept of heterachy. For her, in a heterarchical society, *"each element is either unranked relative to other elements or possesses the potential for being ranked in a number of different ways"* (Crumley 1987:158). For Roderick McIntosh, the Inland Niger Delta was structured by urban clusters (e.g. Jenné-jeno) that provided a diversity of services and manufactured or crafted goods to the wider hinterlands that were heterogeneously populated. Also, he suggested that the absence of graves indicating hierarchy (i.e. no difference between tombs and no obvious evidence for elite groups) and the absence of obvious monumental buildings or architecture suggesting central authority, was indicative of a form of horizontal organization or heterachy, i.e. the functioning of multiple overlapping and competing agencies of both power and resistance to centralization. Jenné-jeno, and by extension other Inland Niger Delta sites, are seen as composed segmented groups of craft specialists living in clusters (grouped by speciality) around a large market for their products. Also, the inhabitants of Jenné and its hinterland may have been horizontally integrated through numerous complex and cross-cutting associations exercising ritual or secular authority over all or parts of the population (McIntosh S. 1995; McIntosh R. 1998, 1993, 2000).

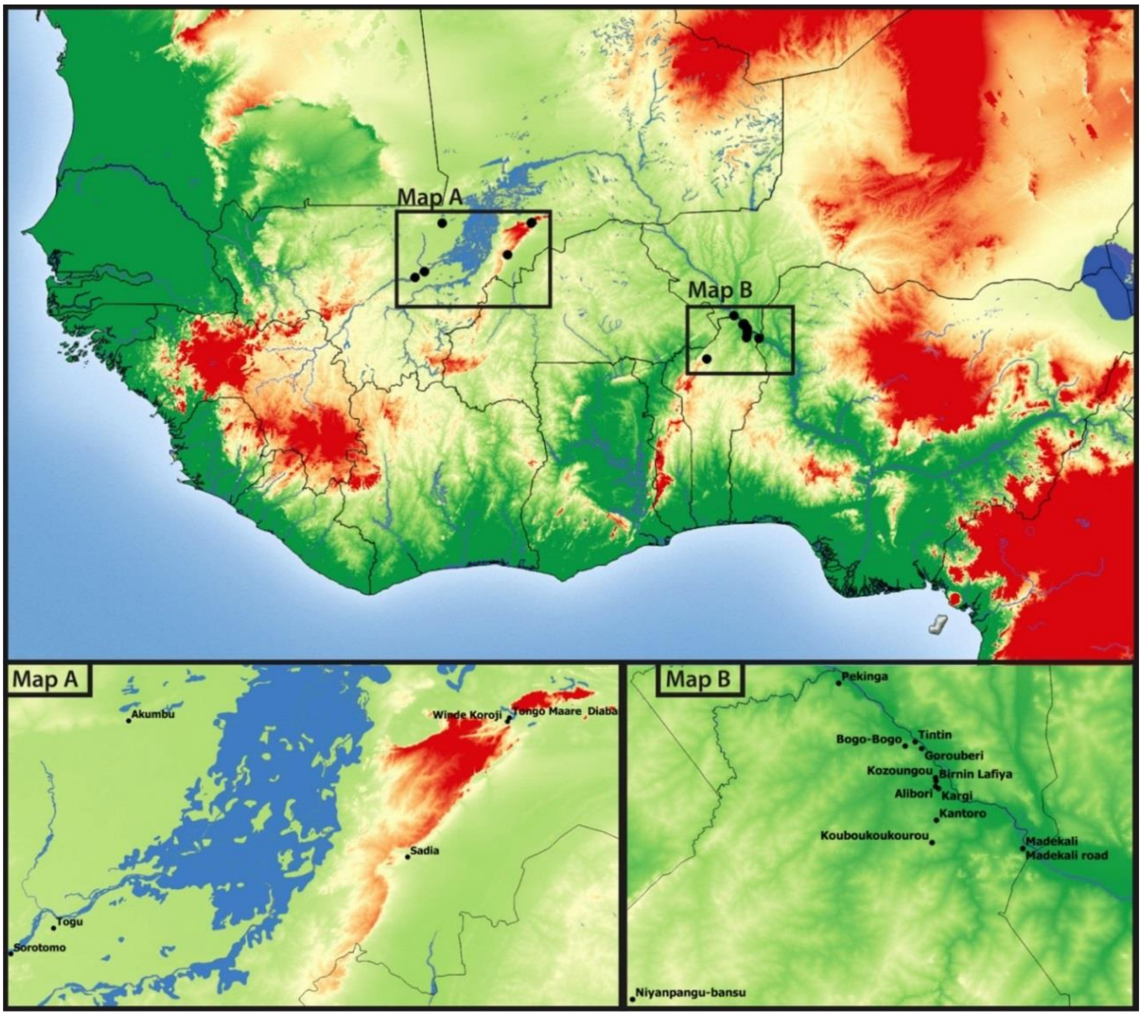
Table 2-6 Different features proposed by MacDonald and by McIntosh about urbanism in West Africa.

	Features
The Self-generated landscape Heterachy in West Africa (R. McIntosh)	No-Monumental construction Undifferentiated burials No apparent elite nor rituals place No centre Organic clustered organisation of space Large settlement (20-80 hectares) Network between sites Aggregated/segmented population Mound sites Specialisation Architectural unity
The state-generated – hierarchically generated – landscape (MacDonald)	Monumental public constructions: protective walls, ditches, Mosques … Multimodal settlement pattern: *Fadugu, Dendugu, cikebugu* Labor division Large population Presence of rulers and elite (King) Presence of capitals Slaves Large trade Religion

This project presents the opportunity to further explore these models within the context of archaeobotanical data presented within this thesis. The aim is consider how agricultural production and consumption of various sites in the Inland Niger Delta may fit one orthe other framework for social complexity.

3. Archaeological Sites

The present research looks at the flotation samples derived from 18 archaeological sites from two countries, Mali and Benin, both situated within the Niger River Basin. All 18 sites are settlement sites. The oldest sites, Windé Koroji Alibori SIII and Kozungu are dated to the second millennium BC. Five Beninese sites (Birnin Lafiya, Tintin, Kantoro, Madekali and Pekinga) and five Malian sites (Tango Maaré Diabal, Sadia, Togu, Sorotomo and Akumbu) are part of the same time period, dating from the first century AD to the 14th century. The last group of site dates from the second half of the second millennium AD (1600-1950 AD) is composed of six sites (Kozungu, Bogo-Bogo, Kargui, Madekali and Kouboukoukourou) located within a modern village in North Benin. This chapter will describe each archaeological site following its placement along the Niger River stream.

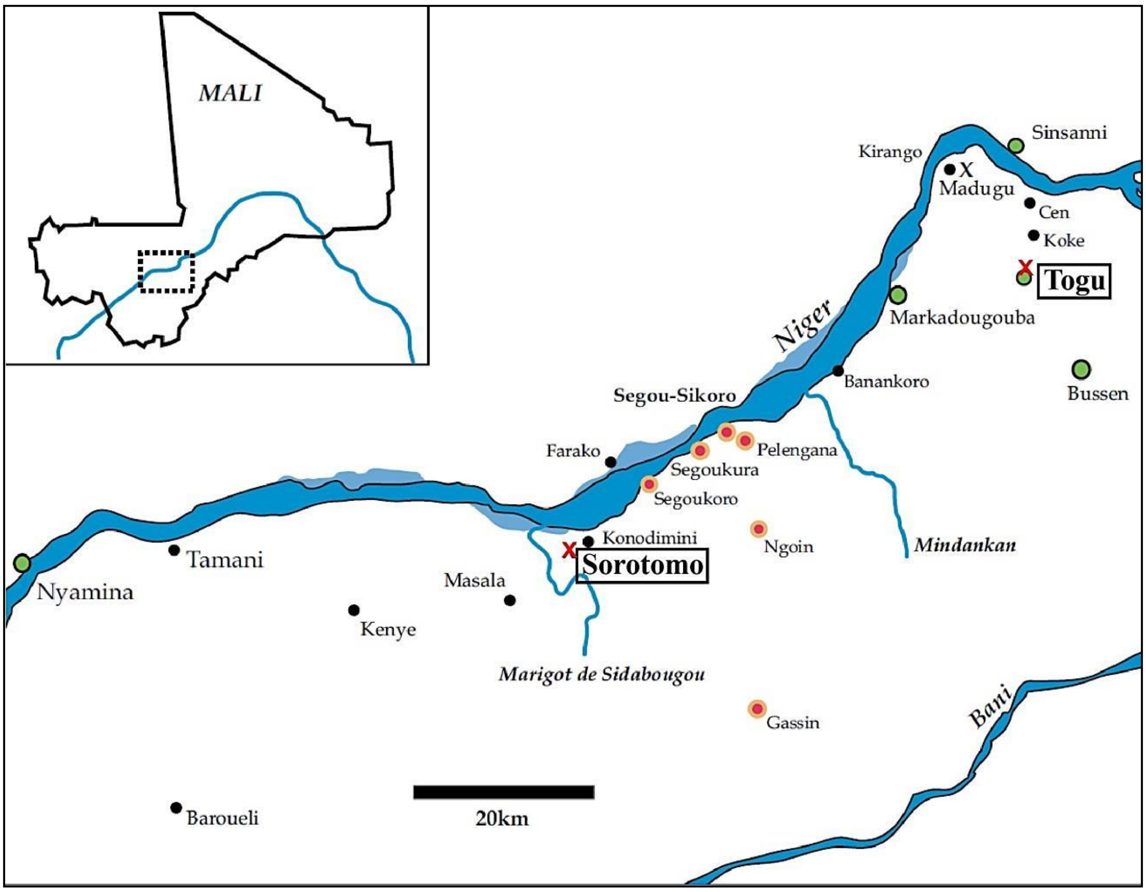


Map 3-1 . Research area, showing the location of the archaeological sites. Map A: Sites in Mali. Map B: Sites in Benin

3.1 Sites in Mali

3.1.1 Upper Niger Valley and the Ségu area

This region has only recently been surveyed archaeologically by MacDonald (cf Macdonald et al. 2011), and subsequently by Gestrich and Keita (Gestrich and Keita 2017). For this research archaeobotanical samples were collected from the site of Sorotomo, a regional centre occupied from the 13th to 15th century AD, and the clustered settlement mounds site of Togu (TOG2) dating from the 11th to 13th century AD.



Map 3-2 Map of the Ségou Region of Mali with the location of Sorotomo and Togu (TOG2) marked with red crosses (Modified from MacDonald et al. 2011:53).

3.1.1.1 Sorotomo – 1200-1500 AD

Units and Excavators:

During the excavation run by MacDonald for the Segou project, two units (A&B) and a sub-unit (BE) were exposed:

- Unit A is a 4X4 m unit, 1.20 metres deep. It contained three horizons of coursed earth buildings with some polished laterite pebble pavement and two hearths. The lower horizon is dated to cal. AD 1210-80.
- Unit B is a larger exposure of 10x6 m and BE is a 1X4 m deep test pit located in the western part of unit B.

Main publications: MacDonald et al. 2011

Figure 3.1 Gestrich & MacDonald excavating the deep, 2.4m depth, Unit BE of Sorotomo (Courtesy of K. MacDonald).

The Segou project goal was to explore archaeologically a Malian region that was well-known for its historic Mande polities – Segou – but where archaeological remains were virtually unknown to date. In 2006 and 2009 MacDonald and his team excavated the site of Sorotomo ("the ruin of Soro"). Oral traditions and historical accounts place it as a centre of political and military power rather than as a commercial centre (MacDonald et al. 2011). Following MacDonald and Camara's (2012) classification, Sorotomo probably corresponds to a 'state-generated landscape', so-called *Fadugu* or *Dendugu* (see Chapter 2.2). With 72 ha extension Sorotomo is one of Mali's largest tell-type sites. It is located 3 km south of the Niger River, upstream from the IND (Map 3-2). Sorotomo was occupied during the foundation and apogee of the Mali Empire between c.AD 1200 and 1500.

Figure 3.2: Plan and picture of Unit B abandonment layer (courtesy of K. MacDonald)

Archaeological sequence

Sorotomo has been classified into three phases (Table 3-1):

Abandonment Phase – AD 1400-1500

The abandonment layer is a large exposition of multiple rooms, both round and rectilinear, buildings (Figure 3.2). The rooms are separated by raw earthen brick walls, made of coursed earth. The living floors are made of fine compact polished lateritic pebble pavement. Evidence from the living floors implies a brutal and sudden abandonment, with potentially sacking, with possessions – from pots and grinding stones, to spindle whorls and cowries – left in place presumably abandoned. In the unit B exposure 35 intact pots were found. This abandonment is dated to 1400-1500 AD, coinciding with the expansion of the hierarchical Songhay Empire (Table 3-1; MacDonald et al. 2011).

Middle phase – AD 1300-1400

In both unit A and BE, the middle phase is characterised by remains of coursed earthen walling, compact earthen or lateritic gravel floors, and other domestic structures such as postholes, middens and hearths.

Lower Phase – AD 1200-1300

The Lower phase shows very similar patterns to the other two later phases as remains of collapsed walls and domestic contexts were recovered. In the extension BE the lowest of the seven successive living floors was dated to cal. AD 1210-90 (Table 3-1)from a hearth located at the base of the unit (2.4 metres depth).

Table 3-1 Radiocarbon dates from Sorotomo excavation

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
A-7, Upper	470 ± 60	Cal AD 1400-1500	Beta 236442	Charcoal (unsp.)	MacDonald et.al 2011
A-11, Middle	520 ± 60	Cal AD 1300-1460	Beta 236443	Charcoal (unsp.)	MacDonald et.al 2011
B-6, Middle	590 ± 40	Cal AD 1290-1420	Beta 274305	Charcoal (unsp.)	MacDonald et.al 2011
BE-38,Lower	760 ± 40	Cal AD 1210-1290	Beta 274306	Charcoal (unsp.)	MacDonald et.al 2011
A-34,Lower	790 ± 60	Cal AD 1160-1290	Beta 274304	Charcoal (unsp.)	MacDonald et.al 2011

Finds

Faunal remains

There is a comparative rarity of fish remains recovered and a relative abundance of cattle and sheep. Horse remains were also found in a cluster in the Middle phase of Unit A.

Pottery

As in many Malian sites, the pottery shows remarkable stability over time in form, decorative motifs and methods formation. The ceramic material is characterised by everted rimmed jars and jattes. Most commonly the outer surface is formed of red slip burnished bands on the upper part of the pot and decorated with a roulette impression on the lower part. One of the only temporal changes is the sudden appearance in the middle occupational phase of decors made with braided strip roulette. On 35 intact ceramic vessels two techniques were observed: the '*Moulage sur forme convexe*' and '*the creusage de la motte*'. Both techniques were used on pots with identical forms and decors. *Moulage sur forme convexe* has been observed in Malinke, Bamana and some Dogon groups, whereas *creusage* has been documented with the Bobo and also some Dogon groups. The preliminary observations seem to indicate that Sorotomo ceramic assemblages show a mixture of traits from different regions such as the Malinke region in the West and the IND in the North (MacDonald et al. 2011).

Archaeobotanical sampling

During the course of the excavation 27 archaeobotanical samples from a total volume of 336 litres of archaeological matrix were floated. Within those 27 soil samples, 19 from intact pots and 8 from domestic contexts (midden, hearth, and postholes) were strategically selected. The average soil by sample was 12.6 litres. Half of the samples were analysed by J. Morris for his master thesis from University College of London (Morris 2013).

3.1.1.2 Togu (TOG 2) – 1000-1300 AD

Units and Excavators:
TOG 2A is a 3X3m unit excavated in 2017 by Daouda Keita (Université des sciences Socials et Géstion, Bamako, Mali) for the **Markadugu Project** led by Nikolas Gestrich from the Frobenius Institute (Frankfurt, Germany). "*Markadugu : the relationship of urbanism and trade to state power in the Segou region of Mali"*
Main publications: Gestrich and Keita 2017

The Markadugu project's main objective is to study the relationship between city and state formation and development in the Upper Niger Valley in Mali. It is an ongoing research project that started in 2016 and will finish in 2020. For this project, Nikolas Gestrich's team undertook some ground surveys and excavated some test pits within some newly discovered sites. TOG2 near the village of Togu is a 30 hectares cluster of 13 deep stratified settlement mounds; the excavation, directed by Daouda Keita, reached 1.8 m deep without reaching sterile soil. The stratigraphy (Figure 3.3) presents several successive phases of pit digging and middens very rich in pottery, faunal and botanical remains (see Chapter 6 ; Gestrich and Keita 2017).

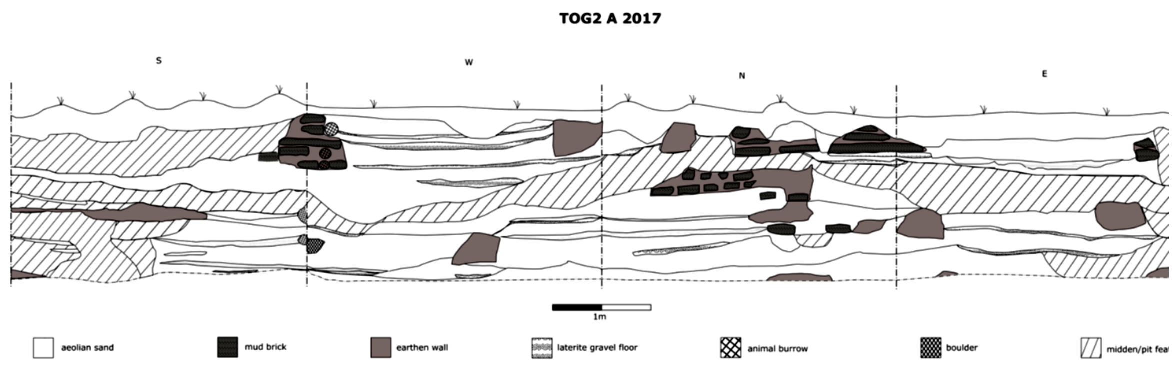


Figure 3.3 Profile of excavations at TOG2. (from Gestrich and Keita 2017:54)

Archaeological sequence

Currently, three radiocarbon dates are available. Each date is related to one of the three main phases of the site. The site was occupied for a relatively short period between 1039 and 1281 cal AD. The initial excavations did not reach sterile soil, but were continued in December 2017 to document the lowest deposits, at around 3m below the surface. Dates for these lowest deposits were not yet available at the time of writing.

Table 3-2 Radiocarbon dates from Togu Missiri

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
C5	780±30	Cal AD 1210-1281	Beta 464271	Charcoal (unsp.)	Gestrich and Keita 2017
C8	880±30	Cal AD 1042-1222	Beta 464267	Charcoal (unsp.)	Gestrich and Keita 2017
C20	900±30	Cal AD 1039-1210	Beta 464272	Charcoal (unsp.)	Gestrich and Keita 2017

Finds

As the project is still ongoing, the material culture found during the excavation remains under analysis.

Archaeobotanical sampling

During the excavation of Togu Missiri (TOG2) 17 archaeobotanical samples were floated. Five of those samples came from inside vessels and another 12 came from domestic deposits such as midden and hearths.

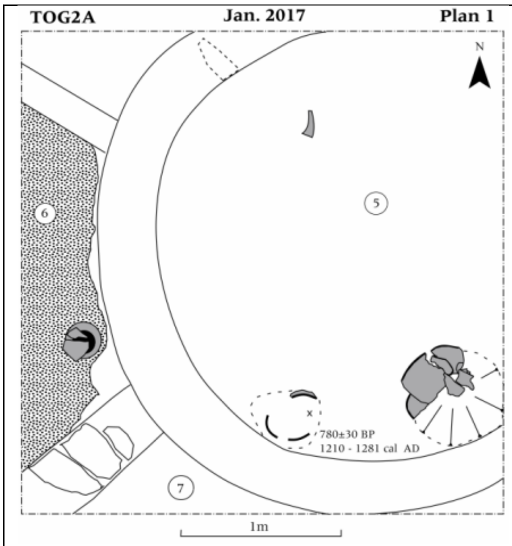


Figure 3.4: TOG2A, Plan of Phase B (from Gestrich and Keita 2017:53)

Phase B –13th century AD

The first occupation layer is Phase B that shows the remains of a round mud-brick building (context 5) with two *in situ* pots. In the west area, a room with a lateritic gravel floor appears between two walls (context 6) (Figure 3.4). This phase is dated to 1210-1281 cal. AD (780±30, Beta-464271) (Gestrich and Keita 2017)

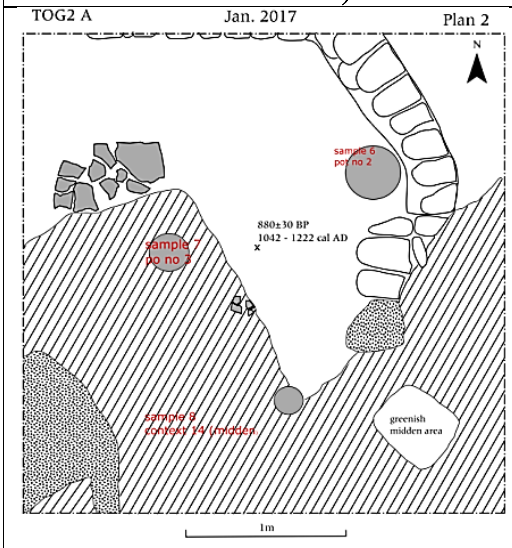


Figure 3.5: TOG2A, Plan of Phase C (Courtesy of N.Gestrich)

Phase C–12th century AD

Phase 3 illustrated in Figure 3.5 gave a date of 1042-1222 cal. AD (880±30, Beta-464267). This second settlement phase shows the remains of mud brick and earthen walls with some lateritic gravel floors. Complete ceramic vessels are also present but the main feature is a big greenish midden area (Gestrich pers. comm.).

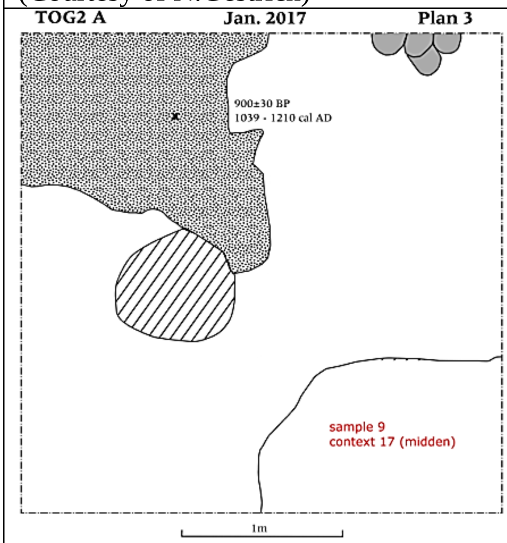


Figure 3.6: TOG2A, Plan of Phase D

Phase D –11th century AD

Phase D provided evidence of a lateritic gravel floor and in the north-east corner the end of an earthen brick wall stump. Two midden areas were also excavated (Figure 3.6) (Gestrich pers. comm.). The lateritic floor (context 20) was dated to 1039-1210 cal. AD (900±30, Beta-464272) from a piece of wood charcoal embedded in the floor (Gestrich and Keita 2017).

3.1.2 Mema

3.1.2.1 Akumbu – 600-1300 AD

The site of Akumbu had different teams of excavators but the archaeobotanical samples present in this research came from Togola and MacDonald's excavations in 1990.

Akumbu is a cluster of settlement mounds; there are three main mounds and several smaller mounds bordering seasonal ponds that continue to attract seasonal pastoralists (McIntosh 2017, Togola 2008). Only three archaeobotanical samples were saved. These three samples came from two of the several Akumbu test pits: AK1 and AK3.

AK1 is a 2x3m unit of 7.5 m depth excavated on Mound A. Two occupation layers were found, an early phase dated to 600-800 AD with around four metres of deposit and a late phase dated to 1000-1400 AD composed of an irregular rectangular mud-brick house.

The second unit, AK3, was excavated on Mound B without reaching the sterile ground. An irregular component made of brick fragments and postholes was found. This layer is dated to 'MIA/early' phase AD 600-100 (McIntosh 2017, Togola 2008, MacDonald pers. comm.).

The ceramics associated with the site are describe by S. McIntosh as being "[…] *generously tempered with organic material, including leaves, seeds, and spikelets, likely of panicoid grasses*" (McIntosh 2017: 198). Also, MacDonald attributed the early ceramic assemblage of Akumbu to the Faïta facies present in Mema that derived from Tichitt pottery (MacDonald 1994; see Chapter 7 for discussion). Iron production evidences were also found throughout the archaeological sequence (Togola 2008).

3.1.3 Gourma des Monts

The “Gourma des Monts” is the region located on the western margin of the Sahelian Gourma region which fills the area south of the Niger Bend. Since the colonial era this semi-arid desert scrub landscape has mainly been a Peulh pastoral area (MacDonald et al. 2017). In 1992/93 during his doctoral research Kevin MacDonald, helped by Tereba Togola, undertook a large survey of the Douentza area. Several archaeological sites were discovered and two were selected to be tested: Windé Koroji (WKO) and Tongo Maaré Diabal (TMD) (MacDonald 1994, MacDonald et al. 1994). Both sites are located at the eastern edge of the Inland Delta’s ancient floodplain near the modern town of Douentza (Gourma region) in a sandy flatland between two escarpments, the Bandiagara and the Dyoundé/Gandamia. Currently, this narrow natural corridor is a major crossroads that connects the Malian interior of the Niger bend and the IND but also the north-western Burkina Faso.

3.1.3.1 Windé Koroji (WKO) – 2200-1600 BC

Windé Koroji (Fulbe for "Where the cattle go without water") is located in a pasture area and appears to be a sporadic settlement site dating between 2100 and 800 BC (Macdonald et al. 2017, Gestrich 2013). With Alibori in Benin, WKO is the oldest archaeological site investigated as part of this doctoral research.

Units and Excavators:

Two 2X2 m test pits were excavated by Kevin MacDonald in 1992-93.

- WKO-I midden cut by well-preserved round pit house (Figure 3.7). This excavation provided all of the ten archaeobotanical samples analysed in this thesis.
- WKO-II exposed the lower half of a mature female inhumation.
- WKO-T5 is a tumulus, 5.5 metre in diameter and 0.5 m in depth.

Main publications: (Macdonald 1996; MacDonald, Champion, and Manning 2017)

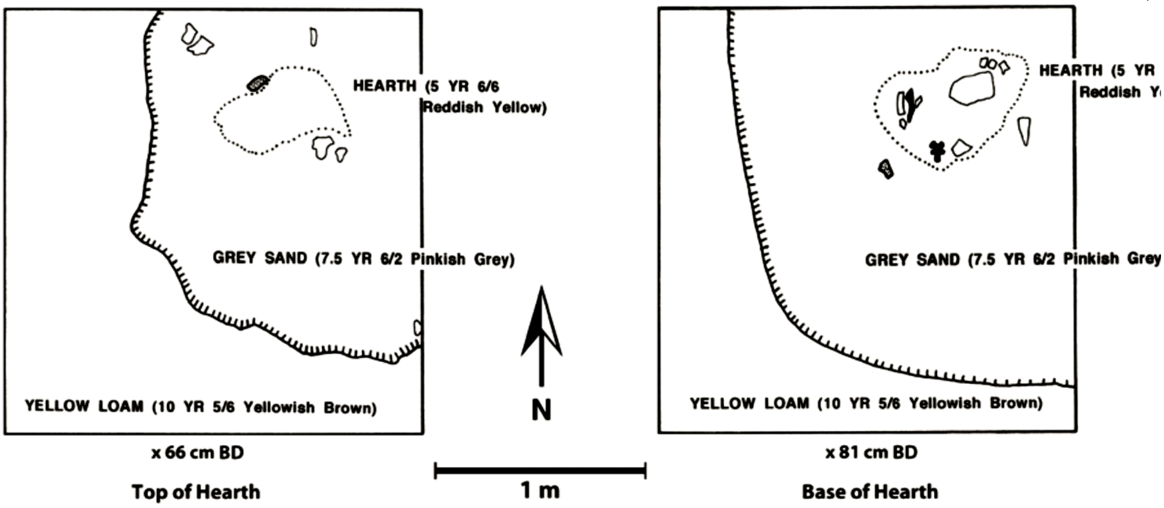


Figure 3.7 Plan of excavations at WKO-I showing the extent of the sunken round house and the location of the hearth (both plans are within Horizon A). Depths are BD (below datum) which was established 10 cm above the surface at the SW corner of the excavation unit (From MacDonald et al. 2017:169).

Archaeological Sequence

During the excavation, 20 contexts were excavated following five stratigraphic layers. After the calibration of the C14 dates those layers were organised in a sequence of three dispositional horizons:

Layer I – Surface wash, Loam with eroded artefacts and bone

Layer II – Semi-Sterile, Sandy Loam surrounding cultural features

Layer III – Midden Deposit, Ashy Sand 3115±195 BP (GX-19234)

Layer IV – Debris from within sunken hut base feature, Ashy Sand (defined hearth present in this layer) 3635±90 BP (GX-19990)

Layer V – Sterile Basal Soil, Sandy Loam (much like II)

Table 3-3 Table 3-4 Radiocarbon dates from Windé Koroji

Context	**C14 Date**	**Calibration (1 sigma)**	**Lab Code**	**Type**	**Reference**
C17 Hearth	3635±90	Cal BC 2136-1893	GX-19990	Charcoal (unsp.)	MacDonald et al. 2017
C 7 Midden	3115±195	Cal BC 1612-1123	GX-19234	Charcoal (unsp.)	MacDonald et al. 2017

Horizon A (Layer IV) – ca. 2150-1900 BC

The initial occupation is characterised by a 'Sunken' Roundhouse of approximately two metres diameter with a hearth and domestic debris. The hearth structure, context 17, was directly dated and calibrated to 2136-1893 BC (3635±90BP, GX-19990).

Horizon B (Layer III & II) – ca. 1600-1100 BC

The later occupation is of a midden that directly overfills the sunken structure. There is no visible change of material culture between horizon A and B. The midden, context 7, is dated to 3115±195 BP (GX-19234) calibrated to 1612-1123 BC.

Horizon C (Layer I) – undated, post 1600 BC

Horizon C is the Abandonment / Deflation Surface (including some sub-recent material).

<u>Finds</u>

Faunal remains

Horizon A is dominated by warthog remains but some livestock such as domestic sheep were found as well. Domestic cattle appear in horizon B where the presence of waterbuck is also present. The faunal remains from both horizons are consistent with a wooded savannah mosaic with standing water. Moreover, the fish remains, but also the shell remains and the wood charcoal analysis evidence provide good environmental indicators suggesting that WKO was situated at the eastern end of the IND floodplain, in a gallery forest zone – a substantially more humid and verdant environment than today (MacDonald et al. 2017).

Pottery

The ceramic and the lithic assemblages present obvious parallels with the cultural material assemblage from Karkarichinkat in the Tilemsi Valley. Indeed, the pottery decorations made of knotted cords, twisted cord roulettes and cord-wrapped elements were the same (MacDonald 1994, Manning 2008, MacDonald et al. 2017).

Interpretation

Windé Koroji was probably a semi-sedentary site associated with herd segments. Even if WKO offers evidence of agro-pastoralist adaptions different than that of coexistent groups from the Lower Tilemsi Valley, their material culture is comparable and both show evidence of early pearl millet cultivation (see Chapter 6).

Archaeobotanical sampling

Ten flotation samples from a total of twenty-six litres of archaeological matrix were collected from the midden and the sunken hearth in WKO. A few samples were preliminary sorted by Cecilia Capezza (a former PhD candidate of K. MacDonald at UCL).

3.1.3.2 Tongo Maaré Diabal (TMD) – 500-1150 AD

<u>Units and Excavators</u>:

<u>by MacDonald and Togola</u>

- Unit A, 2x2m in 1993.
- Units A & B, two 4x4m separated by a 1x4 baulk (Unit C) in 1995 &1996
- Unit D in 1996

<u>by Gestrich</u>

- Unit E, F & G in 2010

<u>Main publications</u>: Gestrich and MacDonald 2018, Gestrich 2013 (PhD Thesis)

Figure 3.8. Excavations of units A & B at Tongo Maaré Diabal in 1995. Excavations would proceed for a further 1.5 m of depth (Courtesy of K. MacDonald.).

Figure 3.9 Photo of circular coursed earth structures in Horizon 1, Unit B. Note the stone grinding basin between the two structures (from Gestrich and MacDonald 2018:6).

The site of Tongo Maaré Diabal is a Tell-type habitation mound of approximately 3 to 4.5 m in elevation and 9 ha in extent. TMD was occupied from 500 AD to 1150 AD at the periphery of Ghana/Wagadu (c.AD 400-1100) and Kawkaw/Gao (c.AD 700-1100) polities and contemporarily of the Middle Niger Urbanism expansion and apogee (Gestrich and MacDonald 2018) (cf Part 1).

TMD was largely occupied by specialist iron-working and pottery-making communities. Earlier excavations by MacDonald (in 1993-1996) uncovered a continuous 650 years sequence of domestic life (AD 500-1150) over three 4 by 4 m excavation units. The excavation units by Gestrich (in 2010) opened a much larger surface spanning two domestic and iron-working compounds at the time of the site's abandonment. The extensive evidence of iron-smelting and working would hint at a potential proto-industrial role in the region. Also, excavations exposed one of the best-preserved examples of early Sahelian earthen architecture with mud-brick walls remains standing at a height of a metre. *In situ* well-preserved artefacts were found such as entire pots, terracotta statuettes and more exceptionally some carbonised textile remains made of *Hibiscus* sp. (Gestrich and MacDonald 2018).


Figure 3.10. South-facing view of the excavations from the northern edge of building F1 (from Gestrich 2013:80).

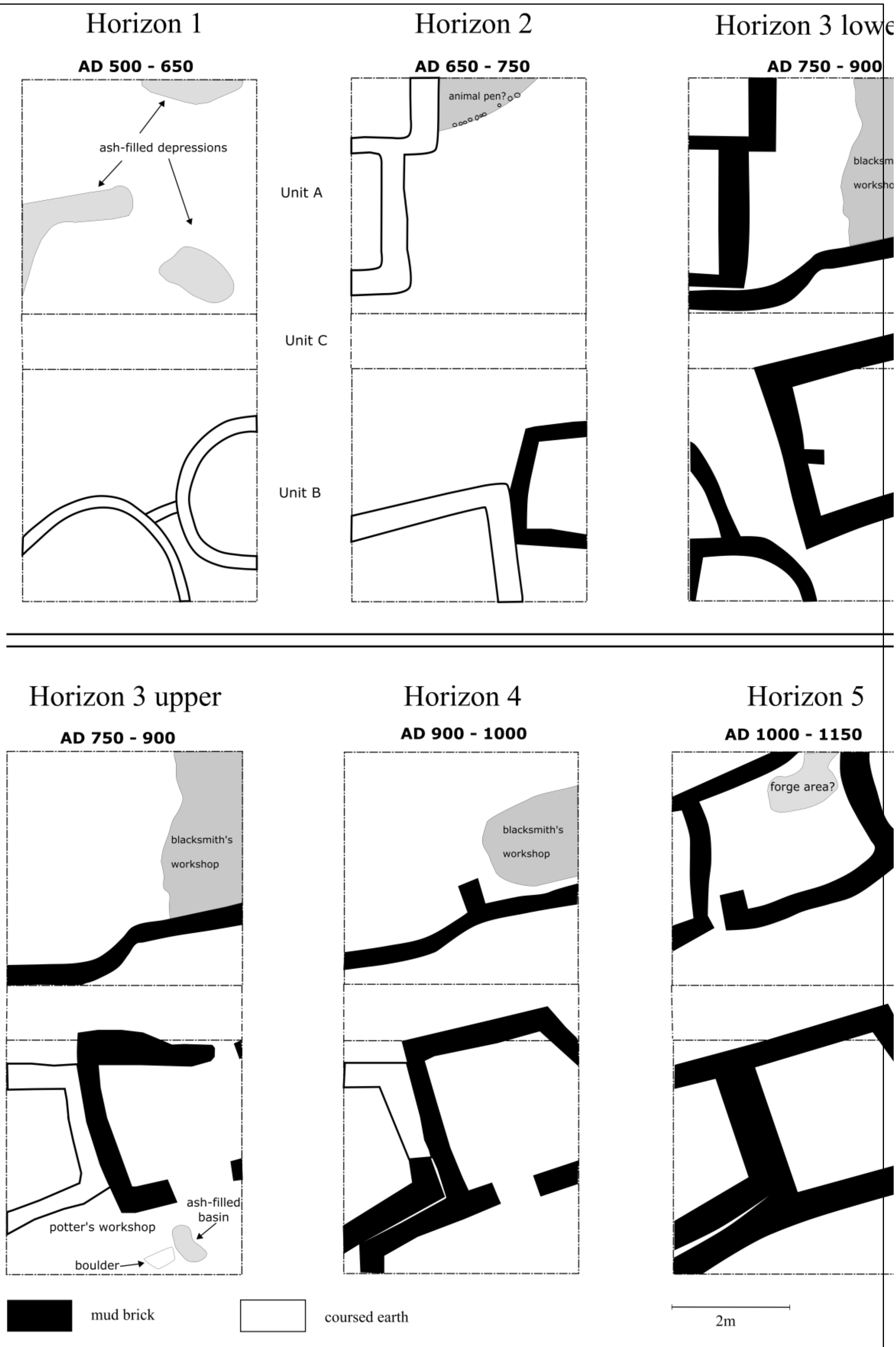


Figure 3.11 The architectural sequence in units A, B and C (From Gestrich and MacDonald 2018:5)

Archaeological sequence.

The site seems to have been continually occupied from the site foundation (500 AD-650 AD) to its abandonment around 1150-1200 AD. Nevertheless, the archaeological deposit sequence shows five horizons of superimposed earthen buildings (**Erreur ! Source du renvoi introuvable.** and Figure 3.12):

Table 3-5 Radiocarbon dates for Tongo Mare Diabal

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
95B-22	950±120	Cal AD 778 -1280	GX-21727	Charcoal (unsp.)	Gestrich and MacDonald 2018
95A-19	1140±85	Cal AD 684 1025	GX-21868	Charcoal (unsp.)	Gestrich and MacDonald 2018
95B-40	1105±80	Cal AD 694 -1147	GX-21728	Charcoal (unsp.)	Gestrich and MacDonald 2018
93A-36	1605±130	Cal AD 136 - 655	GX-19233	Charcoal (unsp.)	Gestrich and MacDonald 2018
95B-66	1235±70	Cal AD 660 - 962	GX-21729	textile	Gestrich and MacDonald 2018
95A-53	1200±110	Cal AD 642 -1026	GX-21869	Charcoal (unsp.)	Gestrich and MacDonald 2018
96B-93	1275±45	Cal AD 659 - 869	GX-24103-LS	Charcoal (unsp.)	Gestrich and MacDonald 2018
95A-66	1455±70	Cal AD 426 - 674	GX-21730	Charcoal (unsp.)	Gestrich and MacDonald 2018
96D-13	1600±45	Cal AD 352 - 563	GX-24104-LS	Charcoal (unsp.)	Gestrich and MacDonald 2018

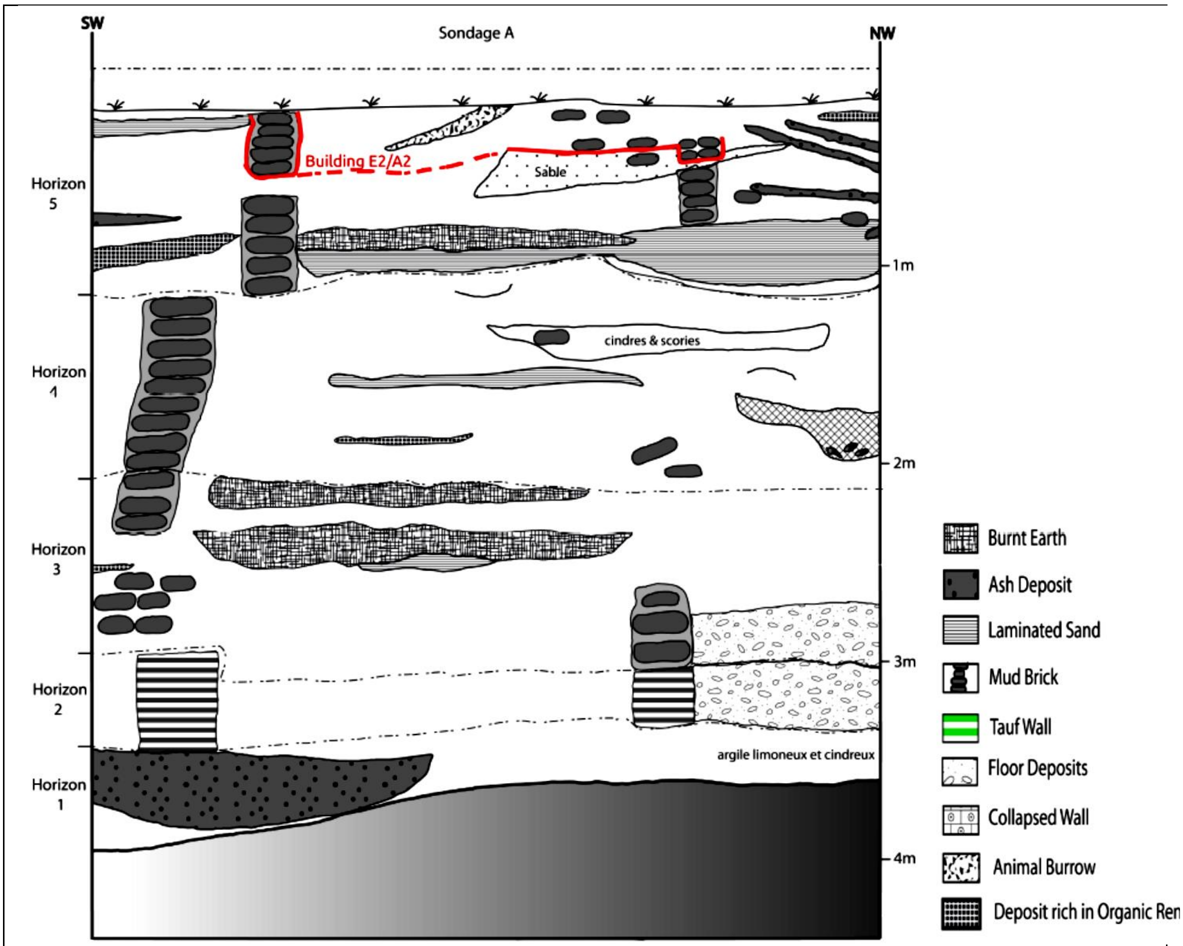


Figure 3.12: Unit A, East section showing the 5 horizons (Dotted line) and in red the remains of Buildings E2/A2 (from Gestrich 2013:32).

Horizon 1 – AD 500-650 (units A & B)

The initial occupation main structure is a curvilinear coursed earth structure that has potential open-air shallow ashy hearths (Figure 3.9) (Gestrich and MacDonald 2018). Similar and contemporaneous structures are well-known in Sahelian contexts, especially in Kirikongo (Dueppen 2012, Gallagher 2018), Oursi Hu-beero (Petit et all 2011) (Burkina Faso) and Birnin Lafiya (this research, North Benin). As all the above listed sites yielded archaeobotanical results these sites will be developed further later in this thesis (see Chapter 6).

Horizon 2 – AD 650-750 (units A & B)

Horizon 2 is characterised by a shift to rectilinear structures made in both coursed earth and loaf-shaped mudbrick. This continuity has been suggested as the new structures are superposed over the earliest circular rooms. The bipartite division of the space seems to indicate the presence of two separated concessions, one in the north (in unit A) and one in the south (in unit B) (**Erreur ! Source du renvoi introuvable.**) (Gestrich and acDonald 2018).

Horizon 3 – AD 750-900 (units A & B)

Two features were exposed. First in the north part with 120 cm depth of dense iron working remains, mainly charcoal and iron working slag, points to the presence of a **blacksmith's workshop** (forge). These remains are present up to horizon 5 where a small forge was exposed. Thus, this concession appears to have been occupied by a succession of iron-working specialists over a 400-year period. Secondly, the south section exposed three curvilinear and rectilinear mudbrick structures with terracotta drainpipes that seem to indicate an earthen flat-roofed house requiring drainage. Moreover a cluster of features show some evidence of a **potter's workshop**. Indeed nine intact vessels were found associated with a carbonised *Hibiscus* sp. mat but also with fragments of raw kaolinite, polished red ochre and lumps of raw clay. The presence of those two complementary workshops – potter's and blacksmith's – correspond to the present day gendered division of labor within the same lineage and same endogamous specialist group: women are the potters whereas the men are the blacksmiths (Gestrich and MacDonald 2018).

Horizon 4 – AD 900-1000 (units A & B)

Horizon 4 is the continuation of Horizon 3, with some evidence of repairs on the south Wall and remains of a terracotta equestrian statuette.

Horizon 5 – AD 1000-1150 (units A, B, D, E, F, and G)

In 2010, Gestrich opened a larger area, unit E (9x5m) and F (7x5 m) in the northwest vicinity of units A&B. Unit E and F are connected and were excavated only on the uppermost occupation level (Gestrich 2013). With the continuation of the blacksmith's workshop and the find of a putative forge, unit A and B gave evidence of three new small mudbrick rooms (Building A1, B1 and B2 in Figure 3.13) (Gestrich and MacDonald 2018). In total, within exposure 1 (Units A, B, C, E and F) twelve rectilinear earthen structures were discovered. The find of hearth, burnt walls and floors associated with large amounts of charcoal, iron objects and slag attest to the presence of another working area for blacksmiths. Exposure 2, unit G, a 7x4m unit located in the eastern part of the site also shows very similar features made up of five contiguous mud-brick buildings (Gestrich and MacDonald 2018). In conclusion, the architectural division of space at TMD strongly suggests that the settlement was divided into stable compounds, presumably lineage compounds similar to historic regional settlement organisation (Walicka Zeh 2000). Those compounds were built with two different techniques: the loaf-shaped mud bricks and the coursed earth (Gestrich and MacDonald 2018). Exposure D was a 4 by 4m excavation placed upon the western part of the site, as a potential point of contrast to Exposure ABC which was placed at the centre of the eastern part of the mound. It did not reach the sterile soil, and only fully exposed horizon 5 of the settlement and scraping the top of horizon 4. The excavation exposed a potential open central courtyard surrounded by a series of four curvilinear mudbrick rooms. The presence of hearths with hearth stones and large concentration of charcoal within ashy concentration also attests to this fact.

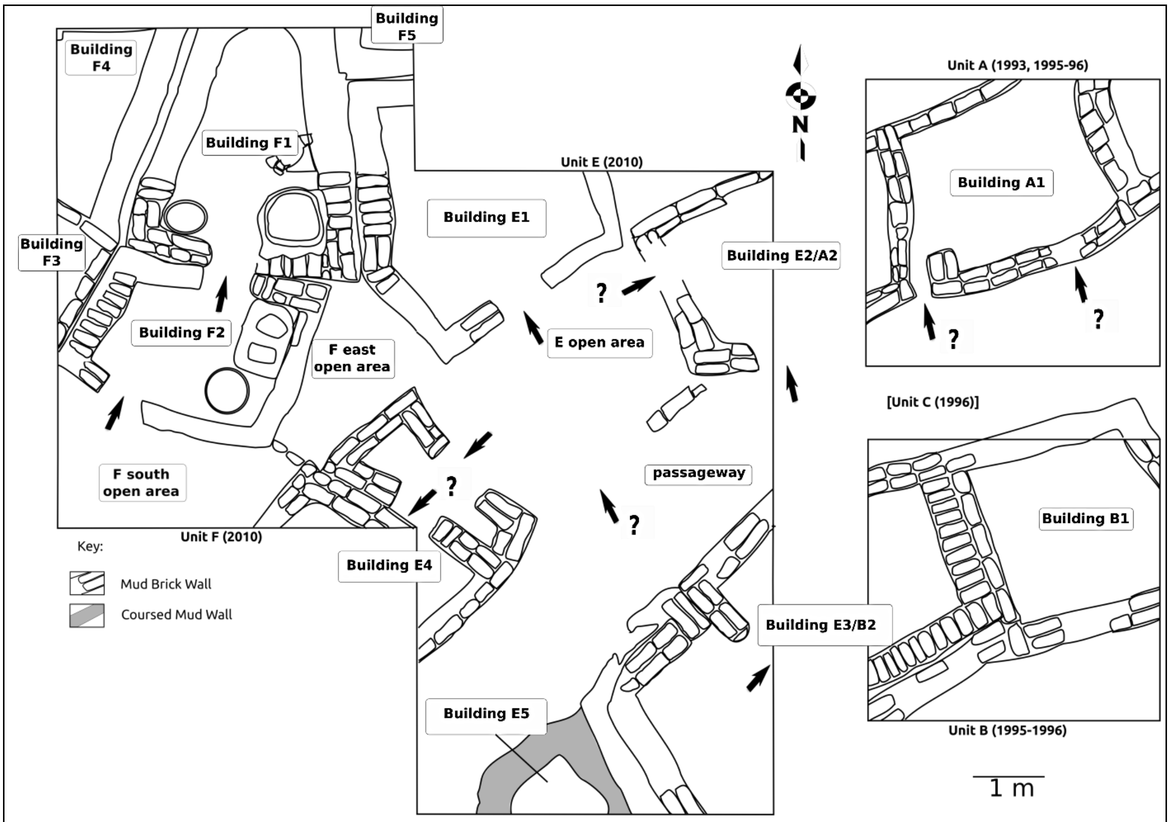


Figure 3.13. Plan of Horizon 5 (AD 1000-1150) in exposure 1 (Units A, B, C, E and F) (from (Gestrich and MacDonald 2018:8).

Finds

Faunal remains

Bones of domesticated and wild mammals, avian and fish remains were recovered at TMD. Bovid bones are the most numerous, followed by fish, dog and bird bones. Small medium bovids – likely sheep and goats but also potentially medium-sized antelopes – are the most common faunal remains. Cattle seem to be rare at the site until Horizon 3, suggesting that cattle-keeping or the presence of pastoral groups in the area may have become more prevalent at this time. The wild bovid that can be identified in the assemblage are adapted to a wide variety of habitats, ranging from open and arid steppe to wetter grasslands and woodlands. The presence of rodent commensals, such as mice and rats is also attested. Usually commensals are a good indication of a granary (Gestrich 2013, Gestrich and MacDonald 2018).

Pottery

The site can be compared with that of Birni Lafiya in Benin – both are settlement mounds (so-called Tells), situated in the Valley and dated to around the 4th and the 11th centuries AD. In addition, the ceramic assemblages have similarities (Gestrich 2013, Champion 2013). From the site foundation (Horizon 1) to abandonment (Horizon 5), two main pottery assemblages co-exist. First, tradition A is made by pounding over a concave mould lined with a straight woven mat of twisted fibres. Secondly, tradition B is made by pounding out a rounded base over a convex mould with the rims added by coil building. The decor of such pottery is usually made from braided cord roulette motifs. Tradition A is also noted but is much less frequent. The 'Red slip only' tradition is composed of fine paste vessels that are red slipped and highly burnished. Tradition A and red slip decrease through time while tradition B remains stable (Gestrich 2013, Gestrich and MacDonald 2018).

Gestrich (2013, 2018) showed that Tradition A shares some quite similar characteristics with the Dogon ceramic tradition A & B (historic and current period) of the Bandiagara escarpment. Also, Tradition B indicates some similitude with the contemporary Songhai pottery of the Lakes region. This proposes that TMD's potters had influences/connections from two separated geographical area, the Middle Niger (IND) and the Gourma region. This would put TMD as being at a cultural crossroad during the first millennium AD. Also, TMD's ceramic traditions appear to represent a clean break from those local ceramic LSA found in WKO and vicinities. This would suggest a transformation or replacement of local populations sometime between 500 BC to AD 500 (MacDonald 1996, Macdonald et al. 2017, Gestrich and MacDonald 2018).

Archaeobotanical Sampling

One hundred and fourteen samples were floated, mostly from domestic features such as middens, hearths and the contents from inside of pots. In the 1990s, Cecilia Capezza analysed 11 samples dominated by pearl millet.

3.1.4 Seno Plain

Between 2008 and 2011, research was conducted on a group of settlement mounds at Sadia on the Seno Plain (Dogon Country, Mali) (Huysecom *et al.* 2011, 2012, 2015), as well as extensive surveys and small-scale test pits at several other sites located throughout the Seno plain. The site of Sadia is composed of five anthropogenic mounds covering an approximate area of 3 ha, on a small natural elevation along the Guringin Valley (Map 3-1).

3.1.4.1 Sadia – (300 AD) 760-1300 AD

This research examines flotation samples derived from Sadia in Mali which were being investigated in 2010-11 as part of the "Human population and paleoenvironment in Africa" project of the Laboratoire Archéologie et Peuplement de l'Afrique (APA, UNIG) led by Eric Huysecom. Flotation success has provided plant macro-remains from 165 archaeobotanical samples dating from the 8th century AD to the 13th century AD.

<u>Units and Excavators</u>:
The APA team of the laboratory of Geneva University ran the excavations over the course of two field seasons. The first was dedicated to four 3x3m deep test pits – Mount I, II, II, and V – maximum depth of 5.5 m (Figure 3.12, Figure 3.14). During the second season the team opened a large area, 14x10m, to expose the abandonment occupation phase (Figure 3.17).
<u>Main publications</u>: Huysecom et al. 2011, 2012, 2015

Figure 3.14: Deep test pit in Mount I (Courtesy of A. Mayor).

Figure 3.15: Mud-Brick circular room from Mount I Phase 3, 2011 excavation (Courtesy of A. Mayor).

Between 2008 and 2011, research was conducted on a group of settlement mounds at Sadia on the Seno Plain (Dogon Country, Mali) (Huysecom et al. 2011, 2012, 2015), as well as extensive surveys and small-scale test pits at several other sites throughout the Seno plain. The site of Sadia is composed of five anthropogenic mounds covering an approximate area of 3 ha, on a small natural elevation along the Guringin Valley.

Archaeological Sequence

A series of Bayesian models relying on a set of 27 radiocarbon dates has enabled a more refined and accurate chrono-cultural framework of the Sadia *tells*. Three main phases can be distinguished for the mounds' development, which is preceded by a pre-*tell* occupation (Phase 0) (Figure 3.16). As the summit of the site had been exposed to erosion for over 500 years, the exact date of its abandonment is unknown. However, Bayesian modelling would suggest that this occurred by the early 14th century AD (Huysecom *et al.* 2015).

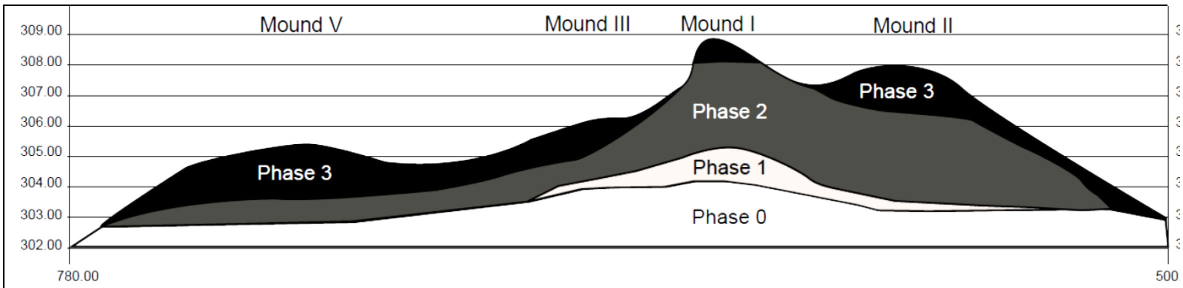


Figure 3.16: Synthesized transects marking the limits of each phase (From Huysecom et al. 2015:12).

Phase 0. 'Pre-Tell phase'. *Terminus ante Quem* of 1st to 3rd century AD

The yellow sandy layer of phase 0 was dated from a single radiocarbon date. This phase is an older occupation episode than the tell formation site (phase I).

Phase 1. From AD 760 to 970

Phase 1 witnessed the foundation of Sadia at the location of the most important mound of the site.

Phase 2. From AD 890 to 1160

Phase 2 saw the most important growth and expansion of the site

Phase 3. From AD1060 to 1300

This phase is the end of the expansion and the abandonment of Sadia. Extensive excavations conducted on the top of the most important mound (Mound 1) allowed a better knowledge of the architectural characteristics of Phase 3. From this extensive horizontal surface of 143 m², architectural features with around 100 structures were found. The habitat was made of domestic units composed of circular rooms and spaces of different shapes. Some of the circular rooms are clearly too small for houses and thus were probably related to specific activities such as cooking in the case of St. 28 (Huysecom et al. 2015).

Table 3-6 Radiocarbon dates from Sadia

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
Mound I, 7	1895±35	Cal AD 29-221	ETH-40328	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 5	1235±30	Cal AD 688-880	ETH-40327	Charcoal (unsp.)	Huysecom et al. 2015
Mound II, 7	1190±30	Cal AD 721-945	ETH-40334	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 4b	1090±30	Cal AD 893-1015	ETH-40326	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 3	995±30	Cal AD 986-1154	ETH-40325	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 2	970±30	Cal AD 1017-1156	ETH-40324	Charcoal (unsp.)	Huysecom et al. 2015
Mound II, 5	1060±30	Cal AD 896-1025	ETH-40333	Charcoal (unsp.)	Huysecom et al. 2015
Mound II, 3	1003±44	Cal AD 903-1158	Erl-15786	Charcoal (unsp.)	Huysecom et al. 2015
Mound III, 6	1050±30	Cal AD898-1097	ETH-40335	Charcoal (unsp.)	Huysecom et al. 2015
Mound III, 5	1110±40	Cal AD784-1019	ETH-39633	Charcoal (unsp.)	Huysecom et al. 2015
Mound V, 7	846±45	Cal AD1049-1271	Erl-15790	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	900±30	Cal AD1046-1186	ETH-40323	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	875±35	Cal AD1041-1252	ETH-43051	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	995±35	Cal AD983-115	ETH-43057	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	925±35	Cal AD1025-1186	ETH-43058	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	900±35	Cal AD 1039-1213	ETH43053	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	925±35	Cal AD 1025-1186	ETH-43052	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	810±35	Cal AD 1167-1274	ETH-43054	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	870±35	Cal AD 1044-1254	ETH-43055	Charcoal (unsp.)	Huysecom et al. 2015
Mound I, 1	885±35	Cal AD 1040-1220	ETH-43056	Charcoal (unsp.)	Huysecom et al. 2015
Mound II, 2b	835±30	Cal AD 1156-1268	ETH-40332	Charcoal (unsp.)	Huysecom et al. 2015
Mound II,1	865±30	Cal AD 1047-1256	ETH-40330	Charcoal (unsp.)	Huysecom et al. 2015
Mound III,3	935±40	Cal AD 1021-1186	ETH-39632	Charcoal (unsp.)	Huysecom et al. 2015
Mound III,1	955±40	Cal AD 1000-1175	ETH-39631	Charcoal (unsp.)	Huysecom et al. 2015
Mound V, 5	802±46	Cal AD 1059-1285	Erl-15789	Charcoal (unsp.)	Huysecom et al. 2015
Mound V, 4b	841±45	Cal AD 1046-1274	Erl-15788	Charcoal (unsp.)	Huysecom et al. 2015
Mound V,1	913±44	Cal AD1030-1211	Erl-15787	Charcoal (unsp.)	Huysecom et al. 2015

Finds

Architectural remains

In total more than 200 domestic features were observed. The most common remains are mud-brick circular buildings (Figure 3.15 and Figure 3.17) and occupation floors but post holes, pits and hearths were also found. The spatial and stratigraphic homogeneity of features types indicated a continuous occupation from the bottom to the top (Huysecom *et al.* 2011, 2012, 2015).

Faunal Remains

Animal remains are essentially based on domesticates. Caprine remains are the largest part of the livestock (51%) with goat clearly being more important. Cattle are also present with around 30% of the animal remains. Donkeys and chickens are present in small quantities. Wild animals (<5%) are represented by varieties of gazelles, giant rats, birds, and reptiles (crocodiles, frogs and snakes). Fish are well-represented by species found in floodplains and temporary ponds. Diachronic analysis has shown a reduction in domesticates with a decrease of cattle paralleling an increase on caprines through the sequence (Huysecom et al. 2011, 2012, 2015).

Archaeobotanical Sampling

From the large exposure (Figure 3.17), with the exception of the walls remains and structures, the archaeobotanical team headed by Stephany Kahlheber decided to take a soil sample from almost every structure. From the deep test pit each context, arbitral or natural was collected systematically from the 3 test pits (SI, SII, and SIII). The average amount of soil collected was 15 litres for each sample, some smaller contexts, such as hearths, were collected in their entirety. Flotation success has provided plant macro-remains from 146 archaeobotanical samples, from around 2200 litres of archaeological soil matrix.

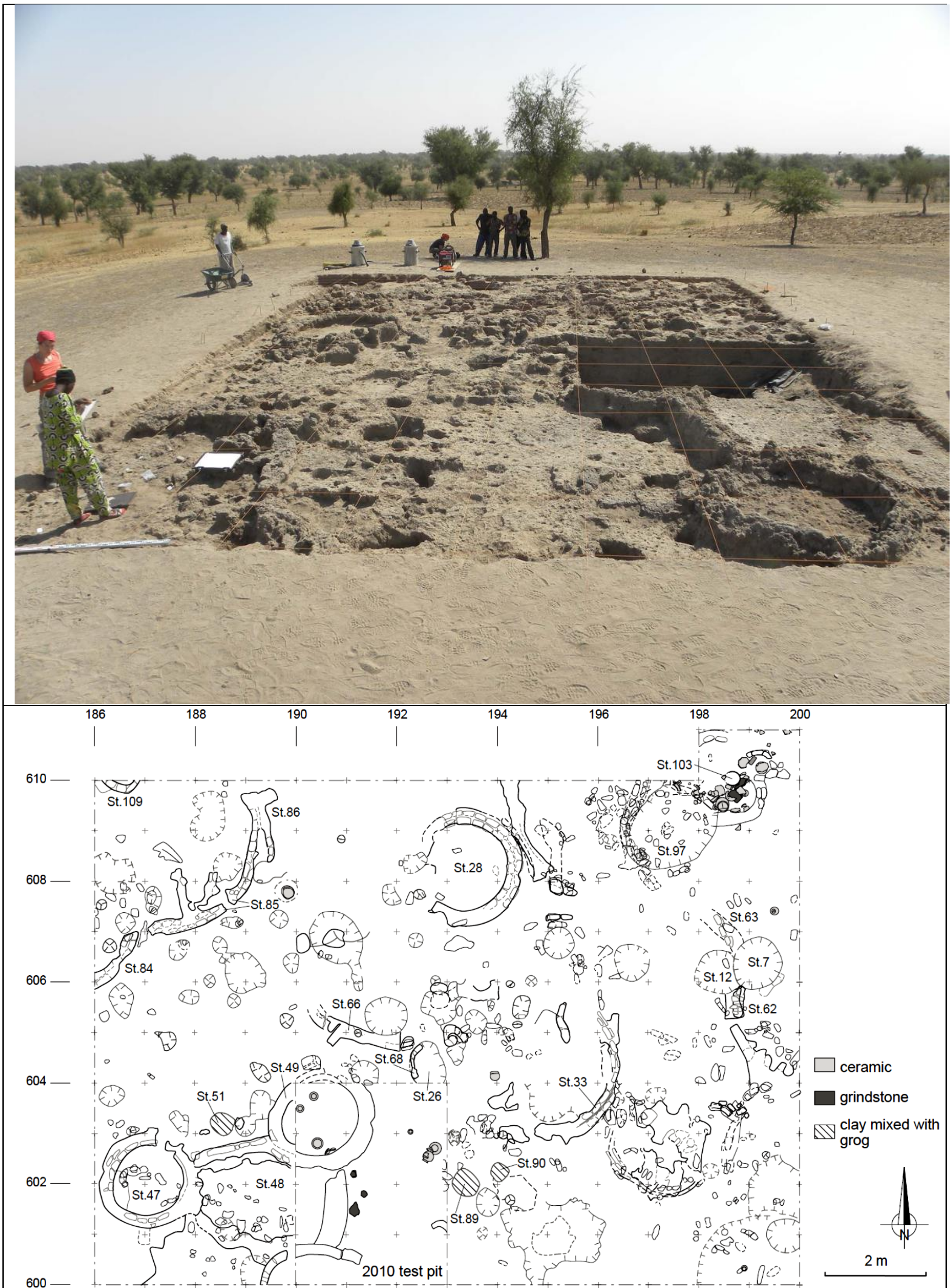


Figure 3.17: Plan of Sadia Mount I extensive excavation. Overview of architectural features of Phase 3 (Courtesy of A. Mayor and plan from Huysecom et al. 2015:15).

Discussion

An extensive study of the region (Huysecom 2002; Huysecom et al. 2004, 2015; Mayor 2011 b; Mayor et al. 2005, 2014; Ozainne 2013; Ozainne et al. 2017) has shown that between 750 and 1250 AD many settlements of similar size were established in the Guringin Valley. This research suggests the development of rural and non-centralised societies during a peaceful period, which were economically self-sufficient and probably politically independent of the first urban centres of the Niger Bend. Thus, the area of direct influence of these early Sahelian polities probably did not extend far from the Niger axis and southeast of the Bandiagara Escarpment before the 14th-15th century AD. However, due to their geographical proximity, the Seno societies developed commercial links with the Niger Bend urban centres, as shown by the presence of goods from medium – and long-distance trade at Sadia. Whilst the abandonment of the Sadia settlement mounds at the turn of the 13th to the 14th century AD cannot be fully explained based upon our current state of knowledge; previous research attempted to exclude climatic-environmental degradation as the main causal factor (Huysecom et al. 2015).

3.1.5 Archaeological timeframe for the Mali

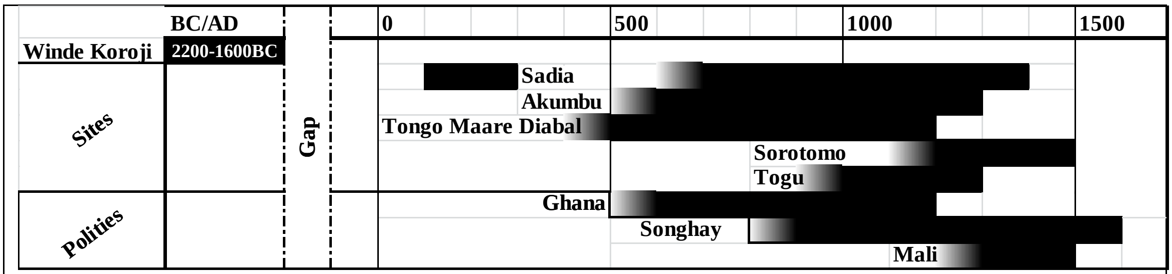


Figure 3.18: Schematic table of the archaeological sequence of the six Malian sites sampled in this research. This is also included the timeline of the main polities cited in the text.

In conclusion, this research includes 317 archaeobotanical samples (from 3,258 litres of soil) from six sites located in what is present-day Mali (Figure 3.18 Figure 3.19). With the exception of Windé Koroji dated to 2200-1600 BC, each site developed during the same period of the polities of Ghana and Mali, ca 400-1500 AD. These sites are located in different ecological environments; floodplain (Sorotomo and Togu), valley edges (TMD, WKO, Akumbu) and dry environment (Sadia). Moreover, each site seems to have a different position in terms of trajectory towards urbanism. First, Sorotomo and Togu were occupied for a shorter period (≈ 250 years), compared to the other sites, and could be related to a *Fadugu*, or stated-generated town. Secondly, Tongo Maaré Diabal and Sadia are at the periphery of the main contemporaneous polities. TMD is a *Numudugu*, a potential state generated settlement specialised in metal working. Sadia is a smaller site that could be part of a broader clustered settlement. The site seems to have developed a proto-urbanization stage but was abandoned, or destroyed by war, before becoming fully-urban. Sadia was probably a *Markadugu* 'en devenir'. And lastly, Akumbu is a larger, well clustered site composed of a multitude of settlement mounds that is comparable with a *Markadugu* (deep stratified …) such as the well-known site of Jenné-Jeno and Dia.

Site	Phase	Surface	Archaeobotanical sample		site type
		Hectares	Numbers	Litres	
Sorotomo	AD 1400-1500	72	20	286	Fadugu
	AD 1300-1400		4	20	
	AD 1200-1300		3	30	
Togu	AD 1200-1300	30	5	25	
	AD 1100-1200		4	20	
	AD 1000-1100		8	40	
Akumbu	AD 1000-1400		2	10	Markadugu
	AD 600-1000		1	5	
Windé Koroji	Post 1600 BC		2	2	Neolithic
	1600-1100 BC		4	12	
	2150-1900 BC		4	12	
Tongo Maaré Diabal	AD 1000-1150	12	71	400	Numudugu
	AD 900-1000	9	19	95	
	AD 750-900		15	80	
	AD 650-750		5	25	
	AD 500-650		4	20	
Sadia	AD 1060-1300	3	87	1317	Markadugu ?
	AD 9890-1160	2.5	42	662	
	AD 760-970	1	8	86	
	I-III century AD	?	9	111	
Total			317	3258	

Figure 3.19: Synthesized table of the Malian sites presented in this research including site type and surface area but also the number of archaeobotanical samples and litres of archaeological matrix collected and floated by site and phase.

Thus, when these six sites are compared with other known archaeological sites in the region that have already yielded archaeobotanical samples from Mali (see Chapter 7), the sites presented in this chapter can be seen as representative of the settlement pattern and agriculture evolution of the Mali agronomic and gastronomic landscape.

3.2 Sites in Benin

The second set of data for this current study comes from north Benin with 13 archaeological sites. One site, Niyanpangu-bansu, was excavated in Banikoara region (around 125 km from the Dendi area) by Mardjoua Barpougouni. The other 12 archaeological sites were excavated for the “Crossroads of Empires” project in northern of Benin. This was an ERC-funded project directed by Anne Haour (University of East Anglia) (e.g. Haour 2011). The project’s aims were to make an inventory of archaeological sites along the Niger River, in an area known as Dendi; and, ultimately to produce an archaeological and ethnographic map for the area, focusing on the materialisation of past polities and craft productions. The broader research aims of the project were to combine archaeological and oral tradition investigations to shed light on the way the historically-attested polities of the area (Songhai, Borgou, Hausa) influenced settlement and material culture across the landscape in the first and second millennium AD. Despite its geographically central location, very little is known about this region of West Africa; no archaeological investigation had been undertaken prior to the Crossroads Project, so a focus was on building up the first chronological, material culture and archaeobotanical sequences for this part of the continent. The choice of research area is not the result of chance. While this part of Benin may still be poorly understood archaeologically, it nonetheless possesses substantial evidence for the presence of ancient human settlement. In fact this region benefits from the great River Niger, which not only irrigates and fertilises the land, but provides an important means of transport and travel by canoe. In addition, the region is at the confluence of two major ancient dry valleys known today as the "Dallols", by which trans-Saharan caravans carried a flow of people and their merchandise. This area is also crossed by numerous trade routes between Hausa country and the Forest Region (now Ghana)

In short, our study area is at the crossroads of three major traffic routes:

- The Northwest ←→Southeast route formed by the River Niger.
- The Southwest←→Northeast axis that connects the Hausa country to Ashanti forests.
- And North←→South axis of the trans-Saharan caravan route.

Thus, this road and fluvial hub made this part of Africa an important centre of trade and cultural exchange.

As part of the Crossroads Project, four field missions have been carried out, the last one in January and February 2014. These multidisciplinary missions included archaeological survey and excavation (Haour et al. 2011, Haour 2013a, b, c), investigation into oral histories (Gosselain 2012), exploration of the architectural evolution and oral and archaeological surveys to track the techniques and modalities of steel production and iron working (Robion-Brunner 2015). The four previous archaeological missions have uncovered, by pedestrian survey, up to 1000 potential archaeological sites. The second part of the project involved oral investigations led by Olivier Gosselain and Lucie Smolderen, both at the Université Libre de Bruxelles. The objectives of their joint work was to collect information on the history of the region of the villages and its inhabitants; to learn about crafts and particularly that of the pre-colonial cotton industry; and to rebuild the ancient trade and exchange systems that intersected in this region. The final component of the oral investigations was directed by Paulo Farias, whose main objective was to locate places and passages along the ancient caravan routes, especially the famous Katangas.

Archaeological background of North Benin

Archaeological data from the Republic of Benin are limited compared to other regions of the world and even compared to other parts of Africa. Indeed, only a few sites were excavated previously and most parts of Benin are currently *terra incognita* from an archaeological perspective. The main exceptions are surveys carried out by N'Dah (2006) in the early 2000s, before which time no archaeological research had been implemented. In his surveys N'Dah identified ten potential archaeological sites called anthropogenic mounds. These sites are characterized by the presence of a very large number of pottery fragments strewn on the ground surface (N'Dah 2006).

One of the few archaeological excavations known nearby are in Nigeria. Indeed, in 1968, rescue excavations in the region of Bussa, approximately 250 km south-east of our study area, revealed 13 archaeological sites, all of which were subsequently destroyed by the construction of a water reserve at Kainji. Within these 13 sites, 26 test-pits were excavated, six of which were selected for analysis. No absolute dates were obtained. It is noteworthy that similar pavements to those found during excavations of the Crossroad Project were discovered and that the ceramic material present was mainly a roulette decoration (Haour 2013).

3.2.1 The Middle Niger Valley and the Dendi area

The various test pits excavated by the crossroad team can be understood when combining their stratigraphy and associated finds, with the landscape in which they are set. Thus, the first part will focus on each test pit and the second part will describe the archaeological phasing of the Dendi area. The site of Birni Lafia, which, in light of its large area (dozens of acres) and the quantity and quality of artefacts found on its surface, is at the centre of the Crossroad Project. Digging in Birni Lafia, allowed us to find a portion of what is probably a house with a circular room paved with potsherds dated to the $11^{th} – 13^{th}$ AD century. The site of Tintin is also a settlement Tell-type hill with evidence of houses. Indeed the excavation went through seven different potsherd pavements. Other sites (Kozoungou, Kouboukoukourou, Bogo-bogo, Gourouberi, Madekali, Kargi) dating to the last part of the second millennium were excavated following the instructions of the oral history investigation. According to the oral history research, these sites are supposed to be the former settlements of the current villages. Thus, it also means that all the test pits were excavated in the current village. The majority of the contexts excavated were middens.

3.2.1.1 Pekinga Pek-12

<u>Units and Excavators</u>:

Pek-12 is a 2x1m test pit, 155 cm deep excavated by Abubakar Sule Sani.

<u>Main publications</u>: Sani 2018

The site is a low settlement mound that contains evidence of various surface cultural materials, including presumed house foundations and other disturbed rock scatters. The location of the trench was decided on the basis of the density of surface materials. The excavation allows us to expose nine contexts (Figure 3.20). Context 1 and 2, are the uppermost layers of the deposit. Due to modern disturbance only one sample was selected for flotation. Context 4 is an ashy deposit, maybe a pit, entirely sampled. Context 5 is a potsherds pavement. Context 6 is a very ashy pit dated to 1040 +/- 30 BP (Beta 321058; Table 3-7). It is notable that a grindstone was recovered from this context. Contexts 7 and 8 are concomitants, 7 is a linear arrangement of stone boulders fixed by the soil matrix of context 8. Context 9 is the end of the excavation with a compact soil layer and few artefact remains. The context finishes with the presence of the natural soil at 155 cm.

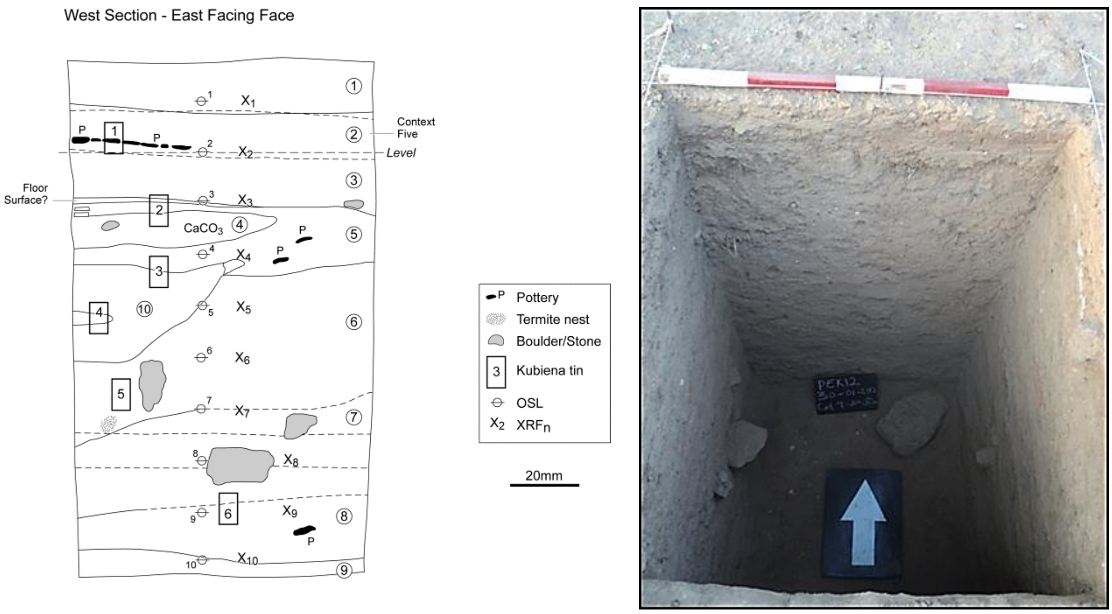


Figure 3.20 Pekinga West Section at completion © Adderley.

Archaeobotanical samples and radiocarbon Dates

Six samples were collected from the main context from a total of 120 litres of soil.

Table 3-7 Radiocarbon Dates from Pekinga

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
PEK-12-SI, context 2 (-22 cm)	610±30	Cal AD 1295-1404	Beta-321057	Charcoal (unsp.)	Sani 2018
PEK-12-SI, context 6 (-130 cm)	1040±30	Cal AD 901-1033	Beta-321058	Charcoal (unsp.)	Sani 2018

3.2.1.2 Tintin Kanza TTK- 13

<u>Units and Excavators</u>:

TTK-13-SI consisted of a 1x2m test pit. The southern part of the test pit was sterile at 140 cm BD, while in the northern side sterility was reached at 390 cm BD. It was excavated by Louis Champion.

<u>Main publications</u>: Champion and Haour 2013, Champion 2018

The site of Tintin Kanza is located on the southern bank of the Niger River, near the small hamlet of Tintin. It consists of a small mound, backed by a cliff to the south and opening on the Niger River in the north. It lies at a point at which the floodplain is very narrow compared to other stretches of the river. It is situated close to two places of current and past ceremonial significance (Kanza cave and 'Nooru Bangu', the cowry marsh). The open-air site of Tintin Kanza is a large settlement mound of about twenty metres high that overlooks the Niger River. The extent of the mound is approximately 16,000 m². The land has been cultivated with sorghum in the recent past and is now composed of dispersed patches of shrubs and trees. At the top of the mound is an escarpment of relatively steep elevation and dense vegetation. Surface collection on the mound has revealed moderate to very high concentrations of pottery sherds and other evidence of past settlement, such as the presence of grindstones.

The excavation of Trench I at Tintin Kanza revealed 26 archaeological contexts, including 12 distinct levels of occupation: 7 ceramic pavements and 5 destruction layers, just over a depth of 110cm. Such destruction layers are defined as resulting from the destruction (mainly by fire in this case) of the previous occupation level. The remains of that destruction were levelled to be used as a new base for the next occupation level. The presence of seven successive pavements in such a short time period, as indicated by the radiocarbon dates (see below), suggests a very quick succession of building episodes in less than 400 years.

Radiocarbon dates

Table 3-8 Radiocarbon Dates from Tintin Kanza

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
TTK-13-SI, context 1, level 5. From inside a large ceramic vessel	620±30	Cal AD 1292-1401	Beta-417590	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, context 2 (-62 cm) Direct association with pavement	1010±30	Cal AD 973-1150	Beta-345502	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, level 7 (destruction level)	570±30	Cal AD 1304-1423	Beta-417589	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, level 9 (destruction level)	930±30	Cal AD 1025-1165	Beta-417591	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, level 12 (Context 21)	910±30	Cal AD 1033-1204	Beta-417593	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, level 12 (destruction level)	560±30	Cal AD 1307-1429	Beta-417592	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, context 16 (hearth in middle of Pavement 7)	880±30	Cal AD 1042-1222	Beta-417594	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, level 10 (Context 18)	900±30	Cal AD 1039-1210	Beta-417595	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, context 18 (-110 cm)	610±30	Cal AD 1295-1404	Beta-348769	Charcoal (unsp.)	Champion & Haour 2018
TTK-13-SI, context 19 (-340 cm)	1060±30	Cal AD 897-1024	Beta-348770	Charcoal (unsp.)	Champion & Haour 2018

There are ten dates for TTK SI (Table 3-8). A sample from the base of Context 19 (level 34, approx. 350cm BD) has yielded a date of 1060±30 BP. Context 18, a horizontal deposit forming the base of the succession of pavements, yielded a date of 610±30 BP while Context 2, a thin deposition layer at the top of the succession of pavements, yielded a date of 1010±30 BP. The former date is too late, considering its position and should be considered intrusive; it may have been brought in by the vertical feature, Context 17. The others dates fit in a site occupation from 1000 to 1400 AD.

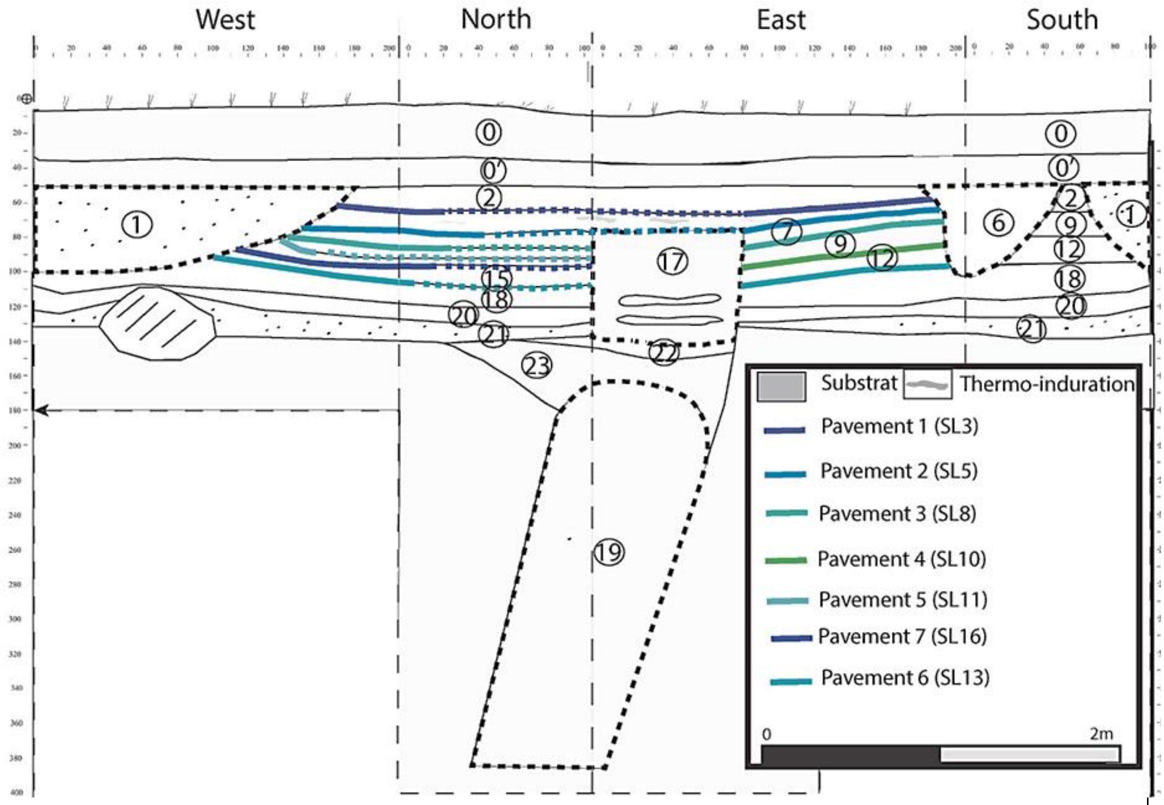


Figure 3.21 Section of TTK-13-SI by Champion

Figure 3.22 TTK SI at completion (Photo Champion, 2013).

Figure 3.23 Sampling of the west section where the seven pavements were visible (Photo Champion 2013).

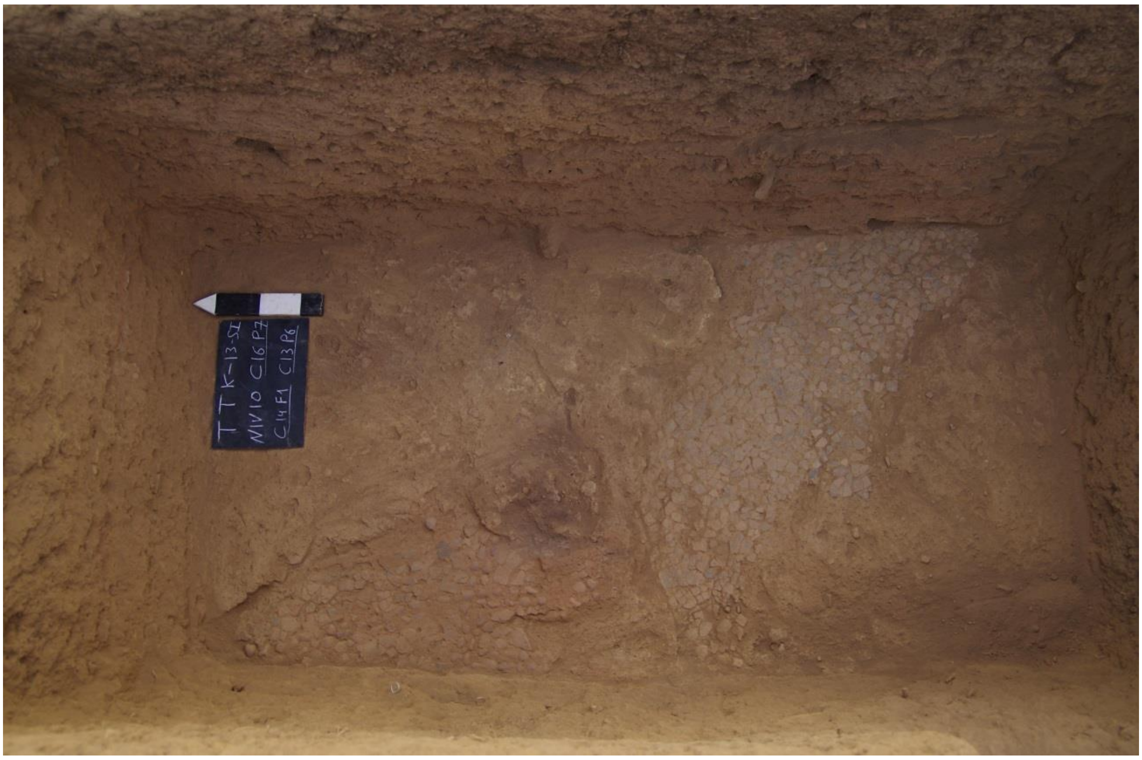


Figure 3.24 Potsherds pavement: Pavement 6 and 7. A small hearth is also visible in the middle of the picture (Photo Champion, 2013).

Figure 3.25 Section East at completion. Potsherds pavements are visible on the right side of the section, especially the top one (Photo Champion 2013).

Archaeobotanical sample

Every main archaeological context, especially the destruction layers, which were full of ash and the hearth, were sampled for a total of 9 samples from 172 litres of archaeological soil.

3.2.1.3 Alibori site 2

Units and Excavators:

ALB 2 – SIII is a 2X1 m unit excavated under the supervision of Professor Didier N'Dah from the Université D'Abomey Calavi in Benin.

Main publications: N'Dah, *In Press*

The site, located on the left bank of Alibori River, is at a slight elevation of 700 m² and littered with lithic débitage and concentrations of pottery. Potsherds pavements were found in places. Four stratigraphic layers were identified. The first layer was yellowish brown, the second layer bright brown while the third layer was very pale brown. The final layer was a light yellowish soil with reddish lateritic gravel. During the excavation, Didier N'dah (*In Press*) found that level 50-60 cm marked a clear separation of the distribution of artefacts and sediments. The north side of the test pit was yellowish with only lithic material debited without pottery sherds, while the southern half was reddish with mainly pottery and some lithics. The southern reddish section revealed itself as a pit that contained a thick ashy layer of charcoal. That peculiar pit was sampled for archaeobotanical purposes (N'Dah, *In Press*).

Archaeological Sequence

Table 3-9 Radiocarbone Dates for Alibori site 2

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
ALB-14 Site 2-SIII (-10-20 cm)	730±30	Cal AD 1224-1298	Beta-378257	Charcoal (unsp.)	N'Dah 2018
ALB-14 Site 2-SIII (-50-60 cm)	2440±30	Cal BC 751-408	Beta-378259	Charcoal (unsp.)	N'Dah 2018
ALB-14 Site 2-SIII (-70-80 cm)	2440±30	Cal BC 751-409	Beta-378258	Charcoal (unsp.)	N'Dah 2018

Following the three dates obtained from this site, two phases are observed. The earliest one is dated to 800-400BC and shows that the site was occupied by people who still worked stone and used pottery. The sherds associated with this occupation are fine and little decorated (Table 3-9; Beta-378258, 2440±30BP from the bottom of the pit at 70-80 cm and Beta-378259, 2440±30 BP from the upper part of the Pit). The second phase is dated to 1250-1300 AD (Beta-378257, 730±30) and correspond to Birnin Lafiya abandonment phase. This phase is characterised by the presence of potsherds pavement.

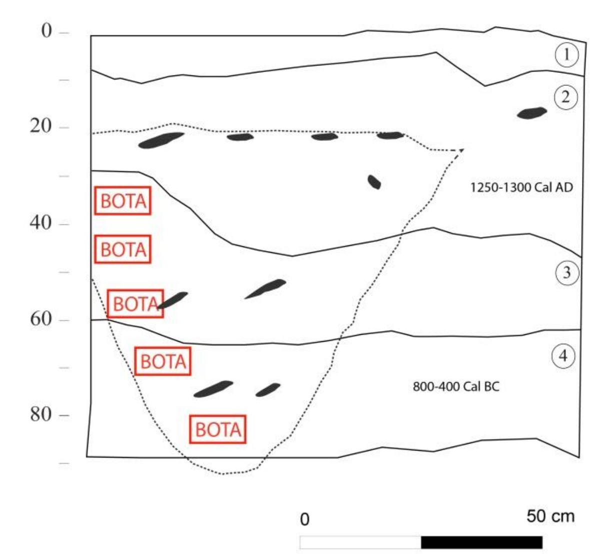


Figure 3.26 Alibori South Section at completion (Courtesy of A. Haour).

3.2.1.4 Birnin Lafiya

Units and Excavators:

SIII, SX, SXIV	Sam Nixon (*In press*)
SIV	Haour and Barpougouni (*In press*)
SV	Smith, Nikis, Champion & Haour (*In press*)
SVIII	Lee (*In press*)
SIX	Smith and Nikis (*In press*)
SXI	Lee (*In press*)
SXIII	Wexler and Labiyi (*In press*)
SXVIII	Guemo and Robion Brunner (not published)
SXIX	Frank (not published)
BAO-FIII	Champion (not published)

Main publications: (Haour et al. 2016), Haour et al. *In Press*

The site of Birni Lafia (BLAF), which, in light of its large area and the quantity and quality of artefacts found on its surface, was the central focus of the Crossroad project. Topologically, it is a large settlement mound, nine meters in height, which surrounds the floodplain. The site is particular for its size (at least 26 hectares) as well as the well-preserved artefacts found on the surface such as ceramics pavement, sherds, and pots and pits (Haour et al. 2016). Birnin Lafiya was first identified in 2001 by Didier N'Dah (2006). Due to its importance, Birnin Lafiya received particular attention during the four years of the project. Indeed more than twenty test pits were excavated. From these test pits, four offered very deep stratigraphy of around 4 metres. One of the test pits is a horizontal excavation that followed the surface of a potsherd pavement. Within those 20 test pits, 14 were selected for archaeobotanical sampling. Every one of these 14 test pits will be discussed further in the following paragraph.

BLAF-12-SIII, BLAF-13-SX and BLAF-14-SXIV

The three test pits consist of the same extensive horizontal excavation dug by excavator, Sam Nixon. The excavation at Birni Lafia, allowed us to exposed 100 m² surface area of what is probably a house with six distinct spaces dated to the 11th -13th century. The house complex consisted of two circular rooms (1 and 2), respectively 3 metres and 2 metres in diameter, paved with potsherds (Figure 3.27 and Figure 3.28). Adjoining room 1, a large well-preserved area was also excavated. This area is divided in two spaces, one with potsherds pavement and the other with laterite pavement, that formed a partially courtyard (Haour, *In press*, Nixon *pers. com.*). Across all the excavation but mainly in room 1, large quantities of crushed pots were found on the floor surface.

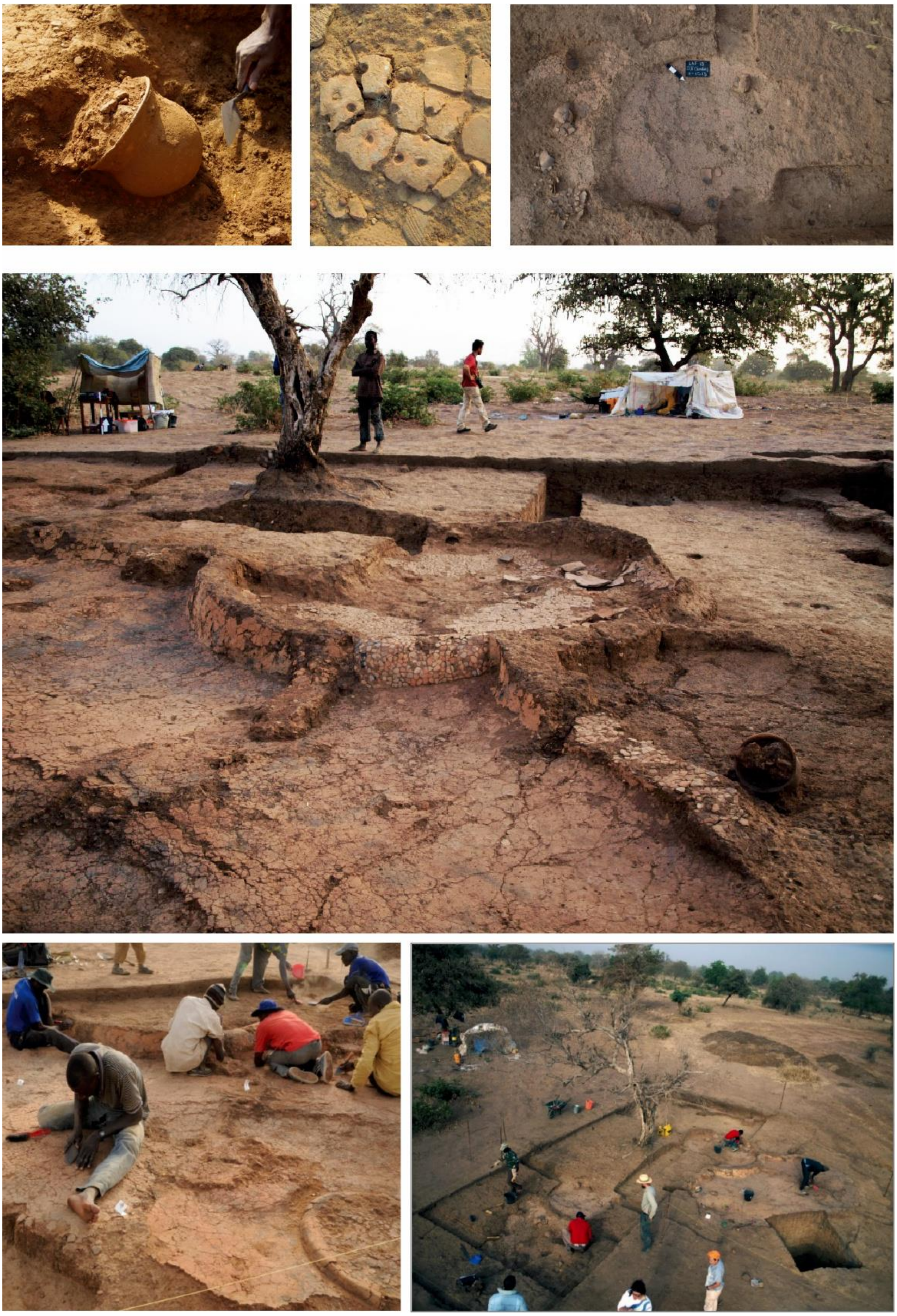


Figure 3.27: Excavating a multi-roomed paved structure at Birni Lafia, 2012-2014 (photos courtesy of Sam Nixon).

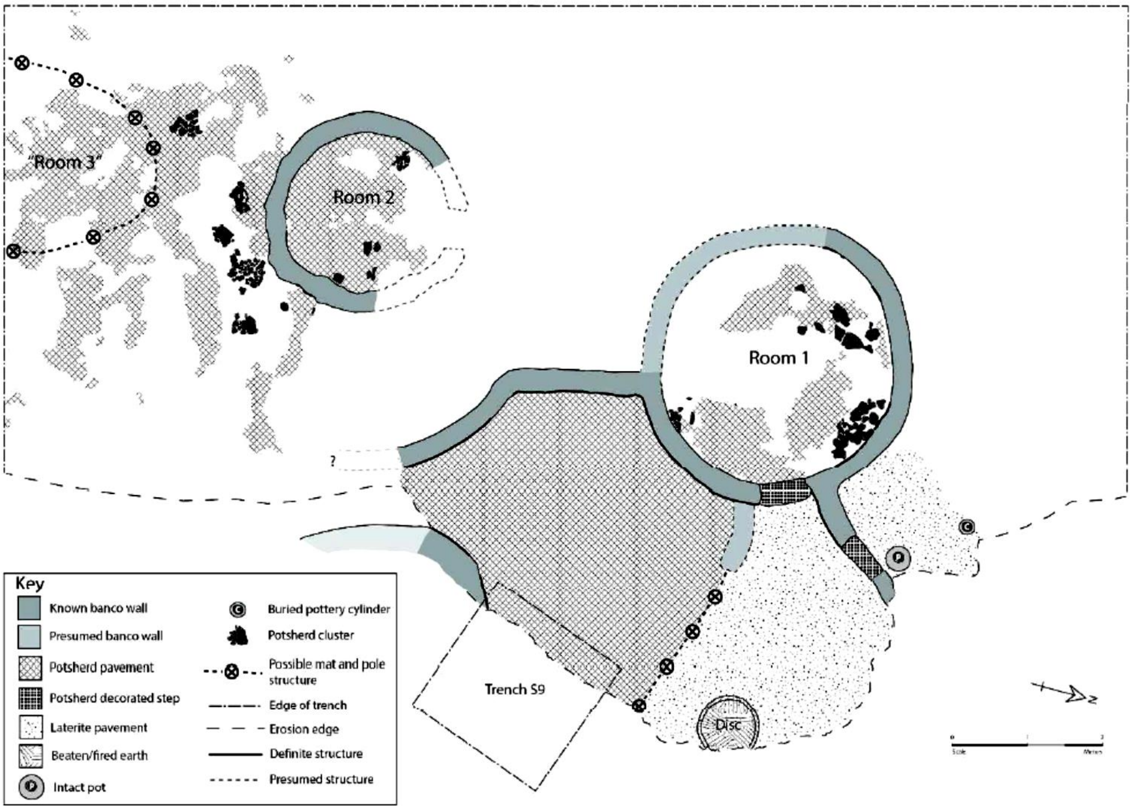


Figure 3.28.Plan of structural complex with walls and potsherds and laterite pavements, excavated as SIII, SX and SXIV. The position of BLAF-13-SIX is also indicated. Drawing by Sam Nixon. Reproduced from Haour 2016.

Archaeobotanical sample

For archaeobotanical purposes, 17 soil samples were collected in 3 units. The samples included deposit and pit contexts but also five well-preserved crushed pots components.

Radiocarbon dates

Fourteen radiocarbon dates (Table 3-10) ranging from 921 ± 23 BP. (OxA-29892) to 740 ± 40 BP. (Beta-305218) are currently available for the unit (Haour et al. 2016).

Table 3-10 Radiocarbon Dates for Blaf SIII and SX

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
BLAF-12-S3, context 6 (paved area & associated step feature)	862±22	Cal AD 1052-1244	OxA-29886	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-12-S3, context 8 (paved area & associated step feature)	910±23	Cal AD 1036-1185	OxA-29887	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-12-S3, context 9 (-40 cm ; On potsherd pavement)	880±30	Cal AD 1042-1222	Beta-320517	Charcoal (unsp.)	Haour et al. 2016: Table S1,
BLAF-13-S10, context 4	887±23	Cal AD 1045-1217	OxA-29889	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 4	819±24	Cal AD 1170-1263	OxA-29890	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 4	843±23	Cal AD 1160-1255	OxA-29891	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, Room 2	921±23	Cal AD 1034-1163	OxA-29892	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, Room 2	869±24	Cal AD 1048-1224	OxA-29893	Charcoal (unsp.)	Haour et al. 2016: Table S1,
BLAF-13-S10, Room 2	781±24	Cal AD 1218-1275	OxA-29894	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 8	906±23	Cal AD 1218-1275	OxA-29895	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 8	840±24	Cal AD 1161-1256	OxA-29896	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 8	908±22	Cal AD 1038-1185	OxA-29897	Charcoal: Anogeissus leiocarpus	Haour et al. 2016: Table S1,
BLAF-13-S10, context 30	819±24	Cal AD 1170-1263	OxA-29888	Charcoal (unsp.)	Haour et al. 2016: Table S1,

BLAF-12-SIV

Test pit SIV, 2X1m, is very deep (320 cm BD) and possesses complex stratigraphy. The deposits consisted largely of a series of pits, cutting into one another. Portions of the living surfaces were also excavated, but it was practically impossible to distinguish between these contexts.

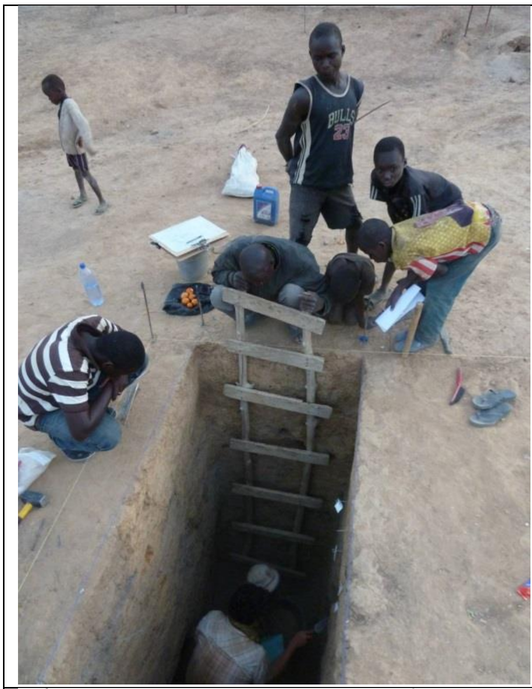
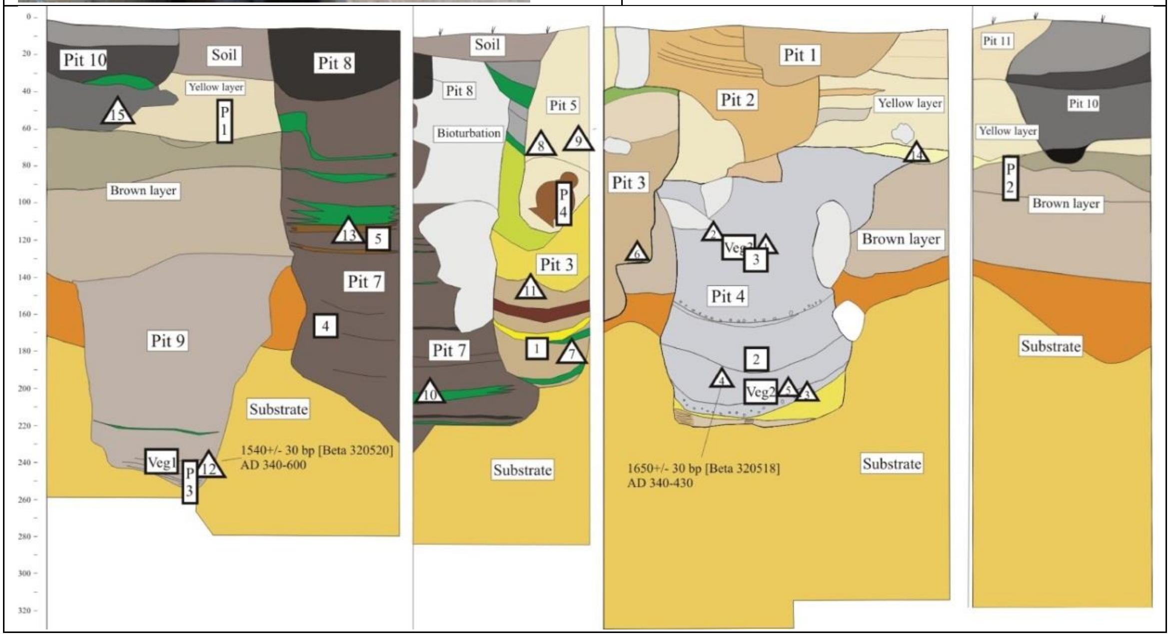


Figure 3.29 Right: Trench SIV being drawn by A. Smith and L. Champion under the amused villagers' eyes. Bottom: Section of Trench SIV. "Veg" indicated archaeobotanical samples provenance.



Trench 4 was excavated by Beninese students under the supervision of Anne Haour. The unit began as a relatively simple exercise intended to familiarise students with the principles of excavation of pit features, largely through the process of surface cleaning, identifying possible pit outlines and then bisecting them and excavating one half. It only became clear later in the day that the pit features visible and close to the unit's surface were underlain by an extremely complicated tangle of pits below the surface. Moreover, the excavation suffered from lack of overall supervisory oversight. Nevertheless, the section drawings done by Alexander Livingstone Smith (MRAC) and Louis Champion are reliable (Figure 3.29). This trench was important in giving a first indication of the depth and complexity of the stratigraphy on the Birnin Lafiya mound. It also yielded a broad suite of modelled clay objects, beads, and a single marine bivalve (Haour and Barpougouni, *In Press*).

Radiocarbon dates

Three dates are available (Table 3-11): Two from archaeobotanical sampled layers: Beta-320518 (1650±30BP) from pit 4 and Beta-320520 (1540±30BP) from pit 9 and Beta-320519 (1210±30BP) from pit 5.

Table 3-11 Radiocarbon Dates from Blaf-SIV

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
BLAF-12-S4. West profile, Pit 4 (-200 cm)	1650±30	Cal AD 264-533	Beta-320518	Charcoal (unsp.)	Haour 2013
BLAF-12-S4, South profile, Pit 5 (-90 cm)	1210±30	Cal AD 695-891	Beta-320519	Charcoal (unsp.)	Haour 2013
BLAF-12-S4, South profile, Pit 9 (-250 cm)	1540±30	Cal AD 426-588	Beta-320520	Charcoal (unsp.)	Haour 2013

Archaeobotanical sample

Seven samples were collected from a total of 91 litres of soil. Three samples were collected by the students during the excavation and the other four were collected after drawing the section. We focused on very rich ashy and carbonaceous layers.

BLAF-12-SV

SV was a small unit located in a midden referred to locally as ‘the king’s rubbish heap’. SV is a one by one metre test pit that was initially done for geomorphological purposes. The deposits were quite loose and ashy and there was little clear stratigraphic definition but we revealed three main contexts: C1A which are the labour layer, C1B and C1C which are similar extremely ashy layers. Due to their richness in ash and charcoal, we collected two samples (40 litres in total) of sediments for flotation. The excavation went down to c.130 cm below the surface (Smith at al. *In Press*).

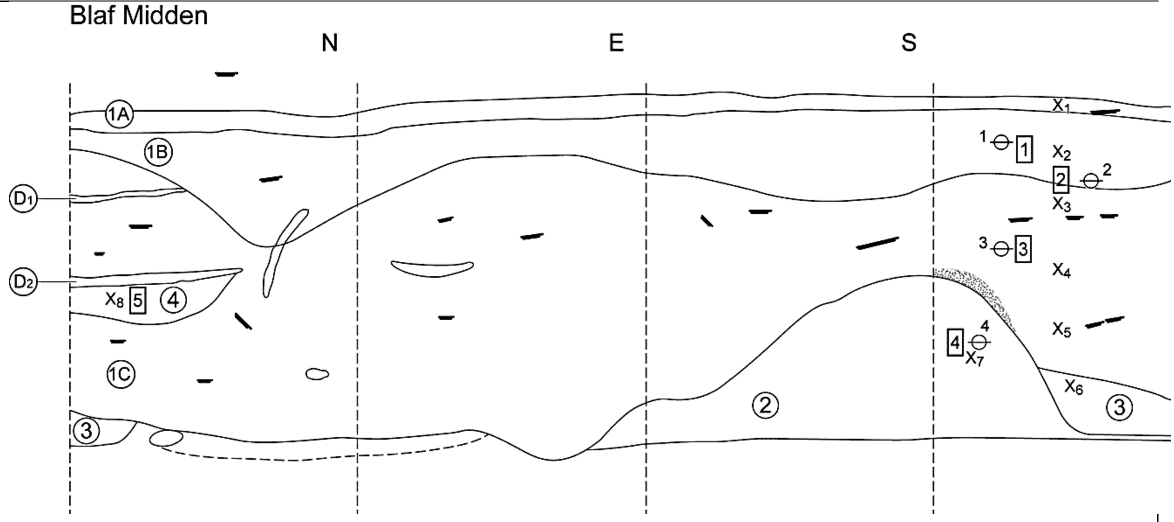


Figure 3.30: Blaf-13-SV section at completion.

Radiocarbon dates

The two dates (Table 3-12) from this trench indicate an accumulation sometime in the eleventh-twelfth centuries AD (Beta-320522 (920±30BP) and Beta-320521 (900±30BP).

Table 3-12 Radiocarbon dates for Blaf SV

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
BLAF-12-S5 (-60-70 cm)	900±30	Cal AD 1039-1210	Beta-320521	Charcoal (unsp.)	Haour 2013
BLAF-12-S5 (-110-120 cm)	920±30	Cal AD 1028-1184	Beta-320522	Charcoal (unsp.)	Haour 2013

BLAF-13-SVIII

SVIII is one of the five deep and complex stratigraphy from Birni Lafia. It is a 2 by 2 m test pit excavated by Richard Lee. Context 2 is a midden and Context 4/5 is probably a latrine and due to its composition rich in organic material and 50% was selected of the total volume for botanical research. The only date for this test pit was done on context 4/5: 1620±30 BP (Beta 345491). The stratigraphy at Trench 8 displayed five levels. The upper Contexts 1-3 were layers of sandy deposits mixed with light ash from the upper levels of a presumed rubbish pit. Below this, Contexts 4-5, the pit, had a significantly higher charcoal and faunal content indicating a highly organic content, and was grey-green in colour. This test pit sampled what appears to have been an area of pit-digging and refuse disposal. The single date available suggests an age consistent with the early phases of Birnin Lafiya (Lee, *In Press*).

Table 3-13 Radiocarbon Date for Blaf-SVIII

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
BLAF-13-S8, context 4	1620±30	Cal AD 382-539	Beta-345491	Charcoal (unsp.)	Haour et al 2016

Archaeobotanical sample

Within the entire context, two pits were sampled: Pit C4/5 and Pit C2 for a total of 50 litres of soil. Five litres from inside an intact pot was also sampled.

BLAF-13-SIX

The SIX is a 2m² test pit excavated by A. Livingstone Smith and N. Nikis and is directly related to the house complex (Figure 3.28). Unit SIX has a four meter deep stratigraphy that revealed 19 archaeological contexts. This stratigraphy is a continuous succession of superimposed living surfaces and pits. Living floors are mainly visible on the eastern side of the pit (towards the architectural complex), while all the other profiles display superimposed pit structures. Trench S9 displays at least 4 main phases of pit-creation, and we propose the following grouping of contexts interpreted as pit structures. Group 1 includes C2, C3 and C4. They close the top of the stratigraphy, just below the pavements that had been seen in S2. They can be roughly dated to AD 1100-1200. The next group includes Contexts 5, 6, 7, and 8. This group is dated around AD 900-1000. Two contexts, 9 and 10, are isolated between this group and the next. Group 3 includes Context 8-10 (with Contexts 14 and 5, which are not distinct contexts, but the prolongation of C8-C10), Context 11, and Context 12. These contexts are dated around AD 800-900. Finally, Contexts 13 and 16 belong to the lower group and appear to be set in a remnant of the original soil of the mound. They are dated to AD 600-800, with an outlying date going back to AD 400-500 for Context 13. This later date is probably background noise from an earlier occupation and should not be seen as valid date for Context 13's end of use (Smith & Nikis, *In Press*).

Archaeobotanical sample

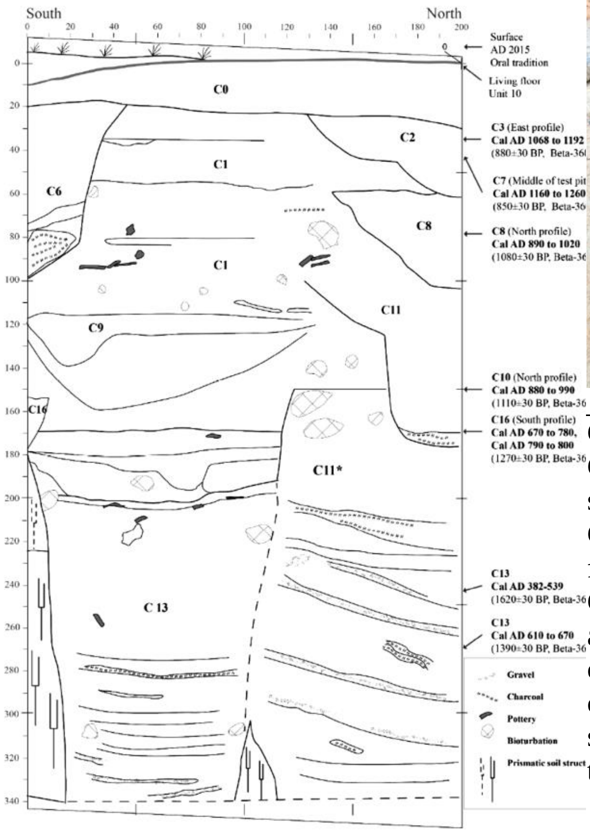
At Blaf -13- SIX from a total of 19 contexts, nine samples were carefully chosen for flotation. All the samples came from deep, ashy pits, generally one sample came from the upper part and one from the bottom of the pit.

Radiocarbon dates

Currently seven radiocarbon dates (Table 3-14) are available for SIX. The dates are spread out from around 400 cal.AD (Beta-360214, 1620±30BP) to 1200 cal AD (Beta-360211, 850±30BP and Beta-360210,880±30BP) with two group of two dates from the average (Beta-360212 and Beta-360213, 1080±30BP and 1110±30BP) and 1270±30BP (Beta-360216) and 1390±30BP (Beta-360215).

Table 3-14 Radiocarbon Dates for Blaf-SIX

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
BLAF-13-S9, context 3 (-45-60 cm)	880±30	Cal AD 1042-1222	Beta-360210	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, context 7, (-90-100 cm)	850±30	Cal AD 1052-1260	Beta-360211	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, context 8, (-150-160 cm)	1080±30	Cal AD 894-1018	Beta-360212	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, Context 8-10, (-220-230 cm)	1110±30	Cal AD 879-1013	Beta-360213	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, context 13 (-260-270 cm),	1620±30	Cal AD 382-539	Beta-360214	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, context 13, (-320-330 cm)	1390±30	Cal AD 602-674	Beta-360215	Charcoal (unsp.)	Haour et al 2016
BLAF-13-S9, context 16 (-185 cm)	1270±30	Cal AD 663-859	Beta-360216	Charcoal (unsp.)	Haour et al 2016



Context 6 is a powdery, ashy grey pit. Context 8 is a green, ashy pit composed of a succession of small stratum (bedding). The pit C8-10 is a pit below C8 and C10, and is formed of bedding layers green and brown. C11 is a very long green, ashy pit with rich ashy and carbonaceous pockets. The last context selected was the context 12. C12 is a circular pit, possibly a well, with a very strong alternated bedding of green and brown thin layer.

Figure 3.31: Stratigraphy and photo from SIX, Drawing and picture by A. Livingstone and N. Nikis 2013

BLAF-13-SXI

SXI is a 2 by 2.5m test pit excavated by Richard Lee. It has very deep stratigraphy, around 350 cm deep. At the bottom of the excavation, a burial was found and dated to 1560 ± 30 BP (Beta 345492; Table 3-15).

Table 3-15 Radiocarbon Dates for Blaf-SXI

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
BLAF-13-S11, context 1	890±30	Cal AD 1041-1218	Beta-412222	Charcoal (unsp.)	Lee, In press [2018]-b
BLAF-13-S11, context 3	920±30	Cal AD 1028-1184	Beta-412223	*(Sapotaceae Vitellaria)*	Lee, In press [2018]-b
BLAF-13-S11, context 18	1460±30	Cal AD 553-648	Beta-412224	*(Anogeissus leiocarpus)*	Lee, In press [2018]-b
BLAF-13-S11, context 23	1560±30	Cal AD 420-565	Beta-345492	Charcoal (unsp.)	Haour et al 2016: Table S1, Lee, In press [2018]-b

A potsherd pavement, Context 7, was also excavated. The upper four contexts, 1-3 and 5, across the 2 x 2.5 m test pit consisted of densely packed orange-brown earth with a slightly burnt texture. Below these contexts the character of the test pit could be summarised as numerous banded horizontal layers of compacted soil and clay; pits filled with highly organic deposits; substantial amounts of grey ash; collapsed mud-brick and a human burial. Context 18, a significant deposit of compacted orange-brown clay containing charcoal, pottery, animal and fish bone, was apparent across the width of the trench. This deep band of soil sealed the human burial and may therefore be one of the most significant stratigraphic sequences in the matrix. All of the contexts above Context 18 appeared to cut into it, and were therefore later than it,, including Context 14, the compacted burnt clay, and Contexts 9, 20 and 22, consisting of the grey-green highly organic fills (Lee, *In Press*). Context 21, the lowest level of C18, appears to be a very discreet context of its own. It is also probably one of the most significant contexts in SXI. It is a cluster of mudbrick with ash, beads, metalwork, bone, human teeth, and one intact vessel which was removed with its contents intact.

Figure 3.32: Blaf-13-SXI at completion.

BLAF-14-SXIII

The excavation of SXIII was supervised by Jennifer Wexler. The 2 by 2m test pit was excavated until the bedrock was reached at 370 cm BD. It is a deep trench with a series of depositional episodes. Rather than representing specific occupational layers, SXIII apparently contains a sequence of settlement debris and pits with no clear occupation structures or layers. Radiocarbon dates (Table 3-16) indicate that this trench has a date range cal AD 600-900 (Figure 3.33) (Wexler and Labiyi, *In Press*).

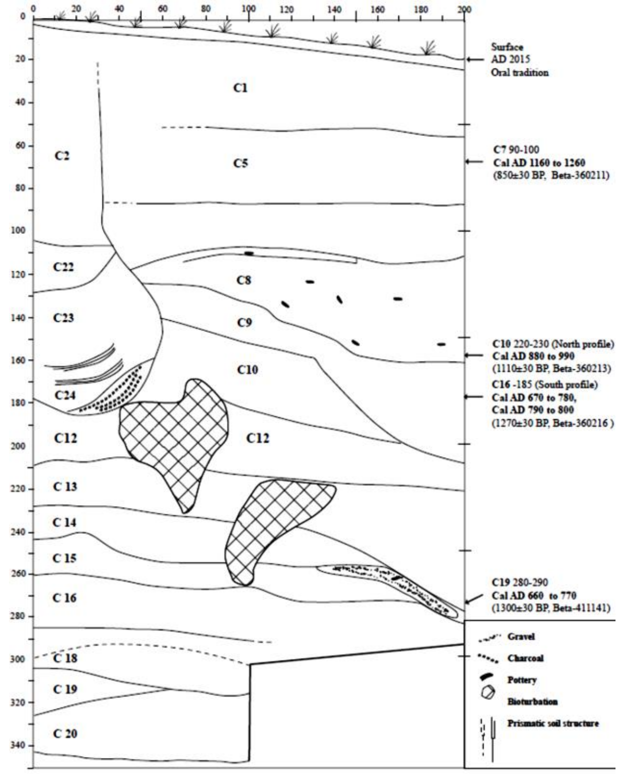


Figure 3.33: Blaf-14-SXIII, South Section at completion. Drawing by A. Smith and L. Champion.

Archaeobotanical sample and Radiocarbon dates

Fourteen archaeobotanical samples were taken after the section drawing was completed.

Table 3-16 Radiocarbon Dates for Blaf-SXIII

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
context 14, (-150-160 cm)	1210±30	Cal AD 695-891	Beta-411139	Charcoal (unsp.)	Wexler & Labiyi, In press [2018]
context 14 (-180-190 cm)	1320±30	Cal AD 652-768	Beta-411140	Charcoal (unsp.)	Wexler & Labiyi, In press [2018]
context 19, (-280-290 cm)	1300±30	Cal AD 660-770	Beta-411141	Charcoal (unsp.)	Wexler & Labiyi, In press [2018]

BLAF-14-SXVIII

This test pit, initially a $1x1m^2$, was excavated to look at a geophysical anomaly noticed by Carlos Magnavita. Initially it was thought that the anomaly revealed the presence of an iron furnace at the beginning of the excavation run by C. Robion Brunner (Université of Toulouse). The absence of any iron making evidence, such as slag or even iron and ore, led Djimet Guemo, a student of Abomey Calavi, Benin, to be asked to finish excavating this test pit. He exposed a mud brick cylindrical structure with the bottom rich in ash, charcoal but also charred seeds and fruit (see Chapter 6). This structure was interpreted as a potential baking oven. Significantly, similar ovens are still used in the area today. Indeed during the ethnobotanical studies, we find one in the village of Madekali (see Chapter 5).

Archaeobotanical sample

Eight samples came from this test pit from a total of 130 litres of soil. The oven was targeted and the resulting archaeobotanical results were impressive. Indeed, these samples are the richest obtained for this doctoral research.

Radiocarbon dates

Three radiocarbon date are currently available for this sites (Table3-17).

Table 3-17 Radiocarbon Dates for Blaf-SXVIII

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
BLAF-14-SXVIII, 4, level 5	1100±30	Cal AD 887-1013	Beta-501546	Seed (*Oryza glaberrima*)	Unpubl.
BLAF-14-SXVIII, 8, level 7	1520±30	Cal AD 428-609	Beta-501545	Seed (*Oryza glaberrima*)	Unpubl.
BLAF-14-SXVIII (-153cm)	1060±30	Cal AD 897-1024	Beta-501544	Seed (*Oryza glaberrima*)	Unpubl.

Figure 3.34. Blaf-14-SXVIII, Oven with some fragments of ceramic steamer (Courtesy of A. Haour and D. Guemo).

BLAF-14-SXIX

The location of this excavation was also found by following a geophysical anomaly (C. Magnavita). It is a 2x2 m test pit excavated by Frank Takpara. Only two different contexts were exposed: C1 and C2. The two contexts were very hard and compact and mainly composed of clay. One archaeobotanical sample was selected from each context. Also, no radiocarbon date is currently available for this test pit.

BLAF-14-BAO-FIII

Blaf Bao FIII is a 1.4x1.4 m unit excavated by Champion. It had a circular green pit on the surface. The excavation, done by quadrant, had the goal to identify the composition of this green layer, which is more often found at the bottom of deep pits. This vivid green colour suggests high phosphate content. The FIII pit is divided into 3 parts:

- *: The "outside" (the natural ground layer) was very compact, grey with orange inclusion and no artefacts were recovered.
- [A]: The upper part of the pit. The fill is composed of some grey/greenish ashy material with very soft layers.
- [B]: The bottom of the pit. The fill is a succession of very soft and thin green/ greyish and green layers. This part had a very high concentration of superimposed layers of sherds mixed with a high quantity of charcoals, ash and fish bones. The structure could possibly be a "fish smokehouse".

Only one radiocarbon date was done on a *Vitex* sp. fruits:

Table 3-18 Radiocarbon date for Blaf-Bao-FIII

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
BLAF-14-BAO (-60-70 cm)	1470±30	Cal AD 545-645	Beta-501543	Fruit (*Vitex sp.*)	Unpubl.

Archaeobotanical sample

In term of sampling, we did one big sample of the more greenish layer to send for analyses. Moreover, we took five samples (70 litres) for archaeobotanical purposes.

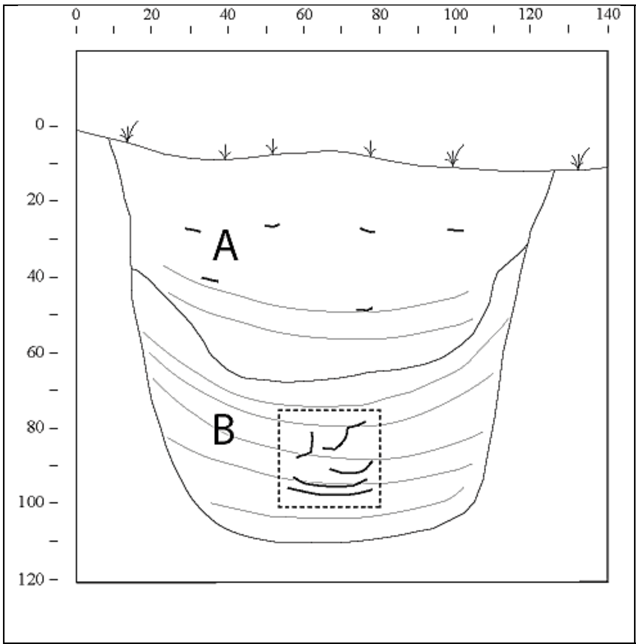


Figure 3.35. Blaf-14-Bao-FIII, Section at completion. The dotted square in part B is a high concentration of big sherds, charcoal and remains of big fish. Drawing: L. Champion.

3.2.1.5 Kozungu (KOZ-14)

Following the oral tradition, Kozungu is an intermediary settlement between the site of Birni Lafia and the modern village. Kozungu is located a few hundred meters east of the village and is marked by a forest of Baobab (*Adansonia digitata)*. The two test pits (SI and SII) were excavated by Nicolas Nikis and Alexandre Livingstone-Smith. For logistical reasons, the excavation was interrupted at 130 cm BD. The two test pits were excavated on the same mound and were separated by approximately 20 metres. The full extent of this site is unknown.

KOZ-14-SI

The stratigraphy (Table 3-19) at KOZ-14-SI is displayed over four stratigraphic units: Level 1 is a layer of compact brown grey sand overlaying a layer of brown grey loose sand. Level 2 consists of compact grey sand overlaying a layer of loose grey sand. Part of the compacted layer is in fact a floor made of compacted and hardened laterite (northeast corner of the square). The third level (Pit 1) is probably a pit, sealed by a thin layer of sand overlaying its stabilisation layers (i.e. the last filling of the pit). The fourth level is barely visible at the bottom of the trench, and appeared to be either a part of Pit 1 or a distinct level. Taking KOZ-14-SII into account, we consider this as a distinct level (Level 3). It is a layer of loose brown sand (Smith and Nikis, *In Press*).

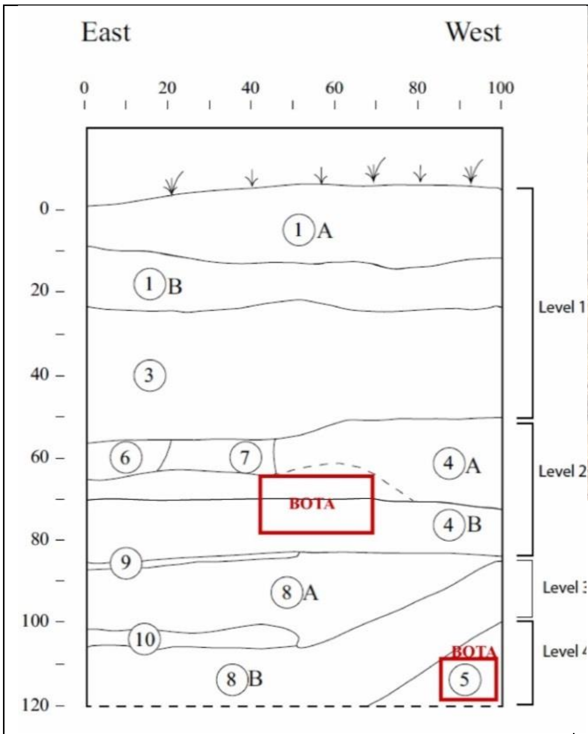


Figure 3.36 KOZ-14-SI at completion . On the top, potential floor remains. Drawing A. Smith & N. Nikis.

KOZ-14-SII

The stratigraphy (Table 3-19) at KOZ-14-SII displays three levels and a pit below the ploughed layer. The first part (Level 1) is made of a layer of compact brown sand overlaying a layer of loose grey brown sand (unit 1a and 1b to unit 3). It is similar to Level 1 in SI, but it includes a thick layer of compact red sand (unit 2). The second unit (Level 2) consists of a layer of loose grey sand (it is much thinner than its equivalent in SI). The third unit (Structure 1) is a pit cutting through Level 1 and 2. The fourth unit consists of a thick layer of loose brown sand (Level 3). It is probably the same as that observed in SI (Smith and Nikis, *In Press*).

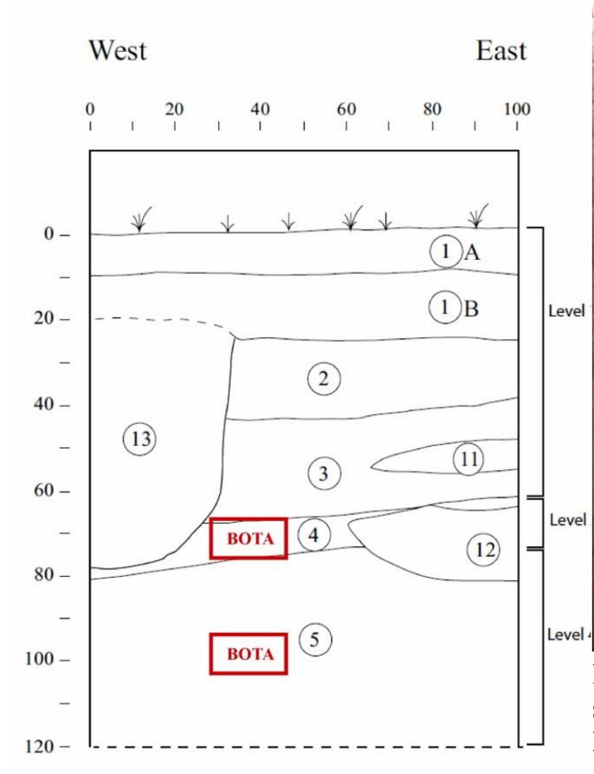


Figure 3.37: KOZ-14-SII. North and East section at completion. Drawing A. Smith & N. Nikis.

Archaeobotanical sample

Four large samples, from 160 litres of soil in total, were collected and floatedfloted. Two samples came from the Early Iron Age or Neolithic layers and two other samples came from the upper part of the section.

Radiocarbon date

Levels 1 and 2 could be post-13th century. Level 3 is probably much earlier, dating to the Early Iron Age or Neolithic, dated in SII. Indeed, three charcoal fragments (Table 3-19) from the bottom of SII (110-140 cm) are dated to 1200-1000 BC (2920±30 BP, Beta -411136; 2910±30, Beta-411137; 2860±30, Beta-411138).

Table 3-19 Radiocarbon Dates for Koz-I and Koz-II

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
KOZ-14-SI (-20-30 cm)	351±30	Cal AD 1457-1635	OxA-31042	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SI (-20-30 cm)	357±30	Cal AD 1452-1635	OxA-31043	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SI (-30-40 cm)	609±30	Cal AD 1295-1405	OxA-31580	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SI, context 4 (-80-100 cm)	557±30	Cal AD 1309-1430	OxA-31577	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SI, context 4 (-80-100 cm)	607±30	Cal AD 1296-1405	OxA-31578	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SI, context 5 (-110-120 cm)	339±30	Cal AD 1471-1640	OxA-31579	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SII, context 4, (-60-70 cm)	605±30	Cal AD 1297-1406	OxA-31044	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SII (-80-90 cm)	601±30	Cal AD 1297-1408	OxA-X-2600-42	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SII (-110-120 cm)	2920±30	Cal BC 1211-1020	Beta-411136	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SII (-120-130 cm)	2910±30	Cal BC 1209-1011	Beta-411137	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a
KOZ-14-SII (-130-140 cm)	2860±30	Cal BC 1118-929	Beta-411138	Charcoal (unsp.)	Livingstone Smith & Nikis, In press [2018]-a

3.2.1.6 Kantoro (KRO-14)

The site of Kantoro is situated just off the main Guene-Karimama road and lies halfway between the modern villages of Kantoro and Sakawan. The site is formed by two small settlement mounds, A and B, which are approximately 6m high. To the north and west, the site is delimited by two small rivers with the road bordering the site to the east.

The two mounds at Kantoro have yielded settlement remains (pottery fragments, ground stone, etc.) and several concentrations of slag including at least nine areas of smelting slag and two areas of forging slag. Judging by their topography, these slag concentrations seem to be related to two settlement zones. The site covers approximately one hectare in area.

On each of the two settlement mounds, a 1x1m test- pits was excavated. The excavators were Pakou Haréna, Séverin Bakrobéna and Djimet Guemona under the supervision of Louis Champion. In both test pits it was necessary to terminate excavation at around 170cm BD due to the risk of section collapse, although archaeological layers were still yielding material.

Archaeobotanical sample

A 15 litre soil sample was taken from each spit for archaeobotanical analysis (in total 19 samples for Trench I and 16 samples for Trench II).

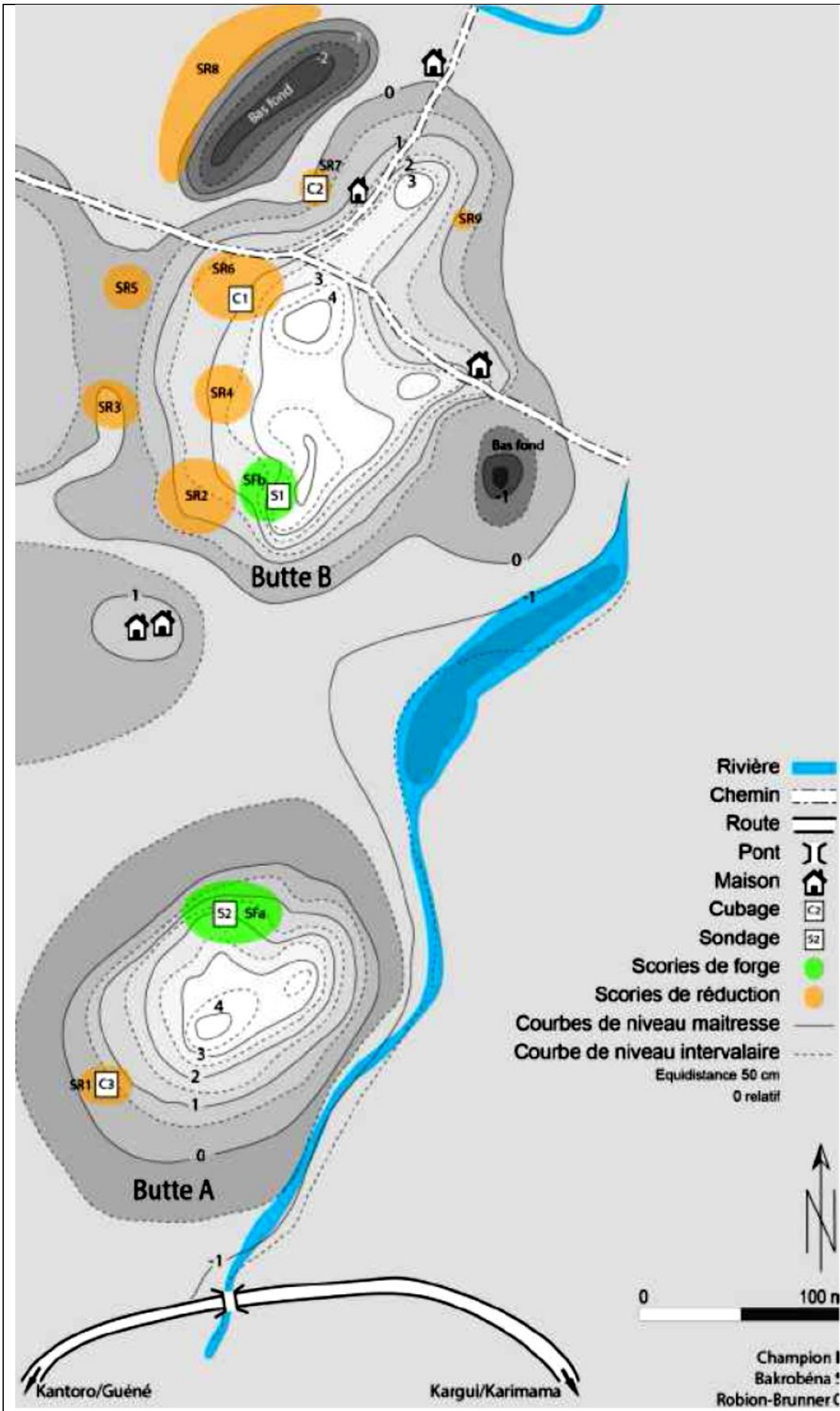


Figure 3.38 Topographic map of Kantoro site. Map by Louis Champion, Sèverin Bakrobèna and Caroline Robion Brunner

KRO-14-SI

Test pit SI was excavated on Mound B, the northern mound.

Layers and contexts

Context 1 (1 - 155cm) is an extremely soft grey layer rich in ash. This context includes a series of small horizontal "litage" with no notable difference between them.

Context 2 (155 - 170cm) is a very soft yellow layer formed of sand.

For safety reasons the excavation was terminated at 170 cm BD.

The presence of ceramics and both forging and smelting slag suggests that the trench sampled was a settlement area, but the presence of such a considerable layer of ash (at around 155cm) is still unexplained (Champion & Filippini, *In Press*).

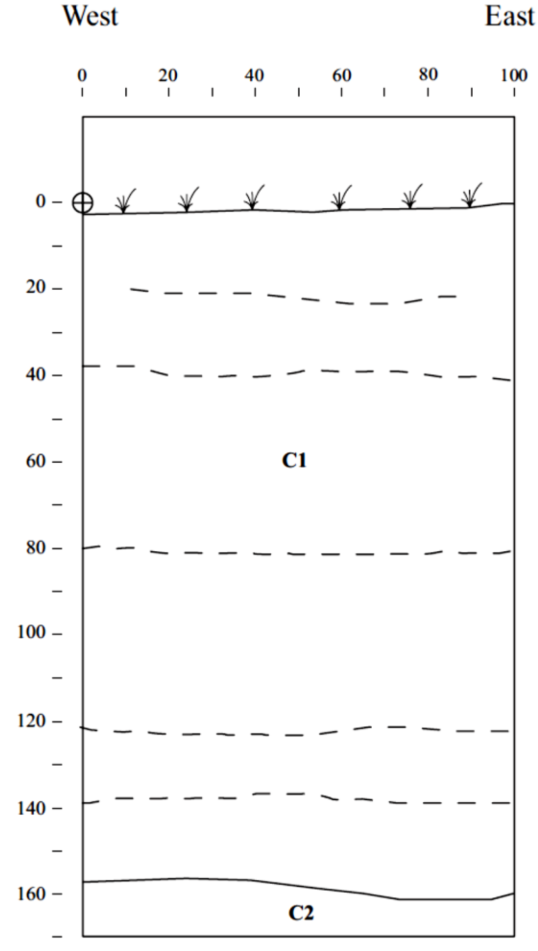


Figure 3.39 KRO-14-SI, East section at completion (Drawing by L. Champion).

Radiocarbon dates

Currently, no radiocarbon dates exist for this test pit.

KRO-14-SII

Test pit SII was excavated on Mound A, the southern mound. The stratigraphy of KRO-14-SII consists of a succession of five horizontal deposit contexts. A high number of metal artefacts were recovered from this unit, as was from Trench I (Champion & Haour, *In Press*).

Context 1 (1 - 55cm BD) is a very soft, grey ashy layer.

Context 2 (55 - 80cm BD) is similar to Context 1, but more brown in colour and more compact.

Context 3 (80 - 90cm BD) is more compact than Contexts 1 and 2. Its colour is yellowish/brown with grey reflections.

Context 4 (90 - 130cm BD) is heterogeneous and is formed by a mix of yellowish/brown and dark brown areas.

Context 5 (130 - 170cm BD) is very compact. It is yellowish in colour and composed of very compact clay nodules with a mix of sherds and charcoal.

This stratigraphy seems to reflect a former settlement site, as indicated by the existence of five distinct contexts.

Three radiocarbon dates exist for this test pit:

Table 3-20 Radiocarbon Dates for Kro-SII

Context	**C14 Date**	**Calibration (2 sigma)**	**Lab Code**	**Type**	**Reference**
KRO-14-SII (-70-80 cm)	890±30	Cal AD 1041-1218	Beta-397870	Charcoal (unsp.)	Champion et Haour, In press [2018]-a
KRO-14-SII, context 4 (-110-120 cm)	960±30	Cal AD 1020-1155	Beta-397866	Charcoal (unsp.)	Champion et Haour, In press [2018]-a
KRO-14-SII, context 5 (-150-160 cm)	1050±30	Cal AD 900-1027"	Beta-397871	Charcoal (unsp.)	Champion et Haour, In press [2018]-a

After calibration, these readings suggest that (barring any old wood effect) these layers accumulated over a period of at least three centuries.

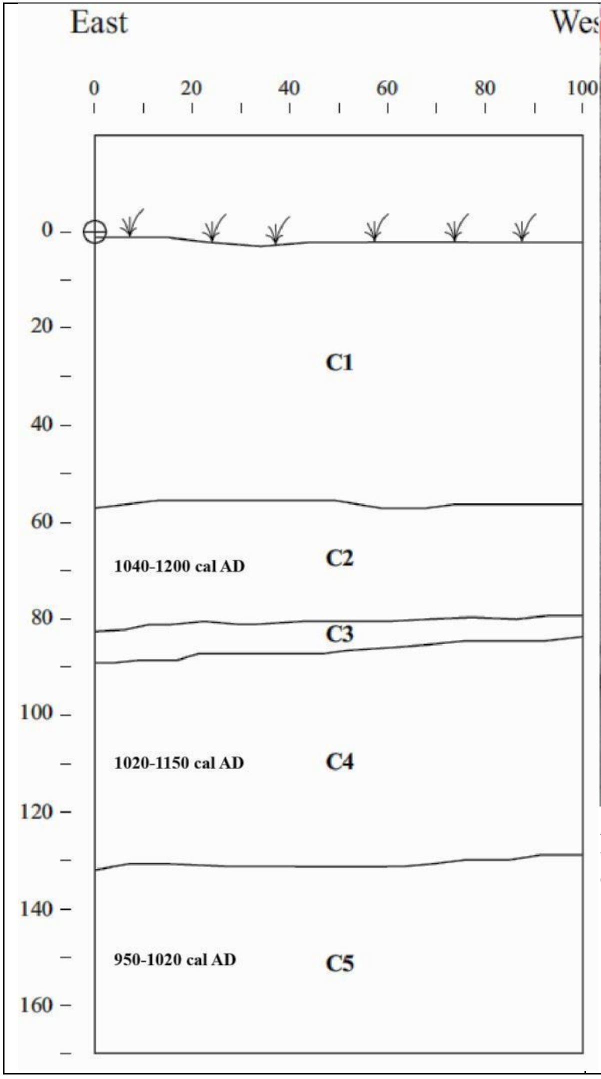


Figure 3.40. KRO-14-SII, North Section at completion (drawing by L. Champion).

3.2.2 The small survey test pits

The small survey consisted of small-scale sampling from many small test-pits (generally 1x1 m) on many sites. The samples collected within this strategy are usually small (average five litres of sediment), and represent each archaeological pit or context of interest such as deep midden pits or ashy layers. Thanks to a NERC[4] application for radiocarbon dating, almost all of these samples will receive direct absolute dating of the plant remains.

The six sites of Bogo-Bogo (GOG-14), Gorouberi (GOB-14), Kargui (KGI-14), Guene-Zeno (ROU-14), Madekali (KLI-14) and Madekali Road (KLI-RCI-14), were all dated to the last part of the second millennium, and were excavated following the instruction of the oral history investigation. These sites then are suppose to be the former settlement of the current villages. Hence, this means that all the test pits were excavated in the current village. Most of the contexts excavated were middens.

Archaeobotanical samples

The general location, usual far from the base camps, of these sites did not allow us to take big soil samples for flotation. Thus, we decided to focus our sampling on pits and very rich horizontal contexts such as very ashy layers. The general idea was to collect samples of approximately five litres each.

Table 3-21. Archaeobotanical samples and associated dates for the small test-pit survey.

	Site	Context type	Context number	Vol (L)	Radiocarbon dates	Laboratory number
1	GOG-14-SI	Pit	Pit 2	5	183 ± 38 BP	OxA-X-2605-39
2		Pit	Pit 1	5	129 ± 25 BP	OxA-31582
3	GOB-14-SI	Pit	Pit 1	10	170± 30 BP	Beta-402969
4	KGI-14-SI	Deposit	U7	5	138 ± 29 BP	OxA-30957
5		Pit	U11	5	168 ± 29 BP	OxA-30958
6	ROU-14-SI	Pit	U6	5	860 ± 27 BP	OxA-31048
7	KLI-14-SI	Midden	U8	5	143±27 BP	Oxa-31049
8		Midden	U16-17	5	162±27 BP	Oxa-31050
9		Midden	U18	5	160±29 BP	Oxa-30959
10	KLI-14-RCI	Midden	U6	5	970±28 BP	Oxa-31051

[4] The NERC application, *"Closing the gap between living memory and archaeological pasts: a case study from northern Bénin, West Africa"*, was obtained by Anne Haour (UEA) and Alexandre Livingstone Smith **(**MRAC**)**.

3.2.2.1 Bogo-Bogo (Gog-14)

The stratigraphy at Bogo-bogo extends down to 190 cm. It can be divided into three main horizons. The first, from 0 to 40 cm, consists of a series of modern trash accumulation such as plastic beads. The second horizon, extending from 40 to 100 cm, also consists of a layer of trash, but with a different set of artefacts (plastic beads and glass fragments). The first two horizons overlie two final contexts, which are probably two refuse pits. Context 5 (pit 1) is covered by the second horizon (Context 4) and sealed by a deposit of burnt earth. Context 5 is dug into another, completely refilled, trash pit labelled Context 6 (pit 2), which in turn is dug into the natural soil. The site is dated between 1600 and 1950 cal AD (Nikis and Smith, *In Press*).

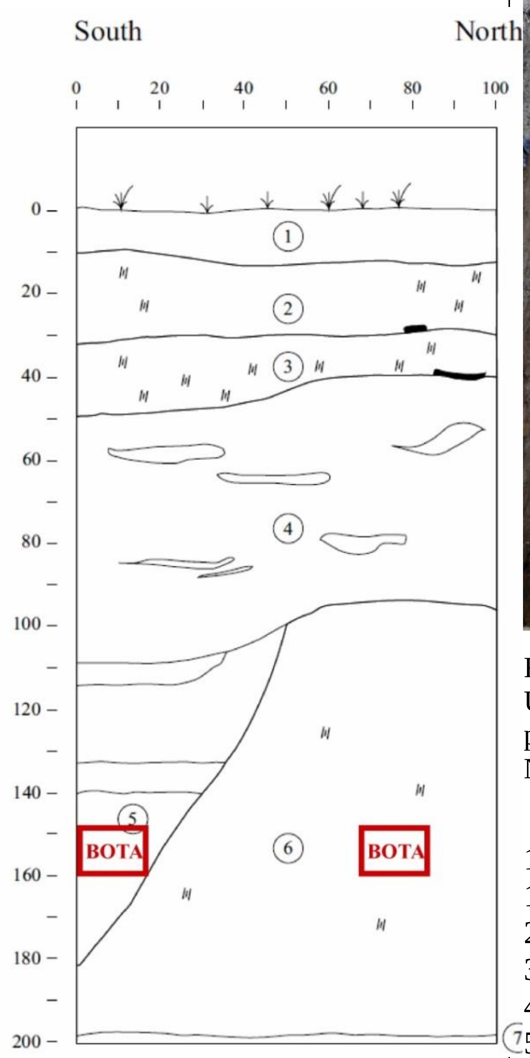


Figure 3.41. Bogo-Bogo (GOG) west profile. Upper stratigraphy is marked by an abundance of plastics and other modern refuse (Drawing N. Nikis).

1 Loose grey ash layer (trash midden)
1 Loose grey brown ashy sand
2 Organic rich clay with charcoal
3 Loose heterogeneous sand
4 Pit 1, clay sand with abundant charcoal
5 Pit 2, heterogeneous dark to yellow sand with charcoal

3.2.2.2 Gorouberi (GOB-14)

GOB-14 is a test pit excavated in the modern village of Gorouberi. The deposits indicate a medium span occupation. The abundance of charcoal in SI could be indicative of iron working nearby. The pottery is indicative of post-medieval contexts. The two radiocarbon readings indicate a 1600- 1900 cal AD phase. The stratigraphy at Gorouberi is varied. SI displays at least 5 contexts, which could be related to 2 or 3 horizons. The first consists of a series of horizontal deposits which could be correlated to the gradual or brutal accumulation of sediments in a village – this layering of floors and trash deposits continues down to 45 cm below the surface. This layering of deposits appears to reflect the spatial organisation of this backyard of the concession. The second horizon could be correlated to the levelling of the area. It overlays a small mound of slag and charcoal indicative of iron being worked or smelted nearby (Nikis et al. *In Press*).

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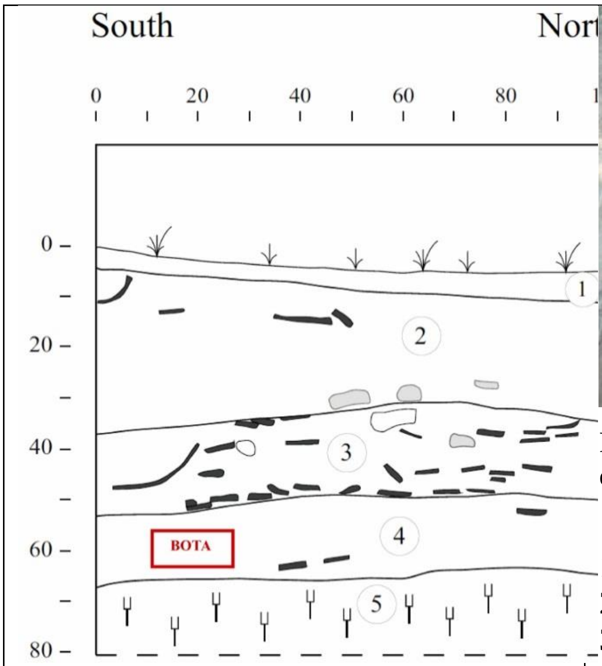

Figure 3.42. GOB-14-S, West section at completion. Drawing N. Nikis.

1 Grey Sandy Topsoil
2 Yellow Brown compact sandy clay
3 Dark Brown sandy clay with gravel
4 Yellow brown compact sandy clay
5 Natural soil

3.2.2.3 Kargui (Kgi-14)

The test pit at **Kargui**, pinpointed by oral tradition as an old village, was located in a courtyard close to the (now-vanished) town wall identified by the team architects; it yielded 4 or 5 distinct horizons dated to 1600-1950 cal AD. Kargui may be related to the history of Karimama. Oral historical data puts its development somewhere at the turn of the 18th and 19th century AD. The excavation shows that the site is not a settlement mound and that the pottery is indeed different from the pottery found on the medieval settlement mounds (Smith and Fillipini, *In Press*).

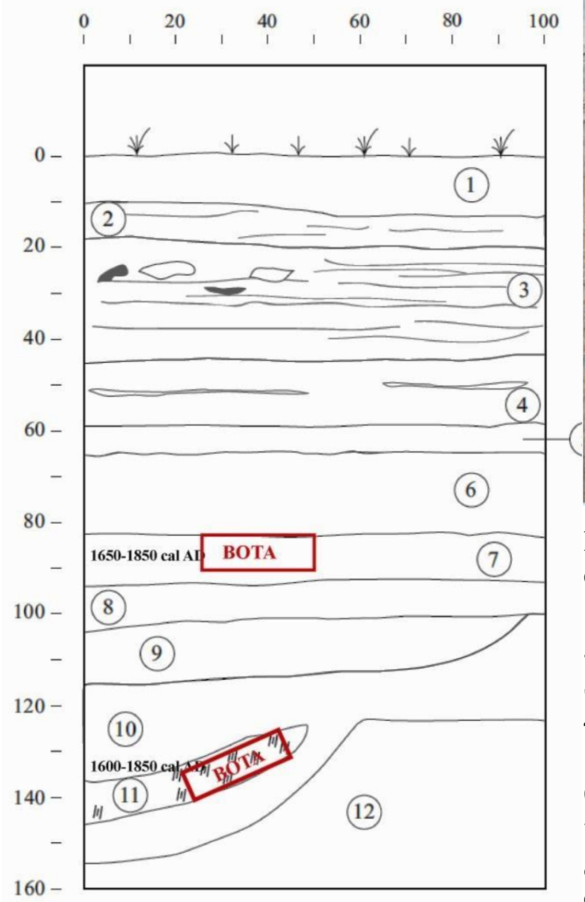

Figure 3.43. KGI-14-SI. North Section at completion. (Drawing A. Smith & N. Nikis).

1 Grey compact sand
2 Yellow sand
3 light beige with lamination
4 Yellow sand
5 light beige with lamination
6 Yellow sand
7 Black “greasy” clay
8 Dark Brown sand
9 Yellow orange sand
10 Black “greasy” clay
11 Black sand with very abundant organic material
12 Natural soil

3.2.2.4 Kouboukoukourou (ROU-14)

The test pit from Kouboukoukourou (‘old Guene’, predecessor site to the strategically situated village of Guene which controlled access across the Niger River, and linked with intensive iron-working remains) evidenced across four horizons. There are four dates from this site and they all fall at the end of period 3 (900-1400 cal AD). One of the dates is directly related with the only archaeobotanical sample (Context U6, 860 ± 27 BP OxA-31048).

Kouboukoukourou is related to the settlement history of Guene in oral traditions. The type of settlement mound and the pottery indicates that the site of Kouboukoukourou is a classic settlement mound. The dates show that its abandonment must have been near contemporaneous with the abandonment of other such mound settlement sites in the valley (Smith, *In Press*).

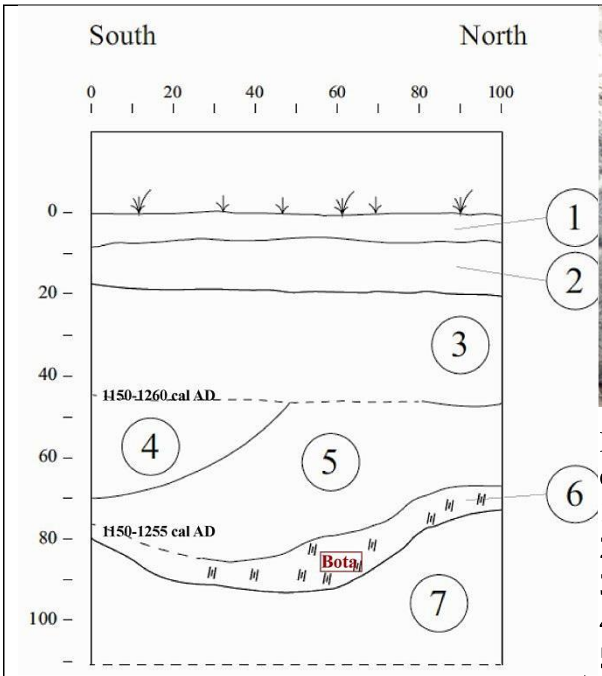

Figure 3.44. ROU-14-SI, West section a completion.

1 Ploughed top soil.
2 Compact dark grey sand.
3 Brown compact silty clay.
4 Dark Ashy sand (pit).
5 Brown silty clay (pit).
6 Brown red silty clay.
7 Brown orange silty clay.

3.2.2.5 Madekali (Kli-14) & Madekali road (Kli-RcI-14)

These units present a long sequence of occupation. They show a deep stratigraphy with 4-5 horizons; the two test pits (SI and RCI) are complementary and give a rare example of continuous stratigraphy from medieval levels to modern ones. The combined stratigraphy of RC1 and SI shows that the modern city of Madekali is built on a medieval settlement mound similar to that of Birnin Lafiya. RC1 displays a series of interconnected anthropic structures overlain by a layer of building rubble. The sequence is indicative of a long history, although trash middens tend to grow quickly. The presence of a sequence above the settlement mound deposits, oral testimonies, supported by the presence of new types of pottery, indicate a post-13th century occupation Although the chronological hiatus may indicate a break in the settlement, perhaps between the end of the 1400 AD and 1800 AD, we think this can be related to the location of the test-pit. Indeed, it was not located in the most ancient neighbourhood of the village, but at one of the gates of the birni. (Smith et al., *In Press*).

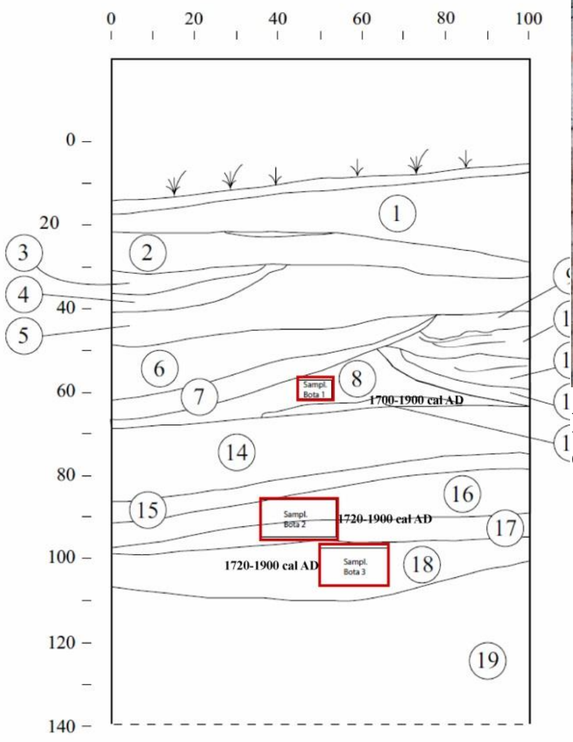

Figure 3.45. KLI-14-SI, West section at completion. Drawing by A. Smith.

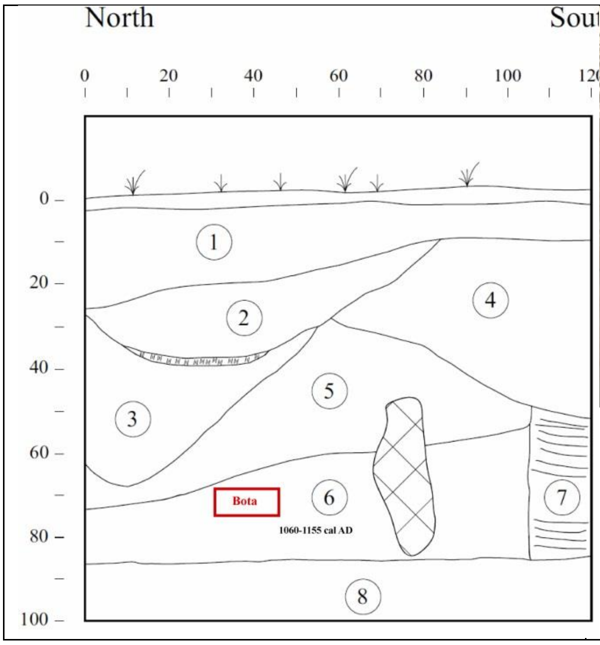

Figure 3.46. KLI-14-RC1, East section at completion. Drawing by A. Smith.

3.2.3 Banikoara/ Atacora Region

3.2.3.1 Niyanpangu-bansu (BNK-13)

The site of Niyanpangu-bansu is located in the W Natural Park on the Mekrou River. The Mekrou is a major tributary of the Niger River. The site was excavated by Mardjoua Barpougouni for his master degree with the Université d'Abomey-Calavi in Benin (UAC) (Barpougouni 2015). The site is a 2 hectares settlement composed of several small shallow mounts of maximum 1.30 metres deep. The excavation consisted of a 2x2 m test pit that reached the sterile soil at around 1.30 metres deep. The stratigraphy is composed of 3 layers that are dated to 1450-1650 Cal AD (Beta 384522: 390±30 BP, Beta 384521: 340±30 BP, Beta 384520: 300±30 BP) (Figure 3.47). The presence of an indigo dyeing pit and spindle whorl in large quantities suggested that the main activity of the site were related to textile production. Such types of dyeing pit are historically well-known and well-documented in the area. Following Gosselain, the dyeing pit in the region (Dendi, Banikoara and Bourgou) is historically related to the Mulanche/Kumate ethnic group (Gosselain and Haour, *In Press*) (cf. Gosselain, *In Press*). The excavation also exposed pipe fragments and cowrie shells.

Table 3-22 Radiocarbon Dates for BNK-13

Context	C14 Date	Calibration (2 sigma)	Lab Code	Type	Reference
BNK-13-1 SI, context 3 (lowest level)	390±30	Cal AD 1441-1631	Beta-384522	Charcoal (unsp.)	Unpubl.
BNK-13-1 SI, context 2	340±30	Cal AD 1470-1640	Beta-384521	Charcoal (unsp.)	Unpubl.
BNK-13-1 SI, context 1	300±30	Cal AD 1489-1654	Beta-384520	Charcoal (unsp.)	Unpubl.

Archaeobotanical sample

Each context was sampled for flotation. In total 60 litres of soil were collected from 3 samples (Figure 3.47).

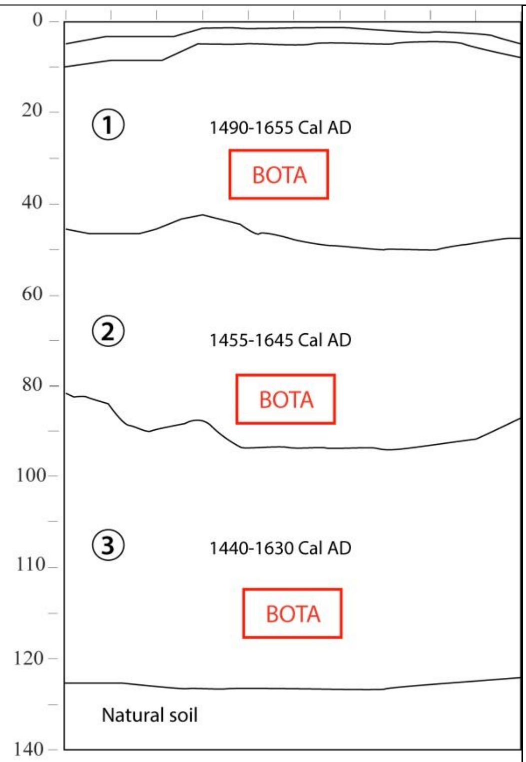

Figure 3.47. Niyanpangu-bansu, West section at completion. (Courtesy of Barpougouni Mardjoua)

1 final occupation of site. Loose, dark soil
2 hard, grey-brown sediment, presence of Cowrie shells
3 light brown, hard and stony. Spindle whorls, pipe fragments.

3.2.4 Archaeological Timeframe for North Benin

Site	Phase	Surface	Archaeobotanical sample		site type
		Hectares	Numbers	Litres	
Pekinga	1000-1400 Cal AD		6	120	Numudugu
Tintin Kanza	1000-1400 Cal AD	<1	9	172	Tell
Alibori Site 2	1250-1300 Cal AD	?	2	20	Settlement
	800-400 Cal BC	?	3	100	Neolithic
Birnin Lafiya	300-500 Cal AD	<26			Tell
	500-1000 Cal AD	>26			Tell
	1000-1400 Cal AD	>26			Tell
Kozungu	1000-1400 Cal AD	?	2	80	Tell
	1200-1000 Cal BC	?	2	80	Neolithic
Kantoro	1000-14000 Cal AD	>1	35	525	Numudugu
Bogo-Bogo	1400- present	?	2	10	settlement
Gorouberi	1400- present	?	1	10	settlement
Kargui	1400- present	?	2	10	settlement
Kouboukoukourou	1400- present	?	1	5	settlement
Madekali	1400- present	?	3	15	settlement
	1000-1400 Cal AD	?	1	5	Tell
Niyanpangu-bansu	1400-1600 Cal AD	2	3	60	settlement
Total			153	2609	

Figure 3.48 : Synthesized table of the sites from Benin presented in this research that includes the site type and surface but also the number of archaeobotanical samples collected by site and phase.

This research includes the analysis of archaeobotanical material recovered from sites located in North Benin. The 12 sites from Dendi were excavated for the 'Crossroad of empires', an ERC-funded project during three field seasons (2012-14). Following the C14 dates and climatic change, Beninese sites can be split into five main time periods. This timeframe also includes the site from the Banikoara region in north Benin.

Phase 1: Prior 1 BC

During this period, the climate was turning drier and more arid (Ballouche and Neumann 1995, Mayor et al. 2005). Period 1 is represented by test-pits at Alibori and Kozungu sites. At Kozungu SII, only the earliest layers are part of this period, and the upper part of the stratigraphy is part of the last period (Livingstone, *In Press*; N'Dah, *In Press*).

Phase 2: From 1 AD to 500 AD

It is difficult to figure out what happens during the last part of phase 1 and the beginning of Period 2. Currently only the site of Gorouberi has provided dates from this interphase period. It is difficult to resolve this chronology in the Iron Age calibration plateau (400-750 BC). This interphase is characterised by a very dry, unstable climate (Mayor et al. 2005), and it has been identified as a period of abandonment in Burkina Faso (Breunig and Neumann 2002; Hohn and Neumann 2012). Nevertheless, this period corresponds to the emergence of large, and subsequently urban sites in the Inner Niger Delta, for example at Jenne-jeno and Dia in Mali, both of which provide evidence of African rice (*Oryza glaberrima*) (McIntosh 1995; Gallagher 2011; Gallagher and McIntosh 2015). Also, this phase corresponds to the foundation of Birnin Lafiya with the early dates coming from SIV and SXI.

Phase 3: From 500 Cal AD to 1000 Cal AD

Phase 2 and 3 are the two initial periods of Birnin Lafiya development. During this third period, rainfall and overall humidity increased reaching maximum humidity around 900AD (Mayor et al. 2005). All samples were selected in lower contexts of test-pits VIII, IX, XI and XIII from Birnin Lafiya. These pits probably represent the second development phase of the settlement of this site.

Phase 4. From 1000 Cal AD to 1400 Cal AD.

Period 4 can perhaps be characterised by a progressive aridification turning from an optimum humidity at ca. AD 900 to significantly drier by the 14th century AD (Mayor et al.2005). Sites from the fourth period form the main assemblage of this study in terms of the number of samples. We have abundant evidence for settlement in the period AD 1000-1400: our largest sample, fifty dates, comes from this time, and it pinpoints settlement throughout the region: at Birnin Lafiya (especially in a large paved complex and adjacent units), Kompa Dune, Tintin Kanza, Pekinga, Alibori Sites 1 and 2, Kantoro, Kozungu, Kouboukoukourou, Madekali and Toutokayori.

Phase 5. Post 1400 Cal AD

The last period is different from the others, possibly due to climatic changes followed by a new settlement phase characterised by the abandonment of former villages. The 13th century AD is thought to mark the end of a dry climatic period followed by more humid conditions (Mayor et al. 2005). In the Dendi area, this phase yielded samples from fives sites (Kozungu, Bogo-Bogo, Kargui, Madekali and Gorouberi). The site of Niyanpangu-bansu was located 125 km away from the Dendi area also belongs to this phase.

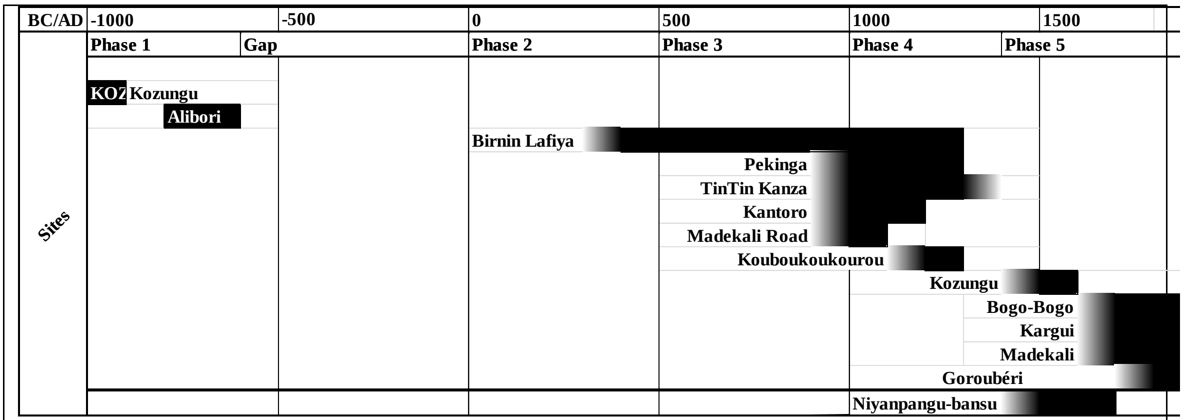

Figure 3.49 Schematic table of the archaeological sequence of the 13 Beninese sites sampled in this research.

In total, this research received 470 archaeobotanical samples from 5,867 litres of soil from 19 sites located along the Niger River Basin (Mali and Benin). The following section of this research will describe how the analysis and interpretation of these samples was undertaken and will further explore the results obtained from these analyses.

4. Botanical methodology: sampling and quantitative methods

4.1 Food production

> *"The danger of generalising about Africa, even West Africa, on the basis of such limited studies are self-apparent; particularly at the level of production and the consumption of food, there are great differences between the people of the savannah and the people of the forest, between those living on cereals and those living on roots and fruits (especially bananas), between pastoralists, hunters and agriculturalists, between the areas of Middle Eastern influence (especially through Islam) and of 'pagan' peoples, between the states of the great lakes (e.g. Ruanda) and other Kingdoms, and the inhabitants of farming villages and dispersed settlements"* (Goody J. 1982:40-41)

One of the major goals of my research is to reconstruct the evolution of food and drink systems, including production and consumption. Studies of past food and drink are about more than just documenting the arrival of new practices or new crop taxa, but about how such practices became embeded in the social, economic, political and environmental history of a society. Indeed, procurement of food is a vital human concern. As stated by Goody (1985, 43): "*We need to see the process of preparing materials for consumption as the end point of that major activity of humankind (reproduction apart), that is, the production of food".* To reach this 'end point' of food consumption we need to understand how people put food onto their plates. Before the long processes of animal and plant domestication, human subsistence activities focused on the gathering of wild plants and hunting of wild animals. But since the transition to agriculture, when societies fell into the domestication "trap" (Fuller et al. 2010), people became forced to grow grain and herd cattle for food in various combinations.

All these agricultural, pastoral and agro-pastoral activities require a number of phases in which the product reaches the point of being consumed as food. These phases are best defined as the initial processes of production of the living biological resource (crop-processing, animal herding), the distribution and storage of the harvested/slaughtered product, the preparation of these products (cooking practices) into food and finally their consumption (Table 3-23 & Figure 3.58; Goody 1982).

Table 3-23 The four main processes and related phases of food production (after Goody 1982, 37), with potential lines of archaeobotanical evidence

Processes	*Phases*	*Locus*	*Archaeobotanical evidence*
Growing	Production	Farm/(Field)	Ecology of weed flora
Allocating/Storing	Distribution	Granary/Market	Routine (post-storage) crop processing; burned storage contexts
Cooking	Preparation	Kitchen	Charred cereals food remains, pottery residues
Eating	Consumption	Table	Gut contents, palaeofaeces, dietary stable isotopes

For foodstuffs, production and consumption are inseparably linked. We can consider food as passing through a trajectory from procurement to consumption filled out by the models developed from ethnography (Goody 1982). Each step will be described in this chapter with an attention to the potential archaeological and botanical remains produced.

4.1.1 Production – Crop husbandry to Crop-processing

From a botanical point of view, production processes concern the entire phase of primary production of the living resource, from soil preparation, through sowing and tending, to harvesting from the fields. After harvesting the crop product, the grain, needs to be separated from contaminating weeds and non-edible plant parts (chaff etc.) by crop-processing. Varying numbers of crop-processing stages will take place before the crop is stored or distributed (Fuller, Stevens and McClatchie 2014).

So after harvesting, the aim of crop-processing is to remove the edible from the inedible, to liberate the grain from the husk/chaff and get rid of the weed seeds (Fuller 2009; Harvey and Fuller 2005).

For non-mechanized farmers, such as those in the Niger valley, there are few methods by which a crop may be effectively processed using traditional techniques. These methods involve a combination of pounding/threshing and separation by winnowing and/or sieving (Figure 3.51; Stevens 2003; Harvey and Fuller 2005). In terms of assemblage composition, all these stages of crop processing modify the crop product producing potentially characteristic assemblages of plant remains.

In this sense, crop processing can be divided in two categories of activities. Firstly, those actions applied to break apart the crop-plant, such as threshing (cereal ears and pulses pods), and later dehusking. Secondly, those used for the separation of non-food elements from the broken crop elements. Separation of light (weight) vegetal parts, such as chaff, can be done by winnowing (Figure 4.1). While, sieving can be used to separate bigger (size) elements, such as weed seed heads from grain (coarse sieving) or grain from small weed seeds (fine sieving) (Fuller 2009; 2014; Stevens 2003; Harvey 2005).

Therefore, the different stages will produce waste with distinctive characteristics associated with the weight and size of various elements (Stevens 2003; Fuller 2014; Hillman 1981; 1984; Glynis Jones 1984.). Thus, the waste of different stages can be used to characterize which activities contributed to an archaeobotanical assemblage, with routine activities more likely to structure typical samples on any given site (Stevens 2003). Normally small and light elements are removed early on, while larger weed seeds are removed within the later stages, making the ratios of large to small seeds helpful for distinguishing crop processing stages (Stevens 2003; Fuller et al 2014; Figure 3.51 & Figure 3.58). Over the course of the crop-processing sequence larger proportions of edible grain are also retained relative to waste (Fuller 2005; Stevens 2003). For Africa, it is noticeable that some crops, such as rice, bicolor sorghum, fonio remain husked after threshing, while some others, e.g. pearl millet and caudatum sorghum, cowpea are free-threshing, e.g. the husk comes free with threshing. The difference between husked and free-threshing crops will have an effect on both the processing of such crops and the resultant assemblage.

Figure 3.50 Threshing and winnowing area outside the village in Dendi (North Benin).The women come to this place once a week.
Photo: L.Champion

The remains of crop processing in archaeobotanical assemblages are most likely to result from routine activities, day to day processing, and thus reflecting repeated small scale activities related to domestic contexts (Stevens 2003; Fuller and Stevens 2009; Fuller et al 2014; cf Van der Veen and Jones 2007). Such activities normally happen after a crop is removed from storage. Thus pre-storage processing, which is usually annual or seasonal is expected to be less well represented.

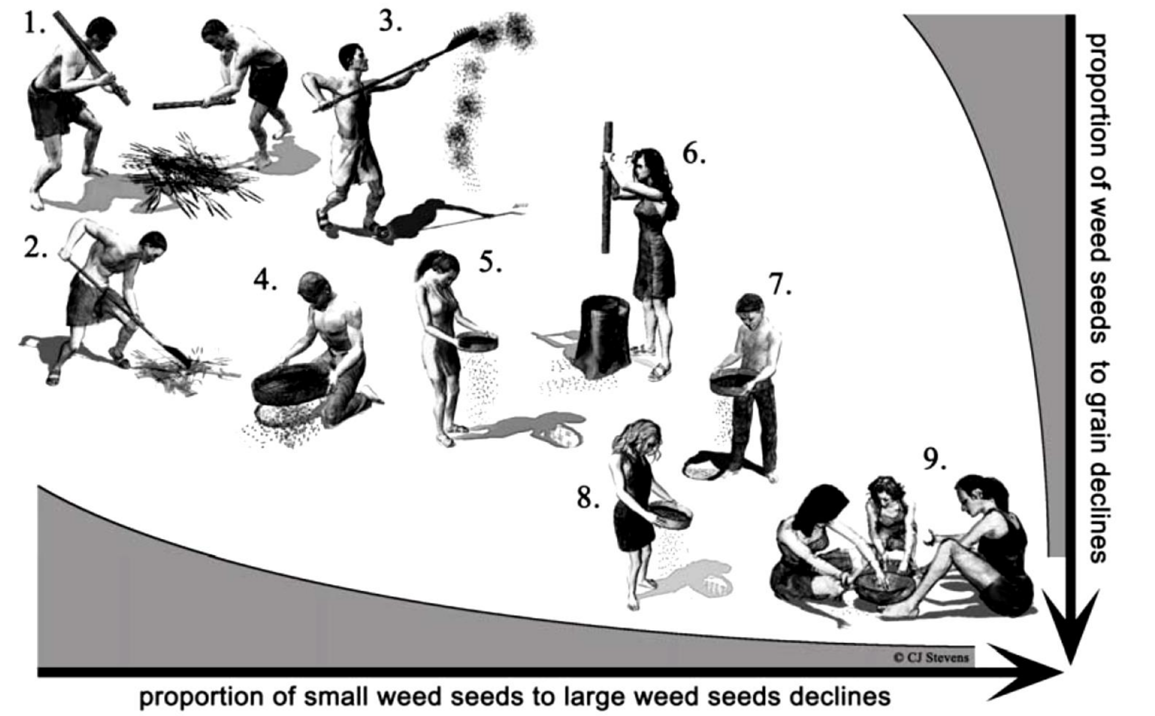

Figure 3.51. A diagrammatic summary of the effect of crop-processing on the composition of grain, chaff and weed assemblages. Through the course of processing, the proportion of weed seeds to grain decreases as more weed seed size/density categories are removed. Also, amongst the weed seeds, it is the species with smaller, lighter seeds than the grain which are removed earlier hence the proportion of small weed seeds to large weed seeds also decreases. The main crop-processing activities are numbered in order: 1. threshing, 2. raking, 3. winnowing, 4. Coarse sieving, 5. first fine sieving, 6. pounding, 7. second winnowing, 8. second fine sieving, and 9. Sorting. Reproduced from Fuller, Stevens and McClathie (2005)

Therefore processing sequences can be divided into two groups of activities: those conducted before storage (cf. Production phase) and those after (Fuller et al. 2014). But where in the sequence of activities this break occurs can vary across societies.

Activities conducted before storage are, in term of seasonality, usually conducted only once or twice a year. Looking at the archaeobotanical assemblages (see below), these activities are less visible for two main reasons. They often happen in the field far from fires and are only preformed a limited number of times. Thus the waste from these steps is only present for a small period of time and hence are often absent (with some exceptions) from archaeobotanical assemblages (Stevens 2003).

The second group of activities, carried out when a crop is removed from storage, will be more visible, archaeologically or archaeobotanically speaking (Figure 3.52). Indeed, this stage is regularly repeated, often within settlements near fires, and therefore the waste has a much higher probability to become charred and to be deposited in what will become archaeological contexts (see below) (Fuller et al. 2014; Stevens 2003). Hence, storage is a crucial point to the understanding of the routine daily activities that follow.

4.1.2 Storage and distribution

In terms of seeds, storage serves the fundamental purpose to conserve grain through the year, before sowing in the next year, for sustenance until the next harvest and as a reserve for times of bad harvests. The process of storage has a strong effect on the composition of archaeobotanical remains, because it separates the seasonal processing stages, those associated with harvesting, often carried out within or near the fields, from the daily routine, post-storage processing. Below I describe the effect of decisions concerning how far a crop is processed before storage has on daily processing activities and recurrent assemblage formation (Figure 3.52). I will then turn to another key variable of storage, which is where and how, in terms of technology and structure, crops are stored.

As indicated in the figure 4.3, different storage strategies to some extent are dependent on the availability of the labour that can be mobilized after the harvest. These strategies then result from work force availability during the harvest time, one of the most labour demanding times of the year (Fuller et al. 2014; Stevens 2003). Thus the size of households or other social groups can be linked to the storage practices. And by extension, the study of archaeobotanical remains can give us information concerning social change in terms of the size of labour available for harvest and pre-storage processing.

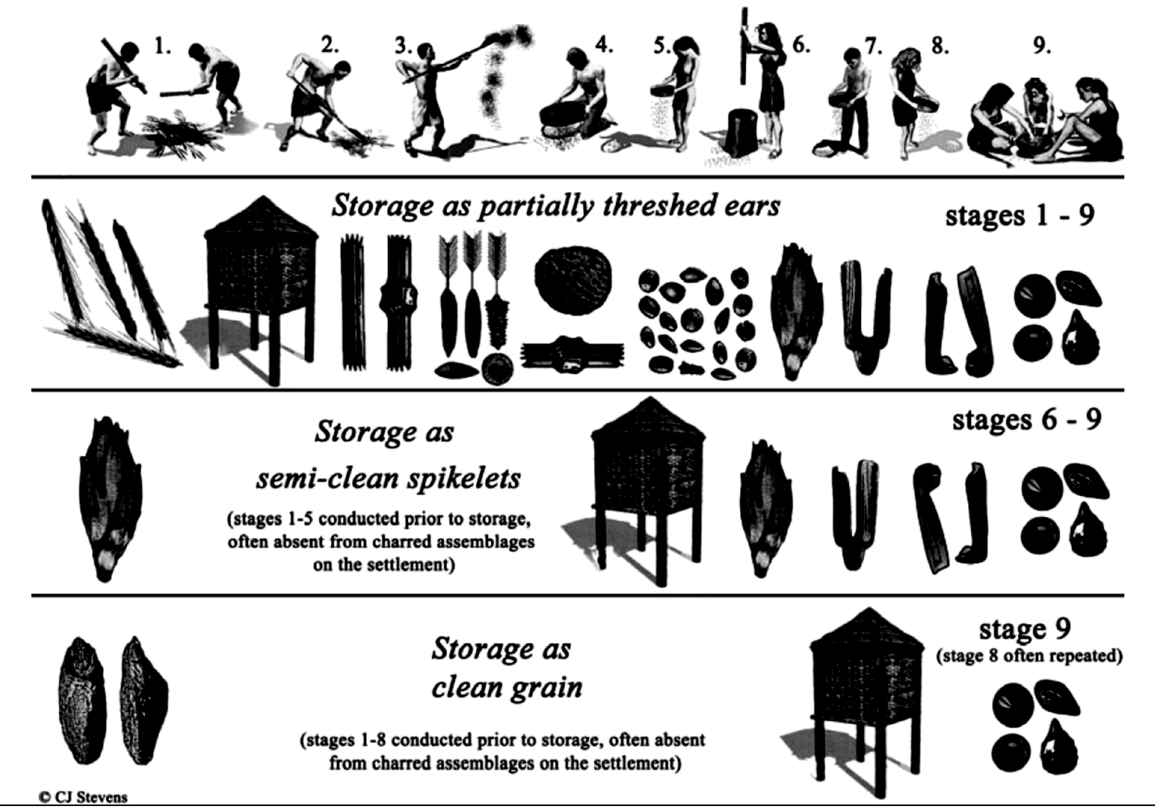

Figure 3.52. The effects of storage strategies on daily processing activities and recurrent assemblage formation. Three alternative storage strategies are indicated, each of which requires different degrees of labour mobilization during the harvest period, prior to bulk storage. This relates, therefore, to how many crop-processing stages, shown in the top row (numbered as in figure 4.2), are achieved prior to storage (Reproduced from Fuller, Stevens and McClathie 2014).

Figure 3.53 a Example of the ‘Sourou’ granaries type in Dendi. ©Livingstone.

Figure 5 b ’Sourou’ Granary © Gosselain.

Figure 5 c ‘Boa’ Granaries © Champion.

In Dendi, there are two mains types of granaries, the ‘Soubou’ (Figure 3.53 a and b) made of wood and vegetale remains (mainly sorghum or pearl millet straw) and the ‘Boo’ (Figure 3.53 c) made of clay and bricks. ‘Soubou’ granaries are the more common type. Granaries are often located all in the same place outside of the village (Figure 3.53 a and b) (see Chapter 5 for more detail).

There are other aspects of crop storage that can be investigated from an archaeological point of view, mainly the method or technology of storage. Indeed different methods relating to past crop storage structures often can be found though excavation.

Above ground granaries are the most visible forms of storage, and are prominent in many ethnographic traditions of western Africa. From the IND, to the Lake Chad via the Dendi, most of the West African granaries are very similar in construction and the way in which they function. Almost all are built on platforms made of wood or stones. The fundamental purpose of raising granaries is three-fold. Firstly for aeration, allowing air to circulate under the grain both cooling the grain (that is often still metabolizing) and keeping it dry (reducing mould); secondly it reduces the presence of pests, both rodents and insects; thirdly it isolates the grain or floor from rain water collecting on the ground. The roof is often made of straw with a small opening that allows a quotidian access to the product (Figure 3.53; Zurro 2005; Douny 2014; Hamon 2012; Logan 2012). However, as they are often constructed of potentially perishable components, such as wood, they may be difficult to track in excavation, and their identification rests on the interpretation of ambiguous postholes. Nevertheless, above ground granaries do imply a significant investment, and some architectural skills, in their construction.

A second form of storage often recovered archaeologically are **underground pits**, which are also a common method of grain storage. Today, the Bunyoro people of Uganda are still using underground pits for the storage of finger millet (Young 1999). In archaeology these pits constituted a primary deposit. Usually, the underground pits are deep pits (2 metres deep) built in a dry area safe away from river flooding. They are usually filled with cleaned sun dried grain, and opened only two or three times a year. Once open, people take a quantity of grain, large enough to last 3 months. This grain is then stored in smaller ceramic pots within the house. Underground pits are usually used to store grain for a maximum of five years but after one year the grain from such pits is not used for sowing (Young 1999; Vignet Zunz 1979). Preservation of grain in huge **ceramic pots** (around 1 metre high) or in granaries is more frequent than in underground pits. Indeed storage pits are often more humid and may be flooded during rainy season. Even so, underground pits are still used today; firstly to conceal the stored crop from thieves and secondly for the taste of the seeds. In South Algeria, after the rainy season around 40% of the pits are flooded. These flooded pits produce 3 types or qualities of grains:

- Rotten grain, generally the grain in direct contact with the soil at the edge and top of the pit often considered too bad to be eaten.

- Fermented grain, from the bottom of the pit. This grain is then dried in the sun and cooked as couscous.
- The "normal" seeds from the upper part of the pit.

Surprisingly, the fermented grain type is more appreciated than the normal type. Also, the fermented types have a better taste for couscous and are much more expensive to obtain than the normal type (Vignet Zunz 1979). It is noticeable that for different crop species, a different type of storage will often be preferred. As in the Lake Chad area where sorghum is only stored in underground pits and pearl millet is packed into granaries (Vignet Zunz 1979).

4.1.2.1 Processed Food storage

Processed food can be stored for a short period. But the climatic conditions in West Africa are not suitable for long-term food storage. Nevertheless, due to the ceramic component and their physical characteristics (evapotranspiration), ceramic pots are a great way to keep fresh any food, water and any liquid such as beer (Jolly 2004; McIntosh 1995).

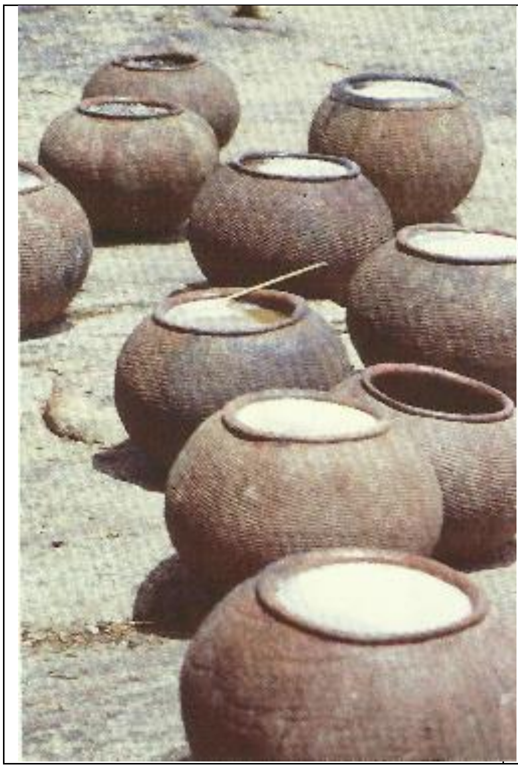

Figure 3.54 Dogon beer jars during the fermentation (from Jolly 2004:319).

During the process of fermentation, beer is generally stored for 10 days (Jolly 2004) (See also cooking and brewing below). In the Minyanka society in Mali, the remains of the evening meal (porridge) will be sun dried and conserved for two or three days in ceramic pots (Hamon 2013).

4.1.2.2 Meat and fish storage

After cereals, pulses and nuts, meat and fish are the two other main food items in Africa. The challenge for a society located in a warm climate such as tropical Africa, is their storage. Meat from large hunted or slaughtered animals, domesticated or wild, is very quickly distributed over a short period of time. This process creates very specific relations of exchange (Goody 1982). In most African societies, the meat day is the market day. Indeed, people choose the market day to slaughter large animals. The meat will then be roasted and sold during the market. The killing and roasting of larger animals is usually reserved as a task for men, whereas other cooking practices lie within the realm of women (Haaland 1995). Fishers, such as the Bozo in Mali and in Dendi, also use a smoking process to preserve fish (Figure 3.55) (Gallais 1967). In North Benin, archaeozoological analysis has demonstrated that aquatic fauna predominated the assemblage with probably less than 15% of other animal meat being consumed (Linseele V. *Pers.com.*).

Figure 3.55 Oven used for the smoking and drying of fish with detail of the preformatted ceramic. Photo taken in a fishing settlement of the Dendi in North Benin (courtesy of O.Gosselain).

4.1.3 Preparation – Cooking & Beer making

Food preparation usually concerns more directly the task of taking food that has been procured (from the market, or stores, or the field) and preparing it for near immediate consumption. However, some cooking techniques may be used to prepare some foods for storage (such as fermentation, smoking and parboiling). Typical examples of initial food preparation may include the shelling of nuts, and grinding of foods, followed by various cooking practices (Goody 1982), which may include brewing beer. Prior to grinding there may often be some daily completion of final crop-processing stages (see above).

4.1.3.1 Grain cooking methods

In Africa there are several grain cooking methods. These differ as to whether grains are cooked whole or pounded as coarse flour or fine flour. Also, the ways of cooking depend on the species.

In the Sahelo-Sudanese region, the daily diet is based on millet (sorghum and pearl millet), and rice. Two processing sequences are necessary to prepare the meal: the preparation of the grain-based dish and the preparation of the accompanying sauce generally made with dried fish, peanuts, palm oil, tomatoes, onions, and or groundnuts, combined with a wide variety of leaves, such as baobab leaves (Logan 2012; Hamon 2013; Jolly 2004; McCann 2010).

Pearl millet and sorghum can be processed and consumed in a variety of ways, including being consumed as a thick porridge called *tô*, a thin, fermented porridge called *koko*, a deep-fried pancake called *marsa* (Ricquier and Bostoen 2011; Ricquier 2014), as a couscous, as a blend with pulses, as a fermented and non-fermented beverage. Usually each of the main recipes implicates different cooking practices. Pearl millet and sorghum are more often ground into flour before being cooked, and fonio and rice are more often cooked as whole grains (Jolly 2004; McCann 2010).

Pearl millet and sorghum are recorded as being prepared by the following methods: Firstly, millet porridge, one of the most commonly consumed dishes in all Africa (Ricquier and Bostoen 2011; Ricquier 2014), is prepared with very fine flour mixed with water and boiled with constant stirring to obtain a good thickness (Hamon 2013). In the Dogon country, the porridge called '*naan'* can be prepared in two different ways.

One in which the millet grain is ground with a grinding stone, with the millet flour then mixed with potash during cooking. The other porridge is prepared through pounding the millet with a pestle in a mortar, it is then cooked without potash (Jolly 2004; Hamon 2013). In the Banda area (Ghana), the thick millet porridge is call T.Z. (from hot porridge: '*tuo zaafe*'). Sometime T.Z. is made of cassava flour instead of millet (Logan 2012).

In the second method, millet couscous made from a coarsely ground millet flour is dried in the sun as small handmade balls. These balls are then eaten dry or steamed in a distinctive vessel, the couscoussière. Also, whole sorghum and fonio seeds can be steamed (Hamon 2013, Cruz 2011).

Thirdly, millet can be prepared as fried pancakes made of fine flour and water.

In the final method, the raw gruel of millet, that is more commonly used in rituals (Jolly 2004), is prepared from a very fine flour mixed with sugar and water (Hamon 2013).

Currently, African rice, *Oryza glaberrima*, is most often boiled or steamed whole, which contrasts with sorghum or pearl millet. As put by McCann: "*West African cooking of rice favoured a method that yielded separate grains of rice […]. The rice would be boiled for ten minutes, the excess water would be drained, and the pot would be removed from the heat and the grain allowed to absorb the remaining moisture. The crusty caramelized residue along the edges of the pot [!] was a particularly popular snack for children."* (McCann 2009:39). But it can be used in other ways such as rice flour.

Cowpea has a very wide range of uses. The seeds can be boiled and eaten with a mix of boiled rice, or can be ground and used as flour and fried with onion. The leaves can be used as the base for soups or sauces (Logan 2012; D'Andrea et al. 2007).

Cereals and pulses are not the only plants consumed in the Sahelo-Sudanese region. Indeed starchy roots, such as cassava and yam are also prepared. While cassava is historically recent, originating in the New World tropics (Denham 2014), yams (*Dioscorea* spp.) are native to western Africa, and *D. cayenensis* is regarded as domesticated around the forest margins of West/Central Africa (Coursey 1976; Fuller and Hildebrand 2013). One of the most common yam dishes is the fufu. The fufu is a firm mass obtained by pounding boiled yams. As stated by Logan (2014:214) "*for both fufu and T.Z. to be acceptable, they should be firm, without chunks, and very smooth* *and sticky. Both staples are swallowed without chewing because the mortar or paddle (in the case of T.Z.) has done the chewing for you. The longer a woman spends making T.Z the smoother and better it is, which serves as a source of pride.*"

Therefore, in West Africa, staples can be boiled, steamed, dried or fried. They can be prepared as porridge, pancake, or gruel. In addition cereals can be turned in beer.

4.1.3.2 Brewing and Beer

While beer can be considered as food, it requires different tools and ways of preparation. Beer preparation is the most long and complex of all cooking preparations (Jolly 2004; Haaland 1995; 2007). Thus the preparation of beer is an integral part of food production. For many peoples in the world, particularly in Africa, drinking beer is a routine daily or weekly activity and "is a pervasive feature of social life" (Haaland 2007:166). Dogon adages say "Millet, it is beer, without millet, no beer"[5] (Calame-Griaule 1965:554 cited in Jolly 2004:307). This statement illustrates well the importance of both cereal and beer in the Dogon society.

In Africa, the production and consumption of beer is well exemplified; for example the Bassari maize beer in Senegal, eleusine beer in the Great Lakes area of East Africa, or rice beer in Congo (Jolly 2004). In the Sahelian area of West Africa, millet and sorghum are the only cereals used for beer, but in other African region we find beers made from maize, finger millet (*Eleusine coracana*), Fonio (*Digitaria* sp.), rice, cassava, yam, banana or barley (Jolly 2004; Champion 2011).

Cereals are the most frequent plant category used in beer preparation. As such the cereal grains destined for use in beer production form an important part of total grain production. For example, Jolly noticed that in the Dogon society around 20% of the millet used in a year were transformed into beer. Although, only 2.5% of the millet produced by the beer-maker herself, *"la dollotière"*, was used for beer. In fact this woman preferred to buy the millet destined for beer and used her own millet production for eating. In that way, beer played a great part of the commercial life of the village community (Jolly 2004). This average, 20%, of seed utilisation implies that archaeobotanical remains may relate not just to food but also beer production.

[5] Translation of French: "Le mil, c'est la bière, sans mil pas de bière. »

Beer is a complex drink that results from the saccharification of the grains starch by the enzyme amylase. The saccharification process then creates sugar that can ferment to produce alcohol (Jolly 2004; Djoulde 2013). There are three main beer categories:

- Beer made with salivary amylase obtained from the chewing of dough, such as the *Chicha* made from maize in Bolivia. This method of fermentation is documented worldwide and is likely amongst the most ancient methods employed (see, e.g. Ankei 1986, Fig 1).
- The fermented liquid porridge ("la bouillie fermentée") beer. This is produced from a flour, usually millet flour, mixed with water and then fermented for 3 days. After three days the product is quickly roasted and stored in ceramic containers. Before being re-fermented for a further 5 days, the cooked, fermented dough is mixed with water and boiled. The beer obtained through this process is a thick and acid porridge. Here the fermentation is not due to the amylase but to lactobacilli bacteria. This kind of beer is mainly found in Egypt, South Africa and can be done with banana or roots as cassava in Central Africa (Jolly 2004). Ankei (1986) reports a sake like drink made from rice in the Congo using this method.
- The last, but not least, category of beer is malted beer. The malt is prepared from germinated cereal grains. The germination creates the amylase required for the saccharification. Finger millet, sorghum and pearl millet beers are usually malted beers (Djoulde 2013; Jolly 2004; Lyumugabe et al.2013; Ankei 1986). The process of fabrication is formed of three steps; malting, brewing and fermentation (Figure 3.56 and Figure 3.57).

  The malting

  During the malting, the grains are first soaked in water for one to two days, the soaking fostering the germination of the grains. After 4 days, the germinated grains are sun-dried for 2 days and finally ground to obtain malting flour.

  The Brewing

  The malt is then mixed with water in a ceramic jar (Figure 3.54). This operation is referred to as "pasting" and constitutes the first step of the saccharification. The decoction, the second stage of the brewing, comprises of boiling the floating undissolved malt flour in order to obtain a "jelly" of cooked starch. After one day, the starch jelly and the heavy un-boiled remains from the decoction are cooked at around 65 to 70 degrees. It is during this low temperature cooking that the starch saccharification happens. From the starch, the amylolysis creates two fermentable sugars, dextrin and maltose. In order to obtain a highly concentrated liquid and reduce the presence of bacteria, the wort so obtained is then cooked for a further 8 hours. Finally the wort is cooled and mixed with an ongoing fermentation and used as a starter culture. In Africa the fermentation is a top fermentation operated through ambient temperature. The top fermentation is generally a one day process. The starter culture is then recovered from the bottom of fermentation pots. The cake is sun dried and kept as starter culture for new production (Djoulde 2013; Jolly 2004; Lyumugabe et al. 2013).

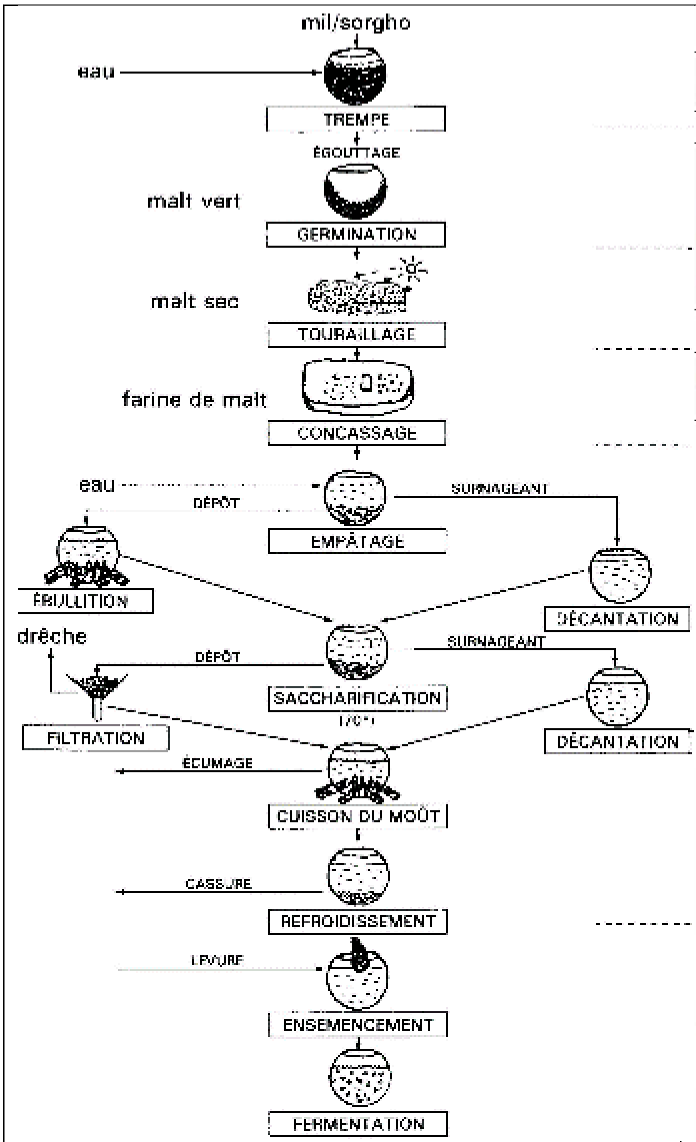

Figure 3.56 Schema of the Millet (*Pennisetum glaucum* or *Sorghum bicolor*) beer preparation in the Dogon area in Mali (Reproduced from Jolly 2004:48).

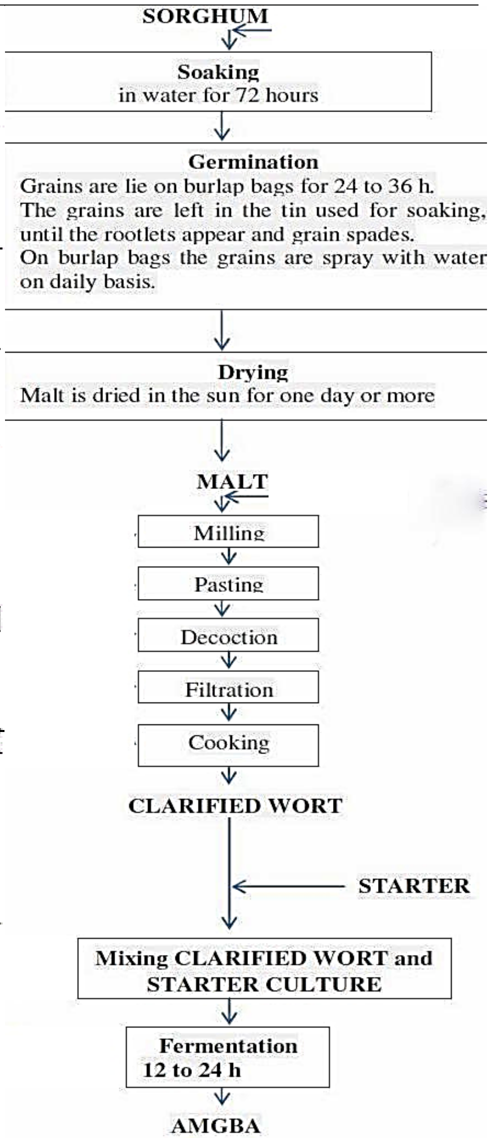

Figure 3.57 Schema of Sorghum beer preparation in Cameroun. (Reproduced from Djoulde 2013:13)

4.1.4 Consumption – Eating and Drinking

In Sub-Saharan Africa the emphasis of consumption is in the form of porridge and beer, and lies in opposition to the Near East where it is on bread and meat (Haaland 2007). The emphasis on bread and baking ovens found throughout West Eurasia lies in contrast with the Saharan 'boiling-and-grinding' approach to cereal preparation. The African cereals, sorghum, millets and rice all lack gluten, which provides the basis for leavened breads or other paste-base preparations associate with baking. Thus, the West Africa food system can be described as a boiling/steaming-and-grinding and roasting tradition that allows the preparation of porridge and fermented foods, as beer, with gluten-free cereals (Fuller and Rowlands 2011; Lyons and D'Andrea 2003; Gallagher 2011). These boiling or steaming systems can be directly associated to ceramic vessel utilisation (Gallagher 2011). In Africa, and particularly in West Africa, porridge is the main culinary preparation, and developed into many varieties.

4.1.4.1 From cooking to ceramics

As discussed above, in West Africa, pounded millet is generally cooked in perforated ceramic vessels identified as steamers, called 'couscoussières" (Gallay and Huysecom 1989, MacLean and Insoll 1999). As MacLean and Insoll (1999:88) put it "*The presence of couscoussières is particularly interesting, as this can be seen as relatively straightforward evidence for the steaming of some foodstuffs"*. As with eating a millet gruel preparation, beer drinking is a daily activity for most people, forming a fundamental part of the definition of social life (Haaland 2006; 2007; Ricquier 2014; Jolly 2004). Here too ceramics play an important role.

For the Dogon, the beer is made and sold by women, but it also plays a part in forming a strong link between son, father and grandfather who will often exchange and consume beer together. Further a Dogon master is required to control the magical power of the beer in order to be a leader. In the Dogon country beer can then be seen to play an integral role within the formation of social relations between every member of the population. For the Dogon then, wealth is not counted in terms of money but in terms of the numbers of beer jars that a family holds (Jolly 2004; Dounay 2014).

For the Massa and the Moussey in the Chad area, sorghum is considered a 'cultural superfood' (Jelliffe 1967; De Garine 1988). A cultural superfood being a food that plays a role throughout the society in terms of reinforcing social structure both through its use in daily consumption and in ritual contexts. A cultural superfood is “bonne aussi bien sur le plan moral et religieux que nutritionnel” [good as well for the mind, the religious and the nutritional] (De Garine 1988: 34). Ceramics, as both the vessel in which food is prepared, as well as consumed, then play an important role within the study of food in African societies.

The primary type of storage and cooking containers are the ceramic vessels that are regularly recovered from archaeological deposits (Gallagher 2010). The consumption of food is directly related to pottery utilisation (Fuller 2005; Bedaux 1986; McIntosh 1995). Moreover, the study of ceramic form can give information on certain cultural behaviours relating to the handling and consumption of foods (Fuller 2005; Goody 1982; Rice 1987).

Porridge is usually cooked in medium size pots that sit directly on the fire. The accompanying sauce is also cooked on a fire but in a separate smaller pot. After cooking, the porridge is usually served in a communal platter accompanied with a small pot of sauce, served in a different vessel from the one it was cooked in (Hamon 2013). Currently, the communal platter is usually made of aluminium and sometimes can comprise of just a plastic bucket, but the elders still use ceramic plates, which were previously more common (*Personal field notes*).

As noted above, the preparation of porridge requires vigorous and constant stirring of the flour or grains in a ceramic pot. The result of this stirring on the ceramic surface is “a very heavy abrasion pattern on the interior walls of the vessel and not on its base” (Reid 1999:105). That characteristic abrasion was observed by Reid in Uganda for the preparation of finger millet (Reid 1999). Thus this heavy abrasion pattern analysis can provide a potentially new means by which to track a particular step of the food production chaine opératoire.

We can further link beer and porridge to two other factors, grain and female labour (Haaland 2006). Traditionally today women are in charge of the preparation of food. From the harvesting of the crop in the field to the men’s plates, women control many steps of the cooking process. This also holds true for the making of the implements of cooking and consumption, the vessels themselves. Indeed, pottery making in Africa is, with few exceptions (e.g. The Dogon around Hambori), carried out by women

(Gosselain 2002; Haaland 2006; 2007). Haaland explains that “the *pottery making and food preparation by cooking involve activities which, in many respects are similar: grinding, the use of water, kneading, and firing*” (Haaland 2006:263).

4.1.5 Food system archaeology

For purposes of putting together a holistic archaeology of food production and consumption we can link the archaeobotanical evidence for production and preparation to the artefactual evidence for preparation and consumption, as well as inferences about storage. Thus we can propose a holistic archaeology of the food system, a “chaine opératoire” of food.

Phases & Processes	Crop Processing		Archaetanical remains		Interpretation of storage practices			Archeological remains
			Chaff	Weeds				
Production Growing	Harvesting							Blades: Lithic/ Iron
	1. Threshing	Early Stage	Free-threshing Rachis and culm nodes		Storage as partially threshed ears			
	2. Raking							
	3. Winnowing			Proportion of small seeds to large seeds declines & Proportion of weeds to grain declines				
	4. Coarse sieving							
	5. First fine sieving							
	6. Pounding/De-Husking	Late Stage	Glumes bases spikelets bases			Storage as semi-clean spikelets		
	7. Second winnowing							
	8. Second Coarse sieving							
	9. Second fine sieving						Storage as clean grain	
	10.Hands picking							
Distribution Storage	Storing							Ceramic pots, pits and Granary
Preparation Cooking Beer making	Depending of the storage, late stage step can be done for the preparation							Ceramics
								Grindstones
								Food residues
Consumption Eating Drinking								Ceramics
								Food residues

Figure 3.58. Summary of the food production “chaine opératoire” from production to consumption. This also includes the botanical, archaeobotanical, archaeological remains resulting from each step.

As we saw above, each step generates remains that can potentially be found in archaeological deposits, but for a holistic perspective we must combine evidence from artefacts, crop-processing and animals remains (Figure 3.59). When combined such evidence provides information about food production and consumption, and can be related to social organization in the past. Archeobotany yields more evidence for production, processing and storage practices, while finds of pottery relate more directly to consumption (Fuller 2005; Goody 1982). Archaeobotanical analysis of crop production and storage provides information about the social system in terms of labour organization (Stevens 2003), while ceramic evidence may relate to changes in social contexts of consumption that may play a role in differentiation within societies or between societies (ethnogenesis).

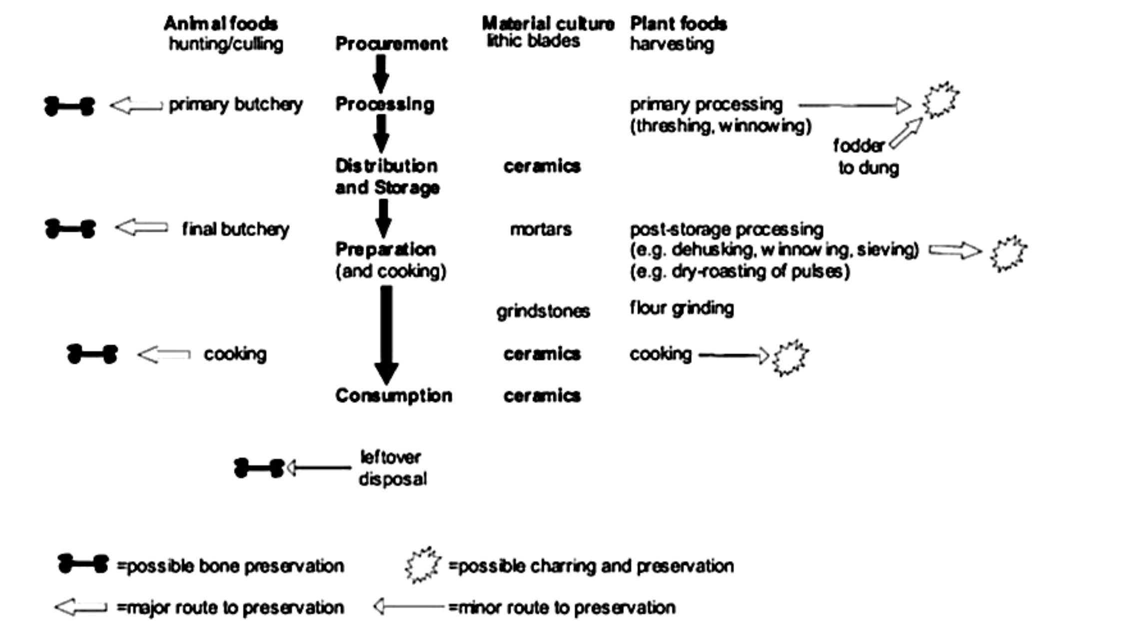

Figure 3.59. The Trajectory of food and possible archaeological data sets. Reproduced from Fuller 2005

4.1.5.1 Interpretation of archaeobotanical remains

To interpret the meaning of archaeobotanical remains, we firstly need to comprehend the formation process of the charred remains. In others words, we need to apprehend what is the composition of the flotation sample, how they arrived in the archaeological deposit, and what was destroyed and what was not deposited. Therefore, to start at the beginning we have to understand how and why plant remains become charred and subsequently deposited within archaeological contexts (Figure 3.60). As stated by Fuller, Stevens and McClatchie (2014: 3): "*To state the obvious, charred remains only become charred and preserved through virtue of having come into contact with fire. It is then surely impossible to interpret the relationship between context and charred plant remains without considering how both relate to the fire responsible for the assemblage's preservation*".

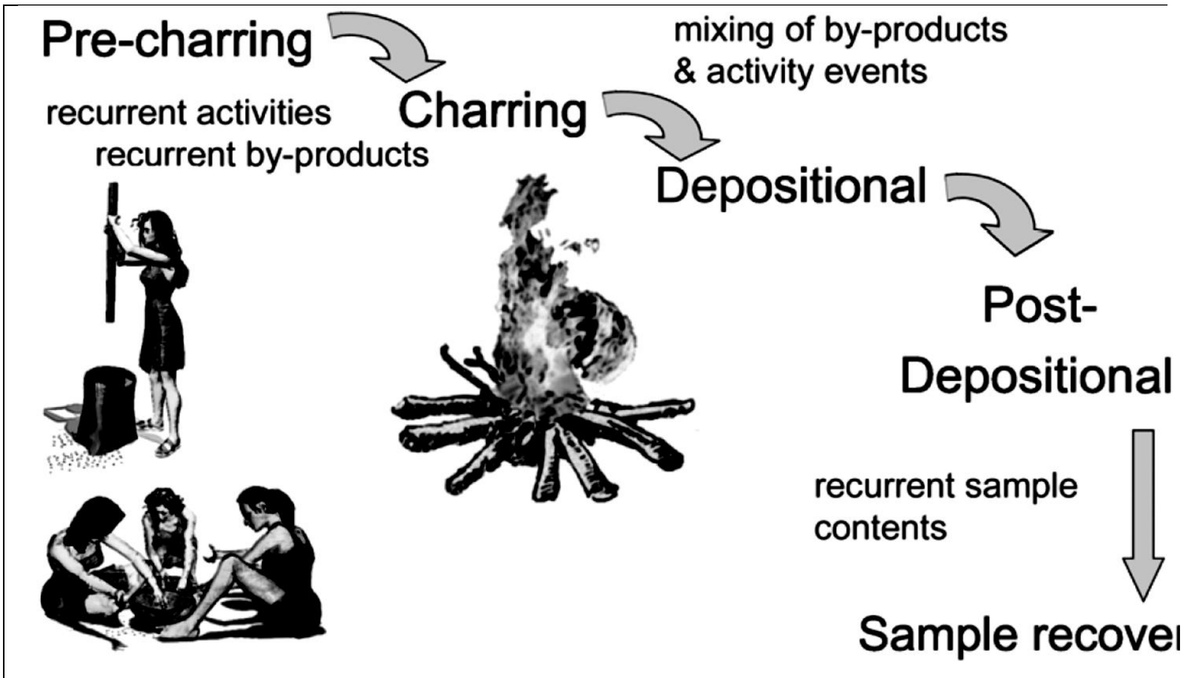

Figure 3.60. A simplified diagram of the major pathways towards preservation of charred plant remains, indicating recurrent final crop-processing, mixed in burning and in redeposited sediments. Reproduced from Fuller, Stevens and McClatchie 2014.

The different categories of charred assemblages can be divided in three groups (Hubbard and Clapham 1992; Stevens 2003; Fuller and Weber 2005; Fuller et al. 2014). The first category, (A), is where the remains have burnt within the context from which they were recovered. Here firstly, the context will show signs of burning. In this case, remains can be considered as coming from a primary deposit (Fuller et al. 2014). The second group, (B), are remains that come into the context from a single burning event and the charred remains have been moved to another context (secondary deposition). Lastly, but not least, the third group (C), differs from group (B) by the way that the assemblage was formed, deriving not from one single event but by many different charring events mixed together during or after deposition

The traditional[6] way of understanding the archaeobotanical remains is to consider group (C) as the most difficult to interpret and that remains from group (A) and (B) are to be preferred (see Hubbard and Clapham 1992). This traditional way can be compared to the 'behavioural context' approach to archaeological interpretation (La Motta and Schiffer 2001) that linked plant processing, burning and archaeobotanical evidence (Fuller et al. 2005). But Fuller et al. (2014) proposed **"to break the tyranny of context**

[6] Here "traditional" is used as "the most communally accepted".

for the power of content". Indeed most archaeologists assume that there is a direct link between activities that created archaeological assemblages and the excavated context from which it was recovered without accounting for how they became charred and deposited or redeposited there. But as Hillman (1973) already recognized when establishing the first ethnoarchaeological study of crop-processing, archaeobotanical assemblages need to be related directly to past activities by quantitative patterns among the plant remains.

As stated, the presence of fire is a prerequisite in the formation of charred remains. In that way, experience has shown that class (C) remains are the more commonly found without regard to context type. As the class (C) assemblage comprise the result of many different activities, random archaeobotanical sampling tends to produce a similar homogenized assemblage. This approach shows that, regardless of context type most contexts produce highly similar assemblages, and these assemblages relate mostly to the arable environment of crops and arable weeds (or other crop-processing waste). This suggests than any variation seen between samples can be related more to variation within the occupation phases or social variation across a site, than to specifics of context type. Therefore, charred remains form a significant proportion of the general background noise of refuse (Stevens 2003; Harvey and Fuller 2005; Fuller et al. 2014). Following this background noise approach, we can consider than each sample has an important role in revealing routine activities by site or time period. "*Charred plant component resulting from routine activities that are conducted day-in, day out are 365 times more likely to be represented than the once-in-year or occasional event.* […] *The internal composition – by which we mean all those seeds/chaff from a single flotation sample- of the assemblage itself that is most informative"* (Fuller et al. 2014:11) Thus the study of one single flotation sample (by archaeological phase or even by site) may in itself be good enough to reflect a past behavioral pattern. But in order to verify this hypothesis, as stated by Fuller, Stevens and McClatchie (2014) we need to study the archaeobotanical remains by both context and by content.

To conclude, archaeobotanical macro-remains provide evidence for routine daily processing. They also have implications for how harvesting and storage might have been organized in terms of the scale of labour units. We expect signals of typical patterns for particular sites or periods, and in the absence of multiple spatial samples across urban sites we expect most differences to be diachronic.

4.1.5.2 Interpretation of Material remains

Ceramics

In order to address the questions of this thesis, the aim of ceramic analysis is primarily, to provide complementary information about the food production step. The first stage of the ceramic study is hence to describe and present the "cooking set" (la batterie de cuisine/ the kitchen artefact) and the vessel forms, and their relation to food production. These different morpho-functional categories of ceramics can then be assigned and compared to ceramics within archaeological phases with the aim to understand their evolutionary trajectories over time.

These ceramic vessels can be divided in their use into three stages of "Food trajectory": (re-) distribution (including storage), preparation (cooking) and consumption (serving) (Figure 3.59). By comparing these stages with ethnographic studies on African food practices, each of these categories can be related to ceramic morphology. In this respect ethnoarchaeological work on pottery provides an indispensable context for interpreting the function of domestic pottery.

As we saw, ceramic and archaeobotanical analysis are complementary in the reconstruction of the food production 'chaine opératoire'. Both provide complementary information and data, while archaeobotany gives us information about the activities involved in processing the crop and the organization of those actives relating to storage, pottery provides evidence for the storage, distribution, cooking (including beer preparation) and consumption of crops. Ceramic and archaeobotanical remains together then form the key archaeological materials in the understanding of the food production trajectory.

In addition to archaeobotany and ceramics other evidence of course also pertains to this reconstruction; for example, archaeozoological data and other relevant artefacts found in excavations, such as grindstones.

Grindstones

As we saw, the preparation of food and beer requires the utilisation of grindstones and mortars. But even though grinding stones are perhaps one of the most commonly found categories of artefact during excavations they are often largely neglected: To quote Kathleen Morrison *"It is curious that groundstone, perhaps the least glamorous* *artefact class and certainly one of the least studied, is closely associated with cooking and food preparation"* (Morrison 2012:234).

For peoples in West Africa, the use of mortars and grinding stones, for the production of flour and oil, form an essential part of the local economy. Without grindstones there is no porridge (Zurro 2005). The study of grindstone will then provide additional useful information mainly about this preparation step in the food trajectory.

4.1.6 Discussion

As a "total social fact" (sensu Mauss 1950), the study of food production gives indications of social activities. Thus, together with the archaeobotanical analysis, the study of food production history in Africa will provide new evidence not just about African food evolution, but about the evolution of African societies through time.

In conclusion, we should see traditions of cooking and food production as intrinsically tied to social and cultural divisions of gender, age, class, community, family and household. Food is central to social culture. As stated by Alegria and Graff (2012:11): *"The relationship between cooking and social structures can change historically in ways that are identifiable archaeologically and that can add complexity to models of the past.*

All the steps of food production involve part or much of the population. Every member of the society has a role, whether political, economic, religious or practical, to play in food production. Therefore food production practices can be seen as a "total social fact" which includes the distribution, preparation and consumption of food (Table 3-23; Goody 1982, Mauss 1950). A total social fact is a concept developed by Marcel Mauss:

« Depuis des années, notre attention se porte à la fois sur le régime du droit contractuel et sur le système des prestations économiques entre les diverses sections ou sous-groupes dont se composent les sociétés dites primitives et aussi celles que nous pourrions dire archaïques. Il y a là tout un énorme ensemble de faits. Et ils sont eux-mêmes très complexes. Tout s'y mêle, tout ce qui constitue la vie proprement sociale des sociétés qui ont précédé les nôtres - jusqu'à celles de la protohistoire. Dans ces phénomènes sociaux « totaux », comme nous proposons de les appeler, s'expriment à la fois et d'un coup toutes sortes d'institutions : religieuses, juridiques et morales - et celles-ci politiques et familiales en même temps ; économiques - et celles-ci supposent des formes particulières de la production et de la consommation, ou plutôt de la prestation et de la distribution ». (Mauss 1950 :7)

« Les faits que nous avons étudiés sont tous, qu'on nous permette l'expression, des faits sociaux totaux […] c'est-à-dire qu'ils mettent en branle dans certains cas la totalité de la société et de ses institutions et dans d'autres cas, seulement un très grand nombre d'institutions, en particulier lorsque ces échanges et ces contrats concernent plutôt des individus». (Mauss 1950 :102)

[For years, our focus is both on the regime of contract law and the system of economic benefits between the different sections or sub-groups which consist of primitive societies and also the ones we might say are archaic. There is just a huge set of facts. And they are themselves very complex. All mingles, everything that constitutes the actual social life of societies that preceded ours - to those of Protohistory. In these total social facts as we propose to call them, to express both and suddenly all sorts of institutions: religious, legal, morals (political and family at the same time) and economic – and those one assume particular forms of production and consumption, with emphasis on service provision and distribution (Free translation from French in Mauss 1950: 7)]

[The facts that we studied are all, total social facts […] that is to say, they set in motion in some cases the whole of society and their institutions and in others case, just a huge number of institutions, particularly when these exchanges and contracts affect some person (Free translation from French in Mauss 1950:102)]

Thus following Mauss's definition food production – and cuisine – is a total social act and the culinary practices studied will give us a broad understanding of at least a big part of the society. "La cuisine est un langage dans lequel chaque société code des messages qui lui permettent de signifier au moins une partie de ce qu'elle est" (Levis Strauss 1967)

[Cuisine is a language within every society input codified messages that allows us to identify at least a part of what it – the society- is. (free translation from French In Levis Strauss 1967)]

Conclusion

In conclusion, the Niger River valley is a favourable ecosystem that historically supported high density settlements and served as a corridor for trade and population movement. The Niger valley had a major role in the rise of elaborated political-administrative organisations, such as the empire of Mali and the Ghana Kingdom. Nevertheless, the long term cultural history that underpinned these political developments is still poorly understood. A necessary component of the growth of populations was sufficient surplus food production, which raised questions about the nature of agriculture and how it might have changed to support political change. At the same time, food culture would have been central to the construction of cultural identities and in maintaining and developing the social differences that developed in complex societies such as the historically known empires and kingdoms

4.2 Archaeobotanical studies

There are many different ways to approach the study of domestication, agricultural evolution and culinary traditions. Because plant foods (cereals and vegetables) are among the most common foods in Africa — and indeed the world — this thesis adopts an archaeobotanical approach to study the history of alimentation. Without omitting other analytical tools developed in this domain, such as modern botanical and genetic studies of crops, I will focus on ancient plant remains and the general contexts (e.g., archaeological, ethnographic) from which they were recovered in order to understand their culinary significance. Indeed, carbonized plant macro-remains provide the most direct evidence for understanding early crops, food and agriculture. Furthermore, new possibilities are developing in the analyses of botanical remains; combined with older methods, they will bring a new body of data able to improve our knowledge of food history in Africa.

4.2.1 Fieldwork strategy

The samples analysed in this study were collected during three fieldwork seasons (2012, 2013, and 2014) in the north of the republic of Benin. During the 2012 field season, I worked under the supervision of Dr Sam Nixon (University of East Anglia) and Dr Carlos Magnavita (University of Frankfurt), who guided me on the principles of archaeobotanical recovery in the field. From 2013, I took full responsibility for the archaeobotanical sampling methodology, as well as excavating several test-pits with the aim of recovering archaeobotanical material.

4.2.1.2 The sampling methodology

The sampling strategy was a great challenge given the large field team, and expansive study area, involved in the ERC project. The strategy was to obtain samples through three avenues:

(1) Archaeobotanical survey

The archaeobotanical survey consisted of small-scale sampling from many small test-pits (generally 1 m^2) across many identified sites. The samples collected within this strategy were usually small (average five litres of sediment), and represent each archaeological pit or context of interest such as deep midden pits or ashy layers.

Thanks to a NERC[7] application for radiocarbon dating, almost all of these samples have been directly dated on plant remains.

(2) Exploratory sampling during excavation

This strategy had a simple goal, to obtain more information about a context, structure or pit. This was applied particularly in the case of problematic contexts for which we did not have a good understanding. This strategy included samples of ceramic pot contents. In most cases, these samples comprised very small volumes of soil (c. 1–3 litres).

(3) The archaeobotanical index trench

These samples were collected systematically from the test pits that I excavated specifically for this thesis (TTK-13-SI, BLAF-14-BAO FIII and KRO-14- SI and SII). Where possible, a minimum sample volume of 15 litres per context or an arbitrary spit was maintained. Smaller contexts (< 15 L) were sampled in their entirety. This strategy also included systematically collected samples from other excavations, for which I drew the section and then sampled. For this method, all the excavators received the same instructions (Table 4-2). All samples, regardless of sampling strategy, were analysed in the same fashion, but the security of these contexts is variable and assessed in the table (Table 4-3) on the following scale of 1 to 5:

1 = Excavated and sampled by myself, contextual details very well-known.

2 = Excavated by someone else; section drawn and sampled by myself; details well-known.

3 = Excavated and drawn by someone else; sampled by myself; details known.

4 = Excavated and sampled by someone else; few details known.

5= Excavated and sampled by someone else; few details known and stratigraphic issues are evident.

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[7] The NERC application, *"Closing the gap between living memory and archaeological pasts: a case study from northern Bénin, West Africa",* was obtained by Anne Haour (UEA) and Alexandre Livingstone Smith (MRAC).

Table 3-24: Archaeobotanical sampling instructions provided to all excavators before the field season.

- Ideally, each sample should consist of 10–30 litres (2–3 buckets) of soil.
- During the excavation, the excavator selects contexts for sampling
- Ash- or charcoal-rich contexts (fire places, pits) should be sampled preferentially. For deep pits (over 1 m), two samples are preferable: one from the base and one from the upper part. Generally deeper samples are the better.
- If a context contains less than 10 litres volume, but seems rich (e.g., ashy), then ideally take 100% of the secure context. A sample can be as little as 1 litre (or even less if needed).
- Do not try to assess whether seeds are visible in a sample — archaeobotanical macro- remains are often not visible to the naked eye, being sometimes between 100 micron and 2 mm in size.
- The presence of modern seed (uncharred) is often due to a bio-disturbance (termite, ant, etc.) and does not correspond to archaeological evidence.

In brief:

1) Take samples during the excavation

2) Preferentially sample contexts that are ashy, charcoals, hearths, pits etc.

3) Collect 10 to 30 litres where possible (but may be smaller)

4) Pack in 1-3 sample bags (no more than 10-15 litres per bag)

5) Enter the site, trench, context and depth of the sample on a label which must be placed in **every** bag, e.g. BLAF-13-SX C19 100cm

6) Seal the bag with string/rope.

Table 3-25: Assessment of sample integrity. Summary of sample information and index of scale. The full names of the excavators and samplers are: Dr. Alexander Livingstone-Smith (MRAC), Dr. Sam Nixon (UEA), Dr. Didier N'Dah, Nicolas Nikis (ULB), Paul Adderley (Stirling University), Nadia Kalhaf (UEA), Richard Lee, Jennifer Wexler, Djimet Guemona, Franck N'Po Takpara, Abubakr Sule, Louis Champion (author).

Site	**Test pit**	**Excavator**	**Sampler**	**Scale**	**Site**	**Test pit**	**Excavator**	**Sampler**	**Scale**
BLAF	SIII	Sam	Sam	4	**PEK**	SI	Abu	Abu	5
	SIV	Student	Louis	2	**TTK**	SI	Louis	Louis	1
	SV	Ali	Louis	2		SII	Nadia	Louis	4
	SVI	Nicolas	Nicolas	5	**ALB**	SII	Didier	Didier	5
BLAF	SVIII	Richard	Richard	5		SIII	Didier	Didier	5
	SIX	Ali	Louis	3	**GOG**	SI	Ali	Ali	2
	SX	Sam	Louis	4	**GOB**	SI	Ali	Ali	2
	SXI	Richard	Richard	5	**KOZ**	SI	Ali	Louis	2
BLAF	SXIII	Jennifer	Jennifer	2		SII	Ali	Louis	2
	SXIV	Sam	Louis	4	**KGI**	SI	Ali	Ali	2
	SXVIII	Djimet	Djimet	5	**ROU**	SI	Ali	Ali	2
	SXIX	Frank	Frank	5	**KLI**	SI	Ai	Ali	2
	Snake	Pol	Louis	4		RCI	Ali	Ali	2
	FIII	Louis	Louis	1	**KRO**	SI	Louis	Louis	1
						SII	Louis	Louis	1

Phytolith and starch grain sub-samples

Sub-samples of sediment for phytolith and starch grain analysis were collected from almost all macro-botanical flotation samples (prior to flotation). In total, 53 samples of around 100gr of sediment each were collected in ziplock bags. These will be considered for analysis in future.

4.2.1.2 The flotation methodology

Flotation is the standard method widely used to separate materials of different density, and is the most common way of recovering charred plant remains from archaeological contexts. As noted by Mark Nesbitt "*Flotation works on a simple principle: soil particles sink, charred plant remains float*" (Nesbitt 1995). Whether mechanical (using a flotation drum or machine) or manual (using buckets), the basic principle is to mix the sediment with water to saturate it and allow it to break apart. The buoyant material, including the plant macro-remains, is then poured off and collected in a fine mesh (Fuller 2008). This process was pioneered by Hans Helbaek and Stuart Struever in the early 1960s and was used for the first time in Illinois (by Struever) and in the Deh Luran Plain in Iran (Helbaek 1969; see also Nesbit 1995; Fuller 2008).

During the three field seasons in Benin, flotation was carried out under my direction in the field adjacent to the base, and with assistance from the field crew (mainly Beninese students) and locally employed workmen. Sediments were processed manually by bucket flotation (Figure 3.61). The flots were collected on a 0.25 mm mesh and air dried in a single bag (Figure 3.62). Bucket flotation is the easiest way to do flotation, and is more convenient for short duration excavations on remote sites: "*Manual bucket flotation has advantages in being highly portable, cheap and can normally be carried out with locally available materials which can be found in markets in the developing world.*" (Fuller 2008). Bucket flotation is also very simple and can be taught to students and local workmen quickly and easily. Apart of the logistical benefits, the main reason why bucket flotation is recommended for tropical sites (where preservation is often poor, and sediments highly organic and clayey/sticky) is because it provides better control over recovery than available during larger scale machine flotation.

Due to the lack of water and technical resources on sites, I had to improvise and find methods to obtain sufficient water. During the first field season (2012), the method employed was to re-utilize the same water for each sample. Although it was not the most efficient system, it was still effective. The second year we established our camp in close proximity to a manual water pump, ensuring a sufficient supply. Finally, in 2014, I had access to large motor pump, but this proved too powerful to use with bucket flotation. In addition, use of the motor pump attracted the attention of villagers making concentration on flotation work difficult: all the women from the neighbourhood came with every kind of receptacle to collect water!

Figure 3.61: Bucket flotation: in the first stage (i), flotation is carried out through manual agitation and pouring, after which (ii) the remaining sediment is emptied onto a screen for wet-sieving of the heavy fraction.
(From Fuller 2008: 197).

Figure 3.62 Illustration of the bucket flotation methodology used in Benin.
Top left: The first season in 2012, with the author employing the water recycling system. Top Right: Third season in 2014, with the team and the water source.
Bottom: Sieves and samples drying slowly in the shade, not in the direct sun which can damage charred material.

Over the three field seasons in Benin, I had the opportunity to train four Beninese and two Togolese archaeology students on how to do archaeobotanical sampling and flotation. Currently, one of them is doing excavation and flotation in the centre of Benin for his PhD.

After flotation, each sample was exported to Europe with the authorisation of the "Direction du Patrimoine Culturel" of the Ministry of Culture.

4.2.2 Laboratory analyses

4.2.2.1 Identification and Quantification

The weight and volume of each flot was measured, and each sample was then sieved into five size fractions: >4mm, 2–4mm, 1–2mm, 0.5–1mm, <0.5mm. The ≥0.5mm sub-samples were scanned for charred plant structures such as seeds, fruits, nutshell and parenchyma with the aid of a low-power stereomicroscope (10–40x).

Preliminary sorting and identification of the samples was made in the field, as well as at the Institute of Archaeology London. Identifications of cereals, chaff, pulses, millets, weeds, nuts and fruits were made by comparing taxa with specimens in the modern reference collection housed at the Institute of Archaeology, University College London, supplemented by modern reference specimens collected in Benin during my field trips. Photographs and descriptions of identifications from a variety of published literature were also used (e.g. Fuller 2003; Fuller and Harvey 2006; Nixon 2011; Murray 2000, 2004, and 2005; D'Andrea et al. 2001). As the identification of West African archaeobotanical material is still within its infancy in comparison for example with Europe, all taxonomic identifications were also subsequently checked and agreed with Dorian Fuller. Recording sheets were used to document the botanical material, classified as seeds, stones, stone fragments, chaff components (e.g. glumes, spikelet bases, rachises), parenchyma, fruits etc. along with an others category for non-charred or non-botanical material.

For all the samples analysed, whole vegetal items were recorded by count in a list of taxa, from which tables of relative frequency were constructed, and ubiquity could be calculated. The relative frequency is the percentage of total seed count. It can be calculated by sample, phase, test pit or site as necessary. In addition, every taxon was logged in a ubiquity table. The ubiquity is the number of samples in which a taxon is present as a percentage of the total number of samples. Ubiquity is a more appropriate means of comparison of archaeobotanical data as opposed to the number of identified specimens (NISP) because it avoids the potential bias of extremely high or low counts of a taxon that are due to differentially seed productivity or preservation potential. Some authors have argued that ubiquity (also called presence/analysis) may be more appropriate for comparisons between sites and researchers as it will reduced biases between the recovery and recording of different taxa counts (e.g. Hubbard and Clapham 1992).

Ubiquity however requires multiple samples from the site or phase. Ubiquities on a wider scale were also determined by taking the percentage of sites per archaeological phase for each crop.

In conclusion, in order to follow this “chaine opératoire” from the field to sample quantification, a catalogue was compiled that summarizes the archaeobotanical finds by sample, archaeological context, phase, test unit, site and area. The catalogue as such provides a tool for making a quick analysis of change between stratigraphic contexts, or between contexts, and sites. The catalogue hence forms the starting point for the outlined study of food production and consumption. Aside from the fact that it offers a degree of transparency and makes it possible to re-interpret the data from each site, it also enables quick comparison of different assemblages and to identify angles for subsequent study. It is also provides the means by which to compare different archaeological finds, such as ceramics, from the same site.

5. Current Gastronomic landscapes

"It is often assumed (not least by those who have eaten in rural Africa) that African food is largely bland, starchy and basic; ***food to fill the belly rather than tempt the palate*** *[…] African cooking stresses the vast diversity of African food (Olaore 1980; Inquai1992).In a continent nearly three times the size of Europe, where over 2,000 languages and dialects are spoken, the rich but largely unrecorded regional repertoire of recipes is being slowly eroded by imported ingredients and methods (Inquai 1992:3). Throughout Africa (as in much of the world), food is indeed characterized by bland local staples, porridges, puddings and breads prepared from either grains, tubers or plantains, which provide the bulk which fuels everyday labour. However, these staples are always served with some form of sauce or stew, the preparation of which may be a complex and skilful process (Olaore 1980:11). It is in the preparation of these local sauces that cultural differences can be expressed and individual art and wealth displayed, and it is these local dishes that are so poorly known.* ***When we know so little of modern African cuisine, can we, with confidence, begin to discuss that of the Iron Age?****"*

MacLean and Insoll 1999: 80-81

After three missions spent excavating in North Benin this statement still holds true for me. However, it was only during the last mission in November 2015 that I found that this area had a much larger gastronomic landscape than I previously believed. Indeed, on the 20th of November our team was invited by mayor of Karimama, Mr.Moussa Maman Bello, to a "cuisine contest". During this competition we discovered tastes and recipes that were totally unknown to us. However, it is only very recent social, cultural and agricultural changes that have created this current gastronomic landscape. This chapter presents a summary of these recent modifications but also included information on the cultivation, processing and cooking of traditional crops from cuisine in North Benin starting in the present day, followed by information on cuisine within the recent past (1970-2010), including historical sources. This information then allows a better insight and interpretation of archaeobotanical material and it's integration into other archaeological evidence.

Ethno-archaeobotany

The archaeobotanical record of food from settlement sites most often provides evidence for the raw resources used in cuisine; e.g. crop remains and stages of preparation, by-products and waste; as opposed to finished foodstuffs. An ethnobotanical study of agriculture and diet has then the potential to provide an insight into crop cultivation, processing and most importantly food preparation.

The main purpose of conducting ethno-archaeobotanical research is to improve our understanding of past botanical remains by comparison with daily activities, such as crop-processing and cooking practices, through observation of peoples who today still use traditional methods. Hence our understanding of archaeobotanical assemblages is enhanced through careful observations of modern processes which create such assemblages that we may find archaeologically. In Africa, very few studies have been dedicated to ethno-archaeobotany to date, hence archaeobotanists working in such regions have to utilize ethnographic models developed for often different crops, developed outside Africa, that have often limited suitability (see Fuller 2018 for Asiatic rice, Figure 1). In West Africa, the Dogon country was studied by French researchers during the 1960s (Dieterlen and Griaule 1960) and more recently by Jolly (2004) and Douny (2016). Both these studies provided an overview of cultivated plant utilisation and alimentation, through which the present study was guided.

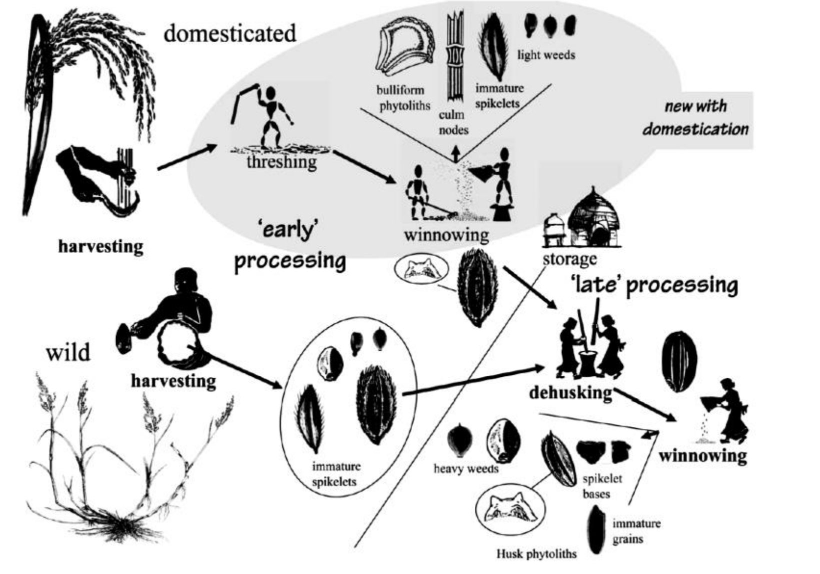


Figure 3.63: A schematic diagram comparing the crop-processing stages for domesticated and wild harvested crops, in this case for rice (from Fuller et al. 2010).

5.1 Methods

In association with Lucie Smolderen, a PhD student from Université Libre de Bruxelles in Belgium (ULB), we conducted oral surveys among the local population. Lucie Smolderen's thesis is entitled *"A story for women. Techniques and material culture approaches of women's activities in the Dendi region (North Benin) from the end of the 19th century to the present day"*[8]. Her project focused on the Dendi history (Niger Valley, North Benin and South Niger). Preliminary historical research conducted by Olivier Gosselain (the supervisor of Lucie Smolderen thesis, ULB), as part of the framework of the ERC Crossroads of Empires project (Sainsbury Research Unit, UEA), showed that the entire historical knowledge was based on oral traditions monopolized by men. Despite the major socio-economic upheavals experienced by the region from the late 19th century to the present day, the place of women in the traditional historical narratives remains unknown. Smolderen thesis's aim was to overcome this knowledge gap by setting up a suitable methodology, one which was able to propose another story for the Dendi region; a story in which women are the starting point.

Faced with the absence of classical historical sources, both written and oral, dealing with women of the Dendi, one of the themes of this thesis was to propose a new methodology, based on other sources. Based on the achievements of cultural technology (science of techniques) and ethnography of techniques (observation and description of chaîne opératoires), material culture and female technical activities are considered as alternative and relevant historical sources from which it is possible to reconstruct vanished social universes. This part of my thesis aims is based on ethnographic field work (conducted between 2015 and 2018), during which time several activities, missing or not, were studied. Whether they belong to the sphere of daily activities (such as culinary practices and spinning) or the ceremonial sphere (such as marital practices and possession cults), these activities all serve as gateways to the past.

Working together (Lucie and myself) allowed us to advance our research agendas by incorporating our different fields of expertise into our individual studies. A key aim of the oral interviews was to inventory crops that are grown both today and in the recent past to enable comparisons both temporally and spatial across different areas. We also

[8] Translation from the original title « Une histoire à hauteur de femmes. Approche des techniques et de la culture matérielle dans les activités féminines de la région du Dendi (Nord Bénin) de la fin du 19ème siècle à nos jours » Smolderen 2018/19.

looked at the processing techniques and at the spatial and temporal distribution of such activities, taking particular note of possible points within food production at which waste was generated, comprising crop grains, chaff and weeds, and/or the crop product itself, and if and when they became charred. The characteristics of such waste products were carefully described, as well as how they relate to the processes that generated them. The main aim for this thesis being to develop a method by which we may identify stages of food production within the archaeological record. In order to understand all aspects of the food production *chaîne opératoire*, we also investigated cuisine and cooking practices. The first step was to study the processes involved in obtaining clean 'naked grains' from the fields (including field practices). The second step was to study food preparation that took the naked grains to the plate. In this study we also looked at the ingredients and spices that were collected wild from the bush and not cultivated.

We had a threefold approach:

1) Villager interviews and personal observations

The most common.

2) Participative observations

For plant processing, we stayed longer in an area and came back during the threshing operations.

3) *Chaine opératoire* Reconstitution and/or observation

We spent two full days with three women to learn how to cook old recipes.
We made a long beer making reconstruction. In order to fully participate in each step for one entire week we visited the village for at least half to one hour a day.

The interviews comprised 99 persons from 29 villages within the Niger valley in North Benin. The questions were systematic and asked to older people of these villages, between 60 to 95 years old, with one exceptional case of a 105 year old man. Interviews were public and everyone was welcome to participate. Usually these sessions lasted between 30 minutes to two and a half hours on average. During these public interviews sometimes other villagers (children, teenagers, men and women) also offered additional information. Each interview was organised more or less the same way. First, we asked to meet the 'chief of the village' to present ourselves and to explain what the purpose of our visit was to him. Secondly, after receiving the blessing of the chief we started the interview following the survey presented in Table 3-26.

Table 3-26 Questions examples asked during the interviews.

A. Interviewed person identity :

Surname and name -- Father's name or husband's name for women
Approximate age
Birth place, and if different of the village, why and how they are here?
Ethnic group
Occupation
Family composition:

1. Paternal part

Father's name, gran father's name…
Who is the first ancestor to come in the area/village? Where he/she is coming from? Why did he come? What is the family 'heritage' (weaver, blacksmith, griot, alfa, fisherman…)?

2. Maternal part

Mother's name, gran mother's name…
Who is the first ancestor to come in the area/village? Where he/she is coming from? Why did he come? What is the family 'heritage' (weaver, blacksmith, griot, alfa, fisherman…)?

B. Observations and open questions:

The questioning was oriented but open.
Agriculture
What crops are you growing? In which way? What methods of crop husbandry do you use? (tillage, sowing, weeding, harvesting, …)
When did you start using this crop?
What are the different varieties of crops (millet varieties, sorghum varieties, and more specifically rice varieties)?
What was the impact of the colonisation on agriculture? What are the crops that white peoples imported? Which crops were they buying?
…
Market gardening
Which plant are you cultivating in the gardens?
When did you start?
Where did you obtain the grain from?
What is the nature of the crops processing?
What are the horticultural techniques (e.g. growing conditions)?
…
Crop-processing (predominately for cereal and leguminous crops)
How are you preparing the crops?
What are the different steps? What is the name of those steps?
…
Cuisine and cooking
How are you cooking? Which recipes are you doing?
What are the steps?
What are the cooking ways?
…

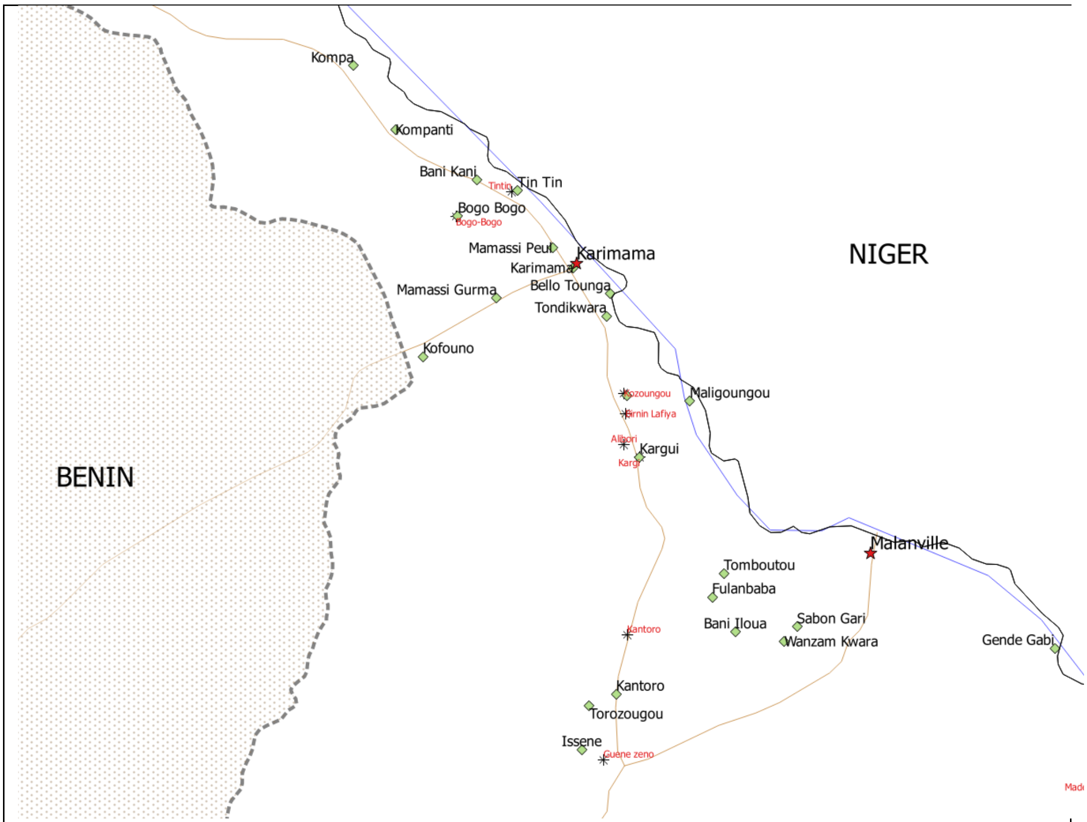


Figure 3.64 Map showing the research location in the Dendi, North Benin. The Green diamonds are the modern villages where we conducted the interviews. The stars with red names are the archaeological sites presented in the archaeobotanical sections of this thesis.

5.2 Results

In Dendi, as in most of Sub-Saharan Africa, the emphasis is on millet porridge and beer, in contrast to the Near East where it is on bread and roast meat (Haaland 2007, Fuller and Rowlands 2011). This emphasis on bread is found throughout Western Eurasia (Fuller and Rowland 2011). The Saharan 'boiling-and-grinding' cereal preparation stands in contrast with this Western Eurasian 'bread world', as the African cereals, sorghum, millets, and rice, lack gluten, the property that provides the possibility of leavened breads or other paste-base preparations (Fuller and Rowland 2011, Lyons and D'Andrea 2003).

5.2.1 Agricultural Husbandry

Downstream of the Inland Niger Delta, the river's double flood effect (described in Chapter 2) offers rich conditions for agricultural practices. This is especially true for the

Dendi region where the two floods allow two field seasons for wet agriculture (rice and sorghum), followed by a dry agriculture (pearl millet, sorghum, cowpea…) season, and market gardening (onion, shallot, tomatoes, chilli, cucumber, salad, cabbage …). For both wet and dry agriculture, the end of the dry season, coinciding with the arrival of the first rains (April-May), marked the start of the new field season.

Wet agricultural systems are dominated by rice, with some décrue sorghum cultivation. So far, 46 rice varieties and two décrue sorghum varieties have been recorded (Table 5.2). Décrue sorghum is cultivated only in very small quantities by a few cultivators. When it is cultivated, sorghum is sown in April and, depending on the varieties, harvested eithers 10-11 months or 6 months later. Rice is largely dominated by deep water and flooded (décrue) types. Located in the flood plain characterized by a rich sandy clay loam soil, wet rice fields are mainly cultivated by the Tyenga and the Kumate (two ethnic groups derived from the Mande diffusion). Others groups (i.e. Haussa, Zarma) also cultivated rice but in smaller quantities and mainly as a cash crop. Among the Mande rice producers, the most commonly cultivated rice is the *'Samozakomi'* type. It is a deep water rice sown and harvested twice a year. One variety is grown in September with the first flood of the year (the 'White Water flood' resulting from the local rainfall), and the second variety sown following the later floods in February-March (the 'Black Water flood' resulting from the Malian flood delay). Deep water rice cultivation is mostly defined as a male preoccupation. The translation of '*Samozakomi*' is a good expression of this masculine job: 'the lazy women cannot harvest or cook'. Most of the rice varieties have a proper name. The most important are *Fondjia*, 'The young lady' and *Heino kizié* 'the millet son' (because this rice is planted and harvested at the same time as pearl millet). Most of the variety names referred to "pragmatic jokes" associated with aspects of the grain's characteristic, such as *Aissa Diori* type, because the grain is "as tiny and beautiful as Aissa Diori", who was the wife of Hamani Diori the first President of the Republic of Niger (1960-74). 'Riz de Gaulle' is a direct reference to the tall size of former French president General De Gaulle. The last rice type, introduced by a Chinese project in the 1980s, received the name of 'Chinoi' (the translation of "Chinese" in French).

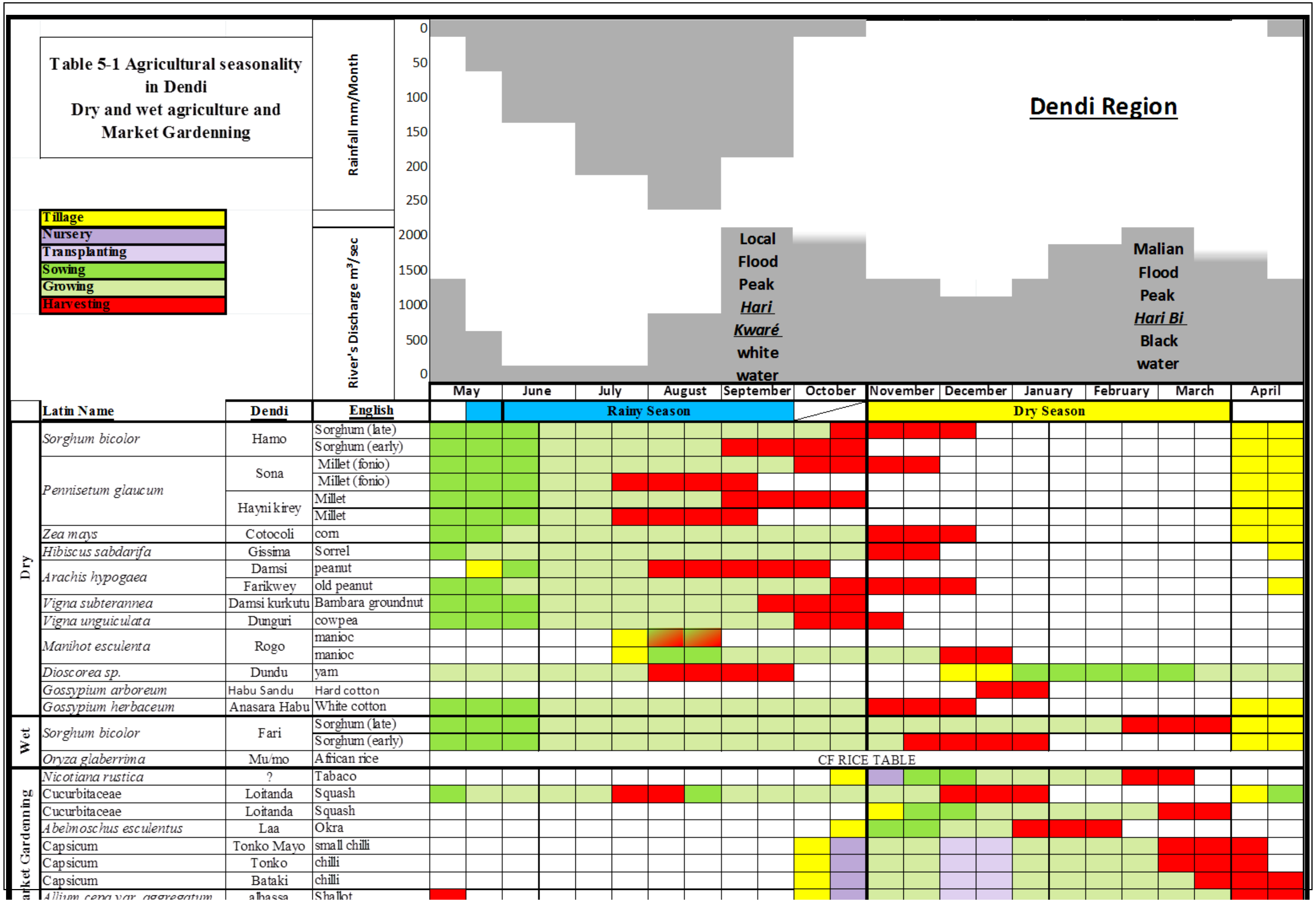


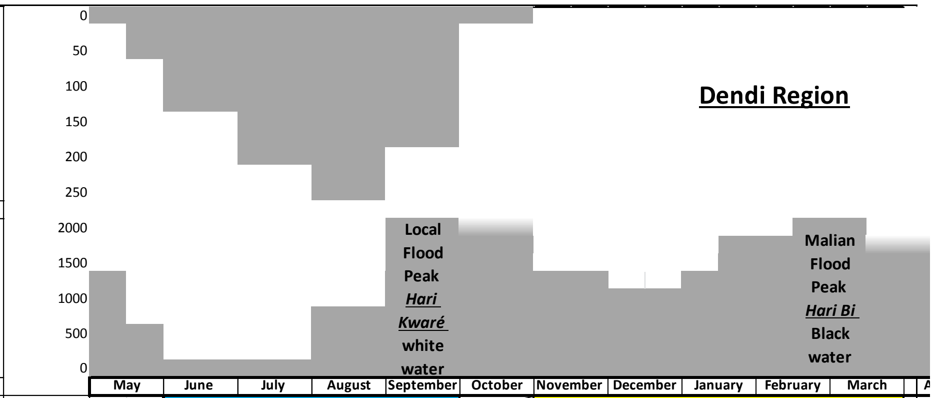
Table 5-1 Agricultural seasonality
in Dendi
Dry and wet agriculture and
Market Gardenning
Tillage
Nursery
Transplanting
Sowing
Growing
Harvesting
Rainfall mm/Month
0
50
100
150
200
250
River's Discharge m3/sec
2000
1500
1000
500
0
Dendi Region
Local
Flood
Peak
Hari
Kwaré
white
water
Malian
Flood
Peak
Hari Bi
Black
water
May
June
July
August
September
October
November
December
January
February
March
April
Rainy Season
Dry Season
Latin Name
Dendi
English
Dry
Sorghum bicolor
Hamo
Sorghum (late)
Sorghum (early)
Pennisetum glaucum
Sona
Millet (fonio)
Millet (fonio)
Hayni kirey
Millet
Millet
Zea mays
Cotocoli
corn
Hibiscus sabdarifa
Gissima
Sorrel
Arachis hypogaea
Damsi
peanut
Farikwey
old peanut
Vigna subterannea
Damsi kurkutu
Bambara groundnut
Vigna unguiculata
Dunguri
cowpea
Manihot esculenta
Rogo
manioc
manioc
Dioscorea sp.
Dundu
yam
Gossypium arboreum
Habu Sandu
Hard cotton
Gossypium herbaceum
Anasara Habu
White cotton
Wet
Sorghum bicolor
Fari
Sorghum (late)
Sorghum (early)
Oryza glaberrima
Mu'mo
African rice
CF RICE TABLE
Market Gardenning
Nicotiana rustica
?
Tabaco
Cucurbitaceae
Loitanda
Squash
Cucurbitaceae
Loitanda
Squash
Abelmoschus esculentus
Laa
Okra
Capsicum
Tonko Mayo
small chilli
Capsicum
Tonko
chilli
Capsicum
Bataki
chilli
Allium cepa var. aggregatum
albassa
Shallot

Deep water rice does not require tillage, or only minimal soil preparation, fields are usually broadcast sown when the river's water level begins to rise. Due to the double floods, deep water rice is planted twice a year, once in April-May (before the rise of the river water level) and once in October-November, between the two flood peaks. The deep water rice variety can grow in a maximum depth of four meters of water. Harvesting is usually conducted by boat and happens between 90 and 180 days after sowing. The most common weeds found growing in association with rice is Borgu grass, *Echinochloa stagnina*, which is gathered with the rice crop. Borgu grass is also collected as fodder for livestock.

The second rice type that grows in Dendi is the décrue (or flooded) rice. Décrue rice is grown on the edge of the floodplain where the flooding is less extreme. This rice needs less water (up to 50 cm) than floating rice. However, it requires more tillage and field preparation than deep water rice. Tillage is done by hand, with the Daba (hoe), 5 to 10 days before the start of the rainy season. The grains are sown two weeks after tillage. The third type, rainfed rice, is also grown in the Dendi region, but in lesser quantities. It requires the same amount of labour as décrue rice; the only difference being the field locations, which are normally away from the flood plain or at the extreme end of the floodplain.

Since 1980 Asian irrigated rice, *Oryza sativa*, has been grown in the region, but in an extremely limited area. Approximately 2000 projects between China and Benin have been undertaken to construct small dams to create larger reservoirs for paddy rice agriculture. Mechanical ploughs for paddy rice preparation were also introduced by the Chinese Rice Project during the 2000's. Between the cultivation of nursery seedings, transplanting, tillage, and the construction of paddy fields and irrigation networks, rice paddy agriculture is much more labour intensive than other types of rice agriculture. The advantage of paddy rice is its two-cropping seasons allow for double cropping. However, due to the double floods effect, deep water rice, and in some case flooded rice, offer the same advantages with less labour input. Also, paddy rice is not produced for local consumption but for export. Thus, rice cultivators prefer having deep water rice fields coupled with market gardening to obtain the cash for the household.

Table 5-2 Rice seasonality



Rainy Season (June–September); Dry season (November–March)

Latin name	Dendi	Ecology
O. sativa	Chinoi	Paddy
O. sativa		Paddy
O. sativa	Veris	Paddy
O. sativa	R-8	Paddy
O. sativa	Semence	Paddy
O. sativa	Paddy	Paddy
O. sativa	Mu Nya leniti	Paddy
O. sativa	Maimanza	Paddy
O. sativa	Garou Tekiyse	Paddy
O. sativa	Fondjia	Paddy
O. glaberrima		irrigated
O. glaberrima	Sumtan/suntan	Deep 3m--4m
O. glaberrima		Deep 3m-4m
O. glaberrima	Mu Bi	Deep 2.5 m
O. glaberrima	Samozakomi	Deep 1.50m
O. glaberrima	Eau Blanche	Deep 1.50m
O. glaberrima	Samozakomi	Deep 1.50m
O. glaberrima	Eau Noire	Deep 1.50m
O. glaberrima	Tama	Deep 2m
O. glaberrima	Meyada	Deep 1m50
O. glaberrima		Deep 1m50
O. glaberrima		Deep 1- 2m
O. glaberrima	Samozakomi	Rainfed
O. glaberrima	Rainfed	Rainfed
O. glaberrima	Sumtan/suntan	Rainfed
O. glaberrima		Rainfed
O. glaberrima	Heini kizié	Deep 1-4 m
O. glaberrima		Deep 1-3 m
O. glaberrima	Aissa Diori	Rainfed
O. glaberrima		Deep 1.5-2 m
O. glaberrima	Damanou	Rainfed
O. glaberrima		Deep 1.5-2 m
O. glaberrima	Pakou	Rainfed
O. glaberrima		Rainfed
O. glaberrima	Lanta	Deep 1.5-3 m
O. glaberrima		Rainfed
O. glaberrima	Haourou Kakoukoug	Rainfed
O. glaberrima		Deep 1.5-2.5 m
Oryza sp.	Zumbo	Rainfed
Oryza sp.		Rainfed
Oryza sp.	Tondi Bong Mo	irrigated
Oryza sp.	Mu Koukouroukou	irrigated
Oryza sp.	Semence Tomboutou	deep 1 m
Oryza sp.		irriguated
Oryza barthii	Beou	Rainfed
Oryza barthii	Beou	Deep

Legend: Not cultivated anymore | WILD | Tillage | Nursery | Transplanting | Sowing | Growing | Harvesting

Figure 3.65 Transport of freshly harvested deep water rice and Borgu grasses. Note in the background, rice fields in the start of dry season November 2015 © Champion.

Figure 3.66 Paddy irrigated rice field in November 2015 © Champion.

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Dry agriculture is mainly centred on sorghum and pearl millet cultivation intercropped with cowpea (*Vigna unguiculata*), peanuts *(Arachis hypogaea*) and beans (*Phaseolus* sp.). The fields and garden edges are often demarcated by *Hibiscus sabdariffa* cultivation (Gissima or sorrel). Cash crops are represented by cotton cultivation, *Gossypium herbaceum* and *arboretum*, but also *Gossypium barbadense* (introduced during an unrecorded later phase (i.e. 1960-80)). During the past decade, the application of chemical fertilizers on cotton fields has increased as they are often grown on very poor soils (Figure 3.68; Figure 3.69). The cotton fibres are directly sold to the main national factory. Fibre collecting happens generally in November between pearl millet and sorghum harvesting. Traditional textile production does not exist anymore, however, some older women still thread the fibre to remember the old times (Figure 3.67).

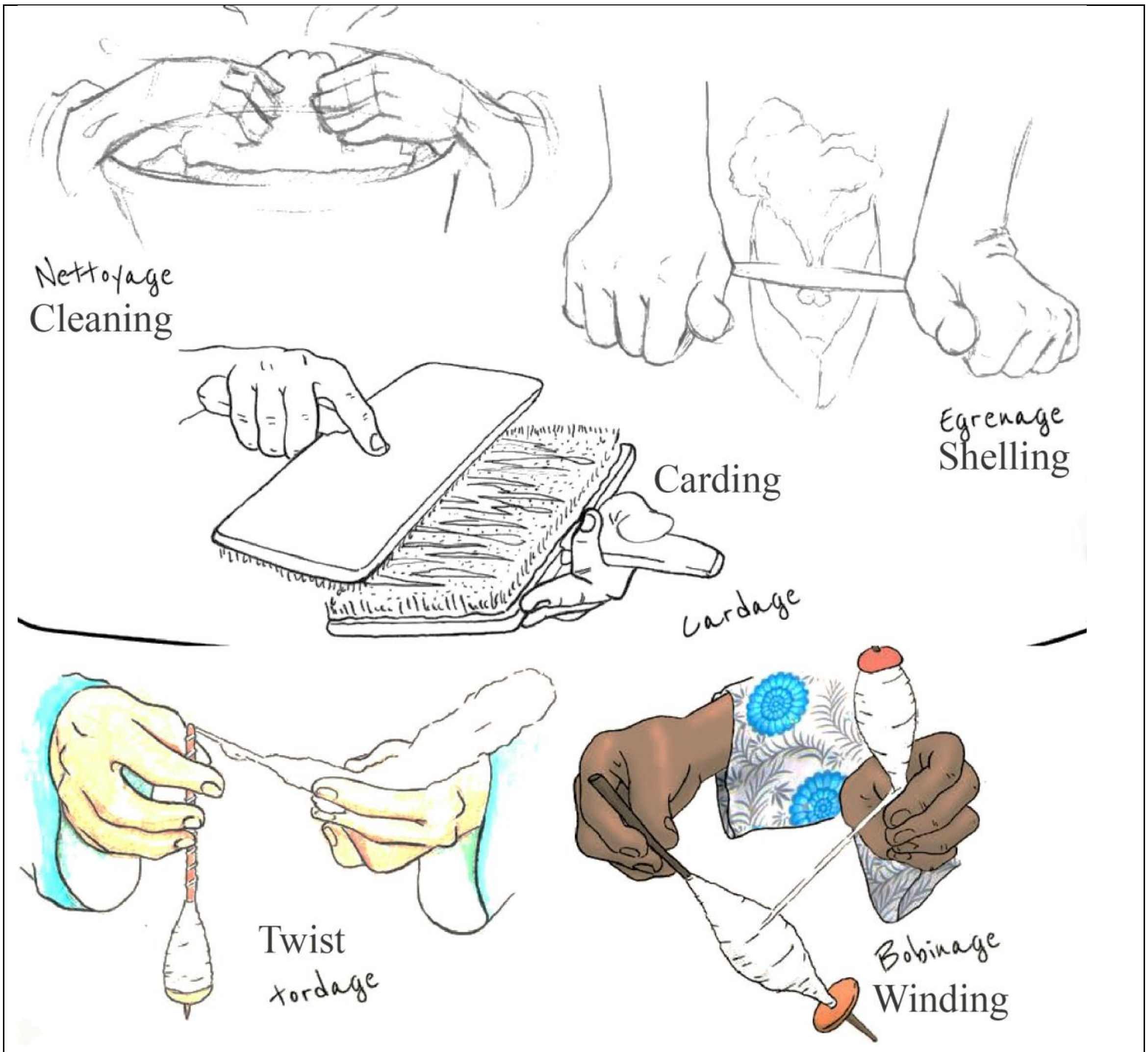


Figure 3.67 Cotton thread *chaîne opératoire* (After Smolderen and Minguet 2014: 310-311)

Figure 3.68 Cotton field (*Gossypium barbadense*) in November © Champion Louis.

Figure 3.69 Cotton field just after the fibre harvest (November 2015) © Champion Louis

For sorghum and pearl millet, crop-husbandry processes are the same. Fields are located in sandier soils at some distance from the rivers, and the only water source is rainfall. The rain is extremely important for the first two weeks of development after which both crops are extremely tolerant to dry conditions. The first rain announces the beginning of the tillage of the fields. The relative soil humidity makes the work easier. Most of the tillage is done by hand with a hoe called a *daba*. Larger ploughs were introduced by the French during the 1960s to improve cotton field production, but currently are still only occasionally used. Generally two weeks after sowing, and two to five days after tillage, a light weeding is done. During the labour intercropped plants, such as cowpea, peanuts and beans, are sown. Cowpea and peanuts are harvested after the pearl millet or sorghum crop (Figure 3.70).

Figure 3.70 Peanut field and harvesting. Note that the field still has the remains of intercropped sorghum which was harvested a few days earlier. Photo taken September 2015 (Courtesy of Lucie Smolderen)

Figure 3.71 Sorghum fields just after harvesting. Dendi region November 2015 © Champion Louis.

Market garden production mainly consists of tomatoes, onions, shallots and chilli peppers cultivated in irrigated square plots. Inhabitants also sporadically cultivate okra, cabbage, lettuce, carrot, eggplants and squash (Table 5-1). The plots are usually located in the flood plain, close to the main rivers (e.g. Niger banks, Alibori), but since the introduction of water pumps market gardening has expanded into new fields, but always on clay soils. Market gardening is based on double cropping, starting in October with plants sown in a nursery, then after three weeks growth these seedlings are transplanted to the irrigated, recently harvested millet fields. The weeding is a recurrent activity always done by hand and hoe (Daba). Harvesting is done at the end of the dry season (from March to May), just before the tillage for dry agriculture has started (table 5-1). The chilli pepper fruits can be harvested three times from the same plant. With the exception of okra, all the other crops are directly sold to big markets that supply the main cities of Niger and Benin (i.e. Niamey and Cotonou). Onions and shallot leaves are directly cut in the fields and taken to the village to be used as condiments and sauces. With okra these are one of the few market gardening products locally consumed.

Market gardening is generally regarded as a woman's occupation. Women have formed cooperatives and buy the seeds collectively, and since two decades ago they owned most of these plots. Today in Benin, these market gardening plots are one of the few means through which women can own land.

Figure 3.72 Example of irrigated Market Garden growing onions and shallots. Dendi region November 2015. © Champion Louis

Figure 3.73 Market Gardens with chilli fields. Harvesting is being carried out. Dendi region November 2015 (Courtesy of Lucie Smolderen)

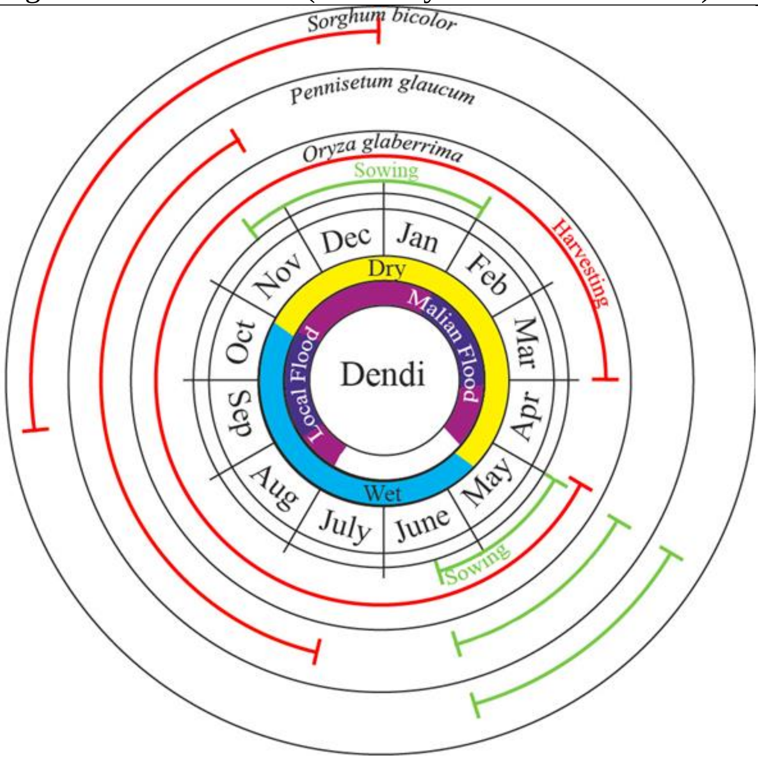


Figure 3.74 Crop Agenda summary for Dendi region in 2015.

5.2.2 Storage

Currently, two types of granaries have been recorded:

- The first is the *Sourou* type, made of straw and wood, and elevated from the ground to protect the grains from the pests, and to allow the air to circulate to avoid any build-up of moisture. The *Sourou* mostly contains sorghum or pearl millet panicles. Thus, with the exception of drying the panicles (Figure 3.75), it does not require any crop processing before being stored.

Figure 3.75 Sorghum and pearl millet drying after being harvesting and before being stored. Dendi region November 2015. © Champion

- The second granary type is more elaborate and is named the *Boa* (Figure 3.78 and Figure 3.76). *Boa'*s are generally made to store processed grains. The *Boa* type is built as a giant ceramic pot, out of wet clay mixed with chaff, then sundried. Four subtypes have been recorded:
    - The rice *Boa* characteristic of rice producing villages, mainly populated by Tyenga or Kumate peoples, and located in the flood plain (Figure 3.76). It mainly contains processed, semi-clean, but still husked rice grains.

- The typical Dendi *Boa* (Chapter 4) made of mudbrick with a laterite stone base. Today they are mainly filled with bags of corn, peanuts and others processed, more or less cleaned cereal grains. This kind of granary is increasingly being replaced by storage rooms inside people's houses.
- The Haussa *boa* is a proper large ceramic granary. Two subtypes are found in villages (Figure 3.78). These granaries are made for longer storage and preservation and are normally turned to when the other types are empty.
    - The *Réhéwa* is the smaller type (up to 1.30m high) and contains a layer cake succession of cowpea grains and sand.
    - The *Réhégo* is larger (up to 2.5m) and it is also a layer cake but more generally made of pearl millet grains and sandy ash.

Thus, granary types depend of the village population. The *Sourou* is the most widespread of all the granaries followed by the brick *boa*. Only the Rice and Haussa *Boa* are characteristic of specific groups (e.g. Kumate and the Haussa).

Figure 3.76 Tyenga/Kumate *Boa* granary type, mainly containing rice grains. In the background, rice fields (flooded and deep water types) in the Alibori-Niger rivers confluence. © Champion

Figure 3.77 Haussa village in Dendi. In front, *Hibiscus* sp. leaves and flowers are drying before being stored in bags. Top right, pearl millet drying before being processed to be stored as grain in the "*Réhégo"* granary.

Figure 3.78 Haussa *Boa* Granaries. On the left "*Réhéwa*" and on the right "*Réhégo*" sub-types. © Champion Louis

5.2.3 Crop processing

From harvesting to dehusking, wet and dry crops follow the same processing steps (see Chapter 4). However a difference is observed between crops being stored as grains or as panicles. Whereas rice will be threshed and winnowed before being stored, separated millet panicles will just be dried before being stored (Figure 3.81 and Figure 3.82). Thus, depending on how well crops are winnowed prior to storage, some threshing waste (e.g. weeds or straw) might still be present in granaries. For the three rice types (décrue, rainfed, irrigated) harvesting is done by hand with circular sickles. Threshing and winnowing are conducted directly after harvesting around the fields (Figure 3.80), before being stored as husked grain in *Boa* granaries, sometimes in bags or sometimes directly sold to the main cities of the country. For deep water rice, harvesting is usually done by boat and collected panicles are processed to husked grain inside the village and stored in *boa* granaries, then consumed locally.

Sorghum and pearl millet are stored as panicles and on a daily basis woman process them in the threshing area outside of the villages (Figure 3.79). Usually women are paid by the crop owner to do the threshing. The waste is directly burned in the same area. After processing, the grains are given back to their owners who will mill and cook them. The dehusking process can be done by pounding in a wooden mortar (inside the kitchen area), but today more generally mechanical grinders are used. Since the arrival of mechanical grinder (≈ 1960), manual pounding (dehusking) in wooden mortar are used less often used. An unexpected side effect of the introduction of the mechanic grinder is the loss of, and increased homogenisation of gastronomic tastes and food texture. For the majority of traditional dishes their flavour and texture is dependent on the coarseness or fineness of the ground grains (e.g. fine or coarse flour, semolina, couscous, bulgur etc.) and on the presence or absence of husk material. With the mechanical grinders everything, husks and grains, are milled together, into the same grade of flour or fraction. The manual grinding, and pounding and dehusking, is a slower process, but by using traditional techniques the women control the calibration and also the presence and inclusion of husks. During cooking, the addition or removal of the husk can greatly influence the taste of the meal.

Figure 3.79 Threshing and winnowing area located outside of the village. The black zones are the waste burning places. © Champion Louis

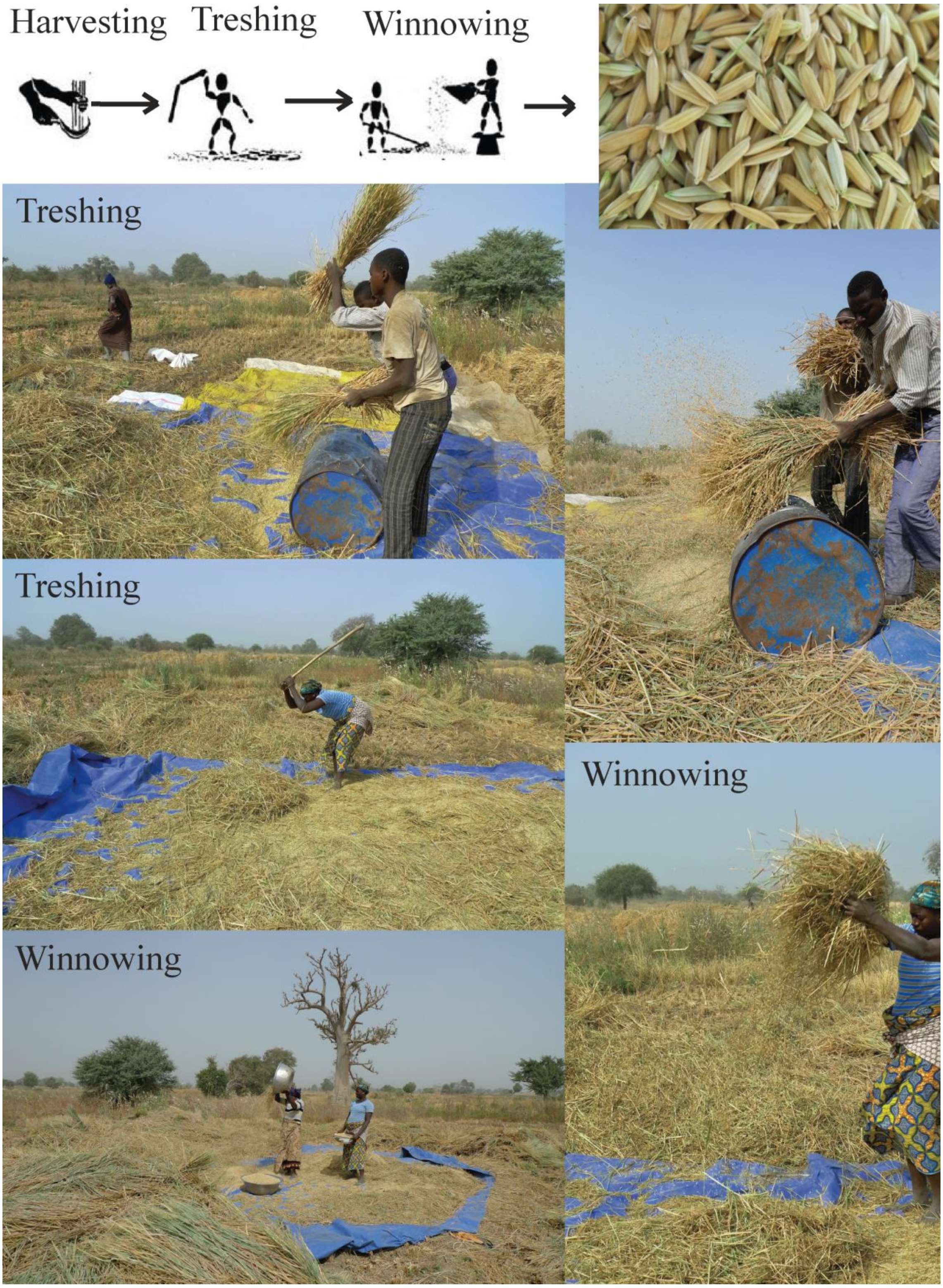


Figure 3.80 Rice processing before storage or being sold to market.

Figure 3.81 Pearl millet and sorghum processing steps from harvesting to cooking.

Figure 3.82 Dry crop processing products and waste. (A) Pearl millet and sorghum panicles (B) Results of threshing-winnowing: (B1) Husked grains, (B2) Threshed panicles. (C) Results of the Pounding-dehusking: (C) Grains during pounding, (C1) Dehusked grains (C2) Flour (C3) Husk. (D) Examples of dishes made from (C) products, (D1) Boiling dehusked grains, (D2) "Sorko-Sorko" dishes made of a mixture of dehusked grains and husk.

5.2.4 Cooking and baking

Currently the main dishes of the Dendi are divided into a multitude of different sorts: fried donuts, boiled or steamed cereal, porridges, roasted livestock and also dry fish. However, four plates typically comprise the daily meal. First, the classic millet paste, accompanied by okra and chilli sauce. It is a thick paste made of boiled pearl millet (or sorghum) flour (Figure 2 in Figure 3.83). In some cases, this sometimes constitutes the only food of the day together with the morning porridge. Boiled rice forms the second dish, usually it is accompanied with some meat sauce (without the meat). Thirdly, the *Donou* is a steamed, undercooked, unleavened "bread", made of millet semolina (coarse flour) mixed with husks. There are two types of *Douno*, one made by the Haussa (4) which is bigger (25-35 cm diameter) and mixed with chilli, and the second prepared by the Fulani is smaller (5 cm diameter) and only made from millet (5). Both are eaten stirred with fresh milk and sugar. And last but not least, the *bouillie or Gruel,* which is more often consumed in the morning but is available in every household at any time of the day. *Bouillie* is a fermented liquid porridge made of sorghum or pearl millet. It requires a fermentation stage and it can be considered a beer (based upon the second category of beer described in the previous Chapter). During her own fieldwork, my colleague, Lucie Smolderen observed that the term *bouillie* is attached with a strong social identity, as the Dendi population are called by their neighbours "the bouillie eaters". Also, the Zarma seem to prepare another type of *bouillie* (unfermented). However, further research into this socio-cultural aspect is still needed. The daily food is completed by small delicacies, usually sold during the market day. The latter usually comprise of such items as a fried cowpea pancake, and wheat/millet donuts (Figures D1 and D2 in Figure 3.85 respectively).

These dishes listed above represent the Dendi gastronomic landscape as it currently stands today, however, over the last few decades this landscape has been deeply transformed by social and technological influences from outside. The main factors of this transformation are: first, the introduction of the mechanical grinder (around 1960) which reduced women's labour, but homogenised the taste of the food. Secondly, the rise of market gardening, which considerably augmented women's agricultural labour, while offering them some economic independency from the male members of their families, such as their husbands. And lastly, the introduction of food products from increased globalisation, such as Maggi seasoning cubes and tomato concentrate. These two products simplified cooking, but again homogenised the taste of food. Before these introductions, food preparation was far more time consuming, but also more diversified. Our combined research has allowed us to discover more than 100 recipes involving different kind of pounding, calibration, sieving, and cooking, the main secret ingredient behind all these recipes being a women's time and labour.

Figure 3.83 The four main daily dishes in the Dendi region. (1) "*bouillie*". (2) Millet paste with okra sauce. (3) Boiled rice. (4) Haussa "*Donou*" bread. (5) Fulani "*Donou*" bread mixed with milk.

One of the other side effects of this altered gastronomic landscape is the progressive abandonment of the traditional sorghum beer. This is mainly the result of the arrival of radical Islamist preachers who have tried to banish the utilisation of beer. However, sorghum beer is still produced two or three time a years during the dry season. In the recent past, we were told, it was produced weekly. The process for making sorghum beer, "*Tchoukoutou*", is described in Figure 3.84. The beer is malted from red sorghum types. After being soaked for 12 to 24 hours, grains are laid out in the circular house dedicated to sorghum brewing: (1). The grains are regularly sprayed with water (every 4-5h) until rootlets and germs appear (2). After three days of germination the malt is ready to be dried (3) for two days. Then the malt is milled into flour (4), which is stirred with water (5) to obtain a liquid paste, the wort (6). The wort is quickly boiled (30 minutes) with constant stirring (7). Afterward the metal cauldron vessel containing the wort is transferred into the house to slowly cool down. The next morning the wort is decanted and filtrated through a special basket (*Kila*), in order to take off the husks (8). The husks are then dried and sold as animal fodder. The liquid is then boiled and the foam is constantly skimmed off during cooking (9). After four hours of cooking, the marmite is once again transferred to the house to ferment for two to four days. The cooked liquid is tasted before being stored in the house (10). During the second boiling, several older men, attracted by the good aromas emitting from the house, came to the house to book in advance a calabash or two of beer (11). For about the last twenty years, beer has been cooked in aluminium marmites and stored in plastic basins, but before this it was done in ceramic pots, and example of which is seen next to the house in the upper unnumbered central picture of Figure 3.84.

This gastronomic transformation is perhaps best observed through changes in the cooking methods. Currently, the three most common cooking methods are boiling (A1 & A2 in Figure 3.85), frying (D1 &D2) and steaming (and in some case roasting for larger animals). The steaming is done with two vessels (marmites); steam arising from the water boiling in the lower marmite enters the second, placed on top of it, through small perforations (~1 cm diameter), that are located on the bottom of the second vessel. Archaeological ceramic pot remains indicate that this technique was well known since at least 300 AD (See Chapter 7). However, today ceramic pots are not used anymore. Another steaming technique was used before the 1960's. This technique involved threshed panicles to separate the boiling water from the cooking dishes (B in Figure

3.85). The last cooking technique that has been so far recorded is the utilisation of ovens to cook millet fermented bread (Figure C in Figure 3.85).

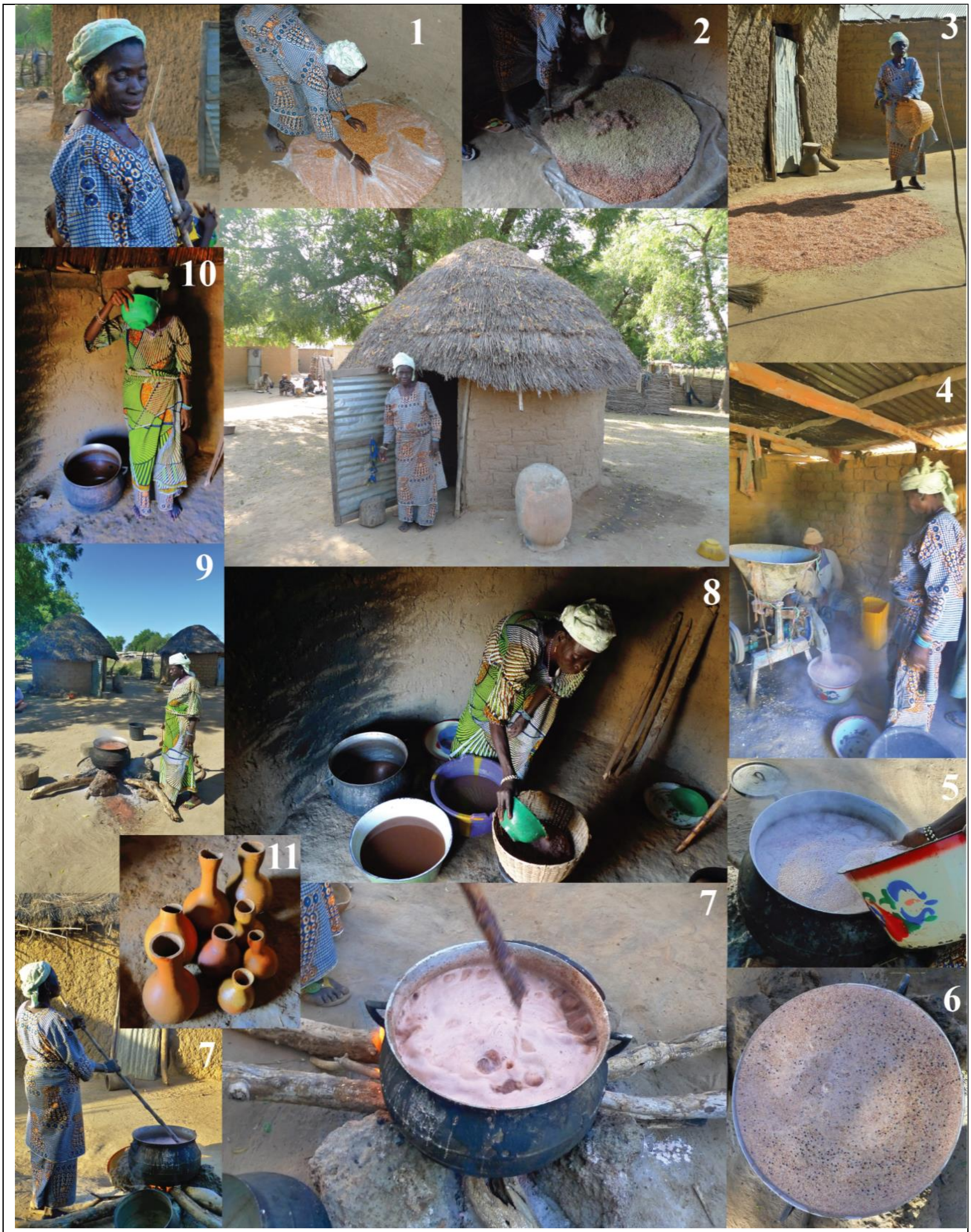


Figure 3.84 Sorghum beer breewing. (1&2) Soaking and germination. (3)Drying Malt. (4) Grinding. (5) Pasting. (6)Wort. (7) Wort boilling (8) Decanting and filtreting. (9) Beer cooking. (10) Tasting. (11) Calabashes to sold the beer. All the Beer preparation stages were explain by Menono Azuma of Torozougou village.

Figure 3.85 Main cooking techniques of the Dendi region. (A) Boiling: (A1) Porridge boilling, (A2) Grains boilling. (B) Steaming on thresehed millet panicles. (C) Millet bread oven. (D) frying: (D1) Wheat/millet Donuts, (D2) Cowpea flour pancake.

Archaeologically, and archaeobotanically speaking, not much remains from all these steps. However, as the methodologically explained in Chapter 4 suggested, some remains (mainly of waste) could provide information on some stages of the crop processing *chaîne opératoire*. A summary for each step by its potential archaeobotanical and archaeological remains is listed in Chapter 4 (Figure 4.9).

For tillage and harvesting the only remains that might be recovered archaeologically will potentially be the hoe (Daba), but as it is an eclectic tool used in many other stages, it would not necessarily be a direct proof of tillage or harvesting. Threshing and winnowing, which for millet is conducted on a daily basis, in a threshing area outside the village, potentially would not leave remains to be recovered from domestic or village contexts either. However, finding high concentrations of threshing waste (threshed panicles, chaff, straw…) in an archaeological context would be an indication of potential presence of a nearby threshing area. For the rice which is grown for local consumption, and threshed directly in the village, the finding of rice waste concentrations will be likely in domestic contexts. But perhaps the most important area in which generated crop waste is to be found is in the kitchen area. From the husked grain to the final dishes and hearth (the only producer of carbonized remains), each stage happens inside the kitchen area. Thus archaeological contexts with remains of pounding waste (mainly husked) for each major crop will be a potential indication of a cooking area.

Having reviewed the current agricultural and cooking practices within the Dendi area and by extension the formation process of archaeobotanical remains, the next Chapter develops the archaeobotanical results from the sites (Red names in Figure 3.64) excavated in the same area and with the inclusion of sites from Mali as well.

6. Archaeobotanical Results and Discussion by Site

Following the methodology set in place in chapter 4, this chapter presents new archaeobotanical results from the 19 archaeological sites contextualised in chapter 3. In general, with the exception of very well-preserved samples such as BLAF- SXVIII, the preservation of botanical remains was poor. An average sample density of 9 items/litres was recorded for all the sites, and an average number of 15 taxa were identified per site across all sites. In total 53052 plants remains were identified from 470 samples representing a total of 5867 litres of archaeological matrix floated from 19 sites. Due to the lack of West African reference collection and the degradation of many specimens, identification to species was not always possible. Presentation of the results is presented by area, and the discussion will follow the natural downstream trajectory of the Niger starting with the six sites from Mali and following with the 13 sites of the Dendi region. Botanical remains from each site are described in frequency and ubiquity, with a focus and discussion on the arrival of new crops and on changes to the archaeobotanical assemblage through time. Discussion and preliminary interpretations of the archaeobotanical data are presented for each site.

6.1 Results from Mali

6.1.1 Upper Niger Valley and the Ségu Area: Sorotomo and Togu Missiri

Archaeobotanical results for the Ségu region come from two sites upstream of the Inland Niger Delta, located 45 km apart. Together both sites cover a 500 year long archaeological sequence, 1000 – 1300 AD for Togu Missiri (TOG2) and 1200 – 1500 AD for Sorotomo. The lowest levels of the archaeological sequence at Togu Missiri were not excavated, thus the layer dating to 1000 – 1100 AD does not correspond to the site's foundation.

6.1.1.1 Sorotomo

Sorotomo archaeobotanical assemblage is composed of 1457 items discovered from 27 archaeobotanical samples (totalling 336 litres of soil for an average density of 4.3 items by litre of soil). 19 samples were from intact vessels and 8 were from domestic deposits. Preliminary sorting of 14 samples was conducted by J. Morris as part of his Master thesis (Morris 2013), however all of the samples were re-analysed as part of this PhD.

With a total of 966 grains for 66% of frequency, fonio (*Digitaria exilis*) is largely dominated the assemblage (Table 6-1). The others crops also present are pearl millet (12%), African rice (4%; A in figure 6.3), sorghum (2.5%) and cowpea (<1%). Pearl millet and rice are mainly represented by chaff items (involucres and spikelets bases): 73% for the pearl millet and 95% for the rice. In term of cash crop, cotton (*Gossypium* sp.) is well represented with 111 remains (Figure 6.3 b and c; caps and seeds) for 7.6% of the assemblage.

Except a slight pearl millet decrease, from 33% to 8% in frequency, and a constant fonio increase, from 32% to 72% in frequency, there is no major change in the assemblage composition throw time (Table 6-1; Figure 6.1 and 6.2).

Table 6-1 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Sorotomo** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Sorotomo			
Date AD	**1200-1300**	**1300-1400**	**1400-1500**	**Total**
# samples **Volume of soil (litres)**	**3** **30**	**4** **20.2**	**20** **286**	**27** **336.2**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	52+12=**64** 33% (33%)	5+2= **7** 7% (75%)	69+32=**101** 8% (65%)	126+46=**172** 12% (63%)
involucre proportion	81%	71%	68%	73%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	9+0=**9** 6% (33%)	8+0=**8** 11% (75%)	37+3=**40** 3% (60%)	54+3=**57** 4% (60%)
Spikelets base proportion	100%	100%	92%	95%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	8+5=13 8% (33%)	0+2=2 3% (25%)	3+20=23 2% (25%)	11+27=38 2.5% (26%)
Chaff proportion	61%	-	1%	3%
Digitaria exilis	50 32% (33%)	32 45% (75%)	884 72% (80%)	966 66% (70%)
Gossypium sp.	11 7% (100%)	9 13% (75%)	91 7% (95%)	111 7.6% (92%)
***Tree/bush* (fruit)**	11 7% (67%)	5 7% (25%)	43 3.5% (60%)	59 4% (55%)
Vigna sp.	2 <1% (33%)	-	5 <1% (5%)	7 <1% (22%)
Total Number	156	72	1232	1457
Density (Items/litre)	5.2	3.6	4.3	4.3

6.1.1.2 Togu Missiri

The second half of the Ségu region dataset come from Togu Missiri and comprises 15 samples. Five of these samples come from the interior of intact vessels and 12 from domestic deposits (midden, hearth, and postholes). Two samples were devoid of any plant remains. In total, 1317 archaeobotanical items were recovered from 75 litres of soil. With 17.5 items recovered by litre of soil, the density is one of the higher presented in this study.

Togu Missiri archaeobotanical assemblage (Table 6-2) is largely dominated by fonio remains (D in Figure 6.3), 709 grains found in 13 samples (87% of ubiquity) representing a frequency of 54%. Pearl millet (E in Figure 6.3) is also well represented with 276 items, 68% of chaff, for 21% of the total assemblage (frequency). Sorghum is present as well but only in low frequency (3.7%). The last cultivated crop present is cowpea but in very low frequency, 3 cowpea for less than 1% of the assemblage. With 37 remains, 3% of the assemblage, cotton is the main cash crop present in the assemblage. Lastly, Cola nuts (*Cola* sp.) and safou fruits (*Dacryodes edulis*) are present in each sample.

The only major change in time evolution that occur in the assemblage is cotton remains arrival. Also, a constant pearl millet decrease is noted (Figure 6.1 and 6.2).

Table 6-2 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Togu Missiri** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Togu Missiri			
Date AD	**1000-1100**	**1100-1200**	**1200-1300**	**Total**
# samples **Volume of soil (litres)**	**5** **25**	**5** **25**	**5** **25**	**15** **75**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	112+49=**161** 29% (100%)	69+33=**103** 18% (100%)	8+4=**12** 7% (75%)	189+86=**276** 21% (87%)
involucre proportion	69%	66%	66%	68%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	-	-	-	-
Spikelets base proportion	-	-	-	-
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	5+9=**14** 2.5% (100%)	10+25=**35** 6% (100%)	-	15+34=**49** 3.7% (67%)
Chaff proportion	36%	28%	-	30%
Digitaria exilis	315 56% (75%)	336 59% (100%)	58 32% (100%)	709 54% (87%)
Gossypium sp.	-	-	37 20% (75%)	37 3% (20%)
***Tree/bush* (fruit)**	16 3% (75%)	65 11% (75%)	53 25% (75%)	134 10% (60%)
Vigna sp.	3 <1% (40%)	-	-	3 <1% (13%)
Cola sp.	Present (100%)	Present (100%)	Present (100%)	Present (100%)
Dacryodes edulis	Present (100%)	Present (100%)	Present (100%)	Present (100%)
Total Number	562	574	181	1317
Density (Items/litre)	22.5	23	7.2	17.5

6.1.1.3 Regional Pattern for Ségu Area

For both sites, and with no discontinuity throughout their occupation, the botanical assemblage (Table 6-1, Figure 6.1 and 6.2) is largely dominated by fonio (*Digitaria exilis*) remains, with a minimum frequency of 32 % and a maximum of 72% during the Sorotomo destruction phase, and an average ubiquity of 75%. Other cultivated crops with a high ubiquity (average >75%) at Sorotomo and Togu Missiri included pearl millet (max 33 % frequency), sorghum (max 8% in frequency) and cowpea (but in small quantities). The three crops are present from 1000 AD to 1500 AD with no major shift seen throughout this time. A gradual decrease in the frequency of pearl millet is seen during the Togu Missiri occupation (from 29% to 7%) and the same general pattern in frequency is observed at Sorotomo (from 33% to 6 %). However at Sorotomo, ubiquity rises from 33% to 63%. While pearl millet was less abundant within individual samples, it was better represented, albeit in low quantities, across the entire assemblage in the later period.

Rice, was not present at Togu Missiri, but appears to have arrived during the Sorotomo foundation phase around 1200 – 1300 AD (with an average of 6% in frequency and in 33% in ubiquity) increasing to 11 % in frequency during the second phase (1300 – 1400 AD). Cotton remains appear around 1200 – 1300 AD at both sites (20% frequency at TOG2 and 7% at Sorotomo) and are present until 1500 AD at Sorotomo. Evidence of cotton is represented by both seeds and caps (Figure 6.3). Also, agroforestry parkland tree remains composed around 20% (on average) of the botanical assemblage with the fruit remains of *Adansonia digitata* (baobab), *Sclerocarya birrea* (marula), and some of *Vitellaria paradoxa* (Shea butternut tree). Finally, *Cola* sp. (Cola Nut Tree) and *Dacryodes edulis* (Safoutier or African Pear) fruit remains were found in every phase at Togu Missiri. Cola nuts, along with Safoutier as a secondary product, were very important to the north-south economic exchange between forest and savannah (Chapter 8 section 8.5 Cola and Safou)

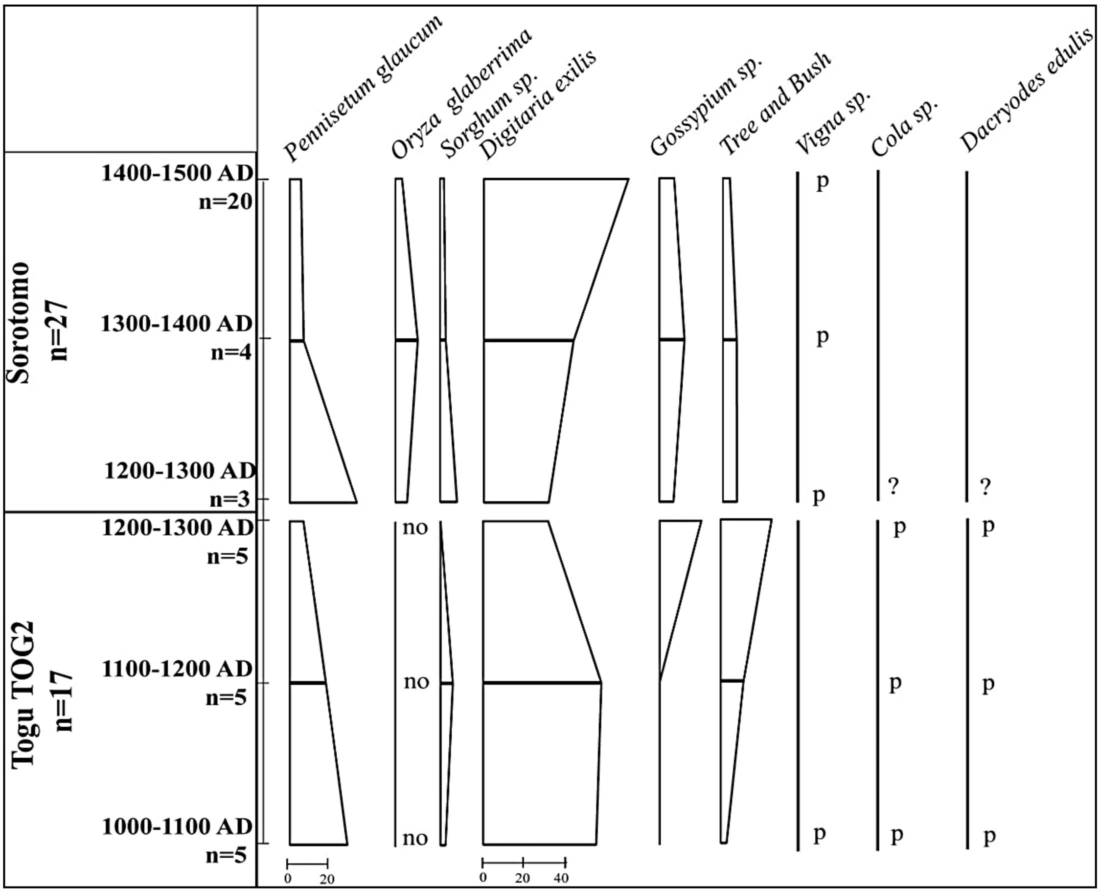


Figure 6.1 **Frequency** of archaeobotanical finds from **Togu Missiri** and **Sorotomo**. 44 archaeobotanical samples composed the data set studied here. n being the number of samples by phase. All taxa frequency depicted at the same scale.

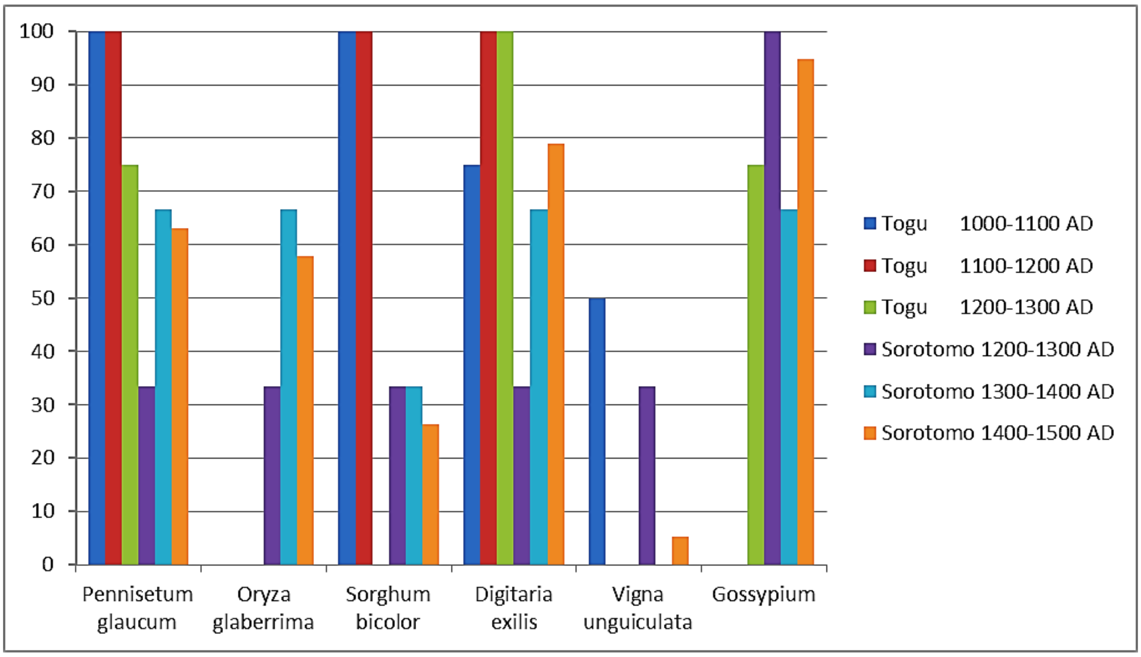


Figure 6.2 **Ubiquity** (% samples as a total of all samples by phase in which each taxon is present) for majors crops at Togu Missiri and Sorotomo.

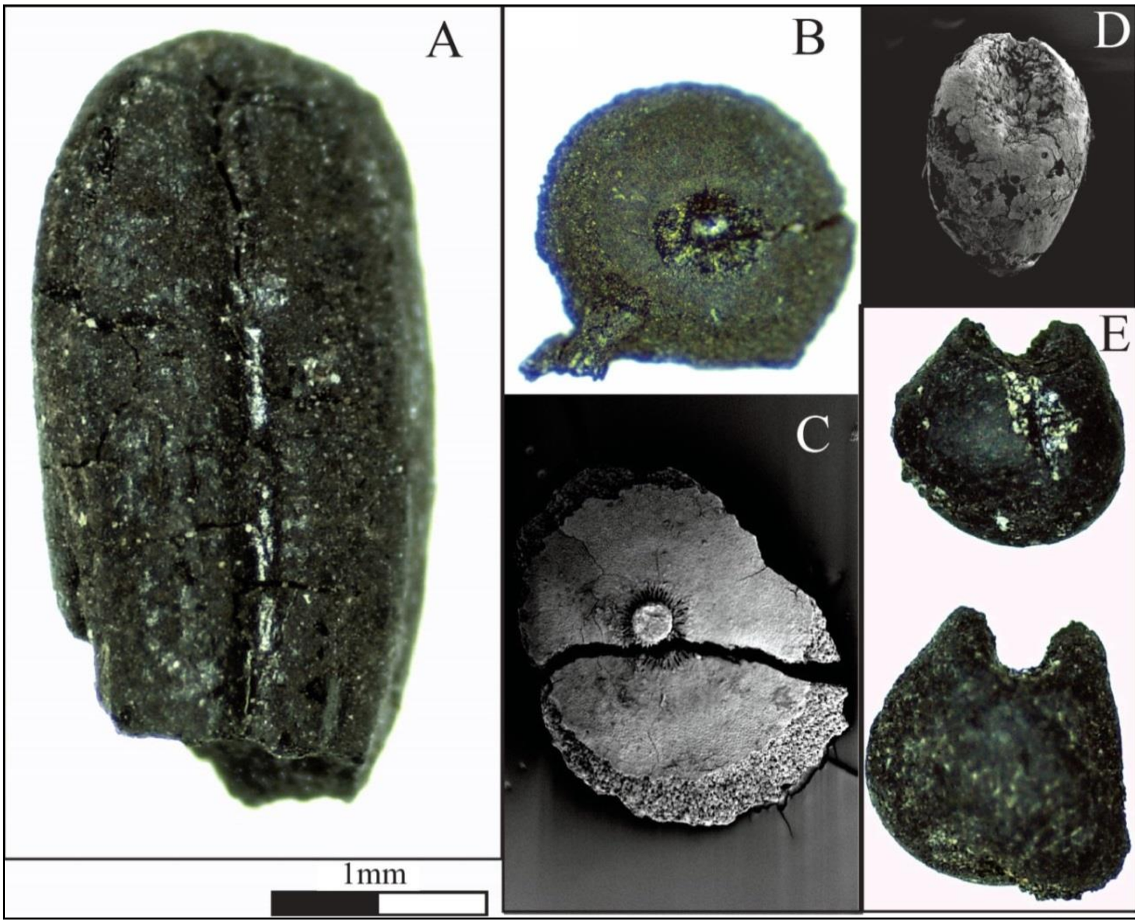


Figure 6.3 Plant remains from Sorotomo and Togu Missiri. (A) *Oryza glaberrima,* African rice grain, Sorotomo Unit BE Pit 22. (B) *Gossypium* sp., cotton caps, Togu Missiri context A10. (C) *Gossypium* sp., cotton caps, Sorotomo Unit A context 16 (midden). (D) *Digitaria exilis*, fonio grain, Sorotomo Unit BE context 35. (E) *Pennisetum glaucum*, pearl millet grains, Sorotomo Unit B context 8.

Interpretation

The agricultural landscape of Togu Missiri can be seen to be composed of dry cultivation fields, characterised by pearl millet and sorghum, intercropped by cowpea. This dry agriculture component is completed by fonio which is grown in fields located on the poorest sandy soils. This landscape appears strewn with useful agroforestry parkland trees, such as baobab, Marula tree and some Shea butter tree. The absence of wet agricultural plants remains (i.e. African rice) in an area where rice could potentially have been grown probably results more from the population's traditional subsistence practises, embedded within their ethic identities, rather than ecological factors. Indeed, even currently the Middle Niger distribution of "ethnic" groups is strongly tied to specific or specialised relationships between natural ecological niches and cultural identity (i.e. the Nono are specialist rice cultivators, the Bozo shallow water fishers).

Based on the current distribution of cultural groups, the original Togu Missiri inhabitants were most probably dryland cultivators (like the modern Bambara). They also likely settled on the main north-south trade road towards the forest, where Cola nut and Safou fruit were growing. During Togu Missiri's last phase (1200-1300 AD) evidence of a Trans–Saharan connection is evident with the arrival of cotton remains (see Chapter 8, cotton section). Cotton' arrival at Togu Missiri appears to coincide with the site abandonment, raising the question of whether the influx of new peoples and influences on the inhabitants' economic spheres contributed to abandonment of the site? Further excavation and archaeological material analysis should hopefully bring some clarification to this point.

During the decline of Togu Missiri, a new settlement was arising at Sorotomo. For MacDonald, Sorotomo is seen as a new emergent political centre of the Ségou kingdom, a so-called "*fadugu"* (MacDonald et al. 2011). This fosters the difficult question of whether Togu Missiri was the former "*fadugu*" which was then destroyed by the new ruler of Sorotomo.

The Sorotomo botanical finds are very similar to those from Togu Missiri with evidence for fonio and cotton cultivation, with the later arrival of rice, although in low quantities. The minor presence of rice might reflect its presence through trade rather than local cultivation. The rarity of fish remains in the archaeological record also indicates a low utilisation of aquatic resources in general. Thus, both sites were probably settled by traders and dryland cultivators.

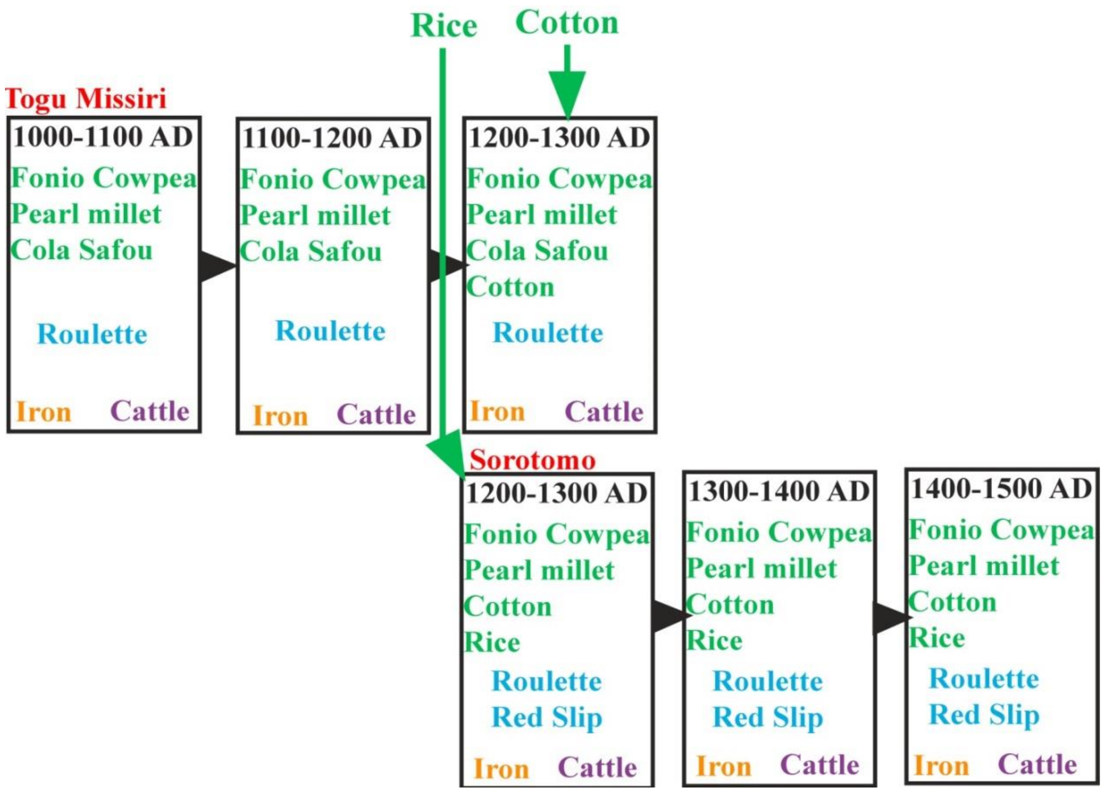


Figure 6.4 Summary of Ségu region archaeological sequence (Togu Missiri and Sorotomo) highlighting the main characteristics of ceramic (in blue), plant resources (in green), technology (in orange) and animal remains (in purple).

6.1.2 Mema Region

6.1.2.1 Akumbu

The site of Akumbu is split into several occupational phases, but only three archaeobotanical samples are presented here. Unfortunately, the other floated samples taken during excavation have been lost (MacDonald pers.com.). Nevertheless, as explained in chapter 4, archaeobotanical charred remains often represent the background noise of plant use in everyday refuse. In the case of agricultural societies, this tends to provide evidence for major crops, and crop-processing waste, including arable weeds, and therefore the agricultural environment. Following this approach, we can consider that each sample has its importance in revealing routine activities by site or time period (Fuller et al. 2014). Thus the study of even a single flotation sample (by archaeological phase or… even by site) may in itself be trusted to reflect a past behavioural pattern. Here, analysis of three samples split from two phases give us a first evaluation of the Akumbu botanical sequence. The three samples presented here are the first to be fully analysed (see Chapter 7 for discussion on Tichitt influences on the Inland Niger Delta occupations).

In total, 466 archaeobotanical remains were recovered. Those remains are dominated by *Echinochloa* sp. grains representing 17% of the assemblage. The second important crop is pearl millet with 55 items for 12% of the frequency. 54% of the pearl millet are from chaff remains.

Table 6-3 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Togu Missiri** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**600-1000**	**1000-1400**	**Total**
# samples	2	**1**	**3**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	10+5=15 4.5% (100%)	20+20=40 31% (100%)	30+25=55 12% (100%)
involucre proportion	66%	50%	54%
Echinochloa sp.	81 24% (100%)	-	81 17% (66%)
Poaceae	19 6% (100%)	14 11% (100%)	33 7% (100%)
Gossypium sp.	-	3 2.5% (100%)	3 1% (33%)
***Tree/bush* (fruit)**	63 18% (100%)	1 1% (100%)	64 13.5% (100%)
Total Number	339	127	466
Density (Item/litre)	?	?	?

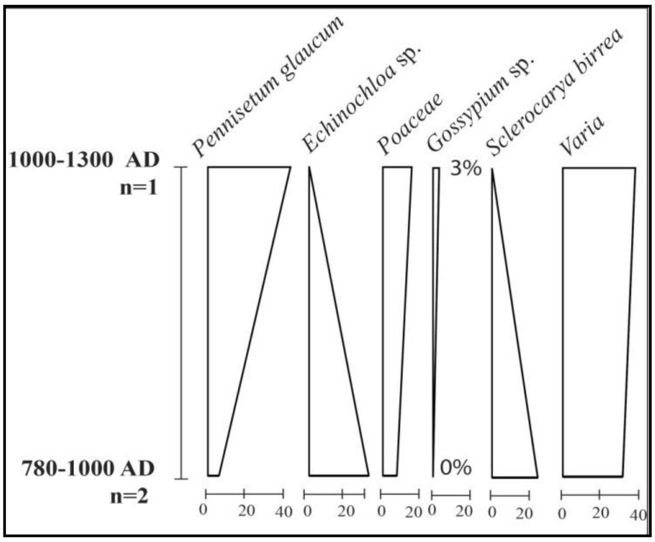


Figure 6.5 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data at Akumbu. Three archaeobotanical samples composed the data set studied here. n being the number of samples by phase.

The "first" phase dated to 780-1000 AD, represented by 2 samples and 258 plant remains (Table 6.3, Figure 6.5 and 6.6), is dominated in frequency by *Echinochloa* sp. grains (32%) and *Sclerocarya birrea* fruits (Marula tree) (23%). Pearl millet constitutes around 10% frequency of the assemblage. The high levels of Echinochloa raise the possibility that this was a major food resource. Although domesticated form is not known from West Africa. However it is an important gathered resource for some ethnographic groups (see Portères; Harlan) and it has been found as the major grain in some archaeobotanical studies such as Essouk (see Nixon 2011) The "second" phase, 1000-1300 AD, is remarkably different to the previous phase. It has only one sample with 92 charred plants remains. The pearl millet remains increased in frequency to 44 % of the total assemblage. Moreover, remains of *Echinochloa* sp. and *Sclerocarya birrea* are absent and, instead, cotton (*Gossypium* sp.) appears in the assemblage. The arrival of cotton coincides with other contemporaneous finds in the middle Niger, such as Togu Missiri, Sorotomo or Dia (this study, Murray 2005). The presence of cotton grains and caps corroborate the six spindle whorls recovered from the upper horizon (*ca.* 1000-1400 AD; Togola 2008).

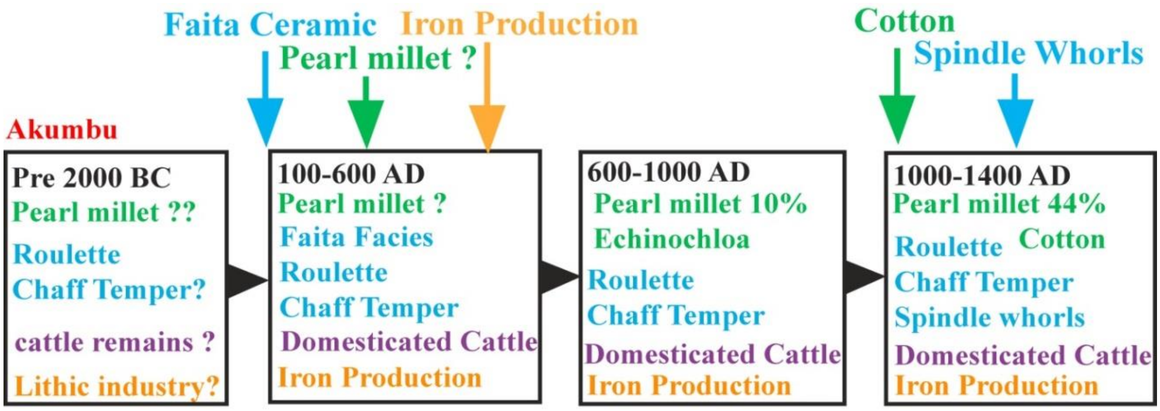


Figure 6.6 Summary of Akumbu archaeological sequence with main characteristics of ceramic (in blue), plant resources (in green), technology (in orange) and animal remains (in purple).

6.1.3 Gourma des Monts

6.1.3.1Windé Koroji (WKO)

The samples from the second millennium BC site of Windé Koroji Ouest (WKO) produced only a small number of seeds (7/L on average) but provide important information on early pearl millet cultivation (MacDonald et al. 2017). From the WKO midden and hearth ten archaeobotanical samples (a total of 26 litres of soil) were selected. Some of these samples were first examined by Cecilia Capezza, who identified the earliest domestic pearl millet grains on the site, and then re-examined by myself as part of this thesis. Within the ten samples only two were completely devoid of plant remains (context 7 A & 7B from Horizon A). Of the 119 finds recovered in the samples only 78 were identifiable.

As shown in Figure 6.7, the analyses suggest some changes through time. However due to the small volume of soil floated, some caution is applied. Still we can observe frequency changes within the tree and shrubs remains: 40% in phase A which shrank during phase B to ≈15%), and totally vanished in phase C (Figure 6.7).

Table 6-4 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Windé Koroji** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Windé Koroji			
Date BC	2150-1900	1900-1100	Post 1100	**Total**
# samples (volume)	**5 (12)**	**4 (14)**	**2 (2)**	**11 (28)**
Pennisetum glaucum grain Frequency (Ubiquity)	15 13% (60%)	6 60% (20%)	6 20% (100%)	17 22% (55%)
involucre proportion	-	-	-	-
***Tree/bush* (fruit)**	15 40% (100%)	1 10% (25%)	-	16 22% (55%)
Vigna sp.	-	-	3 10% (50%)	3 4% (9%)
Poaceae	1 3% (20%)	-	4 13% (100%)	5 6% (27%)
Total Number	39	50	30	119
Density (Item/litre)	3.25	0.71	15	4.25

Remains of *Gramineae* dominate the assemblage. It is nonetheless notable that 17 of these seeds are domesticated pearl millet (Figure 6.8, D & E). Pearl millet has been identified through all sequences, with a peak of phase B. But more importantly, five seeds were associated with the initial phase of the site occupation that was dated from 2200 cal BC to 1700 cal BC. Initially, a radiocarbon date directly on the seeds was scheduled at Oxford, but unfortunately the two seeds were destroyed during pre-treatment without yielding sufficient carbon for dating (MacDonald pers. comm.).

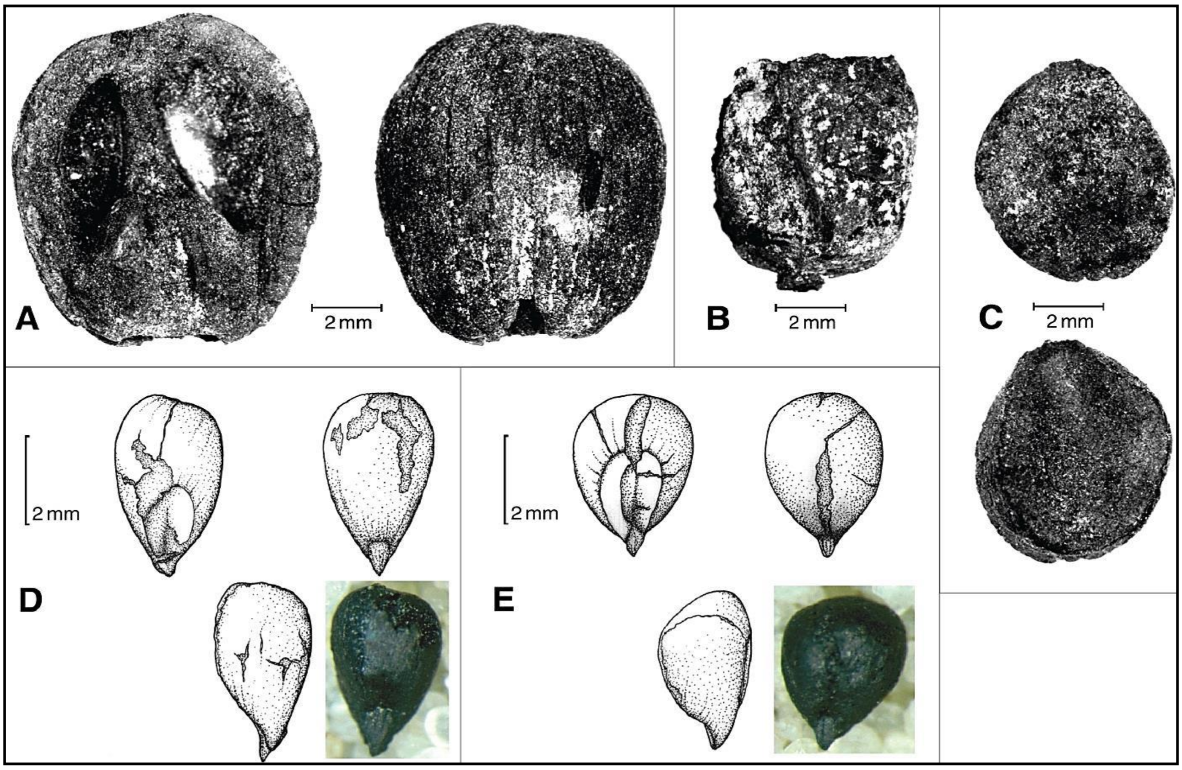


Figure 6.7 Examples of identified botanical remains from WKO-1 : A= Fruit of *Vitex doniana* (context 7); B= Fruit of *Lannea microcarpa* (context 8); C=Fragments of *Sclerocarya birrea* (context 7); D=Drawings and illustrations of the *Pennisetum glaucum* grains from context 19, Horizon A. (Modified from MacDonald et al. 2017:172)

Fruit remains at Windé Koroji represent around 20 % frequency of the total assemblage and 40 % of the Horizon A (2150-1900 BC) where most of the remains come from. The black plum (*Vitex doniana*) is the most common fruit recovered. This tree is sometimes planted for both its fruit and the young leaves -which are used as pot-herb. The fruits, maturing from December to July (Figure 6.10), are edible and produce a sweet beverage. They are also used for medicinal purposes and to produce ink (von Mayell 1986; Cissé 1991; Dalziel 1937). Horizon A also indicates evidence of African grape (*Lannea microcarpa*) a woodland savannah tree that usually grows in more humid conditions than those currently present at the site. Its fruits, ripening between April and June (Figure 6.10), are edible and are especially appreciated for making an alcoholic drink (Cissé 1991, von Maydell 1986). Marula tree (*Sclerocarya birrea*) fruit remains are also present in Horizon A (and only in this Horizon). The fruits ripen between April and June (Figure 6.10), are edible and a fermented drink is obtained from their juice. An oil used for food preparation is extracted from its kernel (Dalziel 1937; Cissé 1991).

Only one seed of cf. *Diospyros mespiliformis*, the West African ebony tree, was recovered from a sample of the later horizon. The tree can be viewed as in a state of semi-cultivation (Dalziel 1937:348).The fruits of this savanna tree are edible fresh or dried and they are also used for beverages, jam and to produce a concentrated juice used for various purposes (Cissé 1991). The wood provides valuable timber, it also makes good fuelwood and charcoal. The leaves are used for fodder. Leaves, bark and other parts of the tree are used for medicinal purposes (von Maydell 1986).

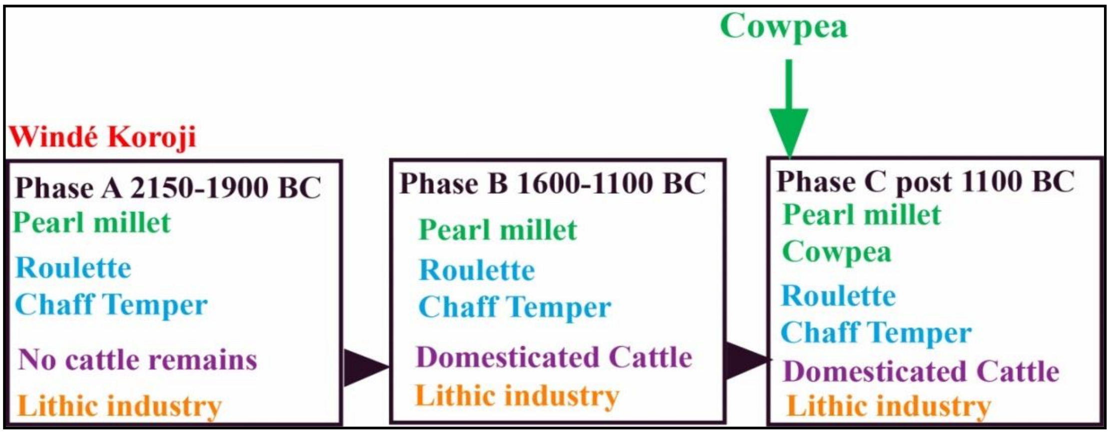


Figure 6.8 Summary of Windé Koroji archaeological sequence with main characteristics of ceramic (in blue), plant resources (in green), technology (in orange) and animal remains (in purple).

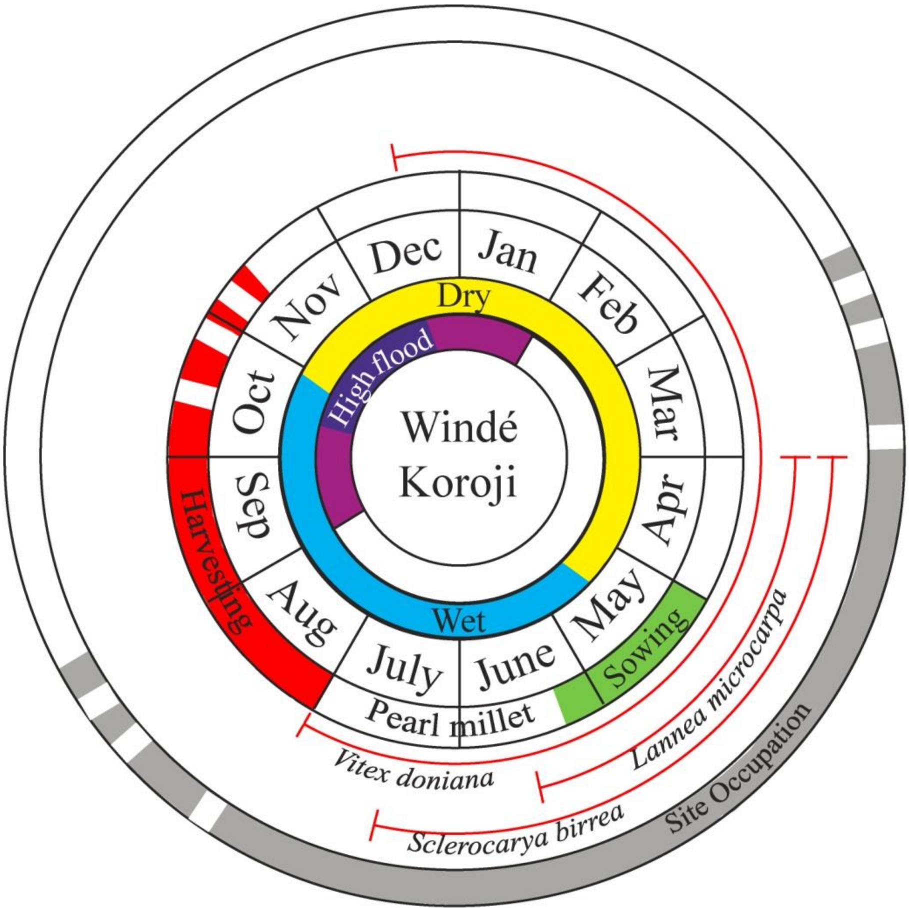


Figure 6.9 Windé Koroji seasonality for the Archaeobotanical remains. Ripening season for the fruit remains (*Vitex doniana*, *Lannea microcarpa*, *Sclerocarya birrea*) and potential occupation period for Windé Koroji.

Interpretation

The presence of both *Vitex doniana* and *Lannea microcarpa* in the initial occupation phase of the site (2150-1900 BC) is an indication of the presence of a river or a water table close by which could support tropical gallery forests or extra zonal vegetation north of their expected extension in an arid phase. *Vitex* is regarded as typical of Sudano-Guinean vegetation, restricted to the far south of Mali under modern climatic conditions, while *Lannea* is found in the Sudanian zone (Eichhorn and Neumann 2014).

Seasonality indicators from the early occupation at Windé Koroji include fruit piths of *Lannea microcarpa* and *Sclerocarya birrea*, which both only ripen in the wet season, and *Vitex doniana*, which ripen over a longer period including during the rainy season (Figure 6.10), as well as extensive shallow water fish remains indicative of floodplain exploitation (MacDonald 2017). Interestingly, the post-1600 BCE occupation (Horizon B) – when cattle are present – lacks comparable botanical indicators, but still possesses fish remains, crocodile and freshwater terrapin remains. It is therefore possible that the initial occupation of the site was confined to the wet season, making the presence of cattle unlikely, with a shift to repeated or extended occupation outside of the peak flood (and tree fruit) season in the subsequent period.

It is proposed that the initial inhabitants of WKO were fruit gathers practicing millet cultivation, without cattle but with small livestock (sheep and goat). The rainy period, the likely occupation period for the site, coincides with the pearl millet sowing season (Figure 6.10; May – June). It is possible that early pearl millet was cultivated around Windé Koroji, as this would fit with the seasonality of the site as indicated via the fruit remains. During this phase it is theorized that after the pearl millet harvest, and manufacture of pottery as pearl millet chaff was found within the ceramic temper, the occupants travelled to other seasonal encampments, probably taking advantage of fish migration in the Niger rising flood. Potentially they took with them pottery, fruit, millet, and dried fish, travelling by boat through a lacework of waterways created during the high flood. As the dry season took hold, it is likely that they fished in the isolated pools of the Niger River following the lowering floodwaters, returning in March-April to WKO for the gathering fruits and sowing of millet in May and so closing the gather farmer-potter-fisher yearly cycle. The association of pearl millet culture with fisher-gatherers apparent lacking pastoralism differs from widely expected associations of early pearl millet culture and pastoralism (e.g. Many and Fuller 2014, Winchell et al. 2018) but this point will be discussed in Chapter 9.

6.1.3.2 Tongo Maaré Diabal (TMD)

114 samples were floated from this site, mostly from domestic features such as middens and hearths, as well as the contents from inside pots.

The archaeobotanical results (Table 6-5) indicate that the principal plant remains from TMD are domesticated pearl millet, accounting for around 85% frequency of the assemblage (15,480 grains and involucres) and are present in every sample (100% ubiquity). The foods consumed at Tongo Maaré Diabal comprise mainly of pearl millet and wild millet species (Digitaria sp.). The sporadic consumption of fruits of local trees (Sclerocarya birrea and Vitex sp.) is also indicated. These are recovered in less quantity (3% frequency in average). The proportion of various plant remains from Tongo Maaré Diabal appear little changed throughout the occupation. The introduction of Sorghum bicolor is noticed from phase 3 (750-900AD) to the abandonment phase (1000-1150 AD), but in very small quantities (43 items, of 18,385 total plant remains).

Table 6-5 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Tongo Maaré Diabal** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**500-650**	**650-750**	**750-900**	**900-1000**	**1000-1150**	**Total**
# samples (volume)	**4 (20)**	**16 (45)**	**19 (100)**	**21 (105)**	**54 (226)**	**114 (496)**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	115+272= **387** 87% (100%)	1625+255= **1880** 94% (100%)	4159+1142= **5301** 85% (100%)	2848+1803= **4651** 85% (100%)	2013+1248= **3261** 85% (100%)	10760+4720= **15480** 85% (100%)
involucre proportion	30%	86%	78%	61%	61%	69%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	-	-	9+5=**14** <1% (5%)	2+14=**16** <1% (14%)	0+13=**13** <1% (7%)	11+32=**43** <1% (14%)
Chaff proportion			64%	12%	0%	25%
***Tree/bush* (fruit)**	7 1.6% (50%)	17 <1% (6%)	308 5% (3%)	17 <1% (14%)	26 <1% (18%)	375 2% (16%)
Vigna sp.	-	-	7 <1% (5%)	15 <1% (5%)	2 <1% (4%)	24 <1% (3%)
Total Number	456	2146	6323	5372	4088	18385
Density (Item/litre)	22.8	48	63	51	18	37

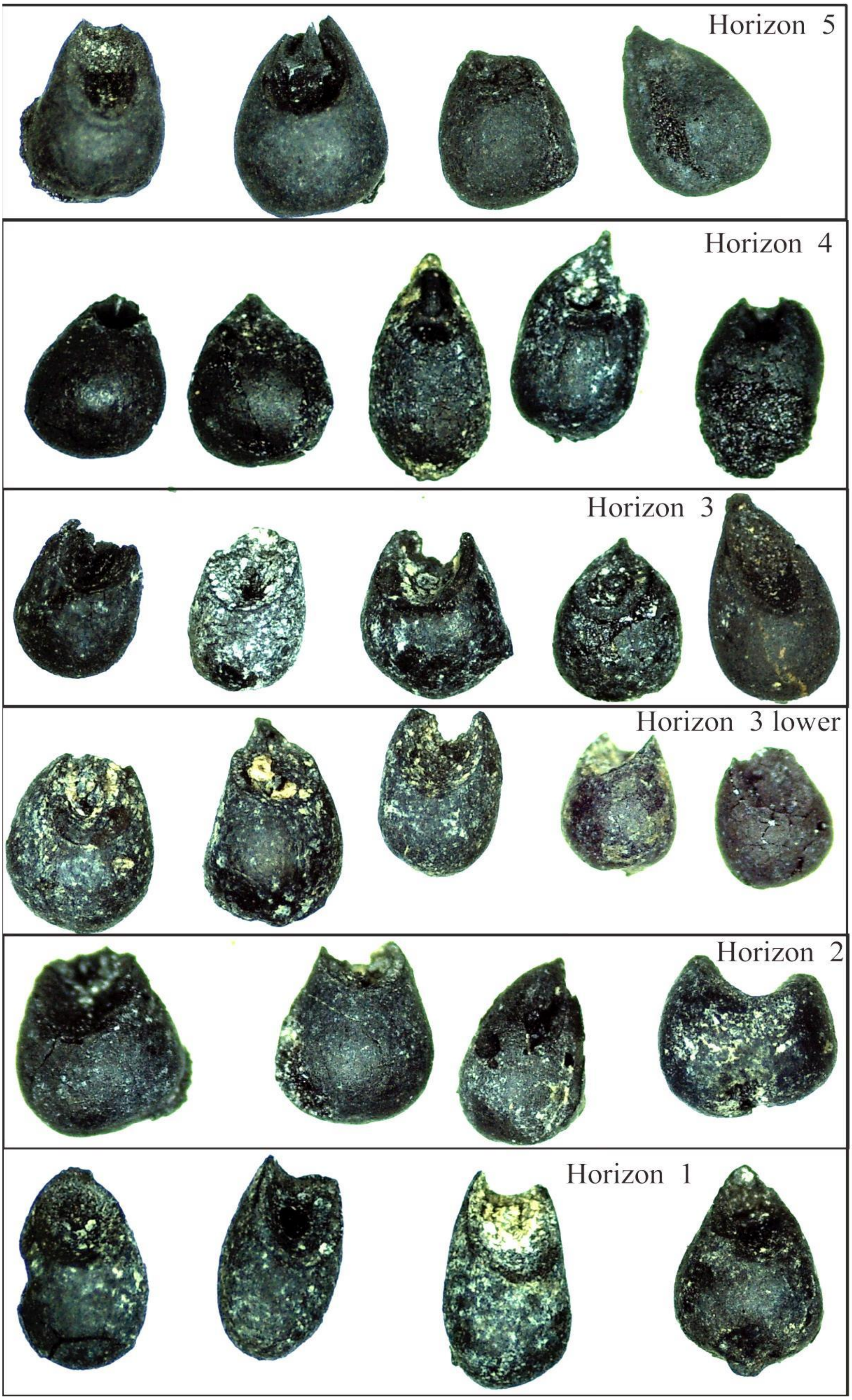


Figure 6.10 Pearl millet grain shape variation at Tongo Maaré Diabal by phase.

Results of preliminary studies on wood charcoal by Dirk Uebel (unpublished) are summarised in Gestrich and MacDonald (2018). Together with the macrobotanical results they indicate that Tongo Maaré Diabal was situated in a mosaic of fields and fallows; pearl millet grains and involucres dominate the botanical assemblage, suggesting that millet was cultivated to the exclusion of other crops. Tree taxa such as *Faidherbia albida*, *Balanites aegyptiaca* and *Schlerocarya birrea* likely provided useful products (fruits/seeds/leaves) for human and animal consumption and thus were likely protected within cultivated fields, as they are today. *Guiera senegalensis* and *Combretum glutinosum* are present in the charcoal assemblage. These tree species recover well after cutting and are therefore seen as indicative of fallow fields (Höhn and Neumann, 2012). Tree taxa such as *Balanites aegyptiaca*, *Celtis integrifolia*, *Prosopis africana* and *Khaya senegalensis* also point to the presence of gallery forest, presumably beyond the cultivated zone. Neither grains nor wood charcoal analysis identified temporal trends in the botanical record, suggesting that TMD was founded within an already established mosaic of fields and fallows and that metallurgical activity evidenced at Tongo Maaré Diabal did not completely eliminate the gallery forest in the vicinity of the site.

Manuring Practices

Pearl millet grains from 15 archaeological contexts (7 to 15 grains by context) spanning Horizon 1 to 5 (500 – 1150 AD) were sampled from this site for Nitrogen ($\delta^{15}N$) isotopic composition analysis by Amy K. Styring from Frankfurt University. Nitrogen isotopic composition analysis has been used on charred wheat and barley grains to reconstruct manuring practices at archaeological sites across Europe and Western Asia. The test run was to try the same methodology on charred pearl millet grains from West African site. In comparison with modern data on pearl millet from a similar ecological region in Senegal, she interpreted the nitrogen isotope values of millet grains from Tongo Maaré Diabal as evidence for modest levels of manure/household waste input throughout the site occupation. It is likely that pearl millet at Tongo Maaré Diabal received low levels of household waste and/or manure from animals grazing after harvest. There is no obvious change in pearl millet $\delta^{15}N$ values through time, although it is interesting that the only pearl millet grain sample classified as receiving high levels of manure derives from a context post-dating A.D. 750, which is when the number of cattle bones on the site increases. What is clear is that there is no decrease in manure application during the occupation of the site, implying strategic management of resources to ensure continuing crop productivity and soil fertility. This would have been particularly important, since the predominance of pearl millet would seem to preclude crop rotation or green manuring with legumes as alternative strategies of replenishing soil nutrients. Equally, the lack of increase in pearl millet $\delta^{15}N$ values during the 650 year occupation of the site implies that manure/household waste was added relatively sporadically, rather than applied to the same plots annually. This continuity in manuring practice reflects the general lack of change in the botanical and charcoal assemblages (Styring pers. comm.; Styring et al in revision).

Interpretation

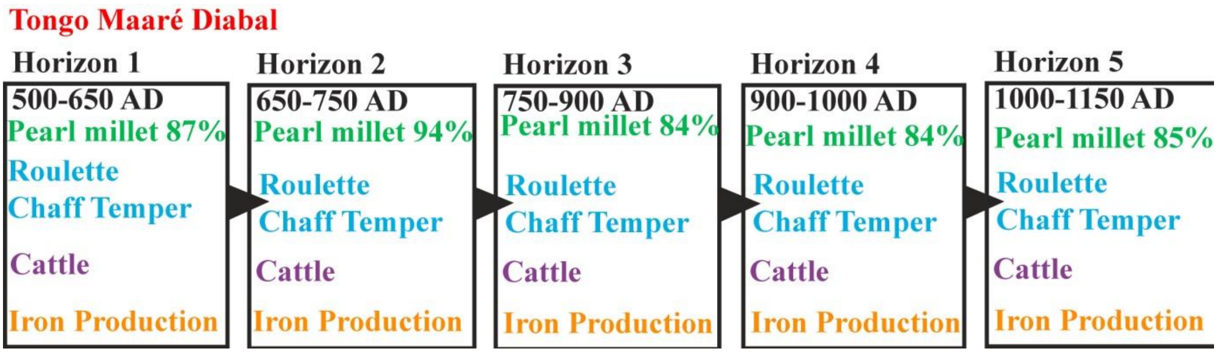


Figure 6.11 Summary of Tongo Maaré Diabal archaeological sequence with main characteristics of ceramic (in blue), plant resources (in green), technology (in orange) and animal remains (in purple).

As described, Tongo Maaré Diabal has strong evidence for iron processing, including intense ore to iron reduction. Moreover, the presence of slag waste from forge activity indicates that Tongo Maaré Diabal was also a smithing site. Ore reduction in iron bloom (smelting) activities, along with evidence of furnaces, has also been found at nearby sites (Boata and Tangu 2), but without direct links to the habitation area or site (Gestrich and MacDonald 2018). One of the excavated bowl furnaces from Boata site yielded a date of 251-620 cal. AD (GX-21726). This date could be associated with Tongo Maaré Diabal's early phase, but there is currently no evidence that indicates any links between these sites. The most peculiar point about Tongo Maaré Diabal is that the site, and the surrounding area, were dedicated to metallurgy and it was not a segregated activity. This fact goes against current expectations. Across most of West Africa, ethnographic, historic, and even archaeological studies, have clearly illustrated that peoples involved in ore to iron bloom reduction are often socially segregated from common settlements; this being a fundamental feature of historic social organisation in

West Africa. So far the best archaeological example of metallurgical specialist segregation comes from Jenné-Jeno, where a potential shift to segregation is suggested by Gestrich and MacDonald (2017, but also Chapter 9). Currently in modern Mali this specific separate ore to iron bloom reducer's settlement is called a *Numudugu* (see chapter 2.2 Urbanism). The huge quantities of slag at Tongo Maaré Diabal suggest that iron production wasn't simply for local domestic activities but part of a wider proto-industrial iron production trading rough iron blooms or bars, in the Inland Niger Delta supra-regional network (Humphris and Rehren 2013, Gestrich and MacDonald 2018). The growth of urban sites, such as Jenné-Jeno and Dia, needed massive iron quantities, not just for the cities themselves but for the growth of farming populations within their hinterlands that formed an integral part supporting these urban clusters. Moreover, during the fourth century AD Jenné-Jeno showed no further evidence of iron smelting (ore to iron bloom reduction) even if smiths' activities (iron blooms shaping) are still observable. Thus Gestrich and MacDonald (2018) suggest that Tongo Maaré Diabal was an iron production area feeding growing urbanization in the IND. They also observed that the decline of the Empire of Ghana accompanied Tongo Maaré Diabal's abandonment in the 12th century.

The archaeobotanical data from the Gourma des Monts region are summarised in Figure 6.13. The assemblage comes from two sites, Windé Koroji and Tongo Maaré Diabal. Both sites are separated by approximately 11 km in distance and 1600 years in time. There are no archaeological links between both sites; nevertheless they offer a good overview of the evolution of agricultural activities in the area.

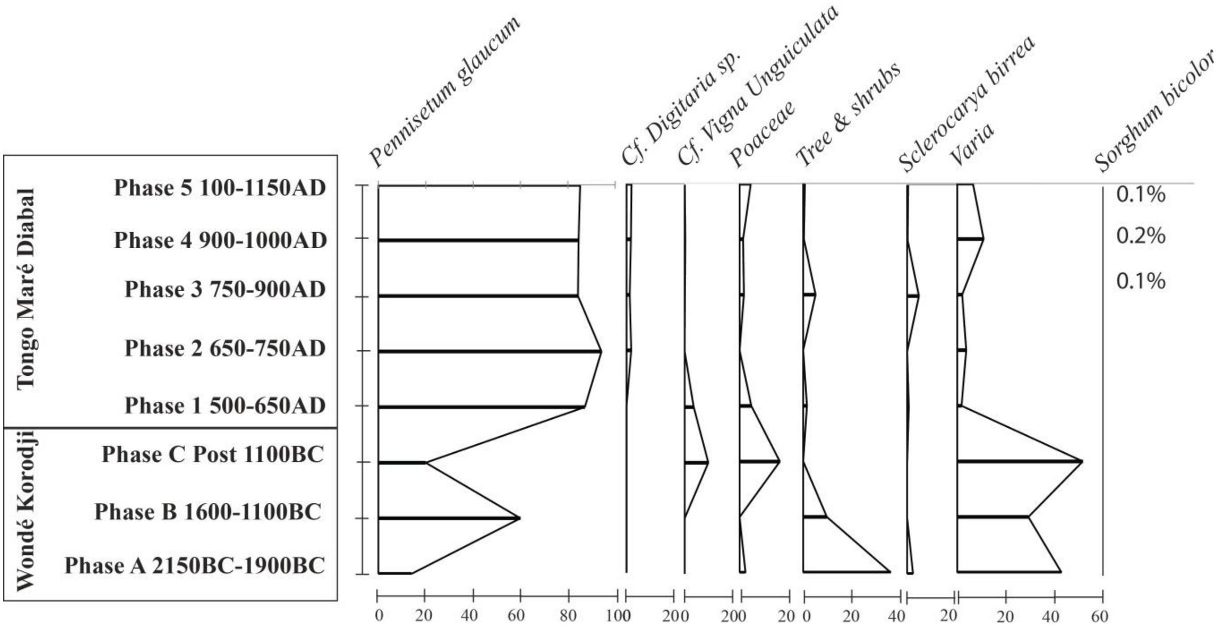


Figure 6.12 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data at Tongo Maaré Diabal and Windé Koroji. 10 archaeobotanical samples (totaling 26 litres) composed the data set studied here. n being the number of sample by phase.

6.1.4 Seno Plain: Sadia

The samples from this site were collected systematically from 3 test pits (SI, SII, SIII) and the horizontal excavation on top of Mound I. Where possible, a minimum sample volume of 20 litres per context or arbitrary spit was taken. Smaller contexts (< 20 L) were sampled by S. Kahlheber in their entirety.

Of the 146 collected samples only five were entirely devoid of identifiable macro-botanical remains. In total around 10,104 plants remains were recorded within 141 samples (4.5 botanical remains by litres of floated soil). Almost all the remains comprise carbonised seeds, although some silicified African rice husks (mainly lemma) were found, and these are also included in the counts in Table 1, figure 6 and 7 provide frequency and ubiquity of important species. Some preliminary results (presence/absence) from 11 samples were published by S. Kahlheber, as well as wood charcoal analysis by B. Eichhorn (Huysecom et al. 2012 and 2015). The present report provides a comprehensive study of all the collected samples.

As with most West African archaeological sites, the most dominant plant is pearl millet (*Pennisetum glaucum)*. Sorghum (*Sorghum bicolor*) and African rice (*Oryza glaberrima*) are the two other staple crops present, but in smaller quantities, in the samples. It is noticeable that two other grains, sometimes considered as weeds rather than staple crops, are found in large quantities: Fonio (*Digitaria exilis*) and the barnyard millet/hungry rice (*Echinochloa* sp.). Some samples also show remains of tree fruits, such as baobab (*Adansonia digitata*), marula (*Sclerocarya birrea*), jujube (*Ziziphus sp.*), shea butter (*Vittelaria paradoxa*) and African grapes (*Lannea microcarpa*). Moreover a good proportion of weeds, probably mostly related to rice cultivation were also found, such as *Commelina* sp., *Trianthema* sp., *Borreira* sp., and some *Paspalum* sp..

In the following sections a description of each of the main economic taxa at this site is presented, and also a discussion of how the plant assemblage evolved through the four phases of the sites occupation.

Sadia: Discussion of the Main Economic Taxa

Table 6-6 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Sadia** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Sadia				
Date AD	**Phase 0 'pre-Tell'**	**Phase 1 760-970**	**Phase 2 890-1160**	**Phase 3 1060-1270**	**Total**
# samples (volume)	**9 (111)**	**8 (86)**	**42 (662)**	**87 (1297)**	**146 (2157)**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	89+73=**162** 56% (89%)	202+36=**238** 49% (100%)	1428+1015=**2443** 59% (95%)	1369+695=**2064** 40% (88%)	3088+1819=**4907** 48% (91%)
involucre proportion	55%	85%	58%	66%	63%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	-	-	108+6=**114** 3% (50%)	59+6=**65** 1.5% (25%)	167+12=**179** 2% (29%)
Spikelets base proportion	-	-	95%	90%	93%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	-	-	10+10=**20** <1% (17%)	23+47=**70** <1% (22%)	33+57=**90** <1% (18%)
Chaff proportion	-	-	50%	33%	36%
Digitaria exilis	-	-	37 1% (19%)	931 18% (53%)	968 10% (40%)
***Echinochloa* sp.**	2 1% (11%)	-	237 6% (52%)	480 9% (13%)	719 7% (23%)
Wild Indet. *Poaceae*	25 9% (67%)	20 4% (38%)	78 2 % (12%)	37 <1% (5%)	160 1.6% (12%)
Weeds and/or wild gathered plants	20 7% (78%)	13 3% (50%)	142 4% (43%)	124 3% (29%)	299 3% (37%)
***Tree/bush* (fruit)**	50 17% (67%)	125 26% (38%)	214 5% (79%)	90 2% (39%)	479 5% (52%)
Vigna sp.	-	-	9 <1% (7%)	1 <1% (1%)	10 1% (3%)
Total Number	288	489	4114	5213	10104
Density (items/litre)	2.6	5.7	6.2	4	4.7

Pearl millet – *Pennisetum glaucum*

Within the archaeobotanical assemblage, 4907 pearl millet remains (chaffs and grains) were identified. Pearl millet is present in 91% of the samples and constitutes 48% of the total frequency. The seeds represent 37% (1819 grains) of the millet assemblage with 63% (3088) of chaff (bristles and involucres bases, B in figure 5) (Table 1). Due to their morphological characteristics, the seeds (club shaped) and involucres (stalked) were very easily determined as domesticated pearl millet (after Brunken et al. 1977; Manning et al 2011). The regular presence of pearl millet remains in domestic contexts and the high involucre base numbers suggests that pearl millet was stored as full panicles and was daily threshed when needed. The bristle and involucre bases are usually separated from the grain during the threshing and winnowing steps of the crop processing. The high quantity found in each context and sample suggests that it was processed in close relation with fires that were used for rubbish disposal, and were therefore probably very close to the household compounds.

Pearl millet is one of the more common staple cereals used in Africa. Today, the seeds are generally transformed into porridge or beer (Jolly 2004; Haaland 2007; Ricquier 2014). So far, the first archaeological evidence of pearl millet consists of a couple of charred grains and seed impressions in ceramics that dated to from ca. 2500 BC to 2000 BC and were found in the lower Tilemsi valley (Manning et al. 2011; Manning and Fuller 2014; Neumann 2018). This supports domestication in or around the Tilemsi valley and subsequent spread southwards in the savannas and through the Sahel. Finds from Ounjougou and Windé Koroji south the Niger river, and Birimi in Ghana, attest the rapid spread of pearl millet cultivation by ca. 1700 BC (D’Andrea et al 2001; Ozainne et al. 2009; Manning et al 2011). Nevertheless, the possibility of a second independent domestication of pearl millet in Mauretania associated with the Tichitt-Oualata Neolithic cultures remains plausible (MacDonald et al 2009; Manning and Fuller 2014). Regardless of the number of origins, pearl millet was established since the Neolithic as the primary staple grain in West Africa, as it continued for many areas into modern times. Sadia fit into this long-term tradition.

Rice – *Oryza glaberrima*

African rice was found in 43 samples and represented 2% of the total assemblage (12 grains and grain fragments, Table 1). This included 167 spikelet bases (C in figure 5) and hundreds of husks (lemma/ palea fragments). One of the samples AB 53, from Mound II (phase 3), indicates that the rice was probably processed (de-husked) at the site, with less than 1 litre of soil, producing large numbers of charred and silicified rice husks and lemma fragments.

Rice spikelet bases provide a good way to differentiate wild and domesticated rice. One of the most important key effects of plant domestication is a shift from natural seed dispersal to human seed dispersal. Mature wild grains fall naturally from the plant creating a smooth, round and regular abscission scar with a small distinct vascular port on the spikelet base. On the opposite, domesticated non-shattered grain needs human threshing to fall apart. The result of this labor is to create a less symmetrical scar with a dimpled appearance (Fuller et al. 2009, Fuller and Weisskopf 2011, Ishii et al 2010). It is observed that within the 167 spikelet bases of the Sadia dataset, 60% are domesticated and only 6.5% are wild. A further 12% are categorised as immature and, due to their bad preservation, the remaining 22% could not be determined. Thus the domesticated proportion can be estimated as ~90% (excluding immature and indeterminate forms) These data indicate that rice at Sadia was from already domesticated populations, with a small presence of wild-type or weedy rice (*O. barthii*) of ~10%.

Currently, the earliest evidence for *Oryza glaberrima comes* from the Inland Niger Delta and the site of Dia. Indeed, with AMS dates on rice grains from the earliest occupation of Dia, placed in the 800-400 BC bracket (Murray 2007a). Further chronological resolution is difficult as this falls in the Iron Age calibration plateau, and thus a date of 5th century BC is just as probable as 8th century BC. This rice is regarded as already domesticated, on the basis of rice grain measurements, as spikelet bases were not recovered (Murray 2007a). Given these data it is not clear whether an earlier domestication processes in the Inland Niger Delta should be hypothesized (as per Portères 1976) or whether rice had spread to this area from a domestication elsewhere, such the tributaries to the Inland Delta to the Southwest, as implied by the inferences from modern genetics (Meyer et al. 2016). Interestingly the first divergences within

African rice is inferred to be between western Guinea coast and hill races and those of the Niger basin (Meyer et al 2016), but currently with the exception of the site of Juffure, dated to 1650-1900 Cal AD (Gijanto & Walshaw 2014) in Gambia and from Sadia (this study), all the sites with domesticated African rice are coming from within the Niger River Basin itself, including the Inland Niger Delta and from Dendi region in North Benin (Bedaux 1978, Champion and Fuller 2018 a &b, Murray 2007a).

There are two ways to understand the presence of African rice in Sadia. Rice first appears at the site around 900AD. During this period, rice is very well attested within the nearby Inland Niger Delta (Dia, Jenné-Jeno, Thièl, Tato à Sanouna, Toguéré Galia & Doupwil,) thus its presence at Sadia could result from trade and exchange, and there are other items at this time that circulated between both parts of the Bandiagara escarpment that would support this argument (Huysecom et al. 2015). Alternatively, the rice in Sadia could be the product of local cultivation. While the presence of definitive rice weeds and early crop-processing stages (threshing and winnowing) could be seen to support local cultivation, the weedy taxa present might represent a combination of wild gathered millets, weeds from dryland millet cultivation (e.g. of fonio), or weed contaminants present in semi-processed rice spikelets received though trade. At present, therefore, the archaeobotanical data are ambiguous as to whether or not rice cultivation was actually conducted immediately around Sadia. Climatic conditions, however, are unlikely to have allowed for rice cultivation in this region, as rainfed rice typically requires a minimum of 700mm of rainfall (Portères 1959, Jacquot and Courtois, 1987), or would otherwise have necessitated irrigation. Trade of rice as semi-processed spikelets therefore appears to be indicated.

Sorghum – *Sorghum bicolor* subsp. *bicolor*

Only 90 (less than 1% of the total assemblage) sorghum remains mainly grains (57) but also chaff (33) were found in 18% of the samples (Table 1). The chaff is composed of involucres, spikelets base (A in figure 5) and torn rachilla characteristic of domesticated sorghum. Such remains probably come from the dehusking waste of race bicolor (on races see Fuller and Stevens 2018).

Genetic analyses on modern sorghum and recent archaeobotanical evidence support domestication of sorghum in the Eastern Sahel region around central/eastern Sudan (Fuller & Hildebrand 2013; Fuller and Stevens 2018). Data from sorghum chaff and spikelet impressions in ceramics indicate that morphologically domesticated forms were close to half the population before 3000 BC around the upper Atbara river east of Khartoum (Winchell et al. 2017; 2018), with a slow increase in domestication characters evident in material from near Kasala (eastern Sudan) at ca. 1850 BC (Beldados et al 2018). Already between 2000 and 1700 BC sorghum appears to have been introduced to India (Fuller and Boivin 2009; Fuller and Stevens 2018). The first sorghum evidences in West Africa are inferred to date by 650 BC from Alibori sites in North Benin (Champion and Fuller 2018a; 2018b), and sorghum is reported from sites Near Lake Chad in the later First Millennium BC, such as Mege and Kursakata (Zack and Klee 2004; Bigga and Kahlheber 2011; Fuller and Stevens 2018). By the early centuries AD sorghum is more widespread, including finds from Mali but always in smaller proportion than pearl millet or rice.

Fonio – *Digitaria exilis* (Kippist) Staph.or *Digitaria* cf. *exilis*

A total of 968 fonio grains, 10% of the total assemblage, were found in 40% of the samples (Table 1, D and E in Figure 5). The most common "Fonio" cereal is *Digitaria exilis* (commonly named true fonio or white fonio) domesticated from *Digitaria longiflora* (Hilu et al 1997; Adoukonou-Sagbadja et al 2007). Fonio is a small-seeded millet, around 1.2x0.7x0.5 mm, widely cultivated across western Africa, but generally considered a minor crop and one that is presently in decline. For Cruz and Portères the arduousness of fonio processing is related to its progressive disappearance. Indeed, the seeds are too small to be easily processed for food (Portères 1956; Cruz 2011). They require laborious dehusking, unlike pearl millet which is free-threshing and thus easily processed to clean grain for cooking or flour making (see Fuller and Weber 2005). On the other hand, brewing can be achieved with some or all grain remaining in their husks, and fonio beers are probably more common than pearl millet beers. Part of the modern importance of fonio, lies in its ability to produce a crop very quickly, and to grow in poor, especially shallow, soils. This is in contrast to the deeper-rooted tall crops of sorghum and pearl millet. Nevertheless, yields are quite low. A study in Nigeria reports fonio yields between 22 kg/ha and 322 kg/ha (Aliero and Morakinyo 2001). Thus, we conclude that the importance of fonio is its ability to produce reliable, if somewhat low yields, in a very short time, evening on poorly cleared, or shallow soils, and even if sown after other crops (and once farmers have some notion of whether other crops may be sufficient or faring poorly). Fonio can be grown on soils marginal for pearl millet or sorghum and too dry for rice.

One of our informants from Dimbal (the modern village located 15km from Sadia in Dogon Country, Mali) explained to us that due to the difficulty of fonio cultivation (and processing) and due to the laziness of the younger generation, who “prefer having fun in town”, cultivators have been sowing less and less fonio. They maintain the practice more for tradition than for needs. Nevertheless, the traditional importance of fonio is indicated by its symbolic association with the creator god of the Dogon, the current inhabitants of the Sadia region (Dieterlen 1955, Griaule 1948).

Currently, timing of fonio domestication is unknown. However, Portères suggested that it was probably domesticated in the Inland Niger Delta (Portères 1959, 1976) Its geographically widespread, but patchy distribution, could be taken to imply that is was once more continuously distributed and might therefore be of great antiquity (e.g. Blench 2006). However, finds have been strikingly absent from most archaeobotanical studies of either Neolithic of Iron Age sites, leading to the alternative hypothesis that was a late, secondary domestication associated with diversification of agriculture during the era of urbanization in the region (Champion and Fuller 2019). If this is the case then it is conceivable that domestication was ongoing at the time that Sadia was first occupied, or that introduction to Sadia occurred shortly after domestication. So far the only strong fonio evidences in the same area are coming from Kirikongo in Burkina Faso where fonio grains compose 8% of the total assemblage. However, only preliminary results are available from this site (Gallagher et al. 2016).

Weeds and/or wild gathered plants

A number of seeds (299 seeds for 3% of the total assemblage in 37% of the samples) of known weed taxa were recovered (Table 1). Weedy taxa are likely to enter the site through being harvested with crops, and then removed during various stages of crop-processing, alongside chaff (on crop-processing in general, see Hillman 1984; Jones 1987; Thompson 1996; Fuller and Weber 2005; Harvey and Fuller 2005; we are unaware of any specific studies focused on crop-processing in African rice). Small, light weed seeds tend to be removed early in processing with the initial threshing and winnowing, while larger and heavier seeds are removed in subsequent winnowing (or sieving) after dehusking, and those seeds closest in weight/size to crop grains must be removed by final hand-picking of processed grain. Weed finds at Sadia include carpet weeds (*Trianthema* sp., family Aizoaceae), and button weeds *Borreira* sp./ *Spermococce* sp., both widely reported groups of weeds of dry tropical agriculture, such as in millet cultivation or in rainfed rice, both in Asia and in Africa (Fuller and Boivin 2009: 27-28). These seeds are of intermediate size and weight and can be expected to contaminate rice spikelets after threshing and winnowing. *Commelina* spp. are also well-known weeds of rice cultivation in Asia of both upland rainfed and lowland irrigated systems (Moody 1989; Weisskopf et al 2014) and Africa (Portères 1976, Bezançon 1995), but as these produce quite large and heavy seeds they are likely to be removed in final processing after dehusking, including final hand-picking of clean grain. Thus all three of the above weed taxa would be expected to contaminate rice spikelets (i.e. in the husk), a form it which crops are likely to be traded as the husks will protect the grain from various forms of spoilage during exchange. In addition large-seeded weedy grasses were recovered, these could be contaminants removed in the latter processing stages, although it is also possible that they may be present as gathered foods. It is currently not possible to determine whether grasses like *Paspalum* and *Echinochloa* represent weeds of harvested rice, gathered (or even managed/cultivated foods) in their own right, or a combination of both.

In conclusion, the high presence of these species, which today usually grow as weeds, in archaeobotanical assemblages could indicate evidence of the local cultivation of rice. However, before these crops are sold, stored or exchanged the grain of these weed species potentially is separated, and by consequence the weed seeds remain on the site where they were processed. But here the remains of *Paspalum* and *Echinochloa* species cannot be used as indicator of rice cultivation.

Fruits, tree and bushes

In total, 479 remains of fruits, 5% of the total assemblage, were found in 52% of the samples (Table 1). Under this category are grouped the species that are more often found in agroforestry parklands. Parkland is a savannah landscape in which mature trees occur, scattered through cultivated or recently fallowed fields. Parkland is generally characterized by the dominance of one or a few species. Species composition is diverse and variable, and the agroforestry parklands in our area are mainly composed of *Faidherbia albida, Vitellaria paradoxa*, *Adansonia digitata, Borassus aethiopum,* *Cordyla pinnata*, *Tamarindus indica* and *Sclerocarya birrea* (Boffa 1999). Several of these trees produce edible fruits, and their charred remains are recovered from the samples studied here; including *Tamarindus, Sclerocarya,* and *Adansonia*. It is highly likely that Shea butternut trees (*Vitellaria paradoxa*) and jujube (*Ziziphus* spp.) were also managed in these parklands. *Lannea microcarpa*, the African grape, would have grown as vines on these trees or even within settlements on outside walls or fences. Such fruits would have been a seasonal supplement to diet, providing variety, micronutrients (like vitamins), and handy snacks.

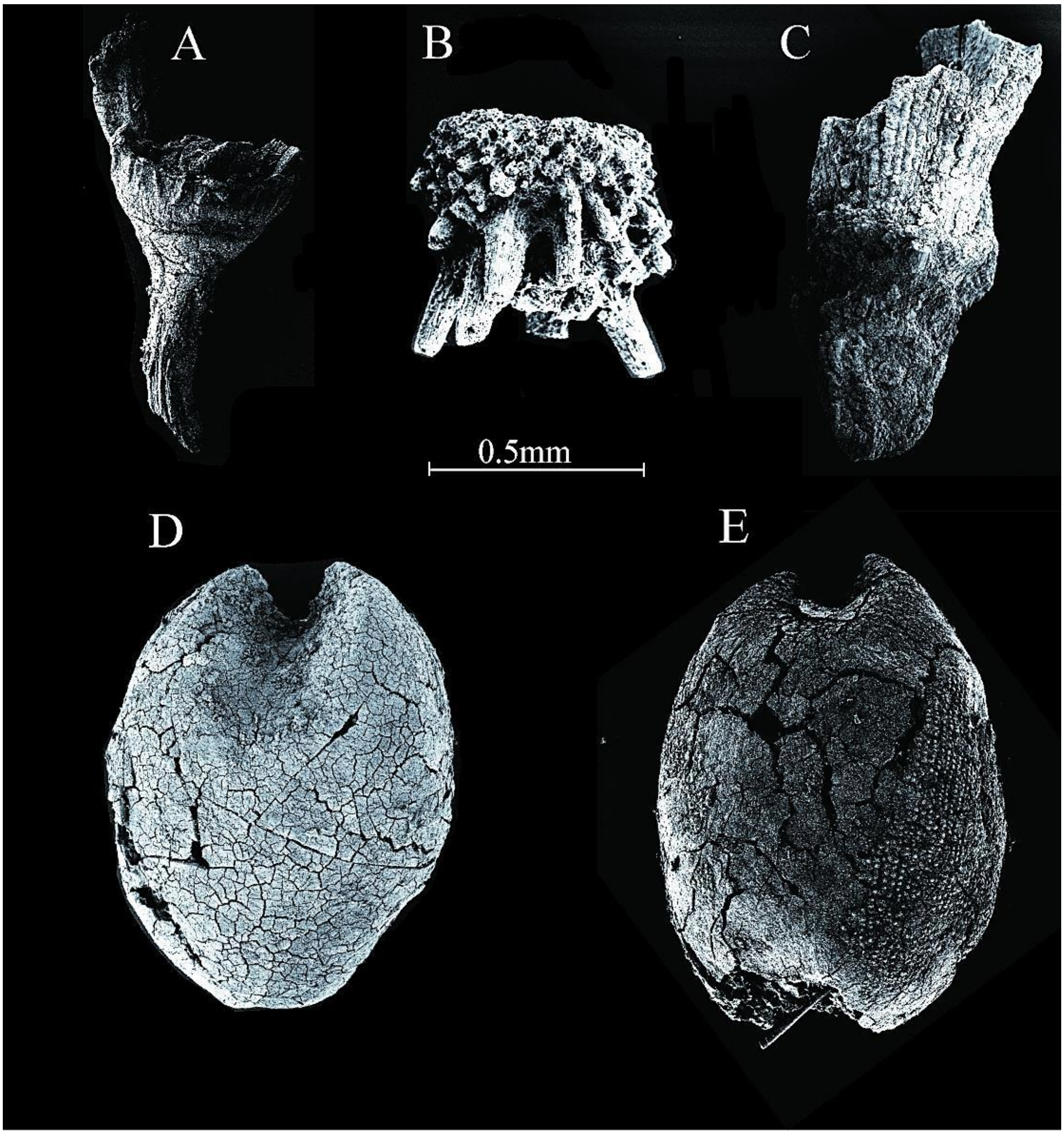


Figure 6.13 SEM of Plant remains from Sadia. (A) *Sorghum bicolor* spikelet base with torn rachilla, AB 38 St 60. (B) *Pennisetum glaucum* involucres apex with bristles, AB 11St26. (C) *Oryza glaberrima* spikelet base, AB 11St26. (D) *Digitaria exilis* grain Embryo face, AB 4 St4. (E) *Digitaria exilis* grain Hilum face, AB 4St4

Changes through time

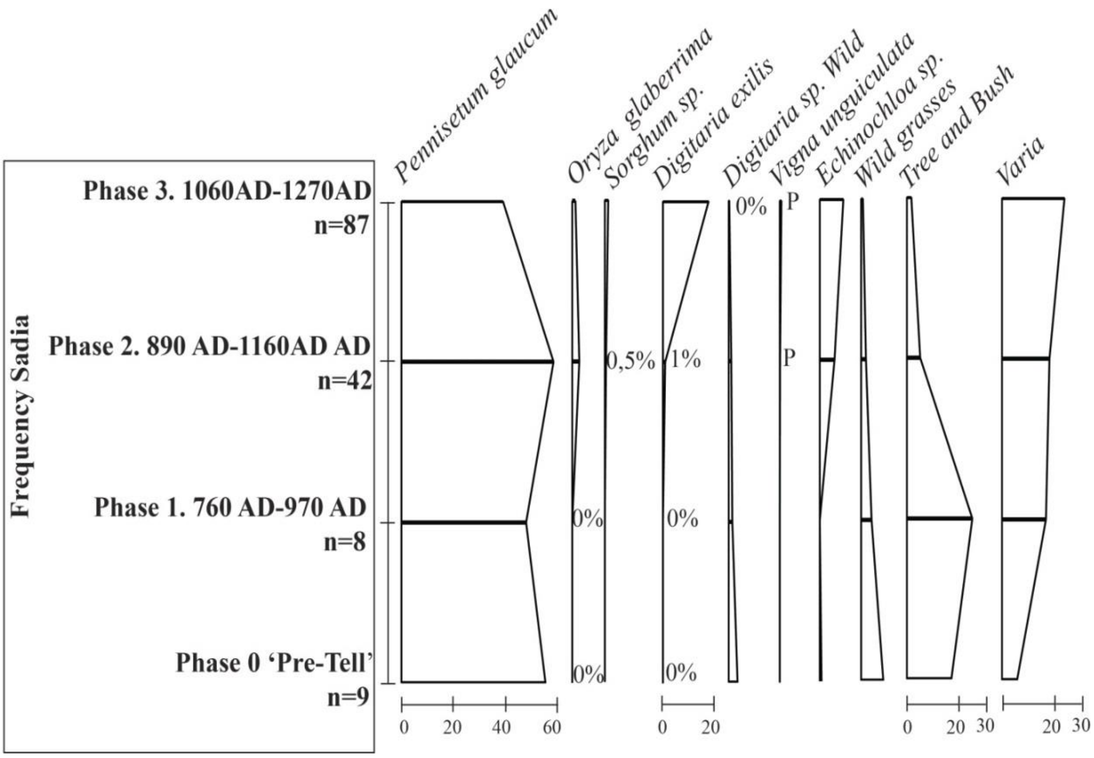


Figure 6.14 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data at Sadia. 146 archaeobotanical samples composed the data set study here. n being the number of sample by phase.

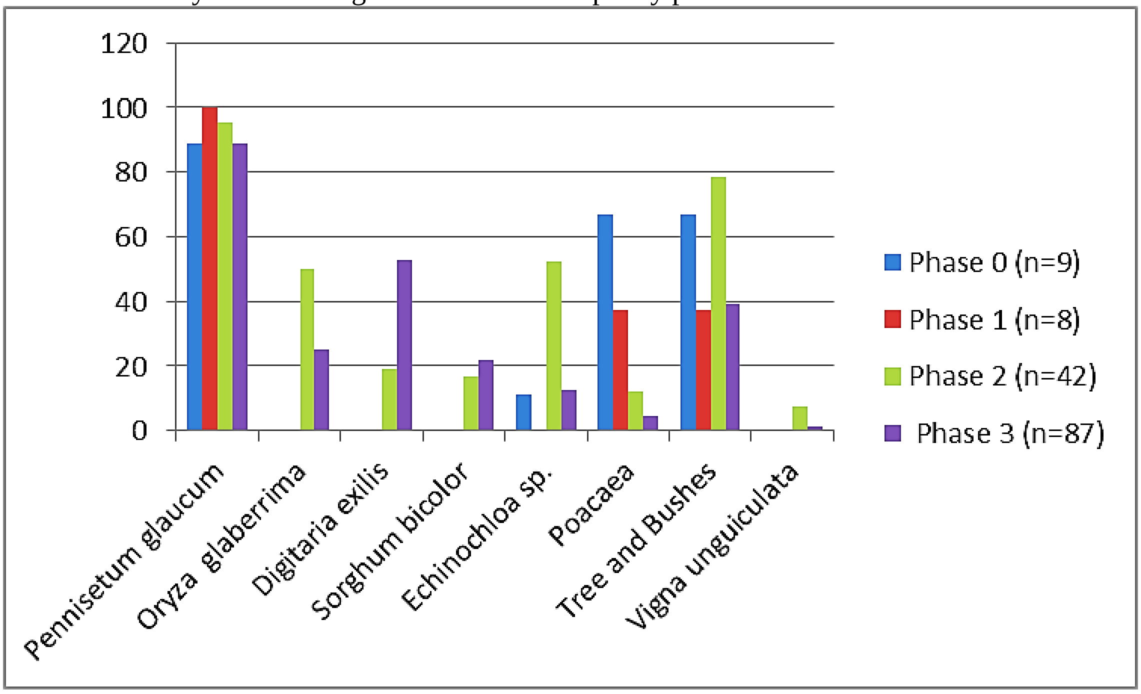


Figure 6.15 **Ubiquity** (% samples as a total of all samples by phase in which each taxon is present) for major crops at Sadia

The 143 samples discussed here have provided plant remains from four archaeological phases dating from the early 1st millennium AD to the early 2nd millennium AD. The four phases were built following three Bayesian models from a set of 27 radiocarbon dates (see Huysecom et al. 2012, 2015). Archaeobotanical results are summarized by time period in figure 4.

Phase 0. 'Pre-Tell phase'. Before 1st - 3rd century cal. AD

The yellow sandy layer of phase 0 was dated from a single radiocarbon date (1895±35 BP, ETH-40328). This phase is an older occupation episode than the mound formation of the tell site (phase I). Phase 0 is represented by nine archaeobotanical samples, totalling 111 litres of sediment from mound I. As expected, pearl millet (*Pennisetum glaucum*) dominates identified remains, 56% for 162 remains of grain and involucres (Table 1, figure 6 and 7). *Hibiscus cf. sababdariffa*, the only other cultivated plant of the phase 0, is present with 5 seeds (≈ 2% of the assemblage). *Hibiscus* flowers are often used as a tea like beverage calls "Carcadet" or "Bissap" but the seeds and leaves are also used in cuisine for sauces (Burkill 1997). *H. sabdariffa* is certainly native to the African savannahs, but little is known of its origins as a cultivar, although Fuller and Hildebrand (2013) suggested it might have originated in the Sudan region. Interestingly there are no evidences of other cereals, either sorghum or fonio. Moreover, remains of weeds and gathered seeds (wild seeds) are well represented by around 7% in addition to 9% of wild grasses (*Gramineae*). The category 'Weeds and Gathered' is dominated by *Digitaria* sp. Seeds (elongated wild-type form), which could be a wild gathered precursor to fonio, and by button weeds, *Borreria* sp. One wild African rice spikelet base, *Oryza barthii* type, was found. With 17%, trees and shrubs are also present and most of the taxa; Marula tree (4%), baobab (4%), tamarind (≈ 1%), jujube (≈2%), Shea butter nut tree (≈ 3%) and black plum (1%) (Table 1, figure 6 and 7). Those trees are often found in cultivated fields to provide shadows, manure and fruits.

The presence of *Prosopis africana* type, *Terminalia* and *Vitellaria paradoxa* (Shea nut tree) from the wood charcoal analysis corroborates that this phase is characterised by a savannah area with open areas of pearl millet fields in which the presence of fallow is inferred from the presence of *Terminalia* sp. that readily grow in old fallow. *Prosopis* sp. are characteristic of a savannah with limited agricultural influence (Huysecom et al. 2012, 2015).

Phase 1. 760 – 970 cal. AD

For the foundation phase of Sadia only eight archaeobotanical samples, of 86 litres of sediment, have been acquired. The assemblage is composed of around 50% of pearl millet (Table 1, figure 6 and 7). A decrease of 'weeds and gathered' are visible, from 7% in phase 0 (with a ubiquity of 78%) these drop to less than 3%, with a presence in less than half of the samples in this phase. Only elongated wild *Digitaria* sp. and carpetweeds (*Trianthema* sp.) seeds are present. The trees and bushes, 26%, are largely dominated by the baobab remains with 17% of the total frequency and 87 seeds. This rise in frequency could be explained by the presence of 69 large baobab seeds in only one of the samples.

Wood charcoal seems to indicate an extension of the cultivation area with the rise of Shea nut tree and decrease of *Prosopis africana* (Huysecom et al. 2012, 2015).

Phase 2. 890 - 1160 cal. AD

This period represents the expansion of the tell site. In this phase, the archaeobotanical results come from 42 samples; 23 from mound I, 12 samples from mound II and seven from mound III comprising a total of 662 litres of soil. Once more, pearl millet dominates the dataset with 60% (total phase 2 frequency) and 2443 remains (1015 grains and 1428 involucres). However, with the emergence of new staple crops and pulses, expansion of the site seems to be based on a much more diversified agricultural practice. Indeed, African rice (≈3%), sorghum (<1%), and broad-seeded *Digitaria (Digitaria* cf. *exilis*), identified as domesticated fonio (≈1%) and the pulse cowpea (<1%) all appear in the assemblage during this phase. In addition, seeds of *Echinochloa sp.* also occur in a high numbers, around 6% of the total phase 2 frequency with 237 seeds (Table 1, figure 6 and 7). Due to the quantity and size of the seeds, it seems probable that they represent a gathered or even cultivated cereal.

In this same era, wild *Echinochloa* was one of the staple grains far to the north at Essouk (Nixon et al 2011), it was also found at Jenné-jeno, and as discussed above this is often a utilized grain throughout the broad West African and Sahelian regions (e.g. Harlan 1989). Thus we interpret this period as one in which demand for increased grain production was met by some expansion of agriculture into marginal soils with low labour investment through the cultivation of "catch crops" of fonio, together with gathering of wild grain from open savannah grassland and fallows (i.e. *Echinochloa*). It is possible that other weedy grasses occurred either as weeds in fonio fields or part of wild grain gathering (i.e. narrow-grained *Digitaria* sp., *Paspalum* sp), although their presence as weedy contaminants of rice cannot be ruled out.

It is also noticeable that in this period the weeds from the assemblage are all plausible rice weeds, such as *Commelina cf. benghalensis* (≈1%), *Oryza barthii* (<1%), *Trianthema sp.* (<1%), *Borreria sp.* (<1%), and *Eleusine indica* (<1%). As already noted *Digitaria sp.* (1%) and *Paspalum sp.* (<1%) could be present as rice weeds or as gathered volunteer grains in harvests of fonio or wild *Echinochloa* gathering. Thus in total 3.5% of the phase assemblage is characteristic of weeds that usually grown in association with rainfed, or less wet rice (Table 1, figure 6 and 7). Assuming that rainfall locally was insufficient to support rice cultivation locally, then rice would have been imported from some place better watered such as the Inland Delta, and these weeds would then be the result of removal of contaminants during final stages of crop processing, in particular dehusking, final winnowing and hand-picking.

The presence of trees and shrubs dramatically decreased to only 5% with a high proportion of Marula nuts (around 3%). This dwindling coincided with a diminution of the useful tree species (*Vitex sp.*, *Vitellaria sp.*) present in the wood charcoals (Huysecom et al 2012; 2015). Also, the rise of old and young fallow species in the charcoals would indicate that the total land area under cultivation increased at this time, with more field area devoted to agriculture some left uncultivated long fallow, allowing for increased regeneration (*Detarium microcarpa*, *Pterocarpus erinaceus*, *Terminalia* etc.), and other areas with short fallow periods (*Guiera senegalesis*) (Eichhorn in Huysecom et al. 2012 and 2015).

Phase 3. 1060 1270 cal. AD

This phase is the end of the expansion and ends with the eventual abandonment of Sadia. The third phase is well represented with a total of 87 samples from 1317 litres of soil. This final phase has been sampled in two different ways: 22 samples were extracted during the 2010 excavation in the mound I (n=2), II (n=14) and III (n=6) and 65 samples from the horizontal excavation in 2011. These 65 samples were distributed across the excavations and therefore also allow for analysis of potential spatial patterning (see below and figure 8).

With nearly one thousand grains representing 18% of all plant remains, spread across 53% of the samples, fonio (*D. exilis*) represents an important crop during this period and a major increase over that seen in previous periods. Pearl millet remains still form the dominant taxon, but fall from 60% frequency, as seen in Phase 2 (2443 remains in 95 % of the samples), to less than 40% frequency (2064 remains in 88% of the samples) in Phase 3. A reduction is seen across most of the assemblage in favour of fonio. The presence of *Echinochloa* also drops up to more than 9% of the total phase and sorghum as well (<2% of the phase frequency). African rice also declines from 3% to 1%. Trees and bushes keep decreasing to less than 2% with the presence of very few fruits of Marula, baobab, or jujube (less than 100 fruit fragments in total) (Table 1, figure 6 and 7). This suggests a possible reduction in woodland cover and increasing cultivation of more marginal soils with fonio. Assuming *Echinochloa* was gathered from wild grassland stands, its decrease could also result from an increase in fonio cultivation. Keeping in mind that the yields of fonio are perhaps only half or less than equivalent areas of pearl miller cultivation, drives towards more caloric staple production through fonio would have required ever more land area.

The long-term trend identified in this site indicates both the diversification of crops but also the expansion of agriculture, with the bringing of more land under cultivation, with probably some reduction in the length of fallow, and the removal or thinning of existing woodland. While local production was probably augmented with the importation of rice reflected in the total quantity of rice, wild resources were important. In the Second Phase (the apogee of the site), wild gathering of “kerb” grasses, especially *Echinochloa* became a prominent part of the subsistence economy such as at Essouk (e.g. Nixon 2011).

Spatial distribution of plant remains in Phase 3

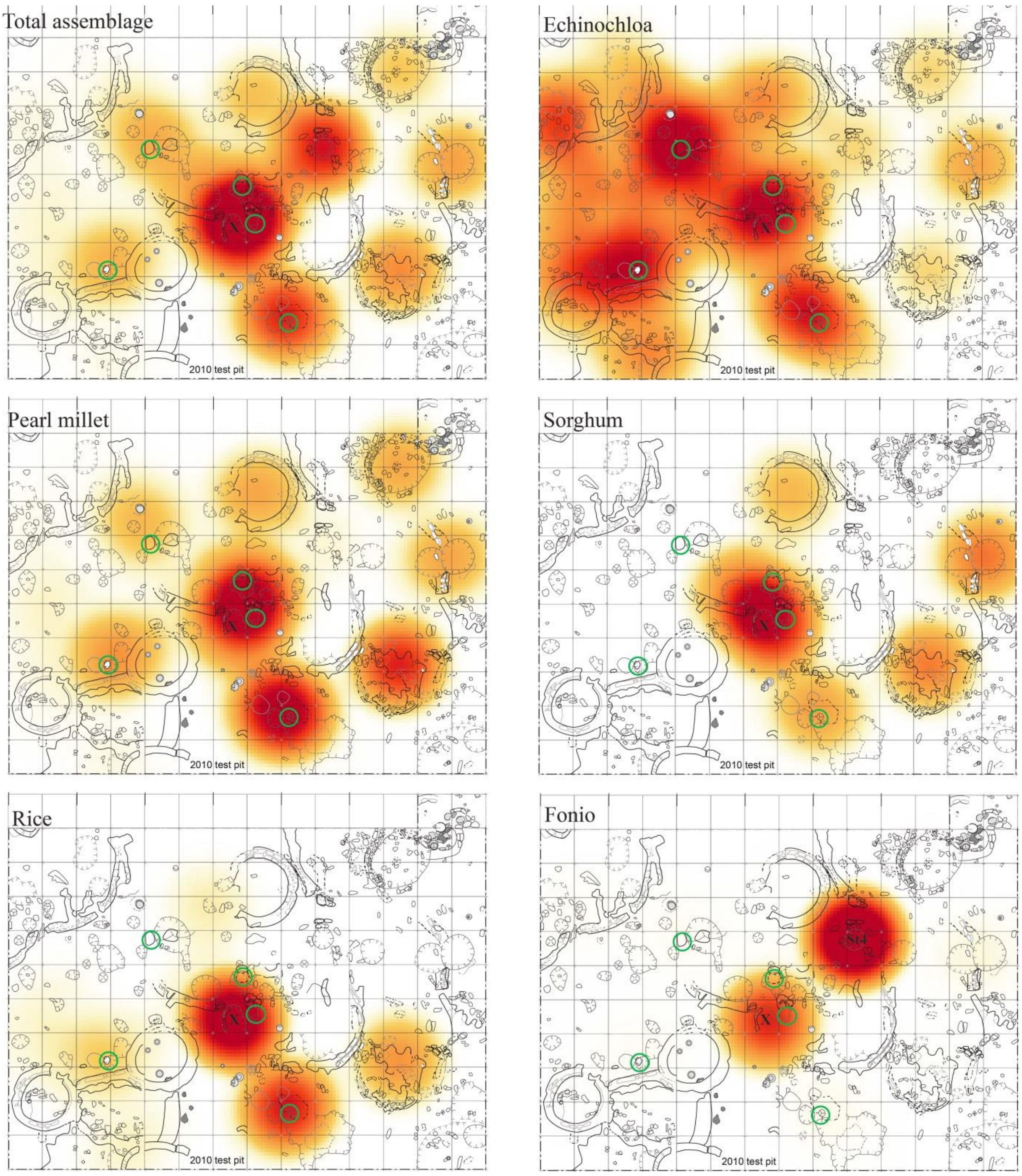


Figure 6.16 Spatial distribution of the density or 5 mains cash crops at Sadia. The Green circles represent the hearths and the X is the special features (St 26) identified as hearth midden.

In 2011, archaeologists excavated an extensive horizontal surface of 143m². They found evidence for numerous architectural features with around 100 identified structures. All of the features uncovered within this excavation belong to the same occupation period from Phase 3 (AD1060 to 1270). During this phase of excavation an archaeobotanical team headed by Stephany Kahlheber took soil samples from almost every structure, excluding walls remains. Thus, around 3000 plants remains were extracted from 65 archaeobotanical samples, totalling 901 litres of soil.

This offers some potential insight into intra-site spatial patterns that could relate to activity areas or to social differences in food use/access across the site (Figure 8). This kind of analysis, however, is made difficult by the fact that preserved plant remains require charring for preservation. Thus food processing, crop-processing and other activities, if waste is simply left *in situ*, will not be readily visible due to decomposition, unless the building has burned down. Instead it must be recognized that the waste of food plant use activities must have been gathered up and disposed of fires after which some of this material survived charring and got redeposited nearby (cf. Fuller et al. 2014)

The separate analysis of the five hearths (green circles in Figure 8) indicate similar proportions of the main crop remains as in the other samples. The exceptions are *Echinochloa* sp. remains that are spread everywhere on the surface and are not present inside the hearths and fonio, *Digitaria exilis*, that is mostly present in the structure 4, a pit that exclusively contained charred fonio grain, 380 grains of the 968 grain from the total assemblage and representing 40% of the total fonio remains, and in structure 26 (X in Figure 8). The structure 26 has been described as a pit filled with a succession of dense ashy layers and carbonized wood and grain layers. It is potentially a pit that contains refuse of the two hearths close by. This ensemble of structures, two hearths, refuse pit and burnt clay brick, is full of domestic remains (mainly animal bones) and eventually could be a kitchen area. The density and varieties of charred plant remains seem to confirm that function.

In this case we assume that remains were not massively translocated, but disposed of into fires closest to where crop-related activities took place, and then deposited after hearth cleaning into nearby rubbish dumps that became settlement fill layers. Thus precise activity areas will be blurred, but broader patterns that might differentiate tendencies of difference between houses or areas of the settlement may be visible.

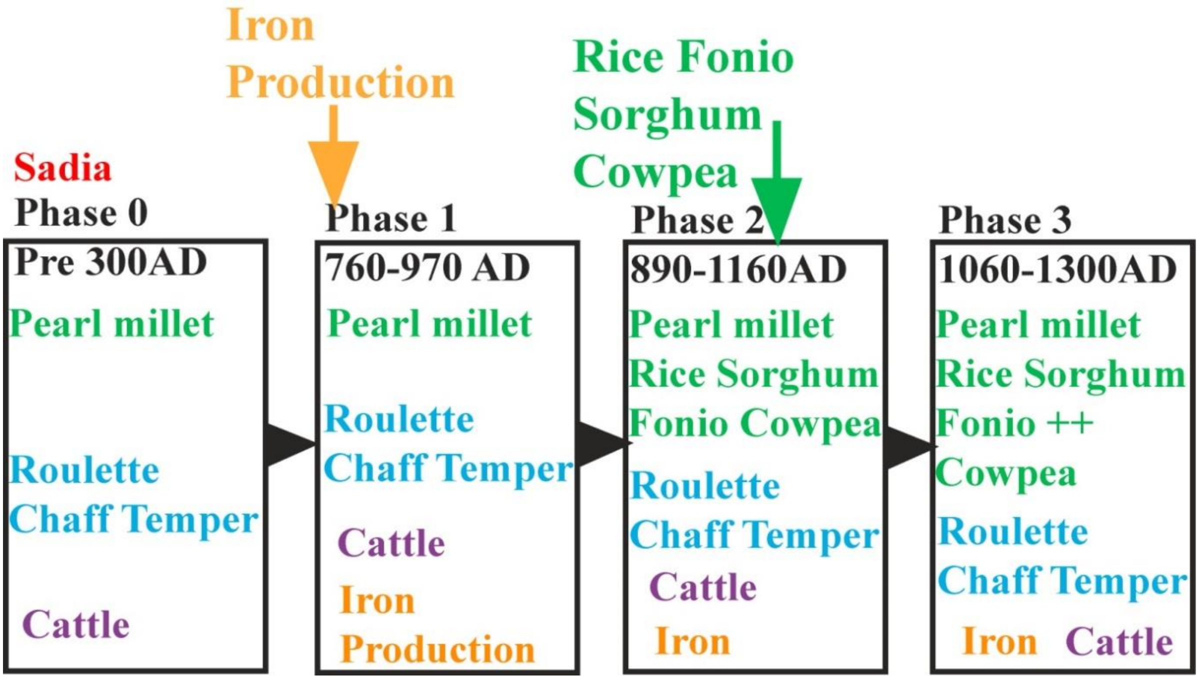


Figure 6.17 Summary of Sadia archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green), technology (in orange) and animal remains (in purple).

Conclusion

The archaeobotanical sequence at Sadia reveals the expected long-term dominance of pearl millet as a local staple crop in a landscape that resembles a managed parkland with many useful trees producing edible fruits. Diversification is seen with the adoption of sorghum and fonio, and likely grain importation in the form of rice. In addition, evidence suggests some use of wild gathered savanna grains, a traditional component of subsistence found widely through the Saharan and sub-Saharan region. However, evidence for grain crop diversification over time may correspond with increasing use of land for field crops and decreasing persistence of useful savannah trees.

Discussion on Mali Sites

This study presented six sites with new original data from Mali. At the opposite with the Beninese sites (next section), the Malian sites are not located in the same area and by consequence it is not possible to develop and discuss a regional pattern. When it was possible, it was already develop within the site section.

However some general remark can be address.
Indeed, agriculture in Mali seems to have had two main consecutive origins and developed separately by the 400 BC -300 AD hiatus. The first one, based on pearl millet cultivation dating from 1900-1600 BC until 800-400 BC came from the Tilemsi Valley and shared the same roulette decoration and chaff tempered pottery association package as at Windé Koroji. As in many West African sites, this first wave was followed by a hiatus. The second wave coincided with the arrival of iron production knowledge (i.e Robion 2008), renewed pearl millet cultivation and development of village networks connected to important proto-urban trade centers (Tongo Maaré Diabal, Jenné-Jeno, Dia). This might be related to a wave of diffusion from Southeast Mauretania associated with the Late Tichitt tradition. As in the neighbouring Inland Niger Delta, this wave has diversified into a complex agricultural system that included several domesticated crops (rice, sorghum, fonio and cowpea). The use of marginal and poor soils is suggested by the presence of fonio (*Digitaria exilis*) within the archaeological record (Togu Missiri, Sorotomo and Sadia, which may represent agricultural diversification and extensification within the drier areas of West Africa. Also, as at other West African sites (see Chapter 7), sorghum remains are present in low frequency but represent a steady, stable component through the sites' occupation.

And lastly, archaeobotanical result from Tongo Maaré Diabal showed its populations were exclusively pearl millet cultivators. Around 80% to 90% of the plant remains consisted of pearl millet. Thus the people at TMD, comprised of chaff tempering potters, metallurgists and cultivators, appear to only have cultivated pearl millet, even though the local environment was suitable for rice, sorghum and/or fonio cultivation. Such suitability is seen today in the Dogon country (Chapter 5), and in the recent past at the site of Sadia, where fonio, African rice, Echinochloa and sorghum are grown in a very similar, potentially even dryer, geographical/ecological conditions as Tongo Maaré

Diabal. The same patterns are observable in North Benin (cf 6.2). Indeed, two excavation sites identified as blacksmiths settlements exhibit similar archaeobotanical assemblages comprising of around 80-85% pearl millet. This common connection between supra-regional iron working and pearl millet cultivation relates to the Late Stone Age connection between supra-regional distribution of chaff tempered pottery and pearl millet focused cultivation.

6.2 Results from Benin

The 12 archaeological sites excavated for the "Crossroad of Empires" project are predominantly located in the higher reaches of the Niger River Valley but still lie relatively close to the floodplain (see Chapter 3). All 12 sampled sites represented past settlements. The two oldest sites, Alibori SIII and the earliest phase of Kozoungou, are associated with Neolithic remains (i.e. micro-lithic technologies associated with ceramics, and no metal), dating from 2200–400 BC.

Six sites (Birnin Lafiya, Tintin, Kouboukoukourou, Kantoro, Madekali Road and Pekinga) relate to two subsequent time periods, dating from the first century to the 14th century AD. All six sites are small tells (settlement mounds) generally associated with potsherd pavements. During the same period, Kantoro and Pekinga are also both associated with iron production areas (Furnaces, slag mounds and smithing areas).

The remaining sites (Kozoungou late phase, Bogobogo, Gourouberi, Madekali, Kargi) date to the fourth period, the last part of the second millennium AD, and were excavated as the precursors of current villages, as identified through oral history. Selected charcoal and seeds were submitted for AMS-radiocarbon dating to help establish a chronology.

Most of the excavated contexts are midden fill deposits, but two of the largest sites also produced contexts within domestic structures. The site of Birnin Lafiya, which, in light of its large area (up to 26-30 hectares) and the quantity and quality of artefacts found on its surface, is central to understanding urbanization in this region. Excavations revealed a portion of a house, a circular room paved with potsherds, dating to the 11th–13th century AD (Haour et al. 2016). The site of Tintin is also a settlement mound with evidence for houses, with seven separate potsherd pavements excavated (Champion and Haour 2013). Also, two test pits at Kantoro were excavated through a midden deposit composed of domestic refuse, comprising ceramics and animal bones in large quantity, along with iron production remains (ashes, smithing waste and smelting slag).Also, the site of Pekinga present the same characteristic than Kantoro.

In a first part, the results are briefly presented by site. It is then followed by discussion by plants. Lastly a more detailed interpretation of the sequence comprising all the sites is presented.

6.2.1 Pekinga (1000-1450 AD)

The site of Pekinga, an iron production site (smelting and smithing), is largely dominated in frequency by pearl millet remains (66%) present in 100% of the samples. Pearl millet chaff represents 36% of the remains. Sorghum represented 5% of the assemblage which is completed by 7% of Baobab (tree/bush) fruit remains (Table 6-7).

Table 6-7 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Pekinga**. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Pekinga	
Date AD	**1000-1450**
# samples (volume)	**6 (89)**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	24+66=90 66% (100%)
involucre proportion	36%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+8=8 6% (33%)
Chaff proportion	0%
***Tree/bush* (fruit)**	11 8% (50%)
Total Number	136
Density (items/litre)	1.5

6.2.2 Tintin (1000-1450 AD)

Tintin is a deep stratified settlement site dominated by cultivated crop remains (**Erreur ! Source du renvoi introuvable.**): pearl millet (48%), fonio (32 %), African ice (16%) and sorghum (4%). Chaff remains are also found in various proportions depending of the crops: pearl millet chaff proportion is 33% and more noticeable the rice chaff proportion is 99%. Indeed three grains fragments where discovered for 476 spikelets base. A cotton cap and grain (one of each) were also found. The tree and bush remains are composed of fruits of baobab, and palm oil nut (*Canarium shweinfurthii* and *Elais guineensis* Figure 6.19 G &H). The presence of the two trees which only grow 350 km south of the site today strongly suggests evidence of trade.

Table 6-8 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Tintin Kanza** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Tintin 1000-1450**
# samples (volume)	12 (198)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	391+618=**1009** 48% (100%)
involucre proportion	33%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	476+3=**479** 16% (100%)
Spikelets base proportion	99%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	8+106=**114** 4% (66%)
Chaff proportion	7%
Digitaria exilis	961 32% (83%)
***Gossypium* sp.**	2 <1% (16%)
Weeds and/or wild gathered plants	220 10% (100%)
***Tree/bush* (fruit)**	104 5% (100%)
Total Number	3033
Density (items/litre)	15.3

6.2.3 Alibori (800-400 BC)

The site of Alibori comprises several smaller sites currently known in the Dendi area associated with Neolithic assemblages (micro-lithic and ceramic) dated to 800-400 BC. Each site probably represents a seasonal camp site. As with many West African sites (see Chapter 7) from this period, the archaeobotanical assemblage (Table 6-9) is mainly composed of indeterminate wild seeds (64%; usually smaller than 1 mm), fruit remains (20%) and the earliest cultivated crops comprising pearl millet, sorghum and cowpea. Cowpea remains are usually associated with pearl millet as they are often cultivated together intercropped. The sorghum present here represents the earliest evidence of sorghum, so far recorded in West Africa (cf. Fuller and Stevens 2018). The fruit remains (20%) were too fragmented to identify them to species, as such it was not possible to establish any occupational pattern as done for Windé Koroji.

Table 6-9 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Alibori** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date BC	**Alibori 800-400**
# samples (volume)	5 (120)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	1+20=21 8% (100%)
involucre proportion	4%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+15=15 5.6% (40%)
Chaff proportion	0%
Poaceae	101 37% (100%)
Vigna unguiculata	7 2.5% (20%)
***Tree/bush* (fruit)**	53 20% (100%)
Total Number	266
Density (items/litre)	2.21

6.2.4 Birnin Lafiya (300-1450 AD)

The site of Birnin Lafiya is one of the larger (up to 35 hectares) settlement sites of the Niger River Basin. With 77 samples it forms the main corpus of Dendi archaeobotanical sequence. The first site phase (300-900 AD) is largely dominated in frequency by African rice remains (55%, Table 6-10). As Birnin Lafiya' earliest phased samples composed the Phase 2 of the Dendi archaeobotanical assemblage, its description follows below (Section 6.2.7 for regional pattern, Figure 6.20 Figure 6.21). During the second phase of the site (900-1450 AD, pearl millet (from 13.5% to 16%), cowpea (0.5% to 9%) and fonio (from 7% to 22%) are present in higher quantities than seen the earliest phase, while rice and sorghum remains decreased within this second phase, from 55% to 15% and from 12.5% to 5% respectively.

Table 6-10 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Birnin Lafiya** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Birnin Lafiya		
Date AD	**Phase 2 300-900**	**Phase 3 900-1450**	**Total**
# samples (volume)	**41 (615)**	**36 (827)**	**77 (1442)**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	804+739=1543 13.5% (85%)	99+378=597 16% (92%)	903+1117=2140 14% (88%)
involucre proportion	52%	17%	42%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	6145+143=6288 55% (98%)	517+25=542 15% (53%)	6662+168=6830 45% (78%)
Spikelets base proportion	98%	96%	97%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	1035+390=1425 12.5% (54%)	91+80=171 5% (30%)	1115+470=1596 11% (38%)
Chaff proportion	72%	53%	70%
Digitaria exilis	812 7% (61%)	799 22% (53%)	1611 11% (60%)
Gossypium sp.	3 <1% (5%)	-	3 <1% (3%)
***Tree/bush* (fruit)**	229 2% (100%)	734 20% (100%)	963 6% (100%)
Vigna sp.	39 <1% (10%)	320 9% (20%)	359 3% (14%)
Total Number	11448	3671	15119
Density (items/litre)	18.6	4.5	10.5

6.2.5 Kozungu (1200-1000 BC & 1450-1600AD)

The first phase, 1200-1000 BC of Kozungu is represented by only one sample comprising 10 unidentified wild seeds (Table 6-11). After a 2500 years gap, the site was re-settled and its archaeobotanical assemblage is dominated by baobab fruit (30%) along with pearl millet grains as the only crop represented (30% in frequency for 16 grians). Other plant remains comprise small fruit fragments and indeterminate wild seeds.

Table 6-11 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Kozungu** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Kozungu		
Date	**1200-1000 BC**	**1450-1600 AD**	**Total**
# samples (volume)	1 (30)	3 (75)	4 (105)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	-	0+16=**16** 30% (66%)	0+16=**16**
involucre proportion	-	0%	0%
Poaceae	10 100% (100%)	10 18% (33%)	20 31% (50%)
Adansonia digitata	-	16 30% (100%)	16 25% (75%)
Total Number	10	53	63
Density (items/litre)	0.3	0.7	0.6

6.2.6 Kantoro (1000-1450 AD)

Kantoro is an iron production settlement site (mainly smithing but also smelting) located a few kilometres from Birnin Lafiya and was probably working as iron producer for Birnin Lafiya. As with most of the West African iron production sites, Kantoro' archaeobotanical assemblage (Table 6-12) is largely dominated by pearl millet remains (40%, mainly grains) and fonio grains (16%). Rice and sorghum respectively represent 1.5% and 5% of the frequency. The presence of rice in such low frequency can probably be attributed to trade rather than local cultivation. This can be compared to the general patterns observed in West Africa (see Chapter 7 and 9) where iron producer sites are dominated by pearl millet and rice is largely absent

Table 6-12 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Kantoro** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Kantoro 1000-1450**
# samples (volume)	35 (525)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	11+695=706 40% (100%)
involucre proportion	2%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	30+4=34 1.5% (35%)
Spikelets base proportion	88%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	4+79=83 5% (68%)
Chaff proportion	5%
Digitaria exilis	291 16% (34%)
***Tree/bush* (fruit)**	354 20% (100%)
Vigna unguiculata	4 <1% (3%)
Total Number	1771
Density (items/litre)	3.4

6.2.7 Niyanpangu-bansu (1450-1650 AD)

The archaeobotanical finds from Niyanpangu-bansu comes from three samples of 10 litres of soil each. The site dated to 1450-1650 AD and its mains characteristic is to be associated with textile dyeing pits and large quantities of spindle whorls. 3 archaeobotanical samples for 60 litres of soil composed the data set study here

Table 6-13 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Niyanpangu-bansu** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Niyanpangu-bansu 1450-1650**
# samples (volume)	3 (60)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	13+14=27 22% (100%)
involucre proportion	49%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	8+0=8 7% (100%)
Spikelets base proportion	100%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	3+10=13 10.5% (100%)
Chaff proportion	23%
Digitaria exilis	32 26% (100%)
***Gossypium* sp.**	41 33% (100%)
Weeds and/or wild gathered plants	22 18% (100%)
Total Number	124
Density (items/litre)	2.1

The whole archaeobotanical assemblage is characterized by relatively low density of specimens (2.1 items/litres of soil, on average) with 124 plant remains recovered in total. However, the assemblage features a wide diversity of remains, including Cotton, fonio, pearl millet, sorghum, African rice and others wild grasses. Indeed, the assemblage (Table 6-13) is dominated by 33 % of cotton, *Gossypium* sp., remains. The cultivated crop category is largely represented mainly by Fonio grains remains (26%) but also with pearl millet (21%), Sorghum (10.5%) and African rice (6.5%). Also, each of the 8 rice spikelets bases presented the classical dimpled asymmetric abscission scar of a domesticated plant.

The large presence of cotton associated with the indigo dyeing pit and the large amount of spindle whorls confirm that site's main activities included textile production (cotton spinning, weaving and dyeing). Thus, the site was probably occupied by Mulanche/ Kumate peoples that were the masters of the indigo dyeing pits in the North Benin, techniques which they had brought with them from Mali. Also, in the Dendi area and in Banikoara region (region of Niyanpangu-bansu) , […] *if former dyers say they are not related to Mulanche/Kumate they stress the Malian origin of their ancestors* […]*The link between Traore and indigo dyeing is also mentioned in some dyeing centres in the region of Banikoara, where other family names are also found, including the "Ture" whom Bregand (1998ab) mentions in her list of surnames of Soninke origin that are associated with the Wangara diaspora* (Gosselain and Haour 2018: 303). Moreover the Mulanche/Kumate has a strong alliance, a Cathartique alliance, with the Tyenga (Gosselain and Smolderen 2018). Both Tyenga and Kumate were possibly at the origin of African rice cultivation in the Dendi region. The low frequency of rice remains (6.5 %) found in Niyanpangu-bansu samples may be attributed to trade with Niger River Valley rather than local cultivation. This interpretation would be in keeping with ethnolinguistic associations that separate Mande speakers rice farmers from Mulanche/Kumate cotton growers and weavers.

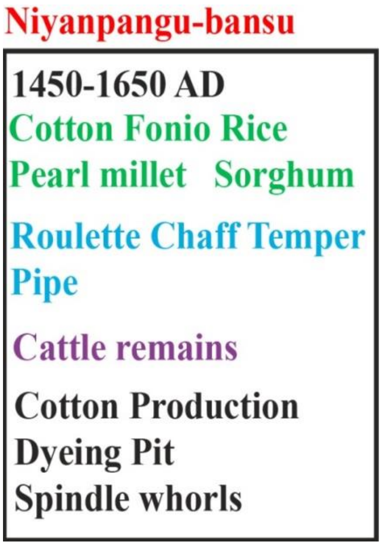


Figure 6.25 Summary of **Niyanpangu-bansu** archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green), and animals remains (in purple).

6.2.8 Bogo-bogo (1600-1950 AD)

The two archaeobotanical samples from Bogo-bogo, both dated to 1600-1950AD, are largely dominated by pearl millet remains (66% in frequency), in this case mainly by chaff (95% of the pearl millet remains). Sorghum remains are also present but in very low frequency (2% for 7 grains). Cash crop is present with remains of cotton but only in low frequency (2%)

Table -6-14 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Bogo-bogo** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Bogo-bogo 1600-1950**
# samples (volume)	2 (10)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	246+13=259 66% (100%)
involucre proportion	95%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+7=7 2% (100%)
Chaff proportion	0%
***Gossypium* sp.**	7 2% (100%)
***Tree/bush* (fruit)**	16 4% (100%)
Total Number	394
Density (items/litre)	39.4

6.2.9 Gorouberi

Gorouberi archaeobotanical assemblage (Table 6-15) is represented by a single sample of 5 litres. It is largely dominated by indetermined small seeds (18 seeds for 74% in frequency). Cotton is the only cultivated crop present with 3 seeds for a frequency of 12.5%.

Table 6-15 Number of items recovered and Frequency for the main crops at **Gorouberi** by phases. First line is the total number of items and second line gives frequency.

Date AD	**Gorouberi 1600-1950**
# samples (volume)	1 (5)
***Gossypium* sp.**	3 12.5%
***Tree/bush* (fruit)**	3 12.5%
Indet. Seeds	18 74%
Total Number	24
Density (items/litre)	4.9

/

6.2.10 Kargui

Two samples (10 litres of soil) were excavated from Kargui. The botanical assemblage is by small (around 0.5mm) indetermined seed (50% in frequency for 85 seeds). Cultivated crops are represented with pearl millet (9 remains, 5%) and sorghum (3 remains, 2%).

Table 6-16 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Kargui** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Kargui** **1600-1950**
# samples (volume)	2 (10)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	4+5=9 5% (100%)
involucre proportion	44%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	1+2=3 2% (100%)
Chaff proportion	33%
***Tree/bush* (fruit)**	11 7%
Indet. Seeds	85 50% (100%)
Total Number	169
Density (items/litre)	16.9

6.2.11 Kouboukoukourou

Only a single sample comes from Kouboukoukourou. The sample (Table 6-17) is dominated with indetermined small seed (50%) and fruit fragments (44.6%) mainly of oil palm nuts. Cultivated crops are noticed but in very low frequency: pearl millet (3 grains, 4%) and sorghum with one single grain (1.4%).

Table 6-17 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Kouboukoukourou** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date AD	**Kouboukoukourou 1600-1950**
# samples (volume)	1 (5)
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	0+3=3 4%
involucre proportion	0
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+1=1 1.4%
Chaff proportion	0
***Tree/bush* (fruit)**	31 44.6%
Indet. Seeds	35 50%
Total Number	70
Density (items/litre)	14

6.2.12 Madekali and Madekali road

Madekali (KLI) and Madekali road (RCI) are two different test-pits excavated in the same village. Madekali road' assemblage (Table 6-18) is dominated (33%) by rice spikelets base (no grains; 47 items). The others cultivated crops are pearl millet (21%), sorghum (1%), fonio (24%) and cowpea (<1%). Madekali (KLI)' assemblage dated from a later period show a different pattern. Rice and fonio totally disappear and cotton is found for the first time (44 remains for 17% of the assemblage). Sorghum and pearl millet are still there but in lower frequency (respectively 8.5% and 8%).

Table 6-18 Number of items recovered, Frequency and (Ubiquity) for the main crops at **Madekali (KLI and RCI)** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

	Madekali (KLI and RCI)		
Date AD	**RCI 1050-1150**	**KLI 1700-1900**	**Total**
# samples (volume)	**1 (5)**	**3 (15)**	**4(20)**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	5+26=31 21% (100%)	21+2=23 8.5% (100%)	26+28=54 13% (100%)
involucre proportion	16%	91%	48%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	47+0=47 33% (100%)	-	47+0=47 11% (25%)
Spikelets base proportion	100%	-	100%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+2=2 1% (100%)	0+22=22 8% (66%)	0+24=24 6% (75%)
Chaff proportion	0%	0%	0%
Digitaria exilis	35 24% (100%)	-	35 9% (25%)
Gossypium sp.	-	44 17% (66%)	44 11% (50%)
***Tree/bush* (fruit)**	21 15% (100%)	56 21% (100%)	78 19% (100%)
Vigna sp.	1 <1% (100%)	-	1 <1% (25%)
Total Number	145	268	413
Density (Items/litres)	29	17.9	20.65

6.2.13 Regional patterns

Over three field seasons (2012–2014) 150 archaeobotanical samples were collected (comprising 2549 litres of sediment from 29 excavation units, across the 12 sites) of which 21458 archaeobotanical charred remains were extracted. Plant remains from these sites are very well preserved and characterized by a high density of charred specimens within floated samples (around 9 items/ litre on average). The total assemblage from the Benin sites comprises a large diversity of remains. This section will describe the assemblage by species and changes over the occupation periods represented by all the sites.

In absolute number and in frequency remains of African rice, *Oryza glaberrima,* dominate the total assemblage. In total, rice represents 7363 remains (grains but mainly spikelets base) for 34% of the total assemblage. However they are only found in two of the four phases and at only four sites. (Phases with rice: Phase 2 – 300-900 AD & Phase 3 – 900-1450 AD) Pearl millet, *Pennisetum glaucum,* is present in every site and phase with 4211 remains (grains and involucres) representing 19% of the total assemblage. Thus, the most common and abundant crop on sites across the whole region and all periods is pearl millet, with African rice coming second. The two other staple crops present in the samples are fonio, *Digitaria exilis* (13% for 2898 grains), and sorghum, *Sorghum bicolor,* (8% for 1848 remains). Some sites also show evidence of baobab (*Adansonia digitata*), oil palm (*Elais guineensis*) and cotton (*Gossypium sp.*), suggesting that the production of condiments and raw material for craft also contributed to the agriculture of urbanisation in this part of West Africa. In contrast, evidence for the presence of cowpea (*Vigna unguiculata*), one of the major pulse crops in west Africa and probably domesticated in the grassy woodlands of Ghana or adjacent states (D'Andrea et al. 2007; Fuller and Hildebrand 2013), seems paradoxically weak.

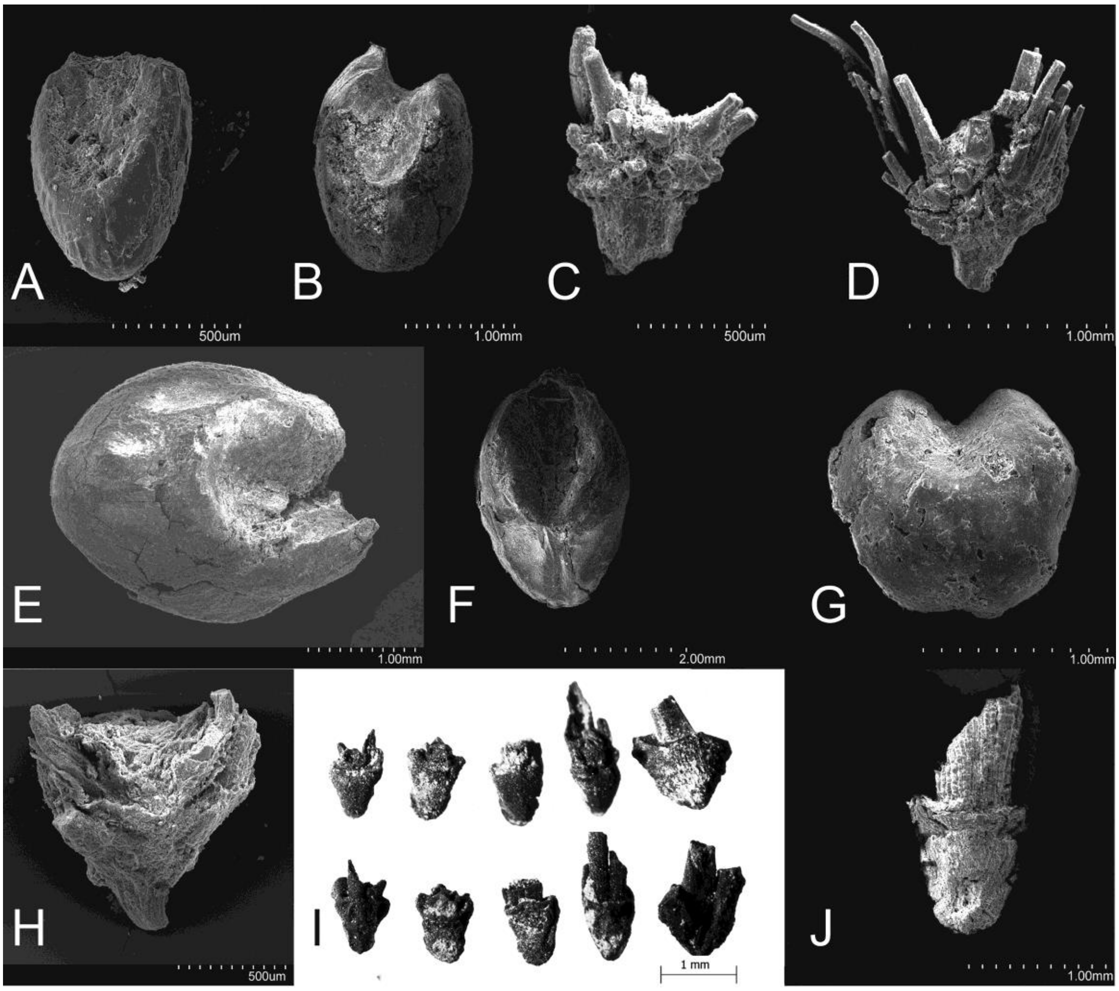


Figure 6.18 Examples of archaeobotanical specimens: (A) *Pennisetum glaucum* grain, from Alibori SIII ALD SIII 30-40cm. (B) *P. glaucum* grain, from Birnin Lafiya BLAF SIX C12 120-130cm. (C) *P. glaucum* involucre base, domesticated type from Birnin Lafiya BLAF SIX C12 120-130 cm. (D) *P. glaucum* involucre base, domesticated type from Birnin Lafiya BLAF SIX C12 120-130 cm. (E) *Sorghum bicolor* grain, probably race bicolor, from Birnin Lafiya BLAF SIX C11. (F) *Sorghum bicolor* grain, probably race bicolor, immature, from Birnin Lafiya BLAF SIX C6 100cm. (G) *Sorghum bicolor* grain, probably race guinea, from Birnin Lafiya BLAF SIX C17 250-260 cm. (H) *Sorghum bicolor* chaff (spikelet base), probably race bicolor, from Birnin Lafiya BLAF SIX C11 (I) Spikelet bases of rice *(Oryza glaberrima*), from Tintin TTK C19 355cm. (J) Spikelet base of rice *(Oryza glaberrima*), from Birnin Lafiya BLAF SXI C17 250-260cm

Pennisetum glaucum – Pearl millet

Within the archaeobotanical assemblage 4211 pearl millet remains were identified; involucre bases and seeds of this taxon represent around 19% of all of the remains identified from the samples studied. On the recognition of these parts of pearl millet see, Klee and Zach 2003; Murray et al 2007; Fuller et al 2007. The seeds represent 72% (3045 seeds) of the millet assemblage for 28% of bristles and involucres bases (1166). Due to their morphological characteristics, the seeds and involucres were very easily determined as pearl millet. The involucre apex gives rise to a dense group of bristles, preserved as stubs; it has attachments that give rise normally to two spikelets/grains as well as a torn pedicel characteristic of domesticated pearl millet (Manning et al 2011). Figure 6.23 indicates that pearl millet is presented in 86% of the samples. Also pearl millet remains were found in every kind of context (domestic, middens, hearths…). The regular presence of pearl millet remains in domestic contexts and the high involucre base numbers suggests that pearl millet was stored as full panicles and was daily threshed when needed. The bristle and involucre bases are usually separated from the grain during the threshing and winnowing steps of the crop processing. The high quantity found in every context and samples suggested that it was processed in close relation with fire thus probably very close to the household compound.

As pearl millet was one of the most important West African crops, a more detail discussion on its utilisation, origin and development are presenting in the next chapter.

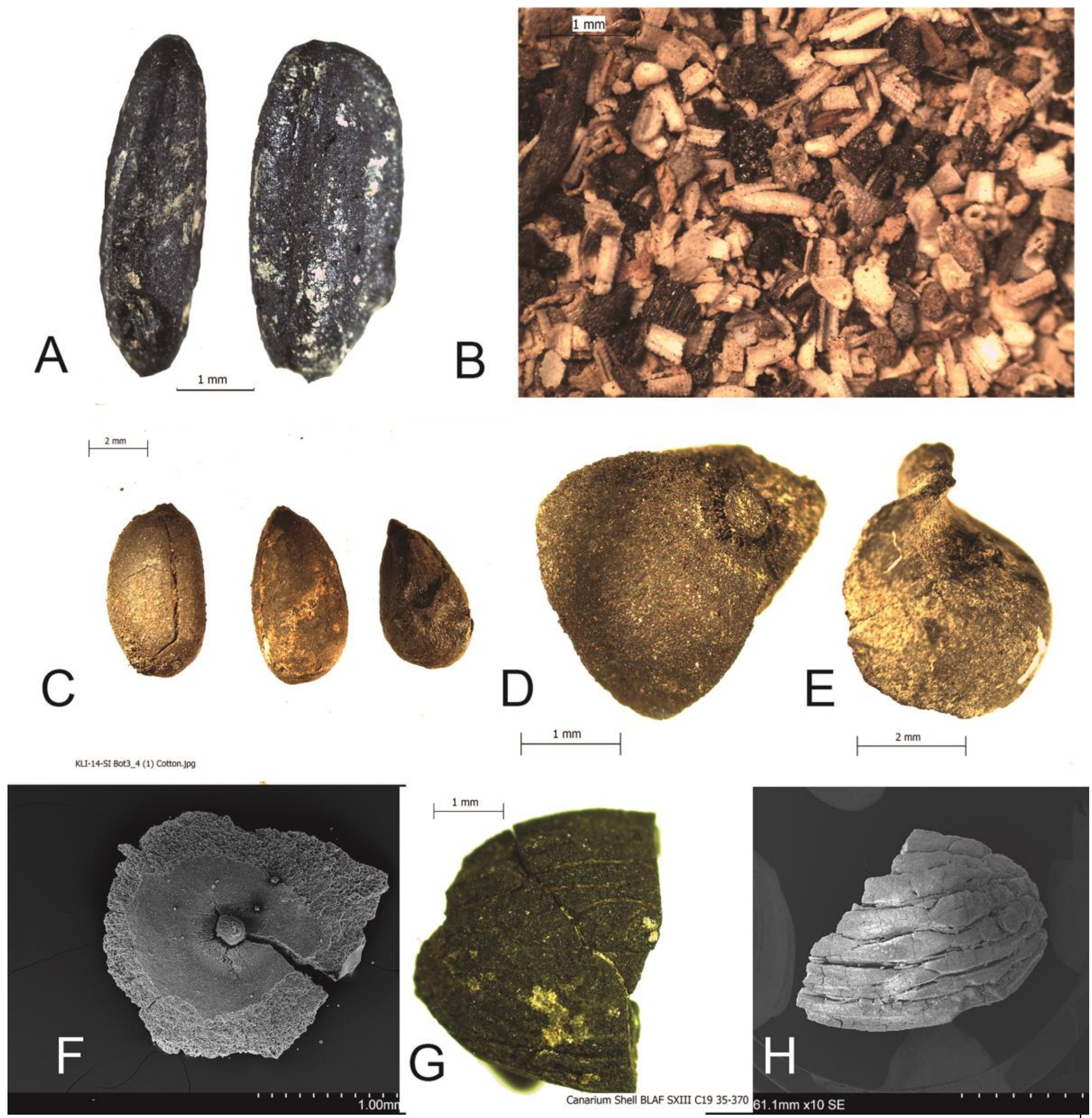


Figure 6.19 Examples of archaeobotanical specimens.
(A) Rice (*Oryza glaberrima*) grain, in dorsal and lateral view, from Birnin Lafiya, BLAFSIV Pit 3 (B) Concentration of silicified (ashed) rice husk fragments from Birnin Lafiya BLAF SIV Veg. 3(C) Seeds of cotton (*Gossypium* sp.), from Madekali KLI-14-SI Bota 3
(D) Seed fragment with hilum of baobab (*Adansonia digitata*) from Madekali KLI-14-RC1 Unit 6(E) Seed fragment with hilum of baobab (*Adansonia digitata*) from Kozungu KOZ-14-SI-80-100cm(F) Cotton seed fragment, funicular cap, from Gourouberi GOB SI 60-70cm
(G) African olive (*Canarium* cf. *schweinfurthii*) nut shell, from Birnin Lafiya BLAF SXIII C19 350-370cm (H) African olive (*Canarium* cf. *schweinfurthii*) nut shell, from Madekali KLI U8

Oryza glaberrima- *African rice*

7363 remains, around 34% of the total assemblage, were found in four sites, Birnin Lafiya, Tintin, Kantoro and Madekali. Spikelet bases (Figure 6.19 I, J) constituted 97% (n=7188) of the rice finds, compared to only 175 grain (i.e. less than 2%). In addition some contexts produced large quantities of rice husk fragments (e.g. Figure 6.20 B), which were not counted individually and therefore are not represented in the quantification. Spikelets base are more common that grains is consistent with archaeobotanical remains of rice from East Asian sites (e.g. Fuller 2000; Fuller and Castillo 2014). All the rice is coming from well dated contexts from 300 Cal AD (Birnin Lafia SIV) to 1200 Cal AD. Currently, three direct radiocarbon dates on rice are available for Birnin Lafiya covering the period from 200 AD to 1200 AD

97% of the rice remains are composed of spikelet base of which the wild and domesticated types can be differentiated based on the morphology of the abscission scar, which is smooth in wild types and torn in domesticated types (see Fuller et al 2009 for examples from Asian rice). Those recovered in the Dendi sites are almost entirely of domesticated type.

Sorghum bicolor

Around 1848 (8% of the total assemblage) sorghum remains, mainly spikelet bases (1126) but also grains (654) were found in the different test-pits excavated (Figure 6.19, F, G, H). Most grains are likely to be the thinner ovate forms from race bicolor, while a few example suggest a plumper free-threshing race, such as race guinea (e.g. Figure 6.19 G), although further work on the systematically separating these types is needed. Chaff remains consisted of basal chaff and rachilla (e.g. Figure 6.19 G) and indicate a domesticated sorghum with a torn rachilla. Such remains likely come from the dehusking waste, probably from race bicolor. Through all the four times periods the representation of sorghum is similar with an average of six percent in every period. It is noticeable that sorghum seeds (around 20) were found in Alibori site (SIII) in levels dated between 800 Cal BC and 500 Cal BC, (2440±30 BP, Cal BC 751-409, Beta-378259 and Beta-378258); these are the earliest evidence for domesticate sorghum in West Africa (Fuller and Stevens 2018).

Vigna unguiculata - *Cowpea*

The number of *Vigna unguiculata* remains found was rather few, although this is expected to have been the primary pulse crop in this region. Indeed only 320 seeds, less than 1.5% of the total assemblage, were found in the “Crossroads of Empires” assemblage. Also, among those 320 seeds, 300 come from two samples taken in a single oven excavation (Blaf-14-SXVIII context 2 and 3). As this is a free-threshing pulse (see Fuller and Harvey 2006), it is likely that processing took place shortly after harvest and may have been offsite, leading to lessened opportunity for preservation. In addition cooking by boiling will also reduce the likelihood of specimens been preserved in recognizable form by charring.

Gossypium sp. – Cotton

Cotton, *Gossypium sp.*, was found in 4 sites and represented only 0.67% of the assemblage (53 seeds, seeds fragments or caps). One of these seeds has been directly dated to the second half of the second millennium AD (OxA-31049:143 ± 27 BP).

Although seeds often fragment during or after charring, one structure on the inside of the seed coat at the hilum end appears to survive well and to be diagnostic (Figure 6.20 F): this is referred as the funicular cap (e.g. Fuller 2008, Fig. 1F; Boivin et al 2014, Fig. 13d).

***Adansonia digitata* –Baobab**

Baobab is represented in the material by 137 seeds, seed coats and fragments (around 2 % of the assemblage). The complete seed is very distinctive as it is a lunate (crescent-shaped) with a circular cross-section. Most often archaeological remains are fragments (Fig 4E). The seed coat has a double layer of palisade cells; on the exterior surface the hilum has a protruding pappus ringed by elongated cells arranged radially (Fig 4D).

Baobab trees are native to Africa, and recent genetic work suggests that they are native to western Africa (Pock Tsy et al 2009). It is therefore inferred that baobab were dispersed to eastern Africa with agro-pastoralists, and in that region archaeological baobab is widely associated with middle Iron Age sites in regions of the Eastern Bantu and near shore Swahili islands (Boivin et al 2013; Crowther et al 2014). The seeds and fruits are both edible and the dried fruit can readily transported, and has been suggested as a key food of mobile pastoralists. At the same time the distinctive and long-lived trees are widely associated with permanent human occupations in the African savannas (Wickens 1982; Baum 1995; Blench 2007). Earlier evidence for this species comes from numerous finds, especially in wood charcoal, from the Neolithic and Iron Age in Burkina Faso (Kahlheber and Neumann 2007).

Undetermined seeds and nuts

Due to absence of reference material for Africa, a significant part of the plant remains have not yet been fully identified, representing 10% of the assemblage of seeds or fragments, and a further 7 % for nutshell fragments. Further work on identification of wild seeds, including likely field weeds, as well as edible fruits/nuts is ongoing.

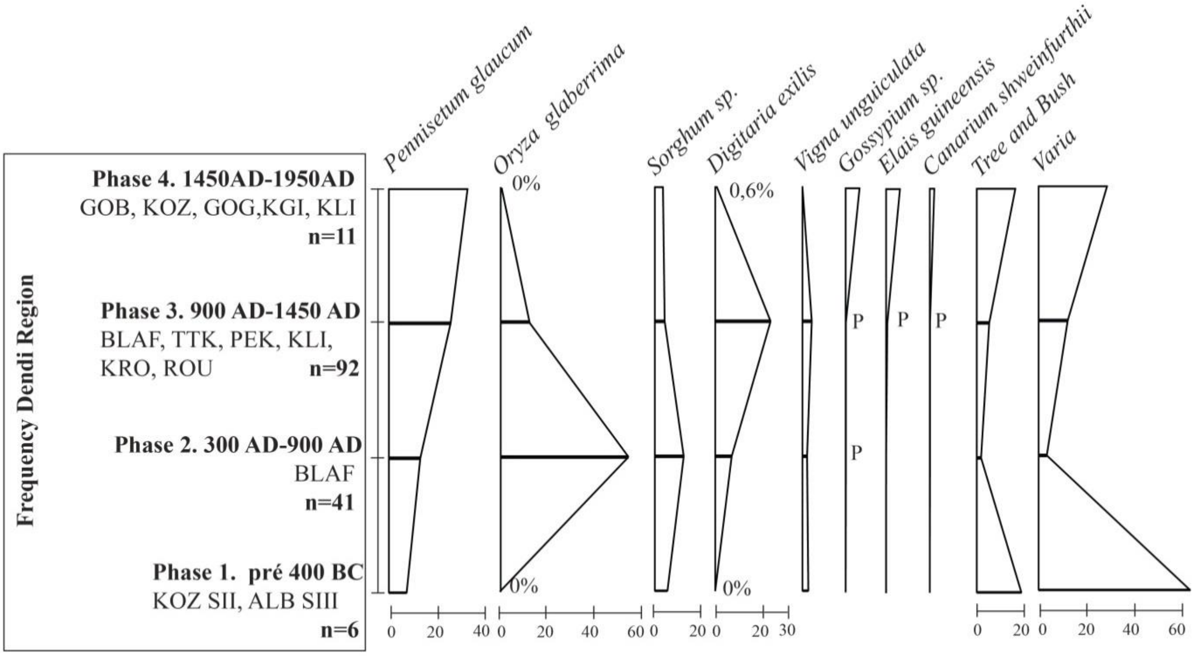


Figure 6.20**Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data in the Dendi Region. 150 archaeobotanical samples for 2549 litres of soil from 12 sites composed the data set study here. n being the number of sample by phase.

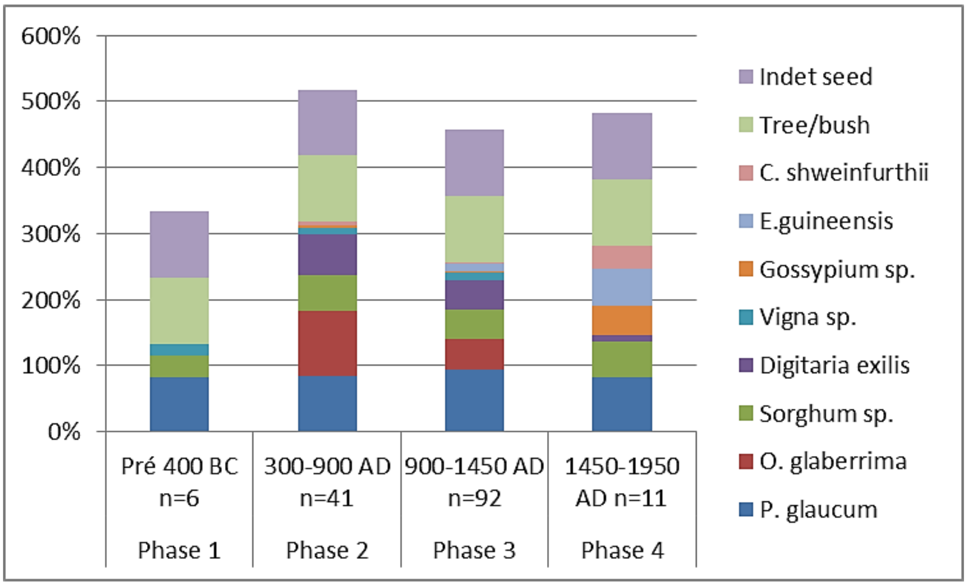


Figure 6.21 **Ubiquity** (% samples as a total of all samples by phase in which each taxon is present) for five major staples crops in the Dendi Region Sites.

Table 6-19 Number of items recovered, Frequency and (Ubiquity) for the main crops in the **Dendi region** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Chaff proportion is the number of chaff (Spikelets, bristles and/or involucres) in comparison with the total number of grains and chaffs within the same species.

Date	**Phase 1** **Pré 400BC**	**Phase 2** **300-900 AD**	**Phase 3** **900-1450 AD**	**Phase 4** **1450-1950 AD**	**Total**
# samples **volume of soil (litres)**	**6** **150**	**41** **615**	**92** **1457**	**11** **115**	**149** **2337**
Pennisetum glaucum Chaff + grain= **Total** Frequency (Ubiquity)	1+20=21 7.6% (83%)	804+739=1543 13.5% (85%)	122+2250=2340 26.5% (95%)	271+36=307 34% (82%)	1198+3013=4211 20% (91%)
involucre proportion	5%	52%	5%	88%	28%
Oryza glaberrima Chaff + grain= **Total** Frequency (Ubiquity)	-	6145+143=6288 55% (98%)	1068+32=1100 13% (45%)	-	7213+175=7388 34% (55%)
Spikelets base proportion	-	98%	97%		97.5%
Sorghum bicolor Chaff + grain= **Total** Frequency (Ubiquity)	0+15=15 5% (33%)	1035+390=1425 12.5% (54%)	82+294=376 4% (45%)	9+23=32 3.5% (55%)	1126+722=1848 9% (54%)
Chaff proportion	0%	72%	22%	28%	61%
Digitaria exilis	-	812 7% (61%)	2086 24% (45%)	6 <1% (9%)	2904 14% (44%)
Vigna unguiculata	7 2.5% (16%)	39 <1% (10%)	320 4% (11%)	-	366 2% (17%)
Gossypium sp.	-	3 <1% (5%)	2 <1% (2%)	54 6% (45%)	59 <1% (10%)
E.guineensis	-	2 <1% (2%)	47 <1% (11%)	52 6% (55%)	101 <1% (16%)
C. shweinfurthii	-	16 <1% (5%)	11 <1% (3%)	16 2% (36%)	45 <1% (10%)
***Tree/bush* (fruit)**	52 19% (100%)	229 2% (100%)	441 5% (100%)	163 18% (100%)	885 4% (100%)
Total Number	276	11448	8826	908	21458
Density (Items/litre)	1.84	18.6	6	7.9	9.2

Changes through time

In the Dendi area sites can be split into four main phases, supported by material cultural and radiocarbon dating evidence (Chapter 3). Patterns in the archaeobotanical evidence are summarized in relation to these periods. Patterns in the occupation of sites with archaeobotanical evidence in the Dendi region and beyond are summarized in Figure 6.22; 6.23 and Tale 6-14.

Phase 1. Prior 400 BC

Period 1 is represented by test pits at Alibori (5 samples) and Kozoungou (one sample, from the earliest layer).Six samples for 150 litres of archaeological matrix from which 270 remains were extracted, that represented a low density of finds, around 1.5 items per litre. The archaeological material associated with this phase, is still under study but contains lithic industry (mainly micro-lithic) and potsherds decorated with roulette impressions and mostly chaff tempered (personal observation). Radiocarbon dates put this period in the calibration plateau (800–400 BC) and plausibly also before this, i.e. 900–800 BC (Haour et al. 2016). As might be expected from previous work in western Africa, with 20 grains and 1 involucre representing 7.6% of the phase assemblage pearl millet dominates the identified remains from these samples, but cowpea (7 seeds) and sorghum (15 grains) are also present. Most of the sorghum grains are too deteriorated to distinguish the guinea or the bicolor forms. However, 50% of the recovered remains are small seeds or seed fragments which due to lack of reference material have not been fully identified but include a range of small-seeded grasses, as well as fragments of probable nutshell that have yet to be identified. Thus, even if the archaeobotanical assemblage is small, it is possible to suggest that people of Alibori period cultivated pearl millet and sorghum alongside harvesting and use of a range of wild grasses, much as Harlan (1989) described extensive ethno-historic use of wild grasses. They were also consuming a variety of fruits (nuts and fragments).

Abandonment (?) Phase: From 400 BC to 300 AD

Between the end of Period I and the beginning of Period II there is a gap of at least 700 years without any archaeological sites in the Dendi area. This gap is characterised by a very dry instable climate (Mayor et al. 2005), and it has been identified as a period of abandonment in Burkina Faso (Breunig and Neumann 2002; Hohn and Neumann 2012).

There is also evidence in southern Cameroun of an opening up of northern parts of the central African rainforest, starting c. 500–300 BC, which has been attributed to increasing seasonality with a more pronounced dry season further south which in turn promoted the expansion of savanna farming systems (Ngomanda et al.2009; Neumann et al. 2012a, 2012b; Kahlheber et al. 2014). It is therefore plausible that abandonments of the early farming sites in Benin correspond to a period of regional environmental change and cultural readjustment (see discussion in following chapters).

Phase 2. From 300 to 900 AD

For this period, archaeobotanical results are derived from 41 samples from 7 excavation units at the urban site of Birnin Lafiya. These contexts probably represent the initial development phase of the settlement of this site.

This period witnessed a higher density of remains (11458 evidences for 827 litres soil, representing 14 items/ litres on average). Moreover, samples from the oven of trench SXVIII show the richest samples of this study. By itself with 4953 items, the oven represents 43% of the phase assemblage, also the context 4 (2 samples) gave 3360 botanical remains for 30 litres of soil (122 items/litre on average).

African rice (*Oryza glaberrima*) dominates the plant assemblage (around 60% of all remains), while sorghum (13%), pearl millet (13%), and cowpea remain present (Figure 6.20). Dry agriculture is completed with the arrival of fonio in the assemblage (7%). The sorghum, pearl millet and rice remains are largely dominated by charred spikelet base, bristle and involucres, the remains of routine on-site dehusking by-products. For the rice, these 5846 spikelet bases are predominantly of the non-shattering morphology of domesticated rice (e.g. Figure 6.20 I). Both baobab (*Adansonia digitata*) and African olive (*Canarium schweinfurthii*) fruits are also present.

It is tempting to attribute part of the success of urbanization to the highly productive cultivation of wet, riverine environments with rice, as well as the use of dry, rainfed areas for millet, sorghum and fonio. This therefore suggests that rice cultivation spread down the Niger River after its earlier establishment in the Inland Delta and around the Niger bend also associated with the rise of the first urban centres in those regions.

Period 3. From 900 Cal AD to 1450 Cal AD

Several sites from the third period have been sampled, and a larger number of samples (n = 47) has been studied from this period. During this period the Dendi area was more densely occupied than in previous periods. Birnin Lafiya seems to reach its largest extent (c. 30 ha) and more intensive occupation (Haour et al. 2016). Other sedentary sites also emerge in this period, including Pekinga, Tintin (c. 1 ha), Kantoro (c. 10 ha), Madekali and Kouboukoukourou. With the exception of Pekinga, all those sites gave evidence of African rice, but in a smaller proportion than during period 2 (around 12%). The site of Pekinga and Kouboukoukourou are totally devoid of any rice remains, and Kantoro had a very weak proportion of rice (1.5% of the site remains for 31 spikelets base). The three sites gave evidence of iron production remains. The presence or rice in Kantoro is probably the result of trade rather than evidence of local cultivation. For the three sites pearl millet remains largely dominated the assemblage (80 to 90%). As at Tongo Mare Diabal in Mali, sites of iron production seem to have been populated exclusively by pearl millet cultivators.

The increase of dry agriculture, represented by the high frequency of pearl millet and fonio and the decrease of wet agriculture (rice and sorghum) coincide with the progressive climatic aridification potentially noticed during this phase. Indeed, Mayor et al. suggested that from 900 AD West African climate turns from an optimum humidity to a significantly drier period by 1400 AD (Mayor et al. 2005) but as presented in Chapter 1 the available climatic data are insufficient to draw any conclusion yet.

Phase 4. From 1450 to 1950 AD

The final period, which includes colonial and premodern times, appears quite different from the others. As in most of West Africa all the previous sites collapsed around 1400 – 1500 AD. From abrupt climate changes to war, invasion (i.e. Songhay) and diseases (i.e. the plague), several reasons are proposed for this sub-continental settlement rupture. However no strong evidence can confirm or refute any of the reasons yet. These questions will be discussed in further detail in chapter interpretation. In the Dendi area, this rupture is marked by the abandonment of the former sites for new sites that formed the base of the current modern village. In term of archaeobotanical remains, 11 samples of 115 litres for 908 plants (8items/l on average) evidences were extracted from five sites (Gorouberi – GOB, Kozoungou – KOZ, Bogo-Bogo – GOG, Madekali – KLI and Kargui – KGI).The results are remarkably different from the previous periods. Indeed, even if pearl millet (34%) is still to be the dominant grain crop of this period, evidence for trees utilization, such as baobab (3%) and oil palm (6%), increase. It is clear than oil palm tree and the Canarium (2%) do not grow naturally in the Sahelian area but are part of the rainforest complex. Surprisingly, the presence of crops such as African rice and fonio decreased dramatically in this period, with rice ultimately disappearing from the assemblages and fonio being barely present with 5 grains. Whether or not this increase in trees represents a shift towards wetter conditions should be considered. As many older sites were abandoned in this period, it is possible there was a degree of reforestation, including more elements from the rainforest complex. However, I favour an alternative socioeconomic explanation, however, that the decrease in grain crops and the increase in tree products represent increasing importance of trade as an element in food supply. In this regard more oleaginous nuts could have been traded from the south. Certainly by this period the slave trade may have impacted labour availability and increased the potential to buy food with money, which would have necessitated less onsite crop-processing and decreased the visibility of grain crop evidence. Another element is the increase of cotton remains, from 1 grain in the previous phase to 54 grains or caps (Figure 6.20 C & F) representing 6% of the phase assemblage. Cotton is a classic cash crop which is labor intensive to process. Production of cotton would have provided a source of wealth also with which to buy cereal grain, perhaps from regions further north, and oleaginous fruits, perhaps from regions to the South.

These abrupt increases (Cotton, Oil palm, tree and shrubs fruits), decreases (fonio) an disappearance (Rice, cowpea), illustrates a great change in the plant utilisation in the Valley. This raises the question of how can we explain the higher presence oleaginous nuts and cotton, which is for craft and trade more than food?

We suggest that this represents increasing importance in crop trade, both food grains and cash crops. Further north, on the Saharan fringes, this was evident somewhat earlier during the high Medieval period of Islamization. For example this was already evident before the end of the first millennium AD at Essouk in north-eastern Mali, with evidence for cotton and imported wheat and sorghum (Nixon et al 2011), as well as wheat and cotton from Dia in the Inland Niger Delta (Murray 2007b). Perhaps after 1400 AD such trade became more important in the Dendi region, with imported food grains less likely to end up charred and preserved archaeologically than locally grown and routine processing of local crops. This would especially be true of imported free-threshing sorghum or pearl millet as food grains. Meanwhile growing of cotton and processing for export of textiles, would both leave a presence of seed remains archaeologically and take arable land away from food production. With increased trade more oleaginous nuts could be imported from more forested regions to the south.

Another factor, related to trade, is likely increased impact of a growing slave trade, which would have both provided a ready source of imported grain to the wealthy and a depletion of local agricultural labour.

The Dendi area, as other regions of Benin, was a slave reserve for the Portuguese trade during the second half of the second millennium AD. Indeed, "Grand Popo" and Porto Novo (the colonial harbour and colonial and current capital of Benin) had a place in the slave trade between Africa and America. Thus, this reduction of local agricultural production can be expected during the 15th century, as trade between the Sahel and savanna declined in relation of trade with the Atlantic coast. During the 15th century, Portuguese initiated a commercial turnaround on the Atlantic coast line at the expense of Sahelian commercial routes (Gallais 1967).

It is surprising that there is no rice evidence in this period. Indeed the historical source "*Tarikh el-Fettach*" chronicle that describes the Songhay empire organisation during the 16th century, and mentions rice in the Dendi area. Indeed the Dendi, one of the borders of the empire, had to produce for the empire one thousand *sounnou* of Rice per year (one *sounnou* is approximately 250 litres) (Gallais 1967, Houdas 1913). It is perhaps the case that what rice was produced was largely for export to the north, as rice in the husk, meaning that there was little local consumption and therefore little local dehusking, leaving no local evidence archaeobotanically.

Discussion

The Dendi region sequence is dominated by cereals, including rainfed savannah cultivation, of pearl millet and perhaps sorghum, and floodplain décrue cultivation based on seasonal river flooding, especially for rice and perhaps also sorghum. In Birni Lafia, a shift in frequency of rice and pearl flip, with early pearl millet dominance in the first millennium BC shifting to rice dominance in the first millennium AD (although there was an apparent hiatus between these periods). After 900 AD, the rice proportion decreases, from 60% to 12%, and millet proportion increases, from 20% to 50%. The extent to which this affected social changes or a response to climatic conditions needs targeted investigation.

We can assume than the earliest settlers arrived with a package of three domesticated cereals (rice, pearl millet and sorghum). As suggested by Susan McIntosh for Jenné-Jeno, the settlers arrived in the area from a similar ecological area with floodplain basin rice cultivation and more distal cultivation of millet and sorghum. The source for the Dendi area settlers in period 2, with the founding of Birnin Lafiya, is likely to have been upstream on the Niger river. As hypothesized by Portères and Gallais, the first rice cultivators of the Inland Niger Delta were presumably related to the Nono, a group of people speaking a Mande language (Gallais 1967, Portères 1949). The first inhabitants of Birnin Lafiya are perhaps associated with the ancestor of the modern Tyenga ethnic group, also a group of Mande speakers. These Mande speakers then would have come from Mali and expanded down the Niger river early in the First Millennium AD. In this period agriculture became more diverse, with a greater range of crops and varieties within crops (such as race bicolor and race guinea sorghum), and probably expanded into more land, increasing productivity and supporting increased population and increased density, e.g. with the urbanisation of Birnin Lafiya.

During the second millennium AD a shift appears in the composition of the charred plant assemblages. First rice declines after the 10^{th} century AD. Then the dryland cereals, sorghum and pearl millet, become increasingly scarce, while oil palm, *Canarium* and the baobab increase and cotton is adopted. This indicates a major reorientation of agriculture (cotton as a cash crop) and the rise of trade (in oleaginous nuts). These shifts, perhaps to be linked to increasing market trade and the slave trade are likely to have undermined local agricultural production for subsistence.

In this regard it is worth noting that until 1400 AD, the crops for which we have evidence are all African (as also noted at Jenné-Jeno McIntosh 1995). Unlike today, when Asian rice and New World crops like peanuts, chili, maize, and tomatoes are prominent. This tends to suggest that population growth, sedentism and urbanism could all emerge from a mixed agricultural economy based by and large on native taxa (although sorghum had probably been introduced from the eastern savannahs of Sudan). Thus, a very profound change to agricultural production took place in the past 500 years through both labour depletion and new crop adoptions.

The major difference of the archaeobotanical assemblage suggests that this small study region needs to be seen increasingly as part of a world system and less in terms of local agricultural subsistence production. The next chapters describe and discuss the integration of the Dendi region, and all the sites studied in this chapter, in a broader pattern of agricultural evolution data in West Africa.

7. A Framework for Archaeobotanical and Archaeological Studies within West Africa

West African archaeobotanical research carried out by various international teams often remain disparate, separate studies. Usually, the data within these publications are neither presented nor analysed in a similar way. In order to compare and contrast these existing datasets with those generated as part of this PhD it became necessary to develop a framework in which to standardize the data. Therefore for every West African site that has provided archaeobotanical data, each archaeological phase within a site is described and characterised for each of the following categories; architecture, faunal remains, ceramics, small finds and archaeobotanical data, with emphasis placed on transitions between more stable periods and potential links towards complexification, if present. Archaeobotanical assemblages are classically presented in three ways (or a combination of the three): frequency, ubiquity, or presence/absence. The frequency spectrum shows the proportion of any individual species or plant part number to total number in a whole assemblage. The ubiquity is the number of samples that any species or plant part is present within in comparison to all the samples by phase or by site. The presence/absence is the presence or absence of any taxon or plant part within each assemblage for each individual site by phase. This chapter in conjunction with the previous two chapters (Chapter 4 archaeological sites and Chapter 5 archaeobotanical results) facilitates the overall interpretation of food production, and agricultural and urban evolution in West Africa.

In this chapter I will review all available archaeobotanical data for most of the West African sites and cultures. This includes about 100 sites in six areas within the Niger River Basin and 9 areas outside the study region (see Fig. 7.1). I start with data collected from the Tilemsi Valley (2500-2000 BC) in Mali which currently shows the first evidence of domesticated pearl millet followed by the results from the Dhar Tichitt-

Oualata-Nema area in Mauritania (Figure 7.1). Although this area is outside the strict geographical delimitation of the Niger River Basin archaeologically it plays a role in the origin of the complexification of Niger River settlements and agricultural diffusion within the region. After describing the Middle Niger region, the discussion will follow the natural downstream trajectory of the river; thus this chapter examines the archaeology of the Niger Bend and explores the Gao site, and then moves to the discussion of the North-east Burkina Faso and associated Oursi/Kissi archaeological area. In the second half of this chapter I will focus on sites located outside the study zone, presenting similarities and differences between these sites and the Niger Basin sites. Archaeological cultures and sites with the most similarities will be described first (Kirikongo in Burkina Faso and Senegambia sites). Following this, Kintampo and Banda sites from areas farther into the forest/savannah zone of Ghana will be presented. Finally, is a discussion of the Nok culture and the Chad Basin area in Nigeria, where the botanical signature presents the sharpest contrast with the Niger Basin. For each archaeological site included the archaeological phases excavated, the general size and settlement patterns, the main types of architecture, and specialist activities during the site's occupation, are described. This section also discusses the current interpretations of the sites especially in relation to urbanisation and social complexity. Finally, I will expound upon issues surrounding reanalysing existing archaeobotanical datasets in terms of frequency, ubiquity and/or presence/absence.

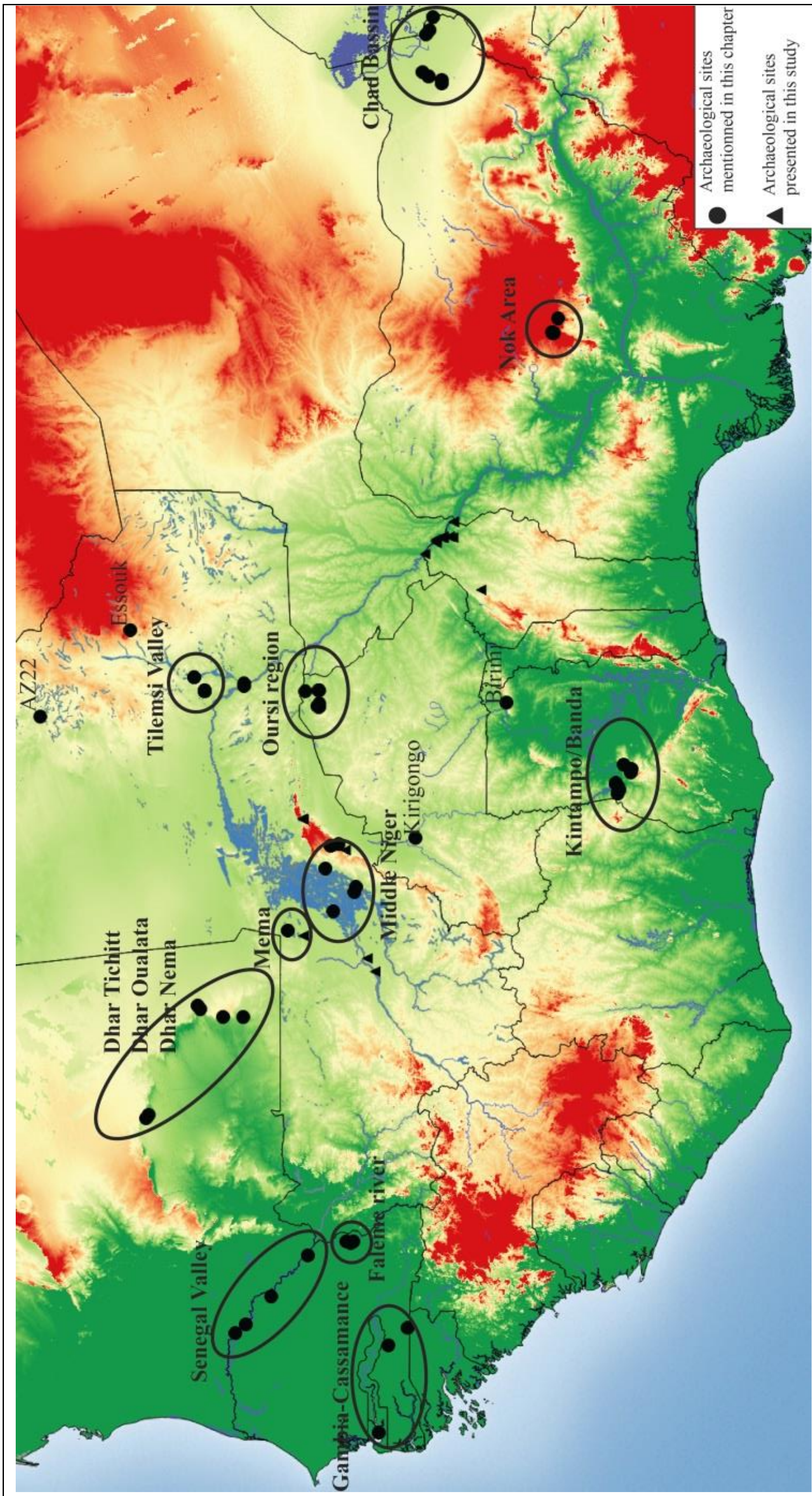


Figure 7.1 West Archaeological Sites and Areas that provided archaeobotanical data. Each main region (in circle) and single site (named) are discussed in this chapter.

7.1 Archaeobotanical studies within the Niger River Basin

7.1.1 The Tilemsi Valley, Mali

The Tilemsi Valley is a critical region for the study of agriculture origins and development in sub-Saharan Africa. Currently the earliest evidence of domesticated crops in West Africa is dated to *ca* 2500 BC and recovered from the Tilemsi Valley. The Tilemsi was a former Niger River tributary flowing directly from the Sahara and former northern Sahel southwards, but it dried up gradually with desertification in the Late Holocene (Figure 7.2). However, during the Mid-to Late Holocene, the Tilemsi Valley supported an active hydrological system, where evidence of domesticated pearl millet has been found as chaff temper in ceramics (Fuller 2003, Tostain 1998, Manning and Fuller 2014).

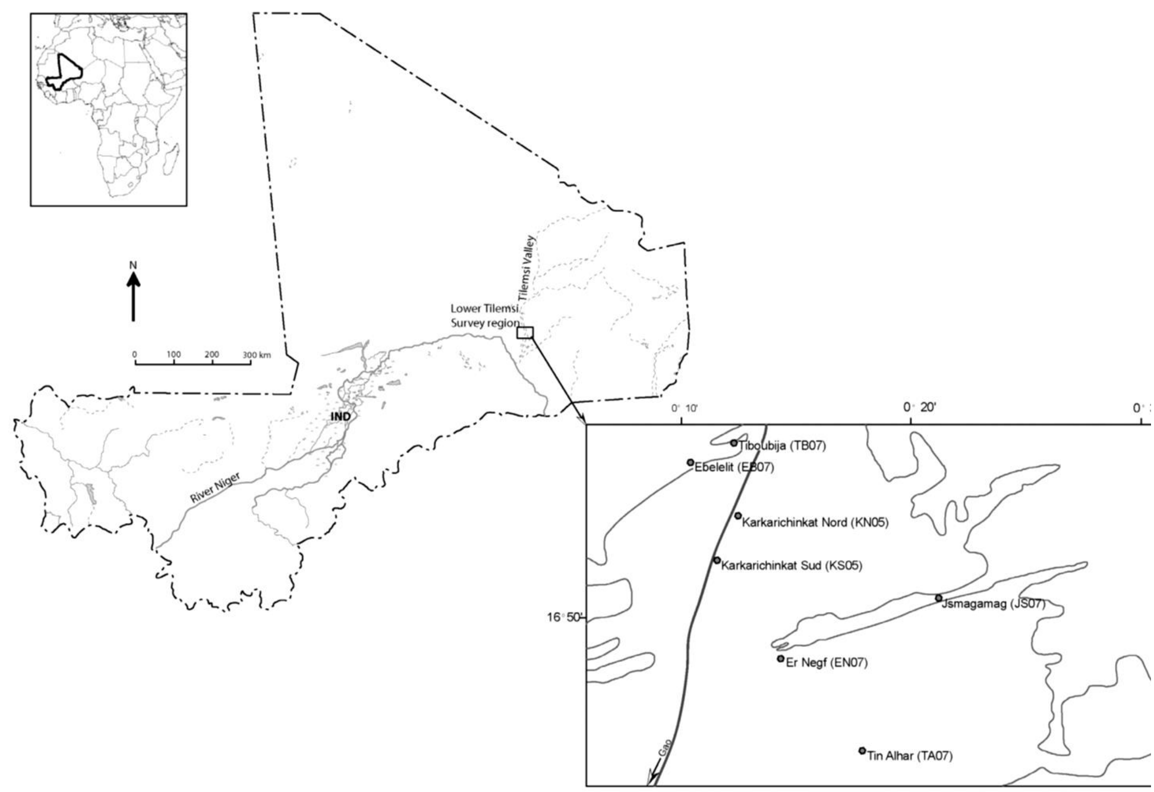


Figure 7.2. Area of the Lower Tilemsi Valley Project (From Manning and Fuller 2014:75).

The Lower Tilemsi Valley Project (e.g. Manning et al. 2011, Manning 2011, 2010, Manning and Fuller 2014, Manning 2008) discovered 86 multi-period sites. Based on Neolithic surface material seven of these sites were excavated: Karkarichinkat North (KN05) and South (KS05), Ebelelit –EB07, Tiboubija-TB07, Tin Alhar-TA07, ErNegf-EN07 and Jsmagamag-JS07-1 and JS07-2) (Figure 7.2). Previous work in the area by

Gaussen and Gaussen (1988), mainly focused on surface collections of artefacts, identified two distinct cultural entities, Facies K and Facies B. Re-analysis of the 2005–2007 excavation material changed this distinction between the two cultural entities, into a chronological distinction. Indeed, Bayesian modelling of 31 dates (Figure 7.3) indicates two distinct phases but no obvious deviation in either technological or stylistic aspects of the material culture from these excavated sites. The Bayesian model distinguished the first occupations to be Karkarichinkat North (KN05), Tiboubija (TB07), Tin Alhar (TA07) and Jsmagamag (JS07-1) that all began around 2500 BC and finished between 57 and 100 years later. A second occupational phase commenced around 2000 BC at EN07, JS07-2 and EB07 and lasted for some 100 years (Manning et al. 2011, Manning 2011, Manning and Fuller 2014).

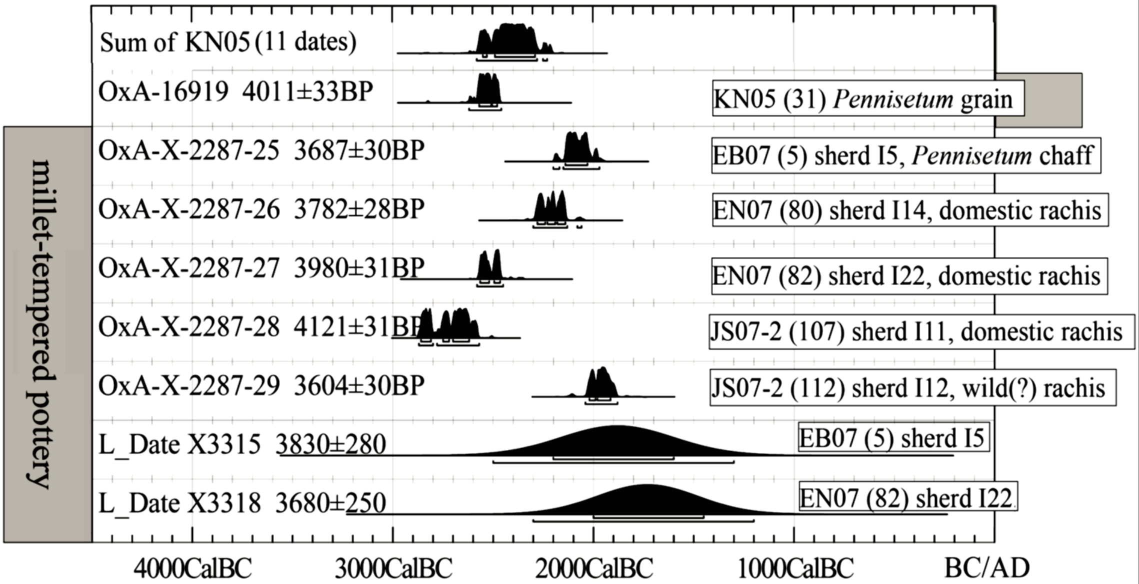


Figure 7.3 Direct radiocarbon dates on pearl millet and on organic fractions of millet-tempered pottery from sites within the Lower Tilemsi Valley Project. (After Manning and Fuller 2014:76)

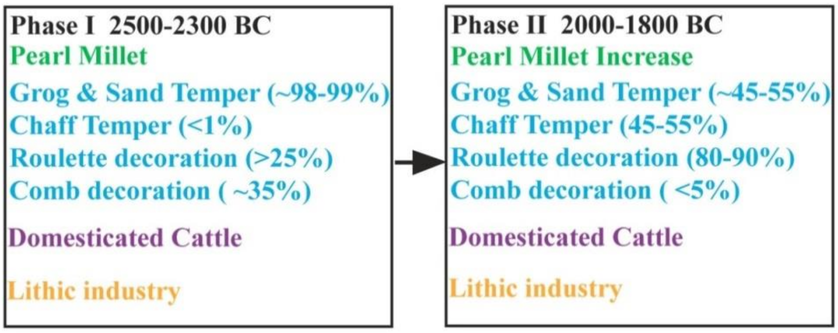


Figure 7.4 Summary of Tilemsi archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green), technology (in orange) and animal remains (in purple).

The sites are associated with an abundance of non-dwarf livestock remains, of goat and sheep, but mainly cattle. At KN05, the find of a fully articulated cattle burial suggests not only that cattle played a role in local ideology but also attests to the potential links with Saharan Pastoralism, and therefore representative of a very long-lasting cultural tradition. Indeed cattle tumuli are found throughout the Sahara from 6500 BC onwards and in the Egyptian desert to 1000 BC in the Western Sahara (Manning 2011, Manning et al. 2011). Well-known examples are the cattle burials from the Messak plateau in Libya, central Sahara dated to 5200-3800 BC. As stated by Di Lernia (2013: 56878-79): ' [...] *the Messak plateau homed the highly formalised local expression of a wider ideological phenomenon centred on domestic cattle. The slaughtering of bovines was an impressive enduring ritual which should be considered as a central part of the socio-*

cultural system of the Messak Middle Pastoral herders.' Other technological and economic linkages can be traced between the Tilemsi and the Sahara, such as stone rings and polished stone hachettes made of stromatolites limestone. This raw material is only found approximately 300 km to the North, in Mauritania and Algeria. The presence of these finished hachettes then suggests a strong exchange network. Moreover zoomorphic clay figurines and stone beads, two classical Saharan objects, were also found. These mature cultural correlations suggest, perhaps not a straight direct cultural link, but speak of at least an economic and pastoral connection (Manning 2011).

At the Tilemsi valley sites, fish remains represent an important food source. The decrease in the presence of deep-water fish (e.g. *Lates niloticus*) corresponds to less humid conditions with more shallow-water fishes (e.g. *Claridae*, *Tilapiini*) persisting until later periods in the faunal assemblage (Manning 2008, Drake et al. 2010). The decline in fish and the drying up of the Tilemsi River follows a longer term pattern of watercourse drying and fish extinction that has been documented across the wider Saharan world (Drake et al. 2010).

In terms of archaeobotanical studies, 58 samples from 276 litres of soil were processed and collected. However, very few macro-plant remains were recovered; *Celtis* sp. being the exception. Nevertheless, two carbonised millet grains were recovered at KN05. One was directly dated (Figure 7.3) and the second fits within the wild size range but possesses the specific club-shape of the domesticate form (Manning et al 2011; Manning and Fuller 2014). Most of the domesticated pearl millet, *Pennisetum glaucum*, evidence comes from the chaff impression in the ceramics. Despite tempering and decoration techniques, the ceramic assemblage remains homogenous in shape and in general dimensions through time. *'Overall, then, there is a preference for medium size globular pots with a regular and fairly thin body wall and simple rim type'* (Manning 2011: 78). Temper choice and surface decoration offer chronological differences (Figure 7.5). Ceramic decorations from the first phase (*ca* 2500-2300 BC) are largely dominated by impressions made from 'the typical Saharan tool kit': comb, styli and occasional carved roulette (≈5%). The temper consists mainly of grit and grog with punctual light addition of chaff (0.7% for KN05 and 2.4% for JS07-1). During the second period, *ca* 2000-1900 BC, fibre roulette decorations (Twisted Cord, Cord Wrapped and variations) became predominant (> 80%) and chaff rose in importance to comprise 50–60% in clay tempering assemblages (Figure 7.5). The increase of roulette use formed the earliest record of intensive fibre roulette use in West Africa (Manning 2011, Livingstone-Smith 2007). Manning's analysis (2011) of chaff-tempered pottery seems to demonstrate a near-exclusive use of domesticated pearl millet chaff for ceramic temper. This suggests that the rise or increase of pearl millet cultivation provided a readily available source of organic tempering material (see McClatchie and Fuller 2014).

Therefore, two main concomitant changes can be observed in the Tilemsi ceramic evolution. First, increase of roulette decoration. Secondly, intensification in millet chaff temper. These ceramic trends preceded or were nearly simultaneous with the rapid spread of pearl millet cultivation.

In 2014, based on computer simulations to model patterns of cultural diffusion, Ozainne postulated that pearl millet agriculture diffusion seems to be related to the diffusion of roulette decorated ceramics (see Chapter 8.1 pearl millet subsections). As we will see throughout this chapter the early evidence of domesticated pearl millet, with the exception of the Nok sites and the Chad basin, where pearl millet arrived earlier than roulette decorated ceramics, is always associated with roulette decoration. In the Tilemsi Valley an increase in domesticated pearl millet frequency is clearly related to an increase in roulette decorated vessels but also with an increase in chaff tempered pottery in which the temper was mainly composed of pearl millet. This original triple correlation between 'roulette decoration - pearl millet chaff tempering and pearl millet as staple crop will diffuse in the whole Sahel zone by mid second millennium BC' (Manning 2011). This correlation confirms KM Manning's (2011:72) suggestion '*that pots played an important role in the constitution of social change'.* Figure 7.5 show an evolution from few chaff tempered (<2%) roulette decorated (≈10%) during the first period to a larger presence, (chaff ≈ 40% and roulette ≈60%) for the second period. Thus current evidence tends to suggest two separate waves of immigration, with only the second group having an economy focused on domesticated pearl millet. The earlier wave could represent an initial period of occupation, by what appears to have been reconnaissance-like pastoral fisherfolk at sites such as Karkarichinkat Nord. Several centuries later the region was more intensively occupied by another wave of the same/related cultural group. This later full-scale occupation, at ca. 2000 BC, brought with it incipient specialisation and a developed agricultural component by at least, implying an earlier origin for domestication in Africa (Manning and Fuller 2014:79).

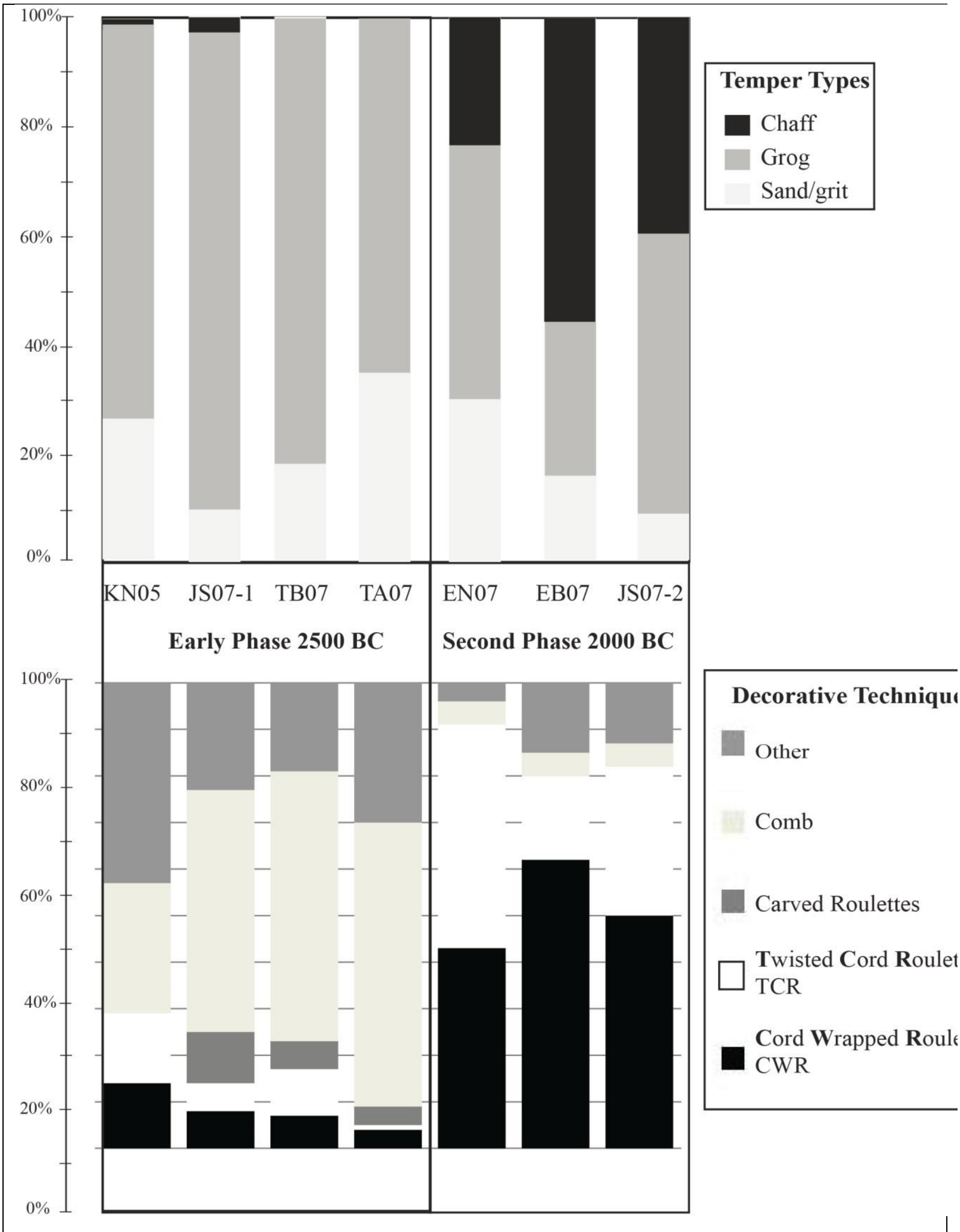


Figure 7.5 Lower Tilemsi Valley: On the top, relative distribution of the three predominant temper for all sherds by phases. On the bottom, relative distribution of the main decorative techniques for all sherds by phases. Modified and reorganised after Manning 2011, figure 2 & 5, pp 76 & 80.

7.1.2 Earlier Wild Pearl Millet Evidence, Northern Mali

Evidence of wild pearl millet utilisation has been reported from the central Sahara, north of the Lower Tilemsi Valley. Pearl millet chaff used as temper has been found in ceramic potsherds from the site AZ22 (see Map, Fig. 7.1). AZ22 is a Neolithic Malian site located in the Oued Oukechert region near the Ine Sakane erg, 500 km north from Gao (Commelin 1984, p. 40-46, Raimbault 1994, p. 814-816). The site AZ22 was discovered in 1980 by a CNRS mission directed by Petit-Maire (Petit-Maire & Riser 1983). During these missions, thousands of sherds were collected from dozens of sites. Currently these sherds are part of the LAMPEA(Laboratoire méditerranéen de préhistoire Europe Afrique) collection in Aix-en-Provence. Ceramic analysis has been carried out by Dominique Commelin (1984) and Michel Raimbault (1994). AZ 22 site was dated from hearth charcoal to 5500-4950 Cal.BC (6340 BP ± 130, Gif-5228) (Commelin *et al.* 1993). Currently, we cannot confirm that the sherds are contemporaneous with the hearth feature. However, due to the presence of lithic artefacts -scrapers, awls, and parts box – we can assume a Neolithic origin (Raimbault 1994, p. 814–816). A total of 193 sherds were collected from the surface of AZ 22 and were examined under a stereomicroscope at x5 – x 20 magnification. Of the 193 collected sherds, 15 were selected to cast and 10 gave evidence of plant remain impressions. The plant impressions were mainly from wild pearl millet (lemma, bristles and grains) but also from wild *Digitaria* sp. and cf. *Panicum* sp. spikelets (Figure 7.6). The overall assemblage suggests that wild *Pennisetum* may have dominated the assemblage but was used alongside other millet grasses. This evidence has provided a starting point for the likely collection of wild *Pennisetum* that preceded the domestication of pearl millet in the 3rd millennium BCE, as indicated in the Tilemsi Valley (see 6.1.1). Assuming the associated date is correct, the wild pearl millet impression from AZ 22 would be one of the earliest direct evidence for wild millet use. Based upon AZ 22's location and date, it can be linked to the Acacus Libyan sites (Ti-n-Torha, l'Uan Tabu and l'Uan Muhuggiag) from the late Acacus period (6500-5000 BC). These Acacus Libyan sites have evidence of charred wild pearl millet grains (Mercuri 2001, Wasylikowa 1993). The proliferation of sherds with wild pearl millet impression in the Malian Sahara, like the ones found at AZ22, and dating to the middle Holocene, significantly a period prior to the onset of documented domesticated morphology in the Lower Tilemsi in the late third millennium BC, provides evidence for the 'pre-domestic' millet cultivation in the Malian Sahara (Fuller et al. in prep.).

An origin of cultivated pearl millet around this area is supported by modelling derived from modern genetic diversity in pearl millet that has been fitted to published archaeological finds (Burgarella et al 2018).

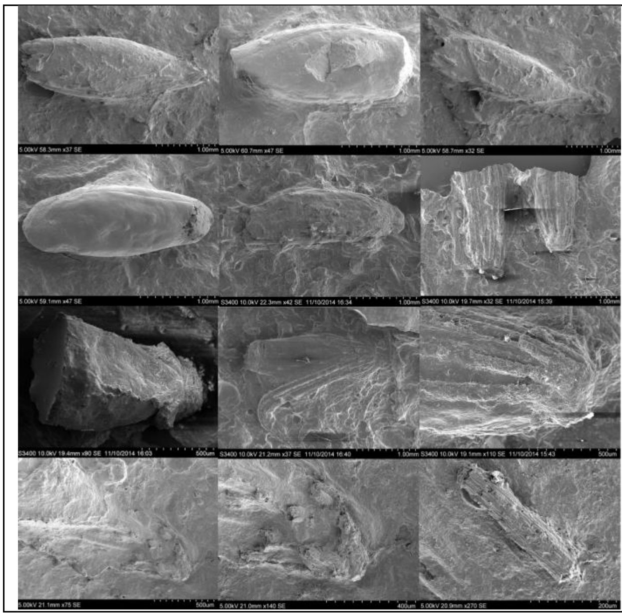


Figure 7.6 Examples of Wild Pennisetum remains from potsherd impressions sampled at AZ 22 site. Cast and SEM were done at UCL for the ERC funded ComPAg Project.

7.1.3 Dhar Tichitt – Dhar Oualata – Dhar Nema (2000 – 400 BC), Hodt Depression, Mauritania

Archaeological sites in the Hodt Depression, including Dhar Tichitt, Dhar Oualata and Dhar Nema, are not, strictly speaking, geographically in the Niger River Basin nevertheless they are important for understanding the development and peopling of the IND and the rest of the Niger Valley. Indeed, these sites were important in the diffusion of pearl millet agriculture into the IND and probably also the iron technology associated with the Faïta ceramic facies. As in the Tilemsi Valley early evidence of pearl millet is attested by chaff tempered ceramics dated to around 2000 BC. These sites have a long occupation with a slow migration towards the IND through time. With Faïta facies, Tichitt ceramics are present early in the IND. Also, the sites of Bou Khzama and Djiganyai have yielded some of the earliest evidence for iron production currently known from this region of West Africa. Thus, based upon this evidence it is probably that this area that represents the origin of a second wave of pearl millet agriculture development that can be associated with the diffusion of iron through the Niger River Basin and linked with the expansion of roulette impression decorated ceramics.

Due to logistical reasons including the lack of water supply, flotation was not undertaken on the sites in the Hodt Depression, but dry sieving yielded eight seeds of *Celtis cf. intergrifolia,* hackberry, from a classic Tichitt context. As in the Tilemsi Valley, the majority of archaeobotanical evidence comes from plant impressions in the ceramics (MacDonald et al.2009).

The Tichitt sites offer another development that is lacking in the Tilemsi Valley. The Tichitt area is probably one of the first with evidence for the rise of proto-urbanisation in the form of a large site (up to 80 ha) with stone-walled compounds built on or near the edge of the Dhar cliff. The Dhar escarpment is a specific geomorphological environment that provides an ecosystem refuge that continued to supply water during dry periods. In this case, the Dhar Tichitt-Oualata-Nema region offered a large refuge area for populations escaping the late Holocene Saharan drying period (Person et al. 2012). Around 4000 BC the Hodt depression was filled with permanent lakes that started to shrink around 1000 BC. During this climatic degradation pearl millet cultivation and the Tichitt tradition of stone architecture and a hierarchical settlement landscape arose in the region. The large number (hundreds) of structures identified as granaries suggest that the inhabitants were not only agriculturalists, but also potters, hunters, and deep and shallow water fishers (Munson 1976, Amblard 1996, Fuller et al. 2007, Person et al. 2012, MacDonald et al. 2009, MacDonald 2011, 2013).

The archaeological sequence initially proposed as seven phases by Munson (1971) was recently re-analysed and simplified into three phases by MacDonald (2011) (6.1.3.1 and Figure 7.8).

Table 7-1 Tichitt archaeological sequence for Munson (1971) and MacDonald (2011)

Phases by Munson (1971)	**Phases by MacDonald (2011)**	**Chronology**
Akreijit	Pre-Tichitt	2300-1800 BC
Khimiya	Early Tichitt	1900-1600 BC
Goungou		
Nkahl	Classic Tichitt	1600-1000 BC
Naghez		
Chebka		
Arriane	Late Tichitt	1000-400 BC
Akjinjeir		

7.1.3.1. Pre-Tichitt tradition (2300 – 1800 BC)

The Pre-Tichitt period, or ‘Akreijit phase’ for Munson (1976), was based on a pastoral economy with cattle, sheep, and goat with hunted antelope and freshwater fish remains also recovered. The ceramics made of sand tempered clay mainly comprised of simple rim bowls decorated with a comb, cord-wrapped element or stylus. No evidence of domestic crops has yet been recovered from pre-Tichitt sites. The transition between early Tichitt and pre-Tichitt was not a break or rupture but rather a smooth, gradual transformation. The ceramic forms and thicknesses are very similar in both periods. It was during the early Tichitt that twisted cord roulette and organic tempered pottery arrived. The main distinction between the two periods is in site typology. Pre-Tichitt sites are comparable with Tilemsi sites: Pre-Tichitt sites are seasonal camps, comparatively smaller with stone compound walls with pillar structures, and the traditional Tichitt architectural features are largely absent (MacDonald et al. 2009).

7.1.3.2. Early Tichitt (1900 – 1600 BC)

Early Tichitt ceramics are dominated by roulette impressed decoration, mainly twisted cord roulette (approximately 52–64% of the ceramic assemblage) and chaff tempered fabric in nearly all of the assemblage (98%). These characteristics are very similar to those assemblages of the later Tilemsi, being dominated by chaff tempered and roulette decorated ceramic. Associated with a similar site typology (seasonal encampments) they potentially indicate a direct link between Tilemsi and Tichitt sites. Tichitt chaff temper is mainly composed of *Pennisetum glaucum* but the presence of cram-cram (*Cenchrus sp.*) is also attested. Munson has posited that the proportion of cram-cram remains decreases through time with the corresponding increase in pearl millet chaff, but without any documented evidence such as casts from pottery to support this suggestion (Munson 1971, MacDonald et al. 2009). Typical vessel forms are similar to the pre-Tichitt phase, with a variety of globular simple rimmed vessels, with very few examples of everted rimmed pottery (max 2% of the total assemblage) (MacDonald 2011). Currently, two Early Tichitt sites provide direct evidence of domesticated pearl millet from ceramic impression casts (MacDonald 2011). The first site, Village 72 in Dhar Tichitt, is dated to 1950-1690 BC (Pa-1157; 3500 ± 100 BP; Amblard-Pison 2006) and the second site, Djiganyai in Dhar Nema, is dated to 1740-1610 BC (Gx-25359-AMS; 3370 ± 40 BP) (MacDonald et al. 2009). The Early Tichitt ceramics were recovered in large quantity from Dhar Tichitt and Dhar Oualata and in smaller quantities from Dhar Nema. These ceramic results appear to show the early beginnings of south-east diffusion of pearl millet agriculture from Dhar Tichitt. Stone architectural remains are only found at five archaeological sites (Amblard-Pison 2006).

7.1.3.3. Classic Tichitt (1600 – 1000 BC)

Classic Tichitt represents a major socioeconomic transformation during which most of Tichitt's main population centres developed. Typical Tichitt sites are composed of cluster settlements, with stone-walled compounds, which started to grow in size and are associated with Tichitt ceramics which spread south-east across Tichitt – Oualata – Nema, but also west through the Tagant. Moreover it is during this period that the Tichitt Tradition enters the Méma region with the Faïta ceramic facies. The classic Tichitt ceramic assemblage becomes much more diverse than previously. The simple rimmed closed pottery forms no longer dominate the assemblage as new forms appear with a proliferation of types not only with everted rims (at least 12 new forms) but also thickened rims. Roulette decorations are still dominant but with a wider diversity of up to five roulette types. Also, for the first time applied plastic motifs appear and flourish. Finally, paste tempered with grog or bone appears (3–4% of the sherds), but chaff tempered clay still dominates the assemblage (MacDonald 2011, 2013, MacDonald et al. 2009). Settlements at this time started to become more complex and organised in different structures from small hamlets (≈ 2 ha), through villages (<10 ha) and district centres (≈ 15 ha) to regional centres that could be regarded as urban (≈80 ha) (MacDonald 2013). Most of these sites present similar internal organization comprising stone-walled compounds with dwellings and granaries. The sites also show an internal network of streets, alleys and squares which are well developed (Amblard-Pison 2006, Person et al. 2012). Person et al. (2012) also notes that most sites have shared common storage elements such as big thick chaff tempered ceramic jars, and stone stilt granaries made of three rows of three flagstones. Grindstones are also common elements within this period largely distributed all over the Tichitt sites (Figure 7.7; Person et al. 2012), and suggest widespread routine plant processing across them, perhaps including grain breaking or flour production.

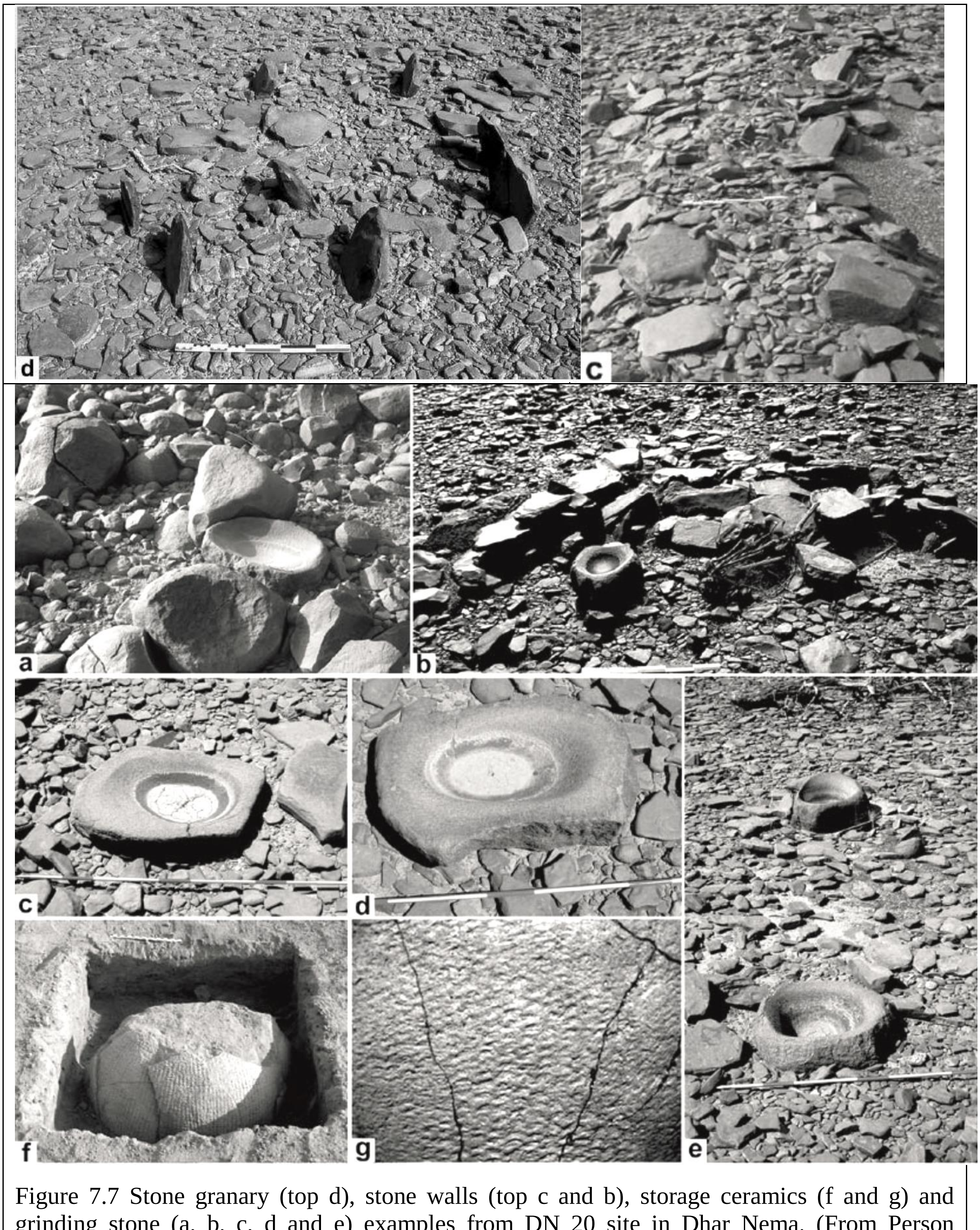


Figure 7.7 Stone granary (top d), stone walls (top c and b), storage ceramics (f and g) and grinding stone (a, b, c, d and e) examples from DN 20 site in Dhar Nema. (From Person 2012:140-141)

It is still unclear if pearl millet was rapidly domesticated in the Tichitt region, but it seems unlikely. It is more probable that pearl millet arrived from elsewhere, as part of an agro-pastoral economic package associated with chaff tempered roulette decorated ceramic and domesticated cattle. Similar associations are also found amongst the Tilemsi Valley sites (*ca.*2500-2000 BC) but the link between both areas remains unclear and is yet to be firmly established. This leaves researchers to ask 'Did Tilemsi Culture spread to Tichitt? Or did both originate from a northern tradition where pearl millet was domesticated and diffused to these areas separately'? The only clue to date is that both gave rise to separate waves of agricultural diffusion (see below).

7.1.3.4. Late Tichitt (1000 – 400 BC)

The decline of the Tichitt tradition remains unclear. The Tichitt tradition presence seems to have increased in this period outside its core area in the Tagant and along the Middle Niger, whereas it appears to cease in the Dhars and the Hodh depression. Ceramic evidence indicates a continuation of the previous phase with the sudden appearance of large high-collared pottery probably originated from a syncretism with incoming Berber pottery styles (MacDonald 2011, Munson 1980). Ceramic and iron furnace tuyères from Bou Khzama proved to be tempered with domesticated pearl millet. A direct date, 760-400 BC, was obtained from a sherd with pearl millet temper (GX-281376-AMS; 2340±40 BP) (Fuller et al. 2007). Also, the presence of iron technologies at both Bou Khzama and Djiganyai suggests the beginning of iron metallurgy in the region in the first half of the first millennium BC (Fuller et al. 2007; MacDonald et al 2009). This currently represents the first evidence of what will become the 'Iron – roulette decoration – chaff tempered – pearl millet' package that diffused throughout the Niger River Valley in a second wave of agricultural diffusion. The overall interpretation of the chronological relationships and cultural dispersal events in Mauretania and adjacent Mali is summarize in Fig. 7.8.

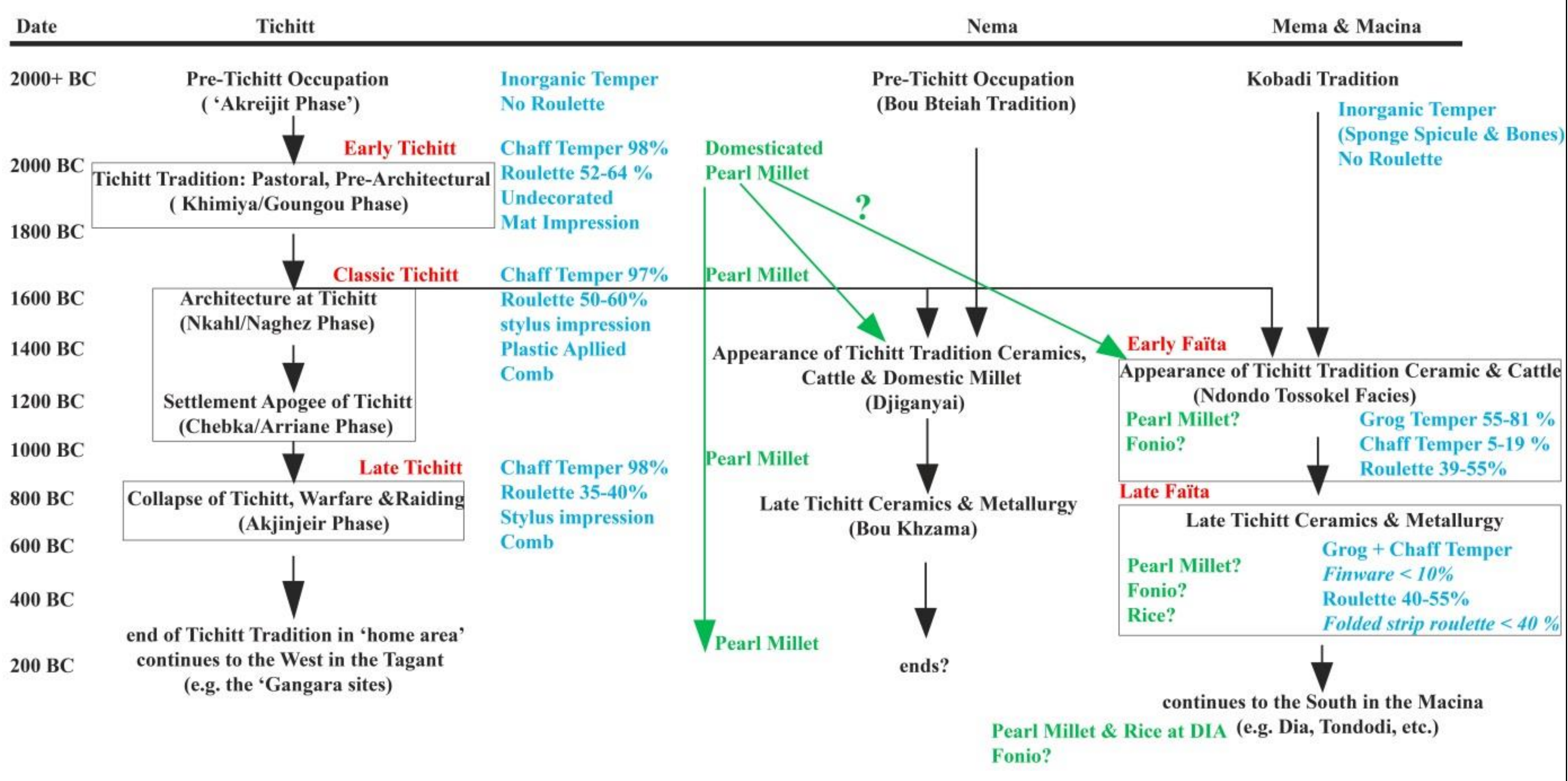


Figure 7.8 The Tichitt Diaspora regional sequence with archaeobotanical evidence. (Modified from MacDonald et al. 2003 and updated from MacDonald et al. 2009)

7.1.3.5. The Faïta Facies

The Faïta facies is the expression of Tichitt migration into the Mema/Macina region. It is characterised by Tichitt ceramics and it is probably associated with the diffusion of iron technologies, pearl millet agriculture, roulette and chaff temper ceramics and clustered settlement organisation into the IND and even further (e.g. into the Dendi region in north Benin).

Tichitt diffusion into the Mema and Macina (e.g. Dia) region has been first suggested by MacDonald following Mauny's illustration of Kobadi vessels (McIntosh 1996, 1998, Mauny 1972). However, *[i]t should be noted that not everyone agrees with this assessment. Writing about the notion of the Tichitt Tradition in the Méma, and making reference to my initial writings on it (MacDonald 1996, 1998), Amblard-Pison (2006, 292) remarks: '. . . il faudrait disposer des éléments qui font avant tout l'originalité des populations des Dhars Tichitt et Oualata. Cette affirmation ne peut donc, actuellement, être considérée que comme une hypothèse basée en fait sur la seule proximité de ces deux régions'.* (MacDonald 2011: 57). [… it would be necessary to fathom the elements that make the very originality of the populations of Dhars Tichitt and Oualata. This assertion can therefore, at present, only be considered as a hypothesis based solely on the fact of the proximity of these two regions] (Trans. by Champion).

This assumption is mainly based on the fact that the 'originality' of the Tichitt populations rests on the architectural stone-walled compounds and that no such settlements exist in the Middle Niger. However, their absence could possibly be explained by the ecology and geography of the region. Indeed as a floodplain, the Méma is lacking any native stones for such construction. But more importantly, different material cultural elements of Tichitt diffusion (other than architectural) are present in the region including ceramic, pearl millet, clustered settlement sites and iron.

Before the Faïta facies population settled the Méma/Macina region, the Kobadi pastoral fisherfolk population occupied areas in seasonal ephemeral camps. The Faïta people were the first to settle in permanent clustered villages. Indeed, without natural stone it was impossible to build the classical Tichitt stone walled compound. Nonetheless their organisational site networks, or clusters, were possible to reproduce, but with earthen architecture substituting for stone. By doing so, the first middle Niger 'urban' sites arose in the form of Tell sites (e.g. Kolima, Akumbu, Tondodi). In that sense, the Faïta population were probably at the origin of urban development in the Inland Niger Delta and beyond.

The best example of the Faïta input is the site of Dia. Indeed, Horizon I (800-400 BC) represents the largest occupation site of the Faïta facies yet known. This horizon is represented by the association of Faïta ceramic, iron slag and tuyères (see below; Smith 2005, Macdonald 2011).

7.1.3.6. Early Faïta (1440-1260 BC) and Late Faïta facies (900-400 BC)

Early Faïta (1440-1260 BC) ceramics possess great similarities with the Classic Tichitt phase. The only difference is that of the temper used, and grog and bone temper (55–81%) dominate as opposed to chaff temper (0–39%) (Figure 7.8, MacDonald 2011). MacDonald explains this change due to lack of access to crop processing waste. *'As it has been hypothesised (MacDonald 1994, 1999) that Early Faïta represents the seasonal presence of transhumant pastoral segment from the Mauritanian Dhars, they would have been unlikely to have much access to chaff'* (MacDonald 2011: 60). However, this could also be the result of an agricultural change. The Méma and Macina regions were more humid than the Hodh depression and less suitable for dry agriculture such as pearl millet cultivation.

During the **Late Faïta facies (900-400 BC)** use of the cord-wrapped element is still present on ceramics, but more frequently used as tools for impressions with less rolling. New elements also appeared, such as folded strip roulette decoration and fine paste, burnished, and often undecorated vessels. This ceramic type is the first expression of Middle Niger 'Fineware' made of very finely sorted and well-fired grog/sand tempered fabric. Nevertheless as with Tichitt ceramics, chaff-tempered pottery still dominates these assemblages (80–86%). MacDonald (2011) noticed that this chaff temper was different from the pearl millet chaff and he suggested fonio (*Digitaria exilis*) as the new crop for tempering ceramics. His suggestion is based on the presence of fonio grains in the macro-botanical remains from Kolima (see Kolima section below) and from a potential identification of an impression of fonio in sherds from Akumbu (MacDonald 2011). However, archaeobotanical samples from Akumbu presented in this study did not show any evidence of fonio, and the Kolima evidence is questionable, and thus more data is needed to support this hypothesis.

The Faïta facies diffusion was probably at the origin of the introduction of iron technologies as well as pearl millet agriculture, accompanied by chaff tempered and roulette decorated ceramic into the Middle Niger region and beyond.

7.1.3.7. Kobadi tradition (1750-800 BC)

Before describing the Faïta presence and development at Dia, a small introduction on the Kobadi tradition is needed. The people of the Kobadi tradition were probably one of the first to settle in the IND vicinity from the Sahara during the early Holocene. Kobadi ceramics were found in different Méma regional sites. Also, importantly, associated with Faïta ceramic, they composed the original layer of Horizon I at Dia (800-400 BC). The site of Kobadi comprises a huge bone deposit dated to 1750-800 BC, located on the edge of a paleo-lake in the Méma region. Currently we do not have any archaeobotanical information about the Kobadi people. Nevertheless, archeozoology analysis indicates the presence of deep-water fish (*Lates niloticus*) associated with remains of aquatic mammals (e.g. hippopotamus), as well as antelope, African buffalos and domesticated cattle. For Gallin (2011, 2007) the Kobadi inhabitants have a Saharan origin, specifically from the Hassi el Abiod region (Azawad region between Dhars region and Tilemsi Valley). The absence of any roulette decorated and chaff tempered ceramic suggests that this tradition is probably older than the Tichitt/Tilemsi sites. Kobadi tradition ceramics are characterised by two main production types, the first is made of bone tempered clay (34% of the corpus), the second of a freshwater sponge spicule tempered clay (65% of the corpus). Decorations are usually of comb impression and zig-zag patterns. At the Kobadi site, chaff tempered ceramics arrived later and were associated with cord roulette impression (Gallin 2007, 2011). The appearance of chaff temper ceramics probably originated with the Tichitt diffusion and the Faïta facies. The presence of freshwater sponge spicules in the ceramics, evidence of deep water fish and large aquatic mammal remains suggests as strong a knowledge of aquatic resources as found in later Bozo-Somono groups. The absence of any archaeobotanical analysis doesn’t allow any further discussion on this aspect of plant use. Nevertheless, the absence of chaff tempered and roulette decorated ceramic in the early occupation of the site would suggest an absence of pearl millet agriculture (utilisation and cultivation) which arrived later, associated with the Faïta/Tichitt diffusion. R. McIntosh has suggested that before the arrival of the population from the Tichitt area, only the Bozo ancestors were living in the Méma and IND, subsisting on wild plant gathering, fishing and aquatic mammal hunting (McIntosh R. 2005).

In this sense, it is reasonable to ask if the Kobadi people are ancestors of the Somono-Bozo? Currently, this is a very difficult question to answer, as more data from the Méma and IND region is needed. Thus, further archaeological and archaeobotanical research is needed in these areas to begin to address these issues.

7.1.3.8. Kolima (900 BC – 1300 AD)

The site of Kolima was excavated by Takezawa and Cissé (2001, 2016). The site is roughly dated from 900 BC to 1300 AD. As with many of the archaeological sites from the Mema region, such as Kobadi and Akumbu, it is key to understanding the link between the Tichitt areas and the Inner Niger Delta. Moreover, Mema is an important area in which to study the rise of urbanism in West Africa. Kolima is usually cited as one of the oldest sites with remains of fonio (*Digitaria exilis*), and it is often used as an indicator of the rise of urbanism. However, this type of data must be used with caution. Indeed, Takezawa states in his paper (Takezawa and Cissé 2016:68):

'L'objectif principal des fouilles étant de constater l'origine de l'agriculture au Méma, nous avons effectué l'examen de la flottation en prenant 20 kilogrammes de sol à chaque niveau. […]Dans chaque boite indiquée par la figure [Figure 7.9], la couleur noir reflète les petits morceaux de charbon et la couleur brune (jaune), les graines de fonio'

' As the main excavation goals were to look into the origins of agriculture at Mema, we examined flotation samples from 20 kilograms of sediment for each level. […] In each box shown in the figure [Figure 7.9], the black colours represent the small fragments of charcoal and the brown (yellow) the grains of fonio' (Champion free translation)

From this citation it seem likely that proper archaeobotanical analysis has yet to be done at the site; and therefore taxonomic identification is open to questioning. Indeed, there are no counts, frequencies or ubiquity data available from the archaeobotanical assemblages from this site. Secondly, based on the colour description (brown/yellow), these apparent fonio grains are unlikely to be ancient and hence archaeological. Unless desiccated material has been preserved (which in this case appears unlikely, and would need to be supported by direct AMS dating), then archaeobotanical remains recovered from the site are expected to be charred, i.e. black. The colour yellow-brown colour of the grains would strongly suggest that they are modern seeds or plant parts, in other words contaminants or intrusive elements, present in these samples. Whereas the black organic remains will represent the ancient charred carbonised elements that we would wish to examine; such charred remains would hold promise if they were to be sorted by a trained archaeobotanist, however, from the excavation reports it is unclear if this has ever been done. Indeed the published photograph (Figure 7.9) clearly shows rich unsorted samples, which may or may not contain ancient remains of fonio, but deserve study. In conclusion, systematic rich flotation sample potentially appear to be available from the site of Kolima, but to my knowledge still need to be sorted and fully analysed.

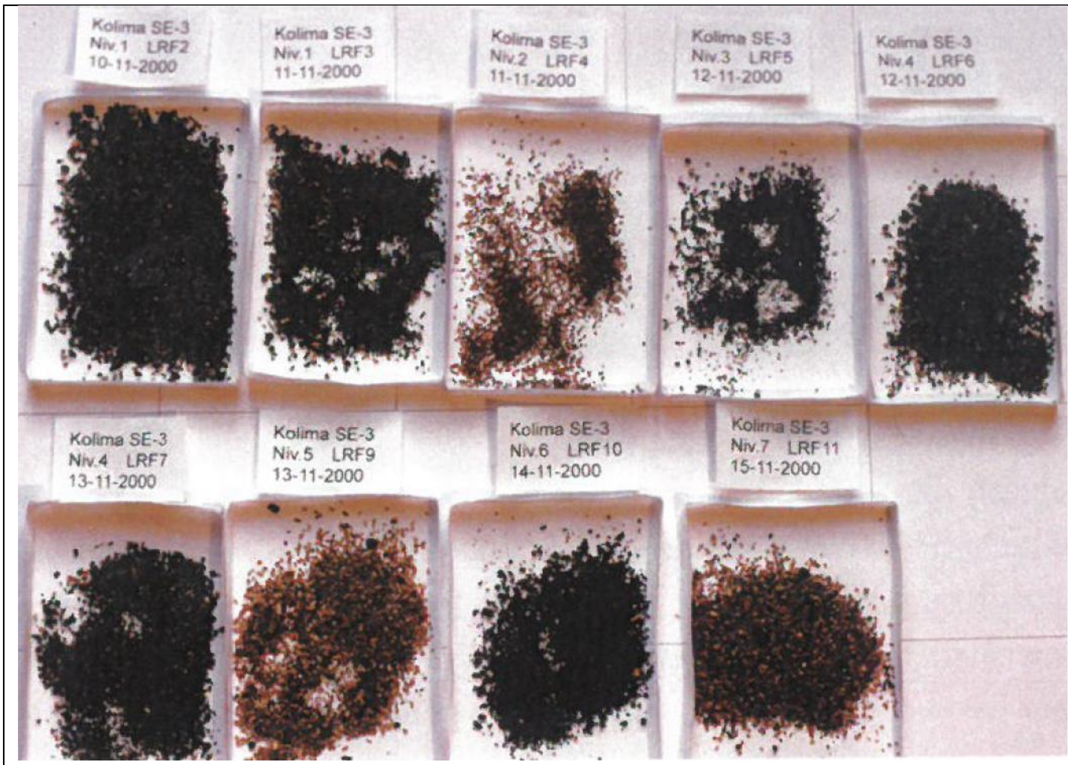


Figure 7.9 Figure presenting the “fonio” remains in Takezawa and Cissé 2016:68

7.1.4 The Inland Niger Delta

7.1.4.1 Dia – 800 BC- 1900 AD

Archaeobotanical data from Dia come from 500 samples analysed by Murray (2005). The soil samples were been floated with 0.33 mm mesh, but so far only the larger fractions (> 1mm) have been analysed, which may explain the absence of chaff in the dataset. Indeed as most chaff remains are less than 1mm they only appear in the smaller fractions.

Table -7-2 Number of items recovered and Frequency for the main crops from **Dia** by phases. First line is the total number of items and second line gives frequency. For Dia, the ubiquity is not available. Data combined from Murray 2005 in Bedaux et al. 2005

Date	**Phase 1** **800 BC-0**	**Phase 2** **0-500 AD**	**Phase 3** **500-1000 AD**	**Phase 4** **1000-1600 AD**	**Phase 5** **1600-1900 AD**	**Total**
# samples **volume of soil (litres)**	107 689	35 214.5	55 347.5	271 1946	32 206	500 3403
Pennisetum glaucum Frequency	2 0.25%	7 1%	8 1.7%	186 5%	0	203 3.4%
involucre proportion	NA	NA	NA	NA	NA	NA
Oryza glaberrima Frequency	324 40%	315 49%	110 23%	622 16%	5 6%	1376 23%
Spikelets base proportion	NA	NA	NA	NA	NA	NA
Sorghum bicolor Frequency	0	0	1 0.2%	9 0.2%	0	10 0.2%
Chaff proportion	NA	NA	NA	NA	NA	NA
Poaceae	34 5%	96 21%	35 9%	625 20%	6 11%	796 13%
***Gossypium* sp.**	1 0.1%	0	1 0.2%	980 25%	15 18%	997 17%
***Triticum* sp.**	0	0	0	4 0.1%	0	4 0.1%
***Tree/bush* (fruit)**	25 3%	15 2%	10 2%	57 1.5%	3 4%	110 2%
Total Number	803	641	475	3974	82	5975
Density (Items/litre)	1.2	3	1.4	2	0.4	2.5

As introduced earlier in this chapter, the Dia settlement originated from an integration between the Kobadi people and a mainly Faïta population. The earlier horizon comprises a Faïta facies package (pearl millet, ceramic, iron technologies, and cluster organisation). Moreover, additions to this initial package are also present. In terms of archaeobotany the main innovation is agricultural complexification (Figure 7.10). In the earlier Horizon I, pearl millet is still attested but in limited frequency (<1%), but for the first time African rice (≈40%; *Oryza glaberrima*) cultivation evidence is recorded. The origins of domesticated African rice are still unclear, but most of the grains present in this assemblage were domesticated. Thus it is likely that the domestication process occurred elsewhere. The main questions are: where did this African rice originate from? And which of the two traditions is the rice related with? Is African rice related to the Kobadi tradition or the Faïta or another tradition that still needs to be defined?

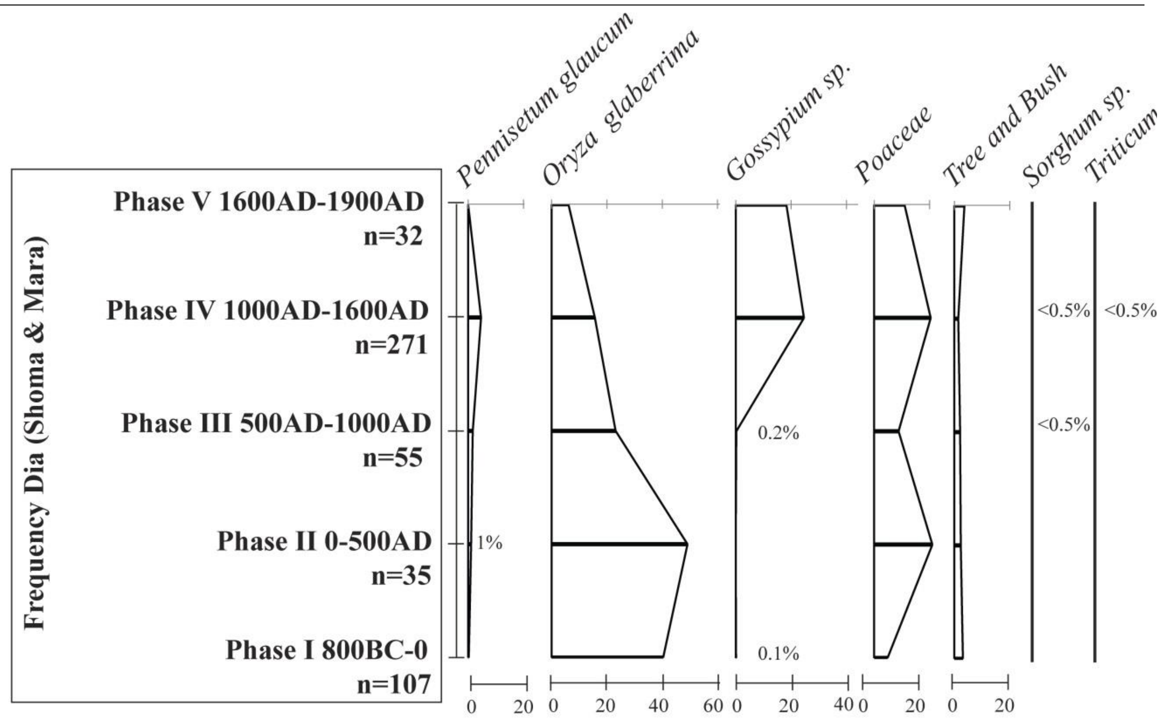


Figure 7.10 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data at Dia. 500 archaeobotanical samples composed the dataset studied here. n being the number of samples by phase. Data combined and calculated from Murray 2005 in Bedaux et al. 2005.

The site of Dia is one of the first sites of the clustered mound type to rise and prosper in the Inland Niger Delta. Dia is composed of two main mounds, Dia Shoma and Dia

Mara, separated by the modern town of Dia (Figure 7.12) (Bedaux et al. 2005, McDonald 2013). In 2011, McDonald reanalysed the available radiocarbon dates and noticed than during the two first phases two hiatuses seem to appear. Consequently, he proposed to re-attribute Phase I to 800 BC-400 BC instead of 800 BC-0 and Phase II to 200 BC-200 AD instead of 0–500 AD. Thus, according to McDonald there is a first hiatus of 200 years between phase I and II and a second hiatus between phases II and III. Additionally, he re-analysed and published a more precise description of the ceramics from Unit B (MacDonald 2011).

7.1.4.1.1. Dia Phase I – 800 BC-0 (800 BC-400BC)

The initial settlement occupation measured at least 19 ha with some early, smaller satellites sites in the vicinity (Figure 7.12). This occupation is characterised by earthen architecture with well-preserved living floors and remains of a potential roof seen through the presence of a large quantity of carbonised palm tree wood fragments. Economic subsistence was mainly based on rice agriculture (40% of the botanical assemblage), the collection of wild grasses (Figure 7.10 and Table 7-2) and livestock keeping. Currently, rice grains found in Horizon constituted the earliest evidence of domesticated African rice (*Oryza glaberrima*). Based on grain morphology (Length, Width and Thickness ratios), Murray (2005) attributed most of the archaeological grains to be domesticated.

Two ceramic traditions are present in Phase I: Delta fineware that dominated the assemblage (≈55–70%) and ceramics derived from the Faïta facies (10–12%) of the late Tichitt tradition. Some sherds of the Kobadi tradition are also noted. The Faïta facies is characterised by a thick ceramic type (2 to 5 cm) with a large diameter (30+ cm) decorated by cord-wrapped or braided cord roulette impression (Schmidt et al. 2005). The reanalysis of Unit B by McDonald (2001) allows for a more precise description. McDonald suggests that Schmidt et al. (2005) erroneously applied the label Faïta only to the large ceramic type described above, but in fact Faïta facies ceramics are more numerous than previously stated. The Horizon I ceramic assemblage combines early and late Faïta elements. Early Faïta ceramics are represented by grog tempered vessels with cord-wrapped roulette (10%). Burnished undecorated finewares (5%) and large chaff tempered ceramics with folded strip roulette (4%) are characteristic of the late Faïta. Mixed early/late Faïta ceramics are also present with medium coarse chaff tempered with braided, folded or twisted roulette (9%). The Faïta facies represent a large component of the Horizon I ceramic assemblage (≈30%). Nevertheless, the bulk of the Horizon 1 ceramics are very fine, highly fired and burnished 'Deltaware' (50%; MacDonald 2011). Deltaware ceramics were first described and found at Jenné-jeno by Susan McIntosh (1995). For MacDonald, even if they share some similarities, Deltaware ceramics are different from the Faïta finewares. Deltaware is more refined in its burnished finish and has a greater hardness than the Faïta finewares. And to conclude: *'The unexpectedly early occurrence of Deltawares between 800 and 400 BC at Dia Shoma – and their absence from the Méma (Togola 2008) – implies that their development was in the Macina region, rather than further north or south. We must continue to research, from both technical and social perspectives, why ceramics of such quality came into existence along the ancient Niger'* (MacDonald 2011:66). Deltaware apparition coincides with the first evidence of fragments of ceramic steamers (or *Couscoussières*) so far only registered in West Africa (Bedaux et al. 2005, Arazi 2005). *Couscoussière* remains an odd category of ceramic that are often overlooked as too obvious and often poorly studied or rarely mentioned.

Horizon I also shows some of the earliest evidence of metallurgy in the IND. The strong evidence for ironworking found associated with micro-lithic tools and Faïta ceramics suggests a transition from lithic technology to metallurgy. With the exception of a couple of glass and faience beads only a few indicators of long-distance trade were discovered (Bedaux et al. 2005, MacDonald 2013, Arazi 2005).

Dia Horizon I represents the largest occupation site of the Faïta facies yet known. The ceramic assemblage is composed of mixed Early and Late Faïta ceramics (other ceramic are found as well but in less quantity). Archaeobotanical remains for Horizon I (Figure 7.10, Table 7-2) are very low in those of pearl millet (0.25% of the assemblage), whereas domesticated rice remains largely dominate (40%). This clearly indicates a shift in agricultural practices and also a lack of pearl millet chaff for the tempering of ceramics.

7.1.4.1.2. Dia Phase II – 0–500 AD (200 BC-200AD)

Phase II is a period of decline where Dia was probably only intermittently occupied. Nevertheless it is during this phase than Dia-Mara was firstly occupied. For both mounds, Dia-Mara and Dia-Shoma, the maximum sizes reached 3 ha for each (Figure

7.12). The ceramic assemblage suggests relative continuity from phase I to II with more Deltaware (77%) and the Faïta facies ceramics decreased significantly. The presence of *Couscoussière*, steamer fragments also increased.

This intermittent occupation was interpreted as a response to the dramatic dry climatological conditions. For Schmidt and Bedaux, this 'big dry' was the direct cause of the intermittent Dia occupation (Bedaux et al. 2005). However, archaeobotanical evidence suggested that the period wasn't necessarily so dry. Indeed, rice represents almost 50% of the assemblage and wild grasses (15%) are dominated by *Acroceras amplectens* and *Sacciolepis*, which both grow in a humid environment, the former being a weed of rice. Moreover the proportion of rice is higher in the second phase than in the previous one. Thus around 65% of the botanical remains are composed of wetland plants. Alternatively, what Bedaux interpreted as an intermittent occupational phase could be the result of the second occupation hiatus proposed by MacDonald (2011).

This scenario provides a good example of how difficult it is to interpret climate evolution in West Africa, in particular in the Niger River Basin. Indeed, the few climatic datasets available (Chapter 1.2 Ecology and climate) seem to indicate an unstable dry climate for the period 300 BC - 300 AD (McIntosh 1998, 2005; Maley 2015). However, even a dry climate in this region doesn't necessarily mean that the Niger River itself runs dry, as rainfall in Guinea (situated in a different climate zone) can still create high floods and substantial water levels in the Niger River even if the general IND area had a dry climate.

7.1.4.1.3. Dia Phase III – 500-1000 AD.

Phase III is characterised by a homogenous soil composition with evidence for collapsed and degraded mud-brick walls, along with beaten mud living floors. The site underwent constant expansion up to a maximum extent of 13 ha at Dia-Shoma and 4 ha at Dia-Mara (Figure 7.12). The ceramic assemblage shows a decrease in Deltaware (from 77% to 55%) and the disappearance of Faïta ceramics. Rice grains also decrease (to 23%) and for the first time cotton remains (0.2%) and sorghum grains (0.5%) were recovered (Figure 7.10; Bedaux et al. 2005, MacDonald 2011).

7.1.4.1.4. Dia Phase IV – 1000–1600 AD

Dia's apogee is dated to 1000 AD when Dia-Shoma expanded to 34 ha and was partially protected by a mud-brick defensive wall. Dia-Mara reached 10 ha (Figure 7.12). The first evidence of rectilinear building made of "loaf-shaped" and rectangular mud bricks appear during this phase. Ceramic remains still show evidence for Deltaware (15%) (MacDonald 2011). As with Deltaware ceramics, rice remains continue to decrease (to 16%) and cotton jumps to 25% of the assemblage (Figure 7.10; Table 7-2) Also, Horizon IV shows the first evidence of wheat (*Triticum* sp.) (Murray 2005). The four wheat grains and the cotton remains indicate evidence of an increase in trade from North Africa across the Sahara. This coincides with evidence of wheat and cotton found at Essouk, a trade caravanserai located in the Sahara (cf. Nixon 2017, 2013, Nixon et al. 2011).

7.1.4.1.5. Dia Phase V – 1600–1900 AD

The end of phase IV is characterised by a general deterioration of both sites. This continued during Phase V after which Dia-Shoma was rapidly abandoned, while Dia-Mara was only abandoned around 1900–1950. Ceramic assemblages still have Deltawares but in smaller quantity (2%). Rice decreases (from 16 to 6%), sorghum vanishes and cotton remains highly cultivated (≈20%; Figure 7.10, Table 7-2).

7.1.4.1.6. Dia Summary

Dia is a clustered mound type site that was probably founded by Faïta population mixed with local inhabitants around 800 BC. The Faïta culture comprises chaff tempered – roulette decorated ceramics, finewares, metallurgy, pearl millet and clustered site organisation. Whereas other additions to this culture from unknown origins are domesticated rice, Deltaware and steamer ceramics. Dia's growth and development was continuous with the arrival of new crops, such as cotton and sorghum at Horizon III (Figure 7.11).

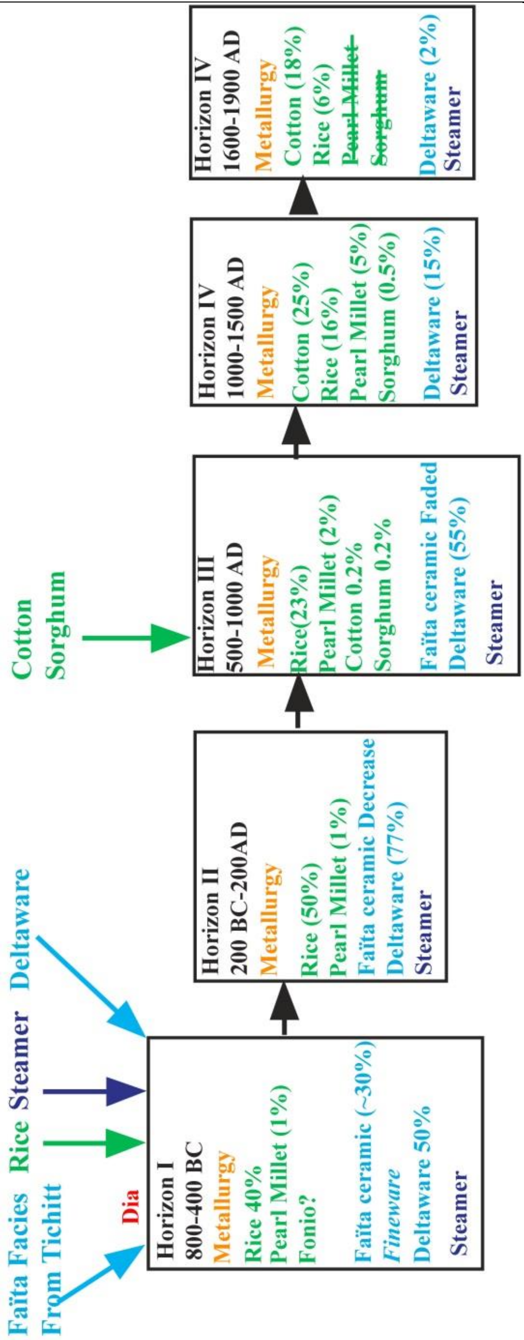


Figure 7.11 Summary of Dia archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and metallurgy (in orange).

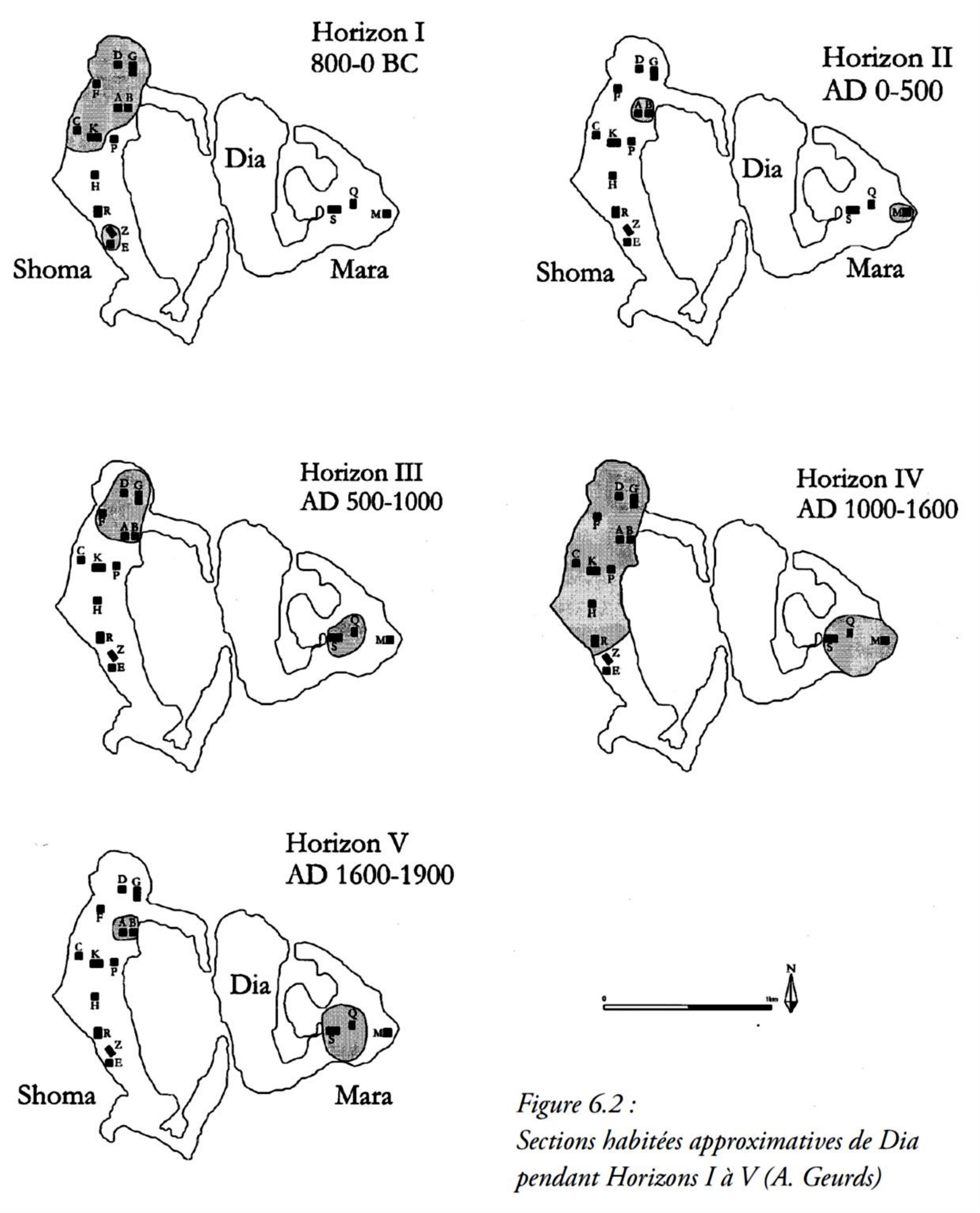


Figure 7.12 Approximate settlement area of Dia during phase I to V. (From Schmidt 2005:187 in Bedaux monograph).

7.1.4.2. Jenné-jeno and its vicinity– 250 BC-AD 1400

The site of Jenné-jeno is very similar in many ways to that of Dia, some 70 km to the northwest. Jenné-jeno's first inhabitants are believed to originate from Dia. In terms of archaeobotany, both sites' development appears to be based mainly on rice cultivation.

Jenné-jeno provided evidence of a large (up to 33 ha) clustered mounds of a Tell type site in the Inland Niger Delta. Excavators were able to establish a four-phase ceramic and cultural sequence which extended from 250 BC to 1400 AD (McIntosh S.1995).

7.1.4.2.1. Jenné-jeno Phase I/II – 250 BC- AD 400

The initial settlement (250 BC – AD100) was a 7 ha village that quickly grew to 25 ha. The subsistence economy was based on a combination of pastoralism (cattle and dwarf ovicaprids), fishing and cereal agriculture based on African rice and the collection of wild *Brachiaria*. Wild animal remains, mainly antelope, are frequent. Wild bovids, *Kobus kob,* were common during this phase but declined radically later. In terms of ceramics, the 'fineware' (also called 'deltaware'), a highly burnished, very fine paste based pottery, dominates the assemblage. This ceramic is also found at Dia during the same period. Evidence of iron working indicates interaction with areas bordering the Inner Niger Delta, since iron ore is absent from the floodplain. Architectural remains are characterised by daub-smeared pole and huts. The presence of a few glass beads indicates potential imports from the Mediterranean sphere (McIntosh S.1995, MacDonald 2013).

7.1.4.2.2. Jenné-jeno Phase III – AD 400–900

During its apogee (at the end of phase III) Jenné-jeno reached a size of 33 hectares, combining all the 25 satellite sites within a 1 km radius (including the site of Hambarketolo) it covered 69 hectares. Moreover, in a 4 km radius 65 site clusters can be distinguished, such as the 48-hectare site of Kaniana (Figure 7.13 and Figure 7.15). Together this created one of the densest settlement landscapes in the region. Occupation of these separate habitation mounds appears to have been simultaneous and continuous for at least 300 years during the first millennium AD (McIntosh R. 1993). During phase III a curvilinear earthen architectural structure (3 metres in diameter), made of cylindrical bricks, became the prevalent form of building. Also at the end of the phase circa 900 AD, a city wall was probably built, functioning more against flooding than being defensive in nature. Potsherd pavements also appear during this period, such as in Birnin Lafiya (Benin). The subsistence economy, however, appears to have remained largely unchanged (McIntosh 1995). The presence of specific smiths' settlements suggests an increase in iron working as a craft specialisation. Ceramics shift to coarser but carefully decorated painted wares. If Jenné-jeno was a site of interregional commerce, evidence of trans-Saharan trade is very sparse. Evidence for copper alloys, the nearest source being 300 km away, only appears around AD 500, while by the end of the phase gold is being brought to the site from sources some 600 km away (McIntosh S.1995, MacDonald 2013).

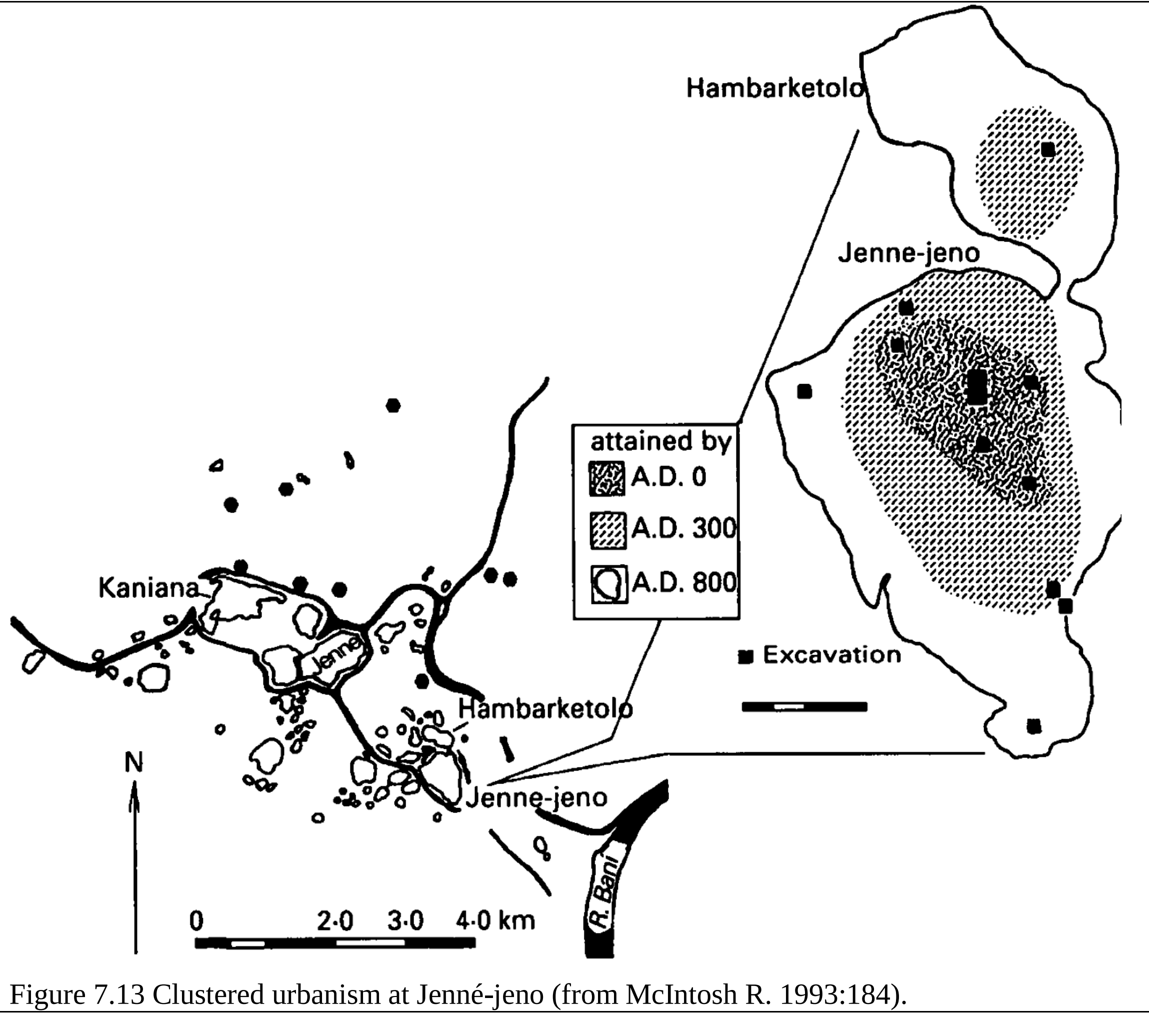


Figure 7.13 Clustered urbanism at Jenné-jeno (from McIntosh R. 1993:184).

7.1.4.2.3. Jenné-jeno Phase IV – AD 900-1400

During this period Jenné-Jeno's material culture diverges significantly from that seen at Dia. Terracotta objects appear in this phase in large quantities, whereas during the same period Dia shows very little evidence for such traditions. Phase IV also witnesses the increasing influence of the Islamic world with the advent of rectilinear structures by 1000 AD, although cylindrical houses are still present. Also, from AD 1000 North African brass is replacing bronze, with North African glass beads appearing in the stratigraphy. Moreover, evidence of sixty-four spindle whorls, coming from one unique context, may provide indirect evidence of cotton utilisation. Cotton, *Gossypium* sp., is well attested in the area by this period (Dia, Tellem) and cotton was probably imported into the area from the Islamic world at this time (see sub-chapter 8.6 Cotton).

From AD 1200 the settlement retracts in size, to eventually be fully abandoned by AD 1400 when the new settlement, a Muslim city, was founded on what was to become the modern town of Jenné.

7.1.4.2.3. Jenné-jeno Archaeobotanical remains and Discussion

Table -7-3 Ubiquity for the main crops from **Jenné-Jeno** by phases. For Jenné-Jeno, only the ubiquity is available. Data combined from McIntosh 1995

Date	**Phase I/II 250 BC-400 AD**	**Phase III 400-900 AD**	**Phase IV 900-1300 AD**	**Phase late IV 1300-1400 AD**
# samples **volume of soil (litres)**	12 ?	28 ?	21 ?	54 ?
Pennisetum glaucum (Ubiquity)	(17%)	(<1%)	(1%)	(26%)
involucre proportion	NA	NA	NA	NA
Oryza glaberrima (Ubiquity)	(83%)	(71%)	(24%)	(68%)
Spikelets base proportion	NA	NA	NA	NA
Sorghum bicolor (Ubiquity)	(1%)	(1%)	(1%)	(<1%)
Chaff proportion	NA	NA	NA	NA
***Brachiaria* sp.**	(67%)	(82%)	(100%)	(98%)
Cf. Digitaria exilis	0	(1%)	0	(7%)
Total Number	?	?	?	?
Density (Items/litre)	?	?	?	?

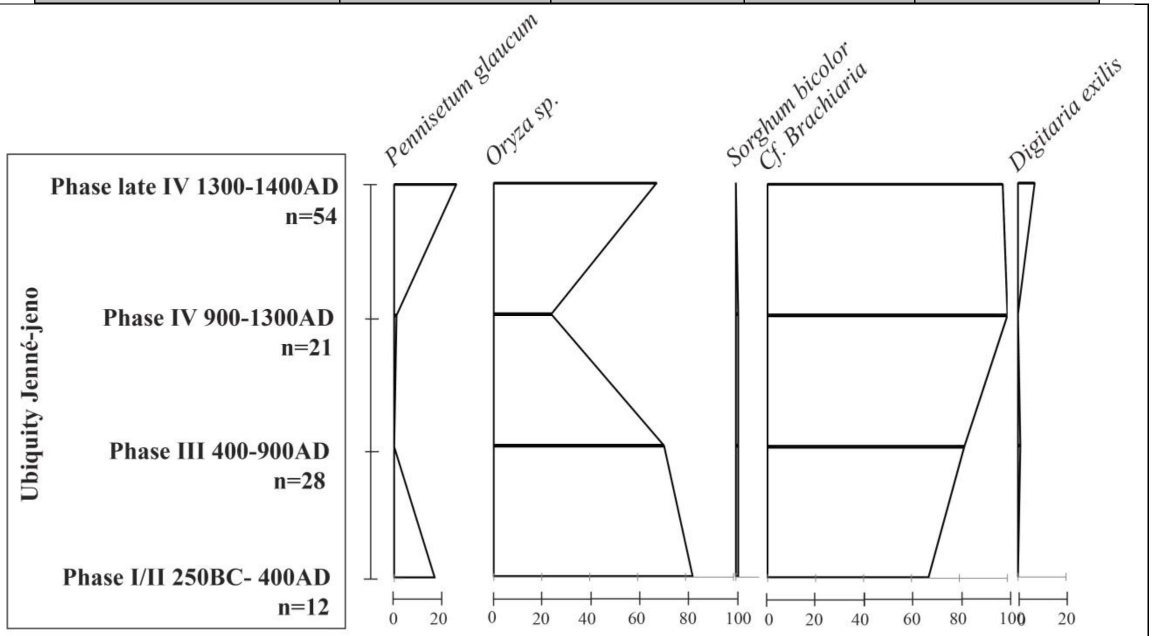


Figure 7.14. **Ubiquity** (% samples as a total of all samples by phase in which each taxon is present) for five major cereal staples at Jenné-Jeno. 115 archaeobotanical samples composed the dataset study here. n being the number of sample by phase. Data combined and calculated from McIntosh 1995.

The ubiquity presented in Figure 7.14 and Table 7-3 was calculated from three presence/absence tables initially published in 1995 (McIntosh S. 1995: 349–350). Among the 126 analysed samples, a variety of different functional contexts were selected, such as occupation floors, pits or hearths (McIntosh S.1995). At this point only presence and ubiquity was available for the Jenné-jeno assemblage, although perhaps in the future relative frequency will also be published.

Figure 7.14 and Table 7-3 indicates that Jenné-jeno agriculture was based mainly on wetland plant cultivation and complemented by those of dry land cultivation. Indeed, the archaeobotanical assemblage is largely dominated by samples that contain domesticated rice (*Oryza glaberrima)* and wild *Brachiaria* cf. *ramosa*. As noted by J. Scheuring[9], the rice assemblage is mainly composed of *Oryza glaberrima*, but its wild form, *Oryza barthii* is also present (but without the frequency data), and it is not yet possible to establish the potential distance from the domestication area, which remains undetermined (cf. Chapter 4). *Brachiaria* cf. *ramosa* is an annual wild grass that grows in very similar ecological conditions to floodplain rice (but not deepwater rice). In India a form of *B. ramosa* was domesticated and widely cultivated (Kingwell-Banham and Fuller 2014), but it also occurs as a weed of rainfed rice, and has sometimes been dicussed as a domesticated form of rice weeds (Kimata et al 2000 cited in Kingwell-Banham & Fuller 2014). Therefore at Jenne-jeno *B. ramosa* could perhaps be considered a weed of rice that was harvested at the same time as rice, and then consumed after being processed out of the rice crop. Indeed, *Echinochloa colona* and *Brachiaria ramosa* are still largely collected on a large scale in the Niger Valley during rice harvesting (Boré 1983). It should be noted that morphologically this species is very close to *Brachiaria deflexa*, so the extent to which this taxon has been clearly differentiated from black fonio ought to be reinvestigated, although traditional distribution of black fonio does not include cultivation or consumption in the IND (Chapter 8.3 Fonio).

The second sets of agricultural practices are related to the cultivation of dry plants such as pearl millet (*Pennisetum glaucum*) and fonio (*Digitaria exilis*). Pearl millet is present from the earlier phase (Figure 7.14 and Table 7.3), even though it seems to vanish

[9] J.Scheuring, Y. Boré and J. Harlan identified the seed from the assemblage for S. McIntosh (1995)

during period III and early in period IV, where fonio appears in larger quantity during the last hundred years of the site's occupation. As we will see later, fonio, in the Niger River Valley, is often more common on settlements during their final phases and just before the site's abandonment. The presence of sorghum, a décrue cereal is also notable, but only present in very small quantities. Harlan has identified in Jenné's assemblage two types of sorghum: race bicolor (a hulled form) and race caudatum (a free-threshing form) (on the differentiation of sorghum races, see Fuller and Stevens 2018).

This assemblage is consistent through time. For S. McIntosh, this subsistence stability is interpreted as a lack of agricultural intensification and *'[i]n view of the staggering population increase that took place in the immediate vicinity of Jenné in the first eight centuries of our era, the lack of any sign of subsistence intensification is astonishing'* (1995:377). However, just using the available data is not, in my opinion, enough to prove either an absence or increase in agricultural intensification. Nevertheless, with the appearance of fonio in phase IV and the indirect evidence of cotton we could state that there is at least evidence for eventual diversification and extensification.

Jenné-jeno also provided indications for several other specialisations including iron, pottery (likely two traditions), both deep and shallow fishers, pastoralists, and wet and dry cultivators. These different specialists lived in symbiotic relations as materialised by regular exchange of their products and services. As shown in the methodology chapter, charred household remains mostly represent daily activities. However, due to their small size archaeobotanical remains easily migrate through the archaeological matrix or are disposed of as waste unless preserved in sealed contexts such as hearth features. Thus, the interior settlement spatial patterns are poorly distinguishable through charred archaeobotanical remains.

In conclusion, Jenné is a cluster mound site that grew quickly to reach the size of 33 ha (without including associated smaller sites in the vicinity). The village and the town lasted for 1650 years without major change.

7.1.4.3. Tato à Sanouna and Thièl (250 BC-AD 1400)

In the vicinity of Jenné-jeno are the sites of Tato à Sanouna and Thièl which were recently excavated by Abigail Chipps Stone of Washington University in St. Louis for her PhD[10] (Stone 2015). The site of Tato à Sanouna is a small site of 2.3 ha located on the Bani River Bank, 3.5 km southeast of Jenné-jeno. It is a tell-type site, roughly 3 metres high. The site of Thièl, as well, is a 5 ha tell-type site located on a sandy dune 7.5 km northwest of Jenné-jeno (Figure 7.15). Both sites are very similar to Jenné-jeno with respect to the stratigraphy, architectural remains, ceramic décor and shape, iron evidence and faunal remains and all correspond very well with the archaeological phases found at Jenné-jeno; although a few exceptions to these similarities are to be found between these sites. Rectilinear banco walls in Tato à Sanouna predate the one recorded at Jenné by 400–500 years. Also, the first settlement at Tato à Sanouna may be a little earlier than at Jenné. However, this is difficult to ascertain as the only radiocarbon date undertaken fell within the Iron Age radiocarbon plateau, such that the bottom of unit SO is only broadly dated to 750 BC to 130 AD (2170±150 BP). The evidence of early occupation (Phases I/II 250 BC-400AD) in both sites indicates that many sites in this area, and not just Jenné, were occupied from this early period. Thus it is becoming clear that Jenné-jeno is not a solitary pioneering settlement. On the contrary, the area seems to have been largely settled more or less around the same time. This has an important impact on our understanding of the origins of urbanism and development in the area.

[10] Stone, Abigail Chipps, ‘Urban Herders: An Archaeological and Isotopic Investigation into the Roles of Mobility and Subsistence Specialization in an Iron Age Urban Center in Mali’ (2015). *Arts & Sciences Electronic Theses and Dissertations*. 487. https://openscholarship.wustl.edu/art_sci_etds/487

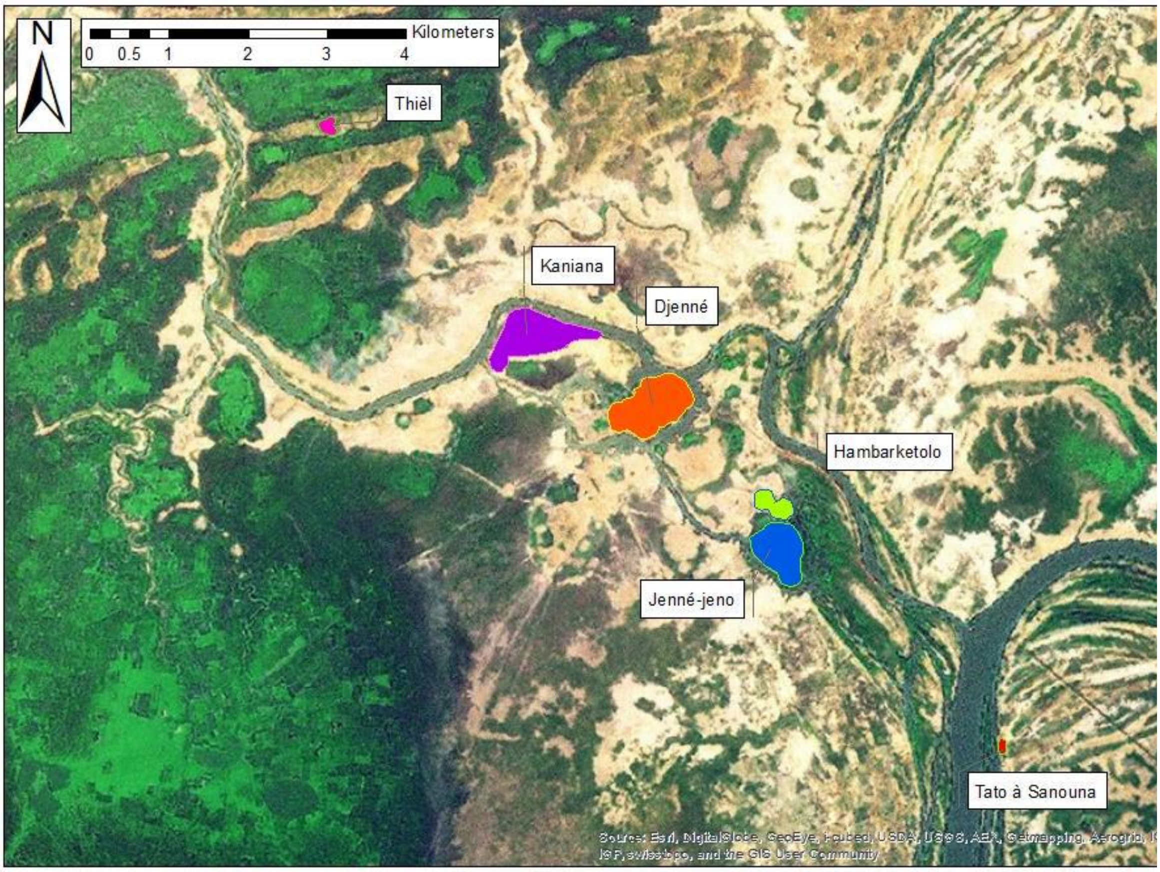


Figure 7.15 Excavated sites near Jenné-jeno. Thièl, Tato à Sanouna and Jenné-jeno were sampled for archaeobotanical studies. (from Stone 2015:6)

Unlike at Jenné-jeno, archaeobotanical data was obtained at both sites (Murray 2015 in Stone 2015), which allowed for the calculation of relative frequency of remains by phase (Figure 7.16 and Table 7-4). In total, 224 samples from 6 litres were floated. Among those samples 57 were totally devoid of any plant remains. As in Jenné-jeno, the archaeobotanical results suggested that the earliest inhabitants of both sites arrived with a fully domesticated package; comprising African rice, pearl millet, sorghum and potentially fonio. The category *Poaceae* (Figure 7.16) is composed of wild grasses and rice weeds remains which largely dominated this group. Also, there is no major fluctuation throughout the sequence. The only changes appeared during phase V, a reoccupation but undated phase, which suggests the abandonment of pearl millet and sorghum, but with predominance of tree and shrubs remains. All through the sequence *Digitaria* sp. is consistently present and appeared in large quantities (15–20% of the assemblage). For their identification Murray (2015:232) mentions that *'Due to their small size (roughly 1 mm in length) and variability, determination of ancient grains to one or other of these species* [*Digitaria exilis*, (fonio) or *Digitaria iburua* (iburu or "black fonio")] *can be difficult, so they remain identified to the genus level'*. Rice remains are exclusively composed of grain, or grain fragments, thus their identification as domesticated was done by grain dimensions in comparison with modern material (See Murray 2004 for modern dimensions). Surprisingly, only 13 seeds of *Brachiaria* were discovered. With the presence of *Digitaria* at each phase from the beginning of the sequence, this is somewhat divergent from the pattern found at Jenné-jeno (Figure 7.14), where *Brachiaria* clearly dominates the assemblage and *Digitaria* appears only around 1300–1400 AD (Late phase IV). Thus, leading one to ask if this is a reflection of the actual assemblage or due to different identification practices with regards to the challenging categories of small millets?

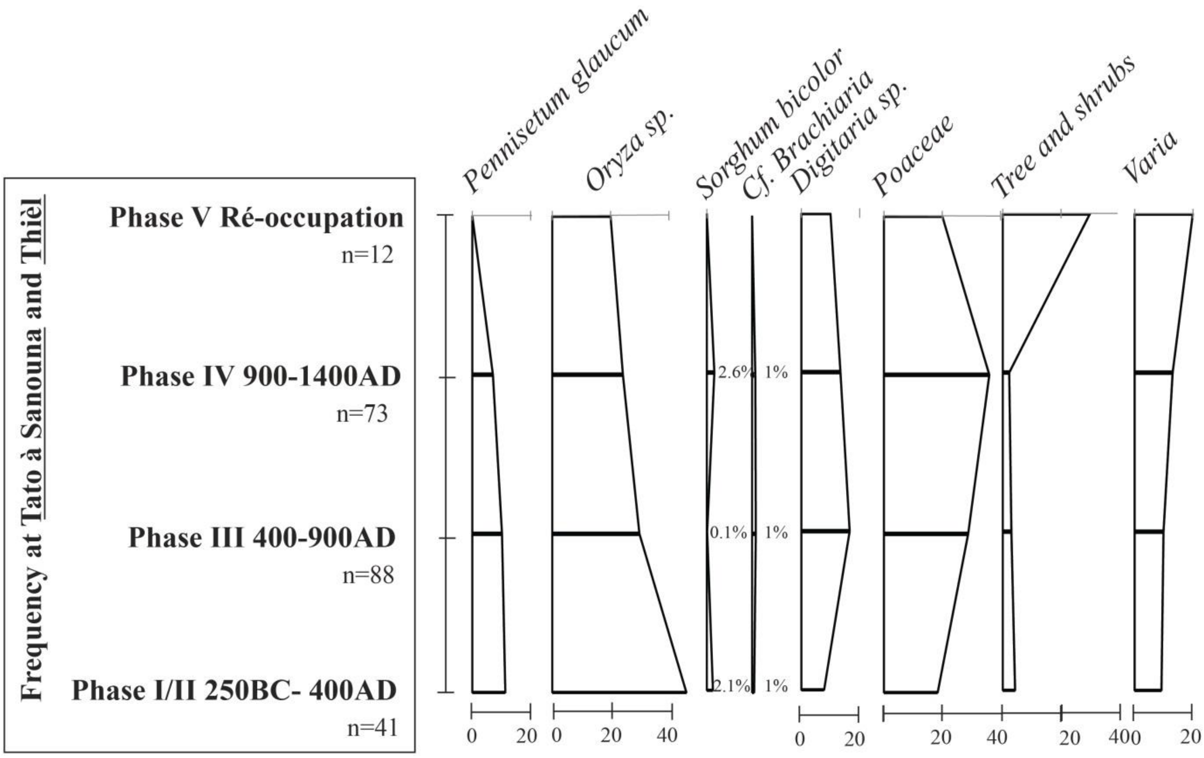


Figure 7.16 **Frequency** (% remains of any individual species as a comparison of the whole assemblage) for the archaeobotanical data at Tato à Sanouna and Thièl. 224 archaeobotanical samples from 6 litres of soil from each sample (for a total of 1344 litres) comprise the dataset present here. n being the number of samples by phase. Data combined and calculated from Murray S. 2015 in Stone 2015.

Table 7-4 Number of items recovered and Frequency for the main crops from **Jenné-jeno vicinity (Thièl and Tato à Sanouna)** by phases. The ubiquity is not available. Data combined from Murray s. in Stone 2015

Date	**Phase I/II 250 BC-400 AD**	**Phase III 400-900 AD**	**Phase IV 900-1300 AD**	**Phase late IV 1300-1400 AD**	**Total**
# samples volume of soil (litres)	41 246	88 528	73 438	12 72	224 1344
Pennisetum glaucum Frequency	16 11%	72 10%	19 7%	0	107 10%
involucre proportion	NA	NA	NA	NA	NA
Oryza glaberrima Frequency	65 46%	211 30%	65 24%	2 20%	343 31%
Spikelets base proportion	NA	NA	NA	NA	NA
Sorghum bicolor Frequency	3 2%	1 <1%	7 2.6%	0	11 1%
Chaff proportion	NA	NA	NA	NA	NA
***Brachiaria* sp.**	1 1%	9 1%	3 1%	0	13 1%
Cf. Digitaria exilis	11 8%	117 17%	36 13%	1 10%	165 15%
***Tree/bush* (fruit)**	6 4%	21 3%	6 2%	3 30%	36 3%
Total Number	141	705	268	10	1124
Density (Items/litre)	0.6	1.3	0.6	0.1	0.8

7.1.4.4. Toguéré Galia and Toguére Doupwil

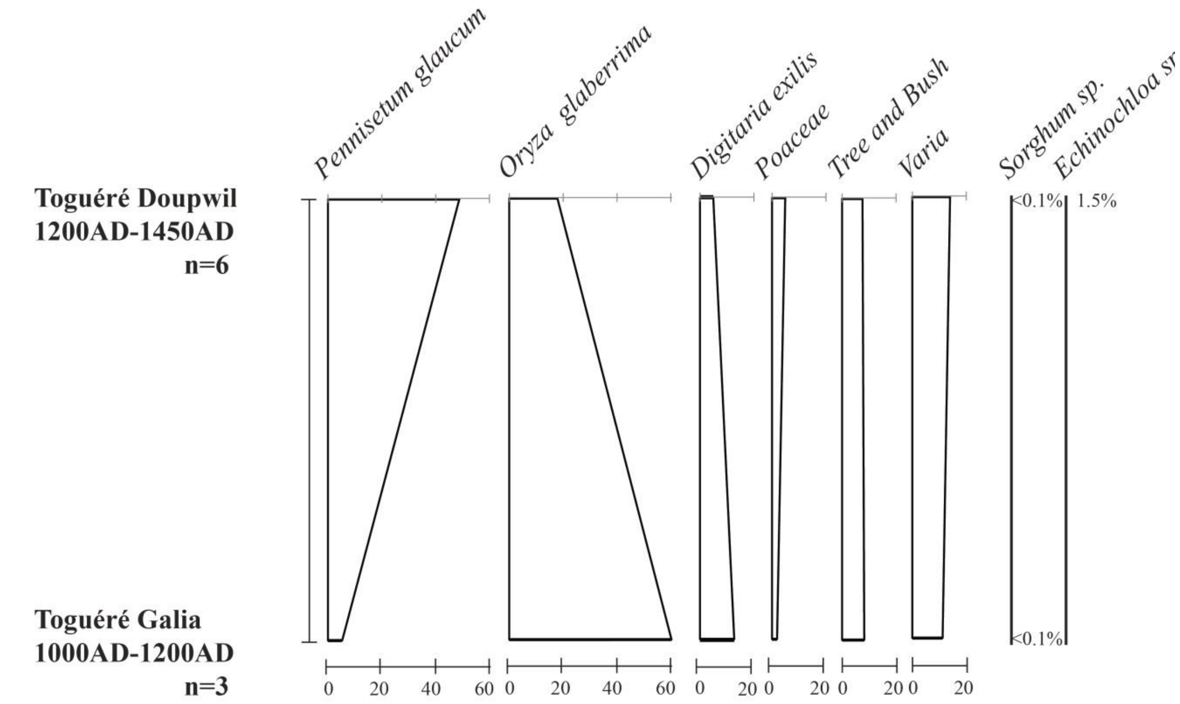


Figure 7.17 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data at Toguéré Doupwil and Toguéré Galia. Nine archaeobotanical samples from 70 litres of soil comprise the dataset present here. n being the number of samples by phase. Data combined and calculated from Bedaux et al. 1972.

Toguéré Galia is a tell site located on the Bani River, twelve kilometres from Jenné and six kilometres from Tato à Sanouna. Toguéré Doupwil is a settlement mound of 8 ha located on the Niger River bank near Mopti. Both sites are settlement mounds that were initially occupied around 1000 – 1100 AD, but structural remains were only identified in layers dated to 1300 – 1400 AD. Toguéré Doupwil was abandoned before 1600 AD while Toguéré Galia was occupied until 1700 AD. The foundation of both sites has been attributed to migration of Jenné-jeno inhabitants. The material culture of both sites is very similar and homogenous through time, as demonstrated by continuous funerary practices, but with no substantial evidence of trade. Both sites presented rectangular buildings made of cylindrical mudbrick as at Jenné-jeno and Tato à Sanouna. Ceramic vessels share various characteristics with Jenné phase IV ceramic that include chaff tempered fabric and roulette, mainly folded strip roulette and decoration (Bedaux et al. 1978, Arazi 2005). The subsistence economy was based on agriculture, deep and shallow fishing, hunting and herding cattle, sheep and goats. Both site's chronologies are uncertain at points but the archaeobotanical assemblages can be associated with two chronological periods. The first roughly dated to 1000 – 1200 AD and attributed to

Toguéré Galia. The second dated to 1200 – 1450 AD from Toguéré Doupwil. The botanical assemblages clearly show agricultural practices were based on rice and pearl millet cultivation but additional crops such fonio (≈15%) and sorghum (0.1%) were also being cultivated (Figure 7.17). Wild Poaceae were also gathered but in a small proportion (≈5%). Also, the wild grasses (Poaceae) could have been collected during the harvesting of rice and fonio as weeds of these crops. However, the author (Bedaux 1972) notes that a large quantity of other carbonised seeds was recovered but not identified or included in the final published table. However, in summary, we can say that agriculture represented a large part of the people's subsistence activities from both sites at Toguéré.

Table 7-7-5 Number of items recovered, Frequency and (Ubiquity) for the main crops from **Toguéré Galia and Toguéré Doupwil** by phases. First line is the total number of items and second line gives frequency followed by (ubiquity). Data combined from Bedaux et al. 1972

Date	**T. Galia 1000-1200 AD**	**T. Doupwil 1200-1450 AD**	**Total**
# samples **volume of soil (litres)**	3 22.5	6 45	9 67.5
Pennisetum glaucum Frequency (Ubiquity)	14 5% (33%)	129 49% (89%)	143 27%
involucre proportion	NA	NA	NA
Oryza glaberrima Frequency	161 60% (68%)	47 18% (79%)	208 39%
Spikelets base proportion	NA	NA	NA
Sorghum bicolor Frequency	1 <1% (33%)	1 <1% (16%)	2 <1% (22%)
Chaff proportion	NA	NA	NA
Digitaria exilis	34 13% (?)	13 5% (?)	47 9% (?)
Poaceae	5 2% (?)	13 5% (?)	18 3.5% (?)
Echinochloa sp.	0	4 1.5% (?)	4 <1%
***Tree/bush* (fruit)**	30 8% (100%)	37 8% (100%)	67 8% (100%)
Total Number	267	264	531
Density (Items/litre)	11.8	5.8	7.8

7.1.4.5. Jenné vicinity summary

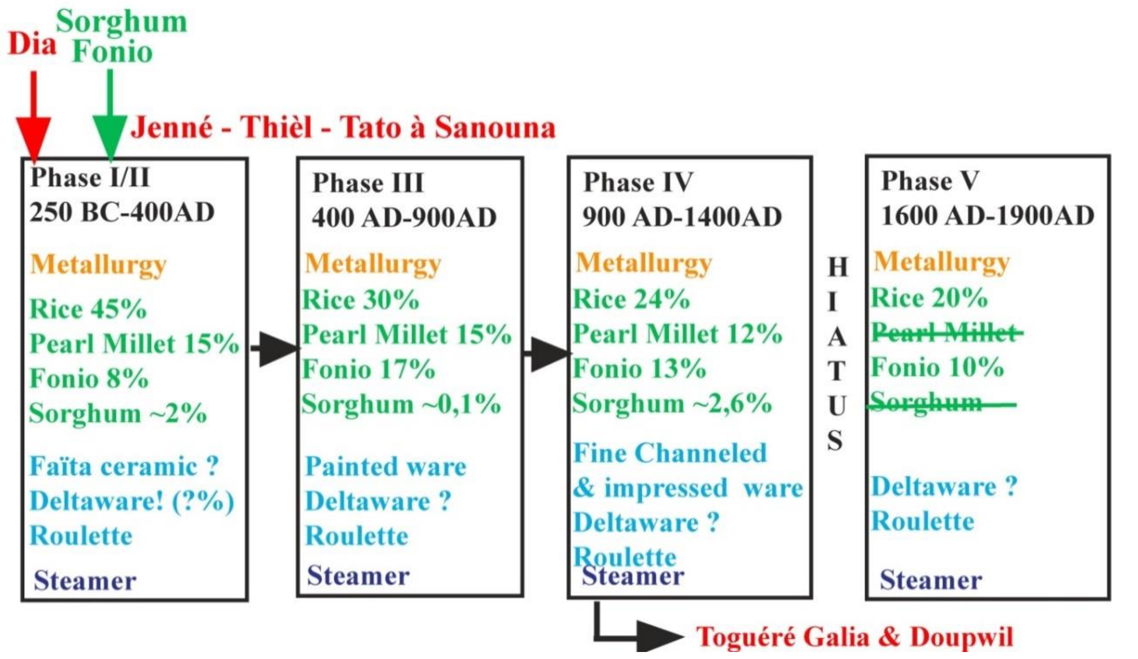


Figure 7.18 Summary of Jenné region (Jenné –Thièl – Tato à Sanouna sites) archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and technology (in orange).

The Jenné region was densely occupied from 250 BC. Indeed, the early occupation of Thièl and Tato à Sanouna also dates to 250 BC and indicates that Jenné wasn't the first centre from where the population started to colonise the region. It is likely that the region was probably settled in several places simultaneously and no centre has yet been identified which offers support to the theory of a heterarchical organisation.

The emerging archaeological evidence increasingly indicates that Jenné was not the most important central place or market from which position arose the creation of a surrounding hinterland. It would appear that this is an archaeological mirage (for instance, the neighbouring sites of Kaniana and Hambarketolo are larger in size than Jenné but haven't received the same archaeological attention).

All the sites from the Jenné area share very similar patterns. They were composed of a large urban and complex landscape of clustered sites. Five of them were sampled for archaeobotanical remains and the results showed very similar frequencies for each site. Indeed it seems that people mainly cultivated rice along with pearl millet, fonio and sorghum but in lower frequencies. The earthen architectural buildings were made of cylindrical bricks.

Iron slag was not recovered in large quantities in any of the sites investigated. This is probably due to the lack of demand for agricultural tools: in contrast with pearl millet, and dry agriculturalists, rice growers use a wooden paddle and a small boat and only require iron axes and adzes for carving their wooden tools.

7.1.5 Middle Niger

7.1.5.1 Gao (600 AD – 1600 AD)

The site of Gao is formed of several settlement mounds: Gao Saney, which measures 32 ha, Gao Gadei and Gao Ancien. Gao Saney is dated between 650 AD and 1200 AD. The archaeological sequence outlined by Insoll (1996, 2000) is organised into fives phases dated from 600 AD to 1500/1600 AD. Recent excavations by a Malian team revealed two extensive buildings in stone. Within these structures a considerable quantity of exotic goods such as 6000 glass beads and glass fragments were discovered. This was initially interpreted as an elite or even a royal residence, but more recently all the sites of Gao have been re-interpreted as a composite group of mercantile and manufacturing sites. In terms of ceramics, the assemblage at Gao Saney was homogenous throughout the sequence. Decoration is dominated by comb impressions and geometric patterns but roulette and mat impressions are also found, but in smaller frequency. At both Gao Saney and Gadei, fragments of *Couscoussière* are found from 700 AD to 1600 AD. Surprisingly, faunal remains are dominated by sheep and goat remains. Cattle are also found, but in much smaller quantity. Fish represented the smallest part of faunal remains recovered. In terms of archaeobotanical analysis (Table 7-6), 26 samples were analysed from Gao Saney. One sample and *in situ* finds constitute the smaller assemblage from Gao Gadei. At Gao Saney, D. Gallagher identified remains of pearl millet and rice. The rice remains comprise two fragments of rice chaff from the 900-1200 AD layers. Some fragments of trees and shrubs were also found (Cissé et al. 2013). At Gao Gadei in the last occupation phase, 1400–1550 AD, D.Q. Fuller found some rice remains in the form of chaff, spikelet bases and one grain fragment. One unique pearl millet seed, some cotton seed fragments, date palm and watermelon seeds were also identified (Fuller 2000).

Site	Datation	*Pennisetum glaucum*	*Oryza glaberrima*	*Ziziphus sp.*	*Tree and shrubs*	*Gossypium sp.*	*Citrillus lanatus*	Table 7-6.Presence/absence of fruit and seed remains from Gao Saney and Gao Gadei. From Cissé et al. 2013 and Fuller 2000.
Gao Saney	900-1200 AD	x	x		x			Cissé et al. 2013
	650–900AD	x		x	x			
Gao Gadei	1400–1550AD	x	x	x	x	x	x	Fuller 2000

7.1.6 Burkina Faso

7.1.6.1Oursi Region (2000 BC – 1950 AD)

The Oursi region is situated in the Dune area of North-West Burkina Faso. This region is located around 100 Km West of the Niger River, forming the edge of its basin.

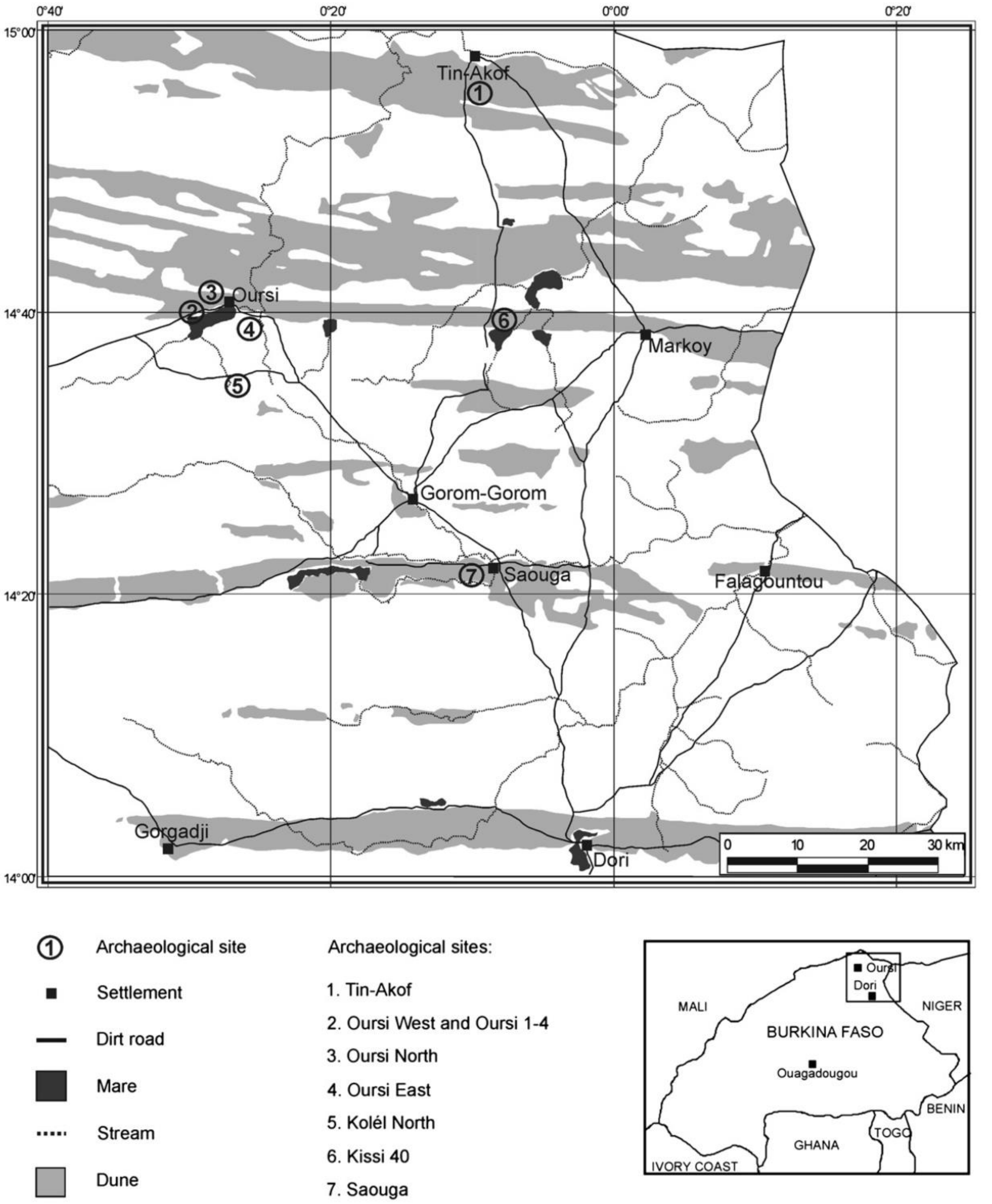


Figure 7.19. Location of the archaeological sites in the Dune area of North-West Burkina Faso. (From Höhn and Neumann 2012:73. Sites described in the text are Tin-Akof, Oursi North and West and Gorom-Gorom.

Table 7-7 Number of items recovered and species frequency for the main crops from **Oursi area** by phase. First line is the total number of items and second line gives the species frequency. For Kirikongo, the ubiquity is not available. Data combined from Kahlheber 2004

	Tinakof and Oursi West Cal.BC			Oursi West and North Cal.AD			
Date	2000-1500	1500-900	400-200	0-500	500-1000	1000-1400	Total
# samples **volume of soil (litres)**	2 737	7 1897.5	4 400	19 1900	8 800	7 700	47 6424.5
Pennisetum glaucum Frequency	5 2.6%	30 16%	492 78.5%	38408 83%	38824 70%	45811 79%	123570 77%
involucre proportion							
Sorghum bicolor Frequency	0	0	0	0	6 <1%	55 <1%	61 <1%
Chaff proportion	-	-	-	-	0	0	0
Vigna unguiculata	0	0	0	20 <1%	108 <1%	79 <1%	207 <1%
Poaceae	8 4%	23 12%	6 1%	659 1.4%	4500 8%	1985 3.4%	7181 4.5%
***Tree/bush* (fruit)**	58 30%	103 55%	95 15%	3376 7%	4247 7%	2575 4.5%	10454 6%
Total Number	190	188	627	46073	55122	57750	159950
Density (Items/litre)	0.25	0.09	1.6	24.2	69	82.5	25

In the 90's, this area was the subject of intense surveys and excavations by a multidisciplinary team from Frankfurt University (see Vogelsang et al. 1999, Breunig and Neumann 2002, Czerniewicz 2002, 2004). The project found hundreds of sites, some of which were excavated. This section will discuss the sites sampled for archaeobotanical purposes. The botanical analysis was performed by Stephanie Kahlheber (2004). Excavations in Oursi region exposed multiple sites with archaeological occupation from 2000 BC to 1950 AD. The temporal sequence is split into three main periods intercut with some occupational hiatuses: Final Stone Age (2000 BC – 900 BC), Iron Age (400 BC – 1400 AD) and historic period (1900 – 1950 AD).

Final Stone Age – Tin-Akof (2000 BC – 900 BC)

Visible sites appear during the final Stone Age, with the sites of Dori and Tin-Akof dated to the second millennium BC. Tin-Akof and other final Stone Age sites were probably established by southward population movements from the desiccating Sahara. The sites were interpreted as seasonal hunter-gatherer or agro-pastoralist (there is evidence for cultivated pearl millet) camps that were formed from shallow archaeological artefact accumulation (maximum 40 cm of deposits). At Tin-Akof, the composition of finds is a mix of ceramic and lithics. Bifacial flint arrows and polished axes are typical lithic artefacts found during excavation. Some grinding stones, probably used for pearl millet preparation, were discovered as well. Ceramic vessels are usually made of organic chaff temper decorated with mat and roulette impression (Vogelsang et al. 1999; Höhn and Neumann 2012). The faunal assemblage doesn't show any clear evidence of the presence of domesticated animals, but wild game and fish remains are present (Linseele 2007).

The Final Stone Age of Tin-Akof is split in two sub-phases. In terms of archaeobotanical remains (Figure 7.20) both sub-phases are represented. The first one from Tin-Akof is dated to 2000 BC – 1500 BC and the second, seen from the upper part of Tin-Akof section and the bottom half of the Oursi West trench (below 480 cm), is dated to 1200 – 900 BC. Macro-botanical remains indicate that subsistence during the Final Stone Age was based on the collection of wild grasses (< 12%) and gathering of tree fruits. Indeed both periods are largely dominated by fruits of trees and shrubs remains (more than 70% of the assemblage) and especially by baobab, *Adansonia digitata*, fruit fragments (25% to 35% in the second period). Pearl millet is the only domesticated remain found in these samples with its frequency increasing from the first (≈3%) period to the second (≈16%). However, pearl millet remains alone do not confirm its cultivation, and it may potentially have been collected from the wild along with other grasses. As most of the fruits found in Tin-Akof ripen during the end of dry season, it has been suggested that the site was only occupied from February to May (Chapter 9, figure 9.5). Furthermore charred wood remains are mainly composed of species whose fruits ripen exclusively during the rainy season, but yet fruits of these species are absent. This suggests that the populations that occupied Tin-Akof occupied other encampments during the rainy season, which is also the most important period for pearl millet cultivation (Höhn and Neumann 2012, Kahlheber 2004). Wood charcoal analysis also indicates that agriculture was not heavily practiced. Indeed, most of the taxa (91%) represent a Sudanian vegetation specific to sandy dunes: savannah trees that grow on the dune and riparian vegetation that are found at the foot of dunes. Also, the rest of the species recovered (8%) belong to the natural savannah. Some of these trees become dominant on fallows in an agricultural system with shifting cultivation (Höhn and Neumann 2012).

Iron Age – Oursi West and North (400 BC – 1400 AD)

From around 400 BC at Oursi West, and from the start of our era for the entire region, a totally new settlement system appeared. This period corresponds with the beginning of the Iron Age. The period is characterised by the development of large numbers of settlement mounds associated with a high levels of iron production, and large amounts of pottery. Archaeological excavations have revealed occupational deposits five to six metres deep. Iron production in the form of slag mounds, tuyères fragments or furnaces are also well attested in all the sites of the region. The chronological stylistic variation in the ceramic types allows for three periods to be distinguished: Early (0–500 AD), Middle (500-1000 AD) and Late Iron Age (1000–1400 AD). Large thick storage pots are present throughout the sequence. These large pots are exclusively decorated with roulette impression (Vogelsang et al.1999; Vogelsang 2000, Höhn and Neumann 2012).

Interphase – Oursi West (400 – 200 BC)

The preceding Stone Age phase is followed by a hiatus of around 500 years during the first millennium BC, lasting from around 900 to 400 BC, followed by an interphase of around 200 years. This hiatus is directly observable between 440 and 470 cm depth within the Oursi West archaeological section. The interphase material culture dating from 400-200 BC is similar to that from the succeeding Early Iron Age. Archaeobotanical analyses shows that pearl millet agriculture is already well-established at this point. Indeed pearl millet comprises around 80% of the total assemblage. Wild grasses have almost vanished, only *Dactyloctenium aegyptium* (1%) is still gathered. The rest of the botanical evidence are from Marula tree fruit, *Sclerocarya birrea* (5%), and Baobab, *Adansonia digitata* (1%) (Kahlheber 2004).

Early Iron Age – Oursi North and West (0–500 AD)

The Early Iron Age ceramic assemblage is characterised by everted-rimmed pottery types mainly decorated with comb, mat and roulette impression. Red slip pottery is also found. Botanical remains come from Oursi West (from 0 to 400 cm depth) and Oursi North (under 750 cm) (see Figure 7.20). Also, presence/absence analyses are available from two other sites, Oursi 1 and Kissi 22. The botanical assemblage remains consistent. Pearl millet still largely dominates (83%), but cowpea (*Vigna unguiculata*) and Bambara groundnut (*Vigna subterranea*) also appear at this time. Both species are represented as *Vigna* sp. in Figure 7.20. In modern times, cowpea and pearl millet are commonly grown together. Indeed, *Vigna unguiculata* has a better growth development under the shade of pearl millet (Kahlheber 2004, Höhn and Neumann 2012). Also, the combination of cereals and legumes contribute to increase yields because legumes enrich the soil by producing bacteria that fix nitrogen (Neumann 2018). However, Bambara ground nuts need more water, and today are usually found in irrigated gardens. Around the 16th century AD the use of Bambara ground nuts faded as profit for peanut cultivation, introduced from the American continent by European peoples, increased. During the Early Iron Age, fruit remains of *Vitellaria paradoxa* are also attested. *Vitellaria paradoxa* kernels are used to prepare Shea butter or Karité well known for cooking (Kahlheber 2004, Höhn and Neumann 2012).

For the following sub-phase, with the exception of ceramic change, the same agricultural pattern is observed. The **Middle Iron Age (500-1000 AD)** at Oursi North **(**750-350 cm in the stratigraphy) is characterised by a fibre roulette ceramic decoration that increases in frequency. In terms of botanical remains, *Sorghum* sp. appears for the first time, but in very low quantity (<0.5%). Devisse (1988) has posited that the small quantity of sorghum suggests evidence of trade rather than illustrating agricultural practices (Devisse 1988).

The **Late Iron Age (1000–1400 AD)** finds at Oursi North (from 350 cm of depth) suggest continuity from the preceding period. The ceramic assemblage is composed of a large variety of roulette type decoration with the mat impression décor almost disappearing at this point. Also, this period coincided with the arrival of larger ceramic vessel varieties such as the tripod and the *couscoussière* (Czerniewicz 2002, 2004, Kahlheber 2004). This suggests the utilisation of new cooking practices that probably came from the Inland Niger Delta. Indeed, so far the earliest examples of couscoussière fragments are from Phase I/II at Jenné-jeno (250 BC – 400 AD) and from phase II at Dia.

Historic period – Gorom-Gorom (1900 – 1950 AD)

Botanical remains for the Historic period were recovered from the site of Gorom-Gorom. The presence/absence botanical analysis (Figure 7.20) revealed that the previous package (pearl millet and cowpea with very little sorghum) was still being cultivated.

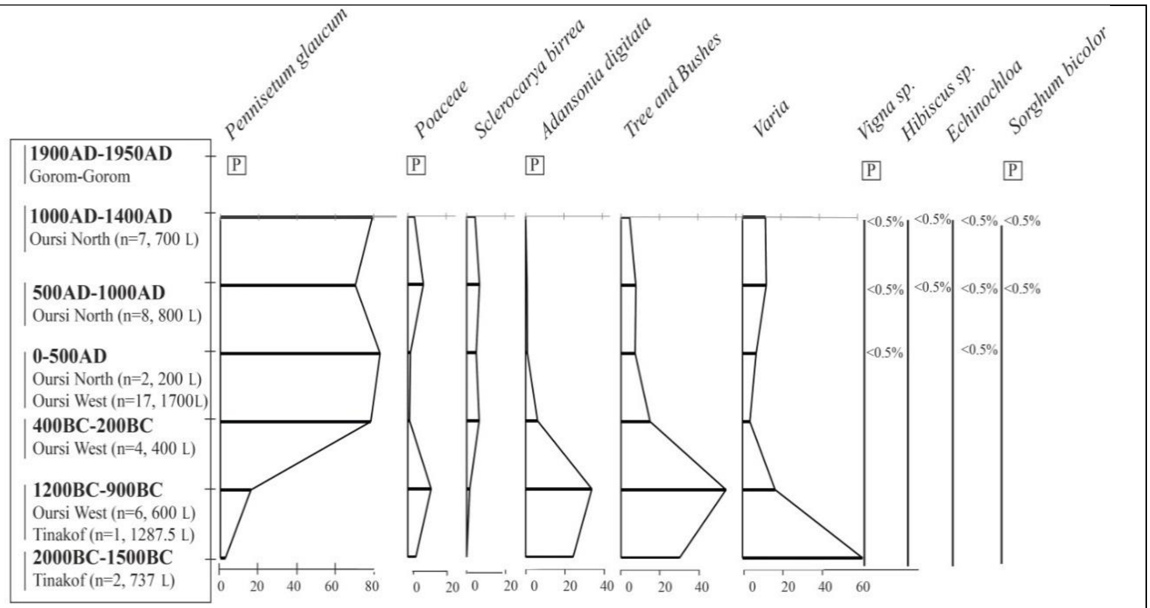


Figure 7.20. **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data from Oursi area in North-west Burkina Faso. 47 archaeobotanical samples for 6424.5 litres of soil comprise the dataset study here. n being the number of samples by phase. The data from Gorom-Gorom are available only by presence. Data combined and calculated from Kahlheber 2004.

To summarise, early Stone Age inhabitants probably comprised of seasonal agro-pastoralist groups, who were coming into this zone during the dry season and hunting wild animals and cultivating pearl millet. These groups also had ceramics with roulette impression decoration. Between 900 BC and 400 BC there is no evidence of any human occupation. From 400 BC permanent settlement mounds start to appear and grow. Economic subsistence is based on pearl millet cultivation, and cowpea was added to this agricultural system around 1 BC/AD. Ceramics consisted of a mix of comb, mat and roulette impression styles. Around 1000 AD couscoussière pots appeared. After a further hiatus, between 1400 AD and 1900 AD, the same pattern is observed until the present. As with most West African sites the area was abandoned around 1400 AD.

Throughout all the sequence, fruit and wood charcoal remains of *Adansonia digitata, Sclerocarya birrea*, *Balanites aegyptiaca*, and *Vitellaria paradoxa* suggest the presence of an agro-parkland system. Charred wood results illustrate that cultivation intensified throw all the sequence. Settlement activities and cultivation increased considerably during the course of the Iron Age. Indeed, the results indicate that fields and fallow systems, the typical system for this cultural landscape, was increasing. This cultural development is observed by the decrease of *Acacias* and the increase of *Combretaceae.* The Natural acacia savannah on the dune was replaced by a system of fields and fallows. The result is that Combretaceae and other parkland species increased (Höhn and Neumann 2012).

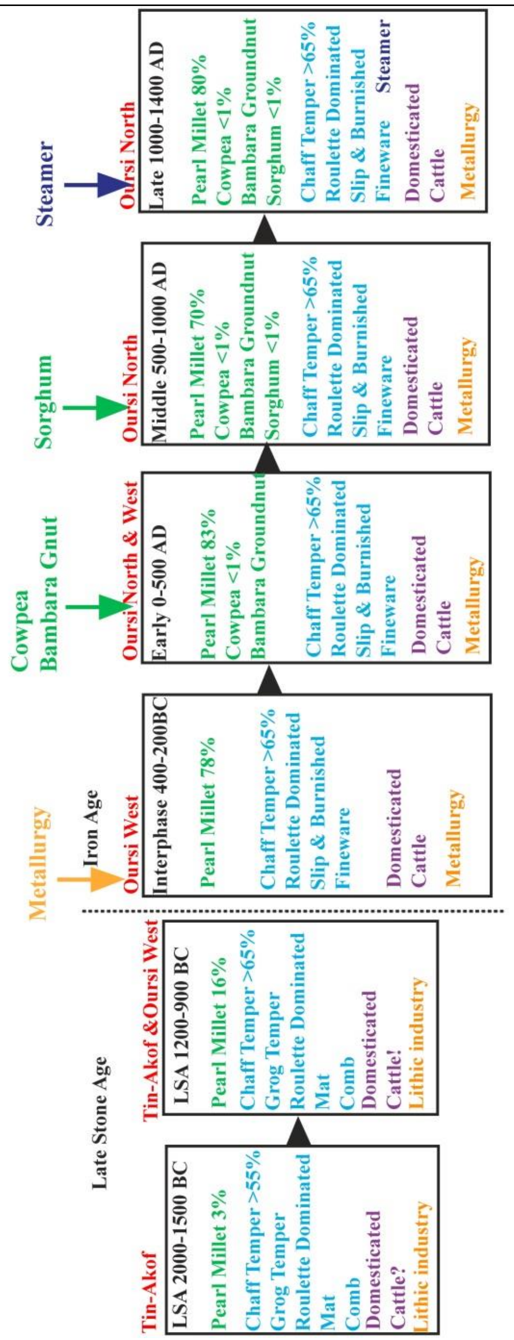


Figure 7.21 Summary of Oursi region (Tin-Akof, Oursi West and Oursi North sites) archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green), animal remains (in purples) and technology (in orange).

Discussion

It is important to mention that the burial site of Kissi 3 dated to 500–700 AD (Middle Iron Age) offers the first evidence of trade contact in the region. Around 1350 glass beads, including Asian beads, and two cowrie shells, as well as quartz, ceramic, bones, and ostrich shell beads were recovered. Iron objects were also discovered, such as swords and knives. Some of the swords present have the traditional characteristic of Byzantine swords. Moreover, organic remains were very well-preserved including leather and wood, as well as wool cords and textiles. Tomb good diversity, from very high to a very low quantity of objects, suggested that we are possibly dealing with a stratified society. Some objects have a foreign origin such as from Asia for some of the glass beads but also East Africa for the cowrie shell and North Africa with copper, glass and carnelian beads. The shape of these swords and knives also indicates a North African connection. As a consequence, the Oursi Area seems to have been part of an international, trans-Saharan trade network. Currently this is one of the main sites, with Gao, that shows such a quantity of imported objects. For the authors, Pelzer and Magnavita (2000), these finds indicated that the Oursi region must be considered within the debate on origins of the main West African polities. They also suggested that the Oursi area's wealth and power was probably the result of gold exploitation and production (Pelzer and Magnavita 2000). Nevertheless, no gold fragments or objects, nor any evidence of gold production, such as crucibles, were found. Strangely enough, no agricultural intensification or diversification is seen throughout the entire sequence. Pearl millet, sometimes intermixed with cowpea, remains the main agricultural crop (i.e. Liverani 2000, Phillipson 2017, Nixon 2011).

7.1.7 Ounjougou region

The Ounjougou sites complex located on the Bandiagara plateau in Mali provides a great number of archaeological sites dated from the older Palaeolithic to the Dogon historical periods. With the exception of the Sadia site (this study) none of the sites have been systematically sampled for macro-archaeobotanical purposes. Nevertheless, direct evidence of domesticated pearl millet cultivation dated to 1900-1400 BC was found at site of Varves – Ouest. Two pearl millet grains from the site were directly dated to 1981-1494 BC (OxCal calibration) or 1692-1533 BC (Bayesian HPD, Ozainne et al. 2009b) (Erl-9196; 3416±109 BP) and to 1628-976 BC (OxCal calibration) or 1285-1055 BC (Bayesian HPD) (Erl-9197; 3078±131 BP). Moreover, bilobate phytoliths from the Yamé River deposit dated to 2600-2300 BC constitute indirect evidence for the presence of millet. (Ozainne et al. 2009, 2017; Garnier et al.2013). Both this direct and indirect evidence coincide with a radical change in ceramic tradition associated with the presence of numerous grinding and mill stones and the appearance of settlement structures (Eichhorn and Neumann 2014, Huysecom et al. 2004, Ozainne et al. 2009). Ceramic change is marked by the sudden appearance of globular vessels, and chaff tempered thin-walled pottery decorated with impressions by composite roulettes. Previously the ceramics were characterised by open pots decorated with dotted wavy lines with temper mainly made of sponge spicules (Ozainne et al. 2009). The cultural material and the presence of domesticated pearl millet coincides with similar contemporaneous finds (2200-1900 BC) at Windé Koroji (this study; Macdonald et al. 2017). Taken together the appearance of pearl millet and roulette decoration ceramics suggest simultaneous diffusion from the Tilemsi Valley sites.

In the Ounjougou region, this period is followed by the sudden appearance of settlement mounds sites around 800-400 BC. From 400 BC to 300 AD, a noticeable occupational decline, along with a hiatus in settlement, is noted. The final Holocene (300-1500 AD) is marked by the growth of tell sites in the Seno plain, such as Sadia (this study) and appearance of iron production sites on the plateau (Ozainne et al. 2009 a & b, 2017). For Caroline Robion-Brunner (2008), the introduction of iron production technologies on the Bandiagara plateau has an origin in the populations of the Inland Niger Delta .

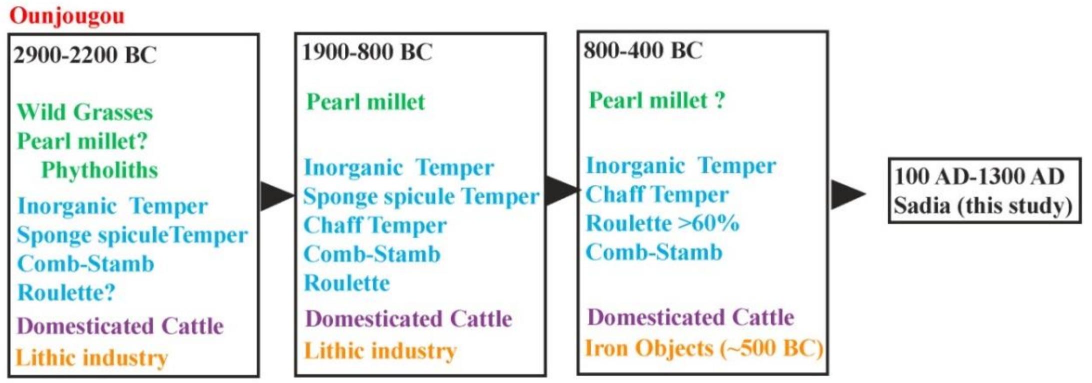


Figure 7.22 Summary of Ounjougou region archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and technology (in orange).

The apogee of Sadia, 900-1250 AD, *'corresponds to the establishment of networks of villages, self-reliant in food resources and everyday consumption goods, alongside the first urban settlements along the Niger* (e.g. Jenné)*'* (Ozainne et al. 2017:223). Interestingly, archaeobotanical results from Sadia (this study, chapter 5), indicate that during phase 0, first century AD, and phase 1, 760–970 AD, the only cultivated crop had been pearl millet which composed around half (50%) of the botanical assemblage. Phase 0 is characterised by ceramics decorated with composite cord-wrapped roulette. Phase 2 coincides with increased diversification and complexity of agricultural systems, with the addition of four new domesticated crops: rice, fonio, sorghum and cowpea. The transition from phase 1 to phase 2 is also marked in the ceramic assemblage by an increase in braided and folded strip roulette styles and an abrupt decrease of those of the composite roulette decorated type (Huysecom et al. 2015).

Thus, in what is currently Dogon country, Bandiagara plateau and Seno plain, agriculture seems to have had two main consecutive origins and developed separately by the 400 BC -300 AD hiatus. The first, based on pearl millet cultivation dating from 1900-1600 BC until 800-400 BC came from the Tilemsi Valley and shared the same roulette decoration and chaff tempered pottery association package as at Windé Koroji. As in many West African sites, this first wave was followed by a hiatus. The second wave coincided with the arrival of iron production knowledge from the Inland Niger Delta (i.e. Robion 2008), renewed pearl millet cultivation and development of village networks. This is apparently related to the Tichitt package diffusion wave. As in neighbouring Inland Niger Delta this wave has diversified into a complex agriculture system that included several domesticated crops (rice, sorghum, fonio and cowpea).

7.2 Archaeobotanical studies outside the Niger River Basin

7.2.1 Burkina Faso

7.2.1.1 Kirikongo (100 – 1450 AD)

Table 7-8 Number of items recovered and Frequency for the main crop species from **Kirikongo** by phase. First line is the total number of items and second line gives frequency. For Kirikongo, the ubiquity is not available.

Date Cal. AD	Yellow I 450-500	Yellow II 500-700	Red I 700-1000	Red II 1000-1150	Red III 1260-1400	Red IV 1400-1450	Total
# samples **volume of soil (litres)**	2	18	14	6	15	11	71 130
Pennisetum glaucum Frequency	6 15%	19 4%	3 10%	0	0	1 2%	29 4%
involucre proportion	NA	NA	NA	NA	NA	NA	NA
Sorghum bicolor Frequency	?	?	?	Present	Present	Present	Present
Chaff proportion	NA	NA	NA	NA	NA	NA	NA
Digitaria exilis	0	83 16%	3 10%	0	10 9%	8 16%	104 13%
Poaceae	3 8%	60 12%	4 13%	1 2%	25 22%	9 18%	102 13%
***Tree/bush* (fruit)**	0	4 1%	0	0	22 19%	8 16%	34 4%
Vitellaria paradoxa	Present	Present	Present	Present	Present	Present	Present
Total Number	39	506	31	42	113	51	782
Density (Items/litre)	?	?	?	?	?	?	6

Kirikongo is located in western Burkina Faso and is composed of 13 individual house mounds, totalling 5.6 ha in size. The site is associated with multiple iron furnaces, iron mines and wells spread over a large area of 37.5 ha. Dueppen and Gallagher established the site chronology based upon two architectural phases (Yellow and Red phase), subdivided into six ceramic sub-phases (Yellow I-II and Red I- IV). The Yellow phase, 450–700 AD, is characterised by course earthen architecture with pounded yellow clay floors and the Red phase, 700-1450 AD, with earthen brick construction with thick laterite/clay pavement floors (Dueppen 2012, Gallagher et al. 2016, Gallagher and Dueppen in press). The most ubiquitous and numerically frequent plant taxon at the site is Shea Butter (*Vitellaria paradoxa*). The large quantity of carbonised Shea fragments is attributed to the use of parching ovens, one of the steps in Shea butter production (Gallagher et al. 2016) (ovens were known in sub-Saharan Africa, but cereals were not adapted for baking but for boiling).

Around 100 AD the site was founded as a single household and was likely an extended self-sufficient family compound. They were performing a large array of economic tasks from herding cattle, reducing (blooming) and shaping iron, pottery and cultivation. The end of phase **Yellow I (100–500 AD)** corresponds with the addition of a second house. Agricultural activities were based on pearl millet cultivation (15% of the assemblage). Inhabitants were also collecting wild grasses (8%; Figure 7.23). The following phases saw the extension of the site from the mound I family compound to the emergence of village life during phase **Yellow II (500–700 AD)** and **Red I (700-1100 AD).** Dueppen has suggested that the site was established around a centralised control over territory, iron-working and livestock wealth, indicating the development of some degree of hierarchical control of the community. This hierarchical phase was mainly based on the control over the iron production. During the course of **Red II (1100–1260 AD)** and **Red III (1260–1400 AD),** a drastic and rapid egalitarian revolution quickly changed the community with a rejection of the previous hierarchical structure. Lastly, during phase **Red IV (1400–1500 AD)** the community diminished significantly in area and population. This reduction corresponds to a significant cultural and economic change. In terms of the archaeobotanical assemblage it showed a sustainable system based on staple crops (pearl millet and fonio) and arboricultural products (Baobab and Shea butter), consistent with a parkland farming system (Figure 7.23) (Dueppen 2012, Gallagher et al. 2016, Gallagher and Dueppen in press). Archaeobotanical samples from the different settlement mounds still await further analysis, nevertheless, some preliminary results attest to the presence of *Sorghum* sp. from the Phase Red II (1100–1260 AD) to Red IV (Gallagher pers. com.).

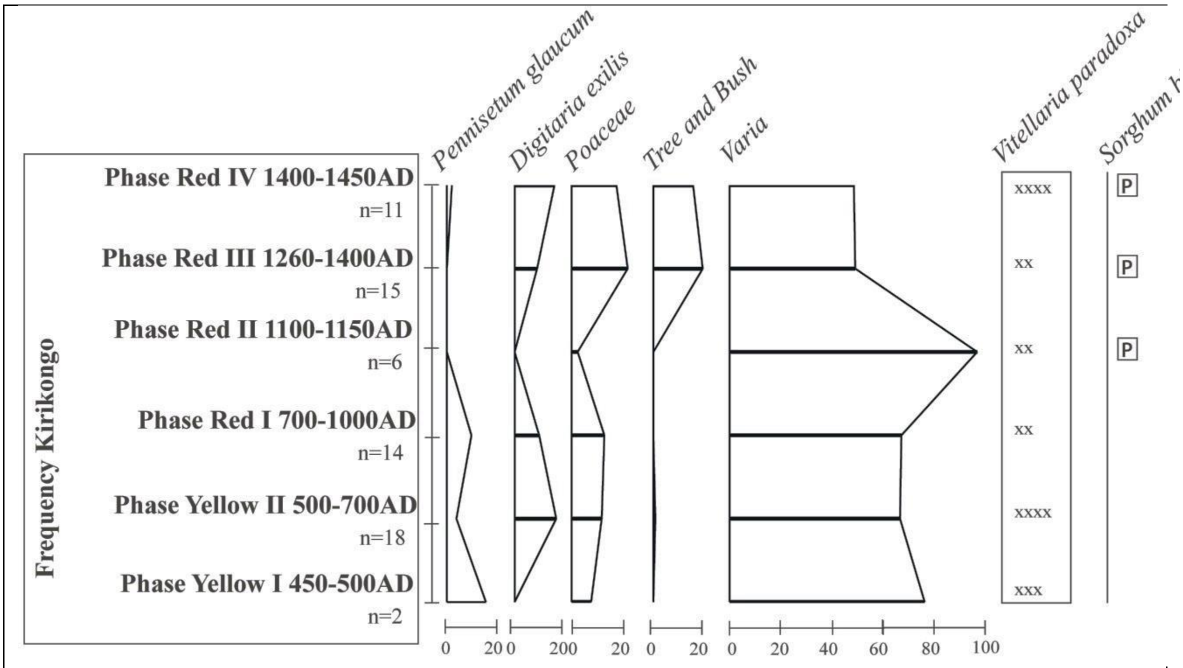


Figure 7.23 **Frequency** (% remains of any individual species in comparison with the whole assemblage) for the archaeobotanical data at Kirikongo Mound 1. 71 archaeobotanical samples from 130 litres of soil composed the data set study here. n being the number of samples by phase. Data combined and calculated from Gallagher and Dueppen (in press).

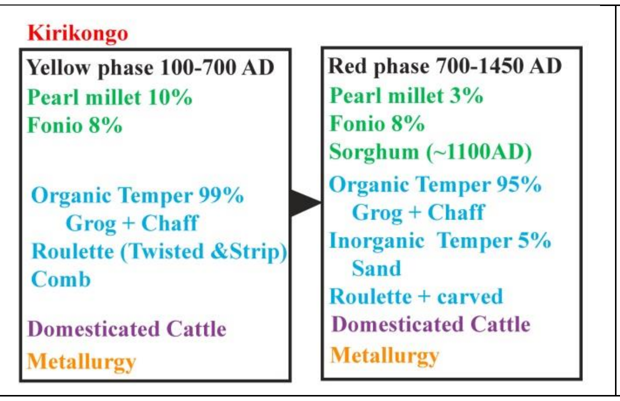


Figure 7.24 Summary of Kirikongo archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and metallurgy (in orange).

7.2.2 Nigeria

7.2.2.1 Nok Culture (1500 BC – 1950 AD)

The Nok Culture spans a period from the middle of the second millennium BC to the last centuries BC. Until recently, the central Nigerian Nok Culture was characterised by well-preserved terracotta figurines dated to the middle of the first millennium BC. However, Nok culture chronology has been re-developed from a combination of absolute radiocarbon dates and fresh pottery analyses (Figure 7.26). A first Nok phase without terracotta figurines developed from 1500 BC to 900 BC. The main phase, 900-400 BC, is characterised by the development of iron production in parallel with the creation of the earliest terracotta figurines. The late Nok phase, with vanishing evidence, extends to 1 BC/AD. The 'post-Nok' period followed the Nok culture with the arrival of carved wooden roulette ceramics during the Gimba phase (0–1000 AD) and fibre roulette ceramics during Janruwa phase (1200–1700 AD) (Franke 2016).

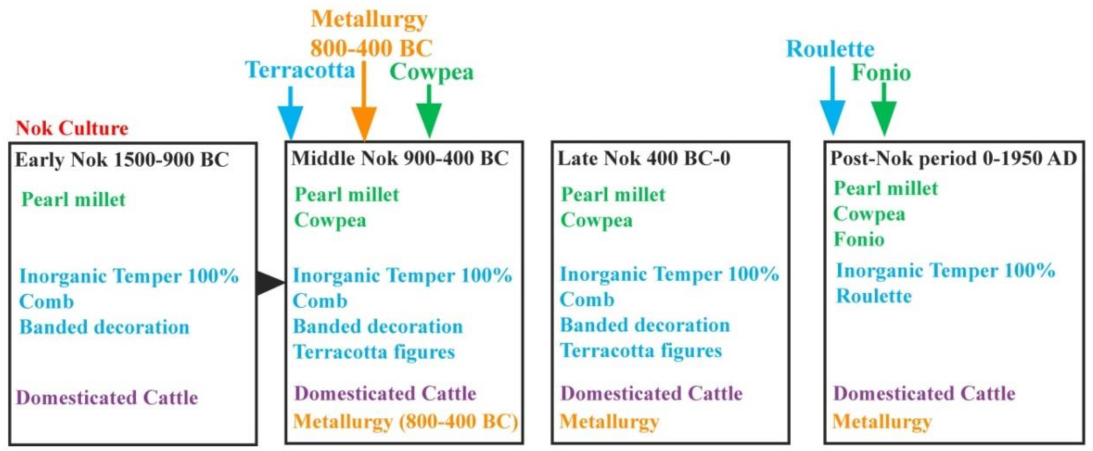


Figure 7.25 Summary of Nok Culture archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and technology (in orange).

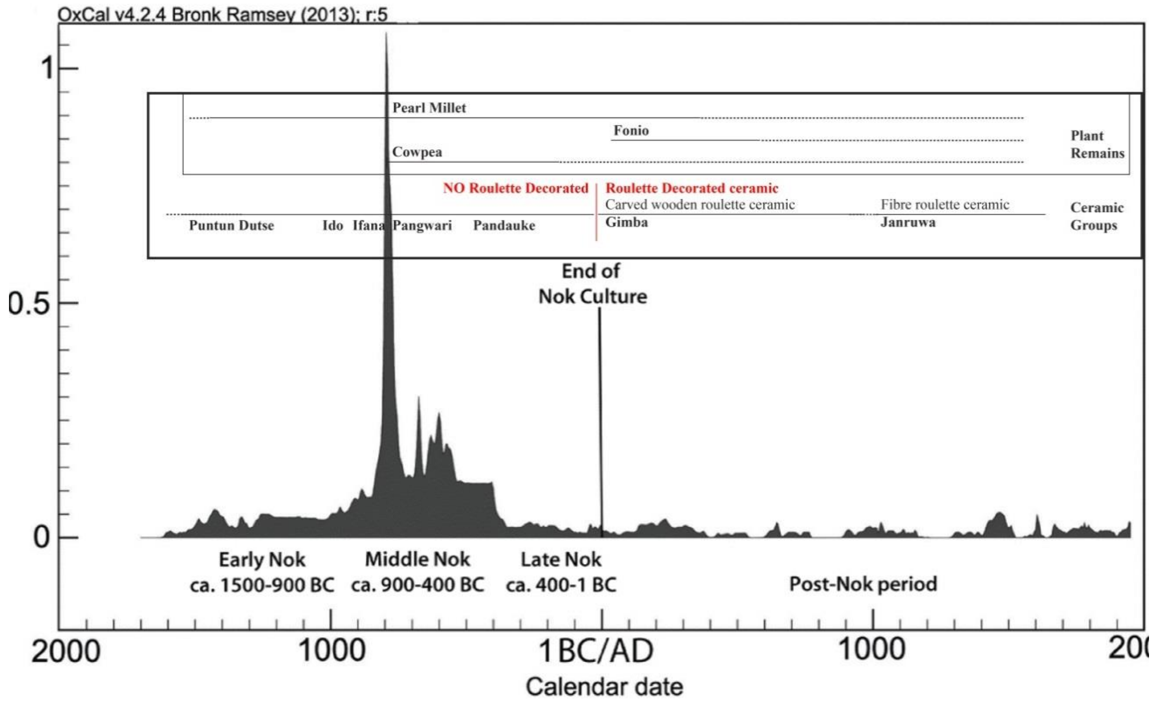


Figure 7.26 Summed probability density of radiocarbon dates obtained by the Frankfurt Nok Project (n=159). Three Nok Phases (Early Middle, Late) are defined by absolute-chronological and pottery analysis. Sites after 1 BC/AD belong to other traditions, taken together as 'post-Nok' (From Franke 2016:272). Plant remains and ceramic data including figures combining data from Franke 2016 for the ceramic and from Kahlheber et al. 2009, Höhn and Neumann 2016 and Höhn pers.com. for the plant remains. As the archaeobotanical analysis is still ongoing, this figure shows only an overview of the preliminary results. The solid line represented the presence of the crop and the dotted line indicates the potential presence. Further analysis will yield a more precise understanding of the situation.

Currently the macro-botanical samples from the Nok area in central Nigeria are still to be studied. Nevertheless, preliminary results indicate the presence of pearl millet from 1500 BC to 400 AD (Table 7-9). At Janruwa C, a pearl millet grain was directly dated to 906-810 BC (2709±27 BP, MAMS 11160). Pearl millet is also present during the early Nok period (Alexa Höhn pers. com.). Fragments of cowpea and tree fruit dated to 800-200 BC were also revealed. Moreover, the oldest archaeological evidence of fonio (*Digitaria exilis*) in West Africa was found at the site of Janruwa C. Two fonio grains were directly dated to 94–338 cal. AD (1800±40 BP, Beta-278001) and 236–386 cal. AD (1740±30 BP, Beta-297287) (Franke 2015, 2016; Höhn and Neumann 2016).

Sites	Dates	*Pennisetum glaucum*	*Digitaria exilis*	*Vigna unguiculata*	*Canarium schweinfurthii*	*Vitex sp.*
Akura	550-450 BC	x			x	x
Janjala	790-400 BC	x		x	x	x
Janruwa A	801-550 BC	x				
Janruwa B	792-432 BC	x				
Janruwa C	133–390AD	x	x			
	906-810 BC	x				
Ungwar Kura	800-200 BC	x		x	x	x
Early Nok	1500-900 BC	x				

Table 7-9. Presence/absence of fruit and seed remains from Nok sites. From Kahlheber et al. 2009, Höhn and Neumann 2016 and Höhn pers.com.

Following the new absolute-ceramic chronology set by Franke (Figure 7.26), wood roulette and fibre roulette ceramics appeared only after 1 BC/AD within post-Nok period. Thus, there are no ceramics decorated with roulette during the Nok period. This is an important point pertaining to the pearl millet road package diffusion hypothesis. As discussed, pearl millet was likely domesticated somewhere in the central Sahara before 2500 BC. Early domesticated pearl millet was found in association with ceramic decorated with roulette in Tilemsi Valley by 2500 BC and also in Windé Koroji (2200-2000 BC) and in the Hodt depression in Mauritania, forming a pattern where every early site with pearl millet is also associated with roulette decoration (cf. Ozainne et al. 2014). However, the presence of pearl millet without roulette, as seen within the Nok sites of central Nigeria, would suggest that another road of diffusion directly from the Sahara was possible (further discussion in sub-chapter 8.1 pearl millet and in chapter 9).

7.2.2.2 Chad Basin area,

Archaeological sites from the Chad Basin offer a further example of two different pathways to agriculture differentiating them from Niger River Basin sites. One pathway possessing roulette impression ceramics the other not, but both have fibre vegetable temper that triggered pottery diversity and further household and agriculture changes, but with a reduced influence of West African pearl millet. Nearly simultaneously with the diversification that was happening in Inland Niger Delta and surrounding vicinities (Hodt depression), in the Chad Basin area cultural organisation was also diversifying. However, the Chad social complexification seems to have arisen from two different influences resulting in two separate patterns. Archaeobotanical remains are marked by a period of wild grass gathering, including wild rice (*Oryza barthii* and *Oryza longistaminata*), followed by the arrival of pearl millet cultivation in later phases. Gajiganna and Nok Culture are two seldom cited Sahelian examples of a pearl millet introduction from the North, significantly neither related to roulette decorated ceramic diffusion, nor are hey exclusively associated with pearl millet chaff temper, but with a dominant mix of wild plant chaffs.

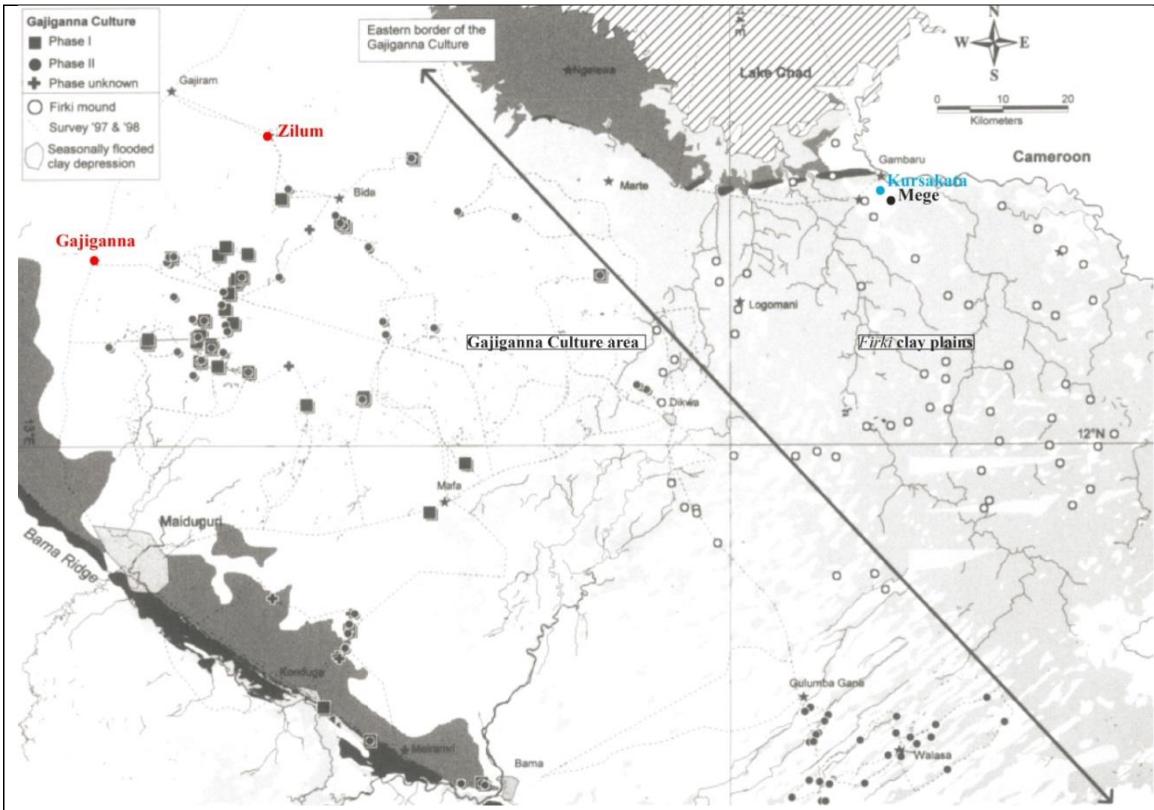


Figure 7.27 Distribution of Firki mounds and Gajiganna culture archaeological sites divided into pastoral (phase I) and agro-pastoral (phase II) stages. Included the four sites with archaeobotanical data (Gajiganna, Zilum, Kursakata and Mege). (Modified from Breunig and Neumann 2002:136)

7.2.2.2.1 Gajiganna culture

Before 2000 BC, the area between the limited of the current Lake Chad and Bama Ridge (South-West of the Lake) was under water (Figure 7.27). By this time, the sandy Bama Ridge, up to 12 m in height, formed the true Mega Lake Chad shoreline (Breunig and Neumann 2002). The last episode of Mega Lake Chad is dated to 3300-2400 BC, after which it began to slowly dry out, and increasingly between 2200-2000 BC (Schuster et al. 2005) and 1800 BC, newly opened dry pastures started being used for foraging by pastoralist groups. The origin of the first settlers is still unknown but based on common material culture and on the location at early sites (Black square on in the northwest of the map in Figure 7.27) Breunig has suggested a Saharan origin for these herders (Breunig and Neumann 2002). This is the early basis of the Gajiganna Culture, an archaeological complex around Gajiganna villages characterised by a dense concentration of low settlement mound sites (max 2 metres high). Archaeobotanical evidence comes from plant impressions in potsherds from the site of Gajiganna (Figure

7.29, Klee et al. 2004) and preliminary flotation results are available for the site of Zilum (Magnavita et al. 2004).

Based upon ceramic evidence the development of the **Gajiganna culture** can be split into three main chronological phases (Magnavita et al. 2004, Breunig and Neumann 2002, Gronenborn 1997, Linseele and Van Neer 2017, Wendt 1997):

1. Pastoral – **Phase I, 1800 – 1500 BC**

During this phase mobile pastoralists groups can be seen to be living on small, low flat sites of a maximum 2 hectares in area. Poor archaeological accumulation corresponds to potentially short-term camp sites. The pottery is dominated by inorganic temper and slipped surface wares. Typical décor is zigzag bands made of comb impressions and triangular stamping which are very similar to decoration from central Sahara tradition. Archaeobotanical evidence suggests that subsistence was based on wild plants gathering (Figure 7.28, Figure 7.29). As the ceramic paste is exclusively inorganically tempered the few plant impressions that are preserved on sherds are purely by accident. The décor is characterised by zigzag bands made by triangular impressions (Wendt 2007). The faunal remains are a mix of domesticated cattle, goat/sheep and contain a number of varieties of wild game including fish and reptiles, such as crocodiles.

2. Pastoral to Agro-pastoral – **Phase II, 1500 – 800 BC**

During this second phase sites expanded to a maximum of 6 hectares in size and storage pits appeared for the first time. The typical temporary camp site of phase I disappeared in phase II. In contrast, large agro-pastoral mounds point to sedentary and village-organised communities. This phase shows strong evidence of a transition to an agro-pastoral way of life: large quantities of ceramics combined with pearl millet cultivation appear to grow in frequency throughout this phase. The most remarkable ceramic change during this second phase is the increase in organic temper, from 40% at the beginning of the period to 90% at the end (Figure 7.29). This vegetal tempering is coupled with a decrease of polishing. Mat impression décor also appears. Pearl millet evidence dated to 1500-1200 BC (phase IIA in Figure 7.29) constitutes only 10% of the ceramic tempering, the rest is composed of *Paniceae* and wild rice (*Oryza barthii* and *Oryza longistaminata*) chaff remains. In contrast with the earliest period faunal assemblages are dominated (60%) by cattle remains, while remains pertaining to hunting and fishing are still present. Others material cultural finds characteristic of Saharan culture, such as polished axes, flakes and bifacial arrows-point, remain unchanged from phase I.

3. Agro-Pastoral – **Phase III, 800 – 400 BC**

For Magnavita, '*this latest phase witnessed a near doubling of the size of the largest Gajiganna settlements* [up to 12 hectares], *the apparent emergence of site hierarchies, a change in internal site organisation that included intensive pit-digging for house construction and for storage, and the appearance of a peripheral ditch-and-rampart system in the largest settlement such as Zilum'.* (Magnavita et al. 2004:1). Moreover, the introduction of new cultivated crops, such as cowpea seems to indicate the adoption of a new intercropping agricultural system. Further evidence is needed to better understand this area's agricultural development. Interestingly, a zoomorphic clay figurine representing what is thought to be humped cattle was found at Zilum in a layer dated to 600-400 BC. However, there is no faunal evidence to confirm the presence of humped zebu cattle (*Bos indicus*) in the area, which are evident in figurine evidence. Contradictorily, with this dry area both cattle and sheep/goat data suggest we are dealing during this phase with types specifically adapted to humidity-related diseases. Possible remains of dwarf sheep/goat and larger cattle, such as the modern N'Dama were found, accompanied by lungfish among the large varieties of fish, wild turtles and aardvark (*Orycteropus afer*). All these remains feature the new, more humid distinct faunal assemblage of this last period (Linseele and Van Neer 2017).

The first evidence of iron production is dated after 400 BC. Gajiganna culture was followed by Iron Age occupation of the area starting around the beginning of our era but currently no botanical data is available for this period.

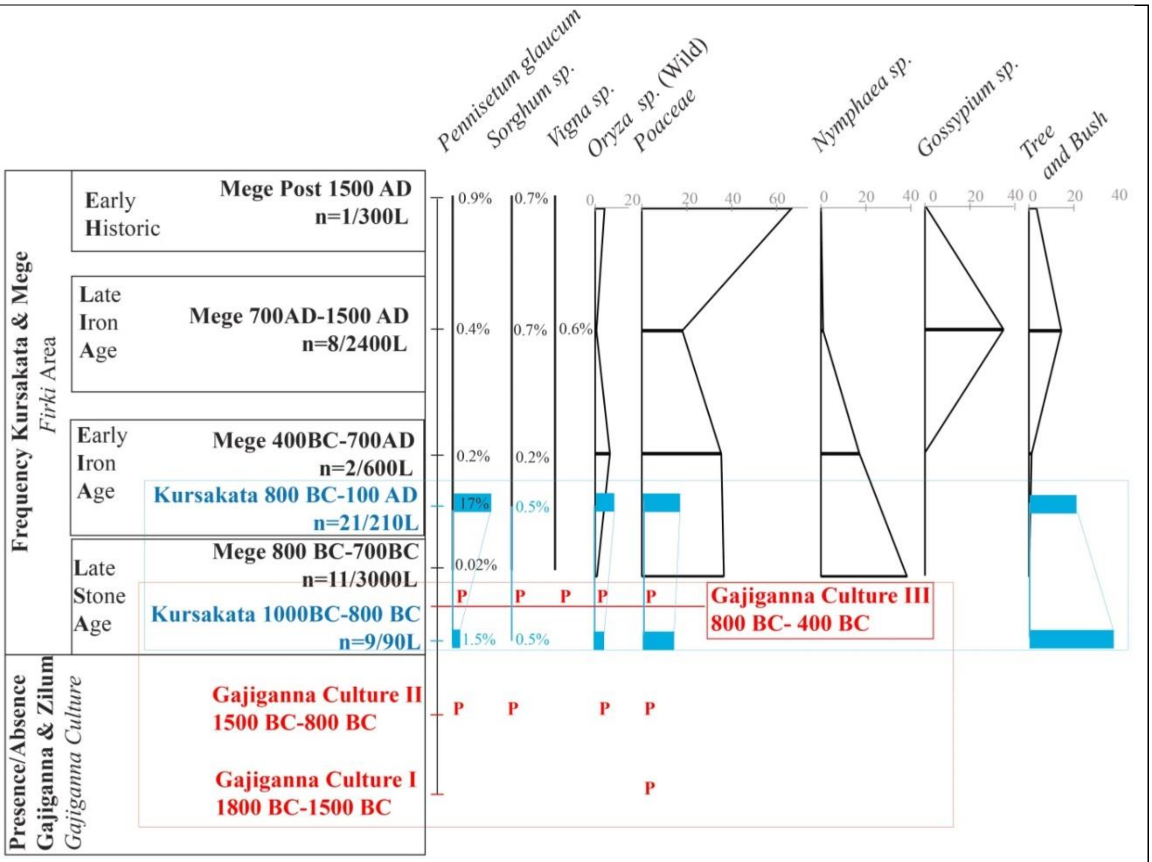


Figure 7.28 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data from the ***firki*** area sites, **Kursakata** and **Mege** of the Chad Basin. 52 archaeobotanical samples for 6600 litres of soil comprise the dataset under study here. n being the number of samples by phase. Data combined and calculated from Bigga and Kahlheber 2011 for Mege and from Klee et al. 2000 for Kursakata. **Presence/Absence** for the data from the Gajiganna culture sites. For the site of **Gajiganna** the data comes from ceramic impressions (Klee et al. 2004 and Breunig and Neumann 2002). For the site of **Zilum**, preliminary results of a systematic flotation was published in Magnavita et al. 2004.

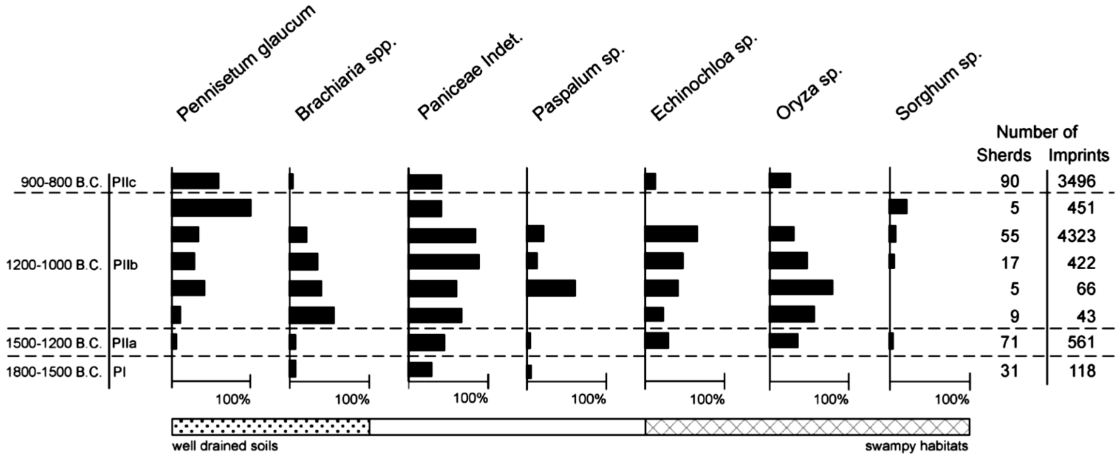


Figure 7.29 Frequency of the main taxa from potsherd impressions in Gajiganna Phase I and II. (from Klee et al.2004:134)

7.2.2.2.2 Firki Clay Region, Northeast Nigeria

The second pathway appeared in the *firki* clay region, south-east of the current lake, with settlement mounds starting to form around 1000/800 BC. These mound sites can be differentiated from the Gajiganna culture sites in that they have a different material culture with a potential different area of origin. Currently, two origins are proposed, an eastern source is possible, but also a Middle Niger diffusion has been proposed. In sharp contrast to the neighbouring Gajiganna culture, roulette decorated ceramics are present from the earliest occupation phase, as well as evidence of pearl millet. Aside from the presence of roulette décor, the ceramic assemblage can be characterised by incised and impressed decorations, applied mostly in horizontal bands, with mat impressions also present. Carved roulette styles appear only in the Late Iron Age (500-1600 AD; Wiesmüller 2001).

Hundreds of sites have been recorded but few excavated. Amongst these few, two sites have been systematically sampled for archaeobotanical purposes: Kursakata and Mege. Separated by only 10 km (Figure 6.26) these two sites have a similar material culture and occupational phases, yet possess different botanical signatures. As shown by Figure 7.28 the site of Kursakata's (in blue) development was based on pearl millet and sorghum cultivation with the gathering of wild rice, grasses and tree fruit, whereas at Mege (in black) there is very little evidence at all of agriculture. At Kursakata from the first phase (1000 BC-800BC) to the second phase (800 BC-100 AD) there was an increase in agricultural practices with a rise from 1.5% to 17% in the frequency of pearl millet present in the assemblage. At Mege, the first phase is largely dominated by seeds of wild grasses (36.5%) and water lily (*Nymphaecea, 38*%), with only 0.02% of pearl millet (5 grains) and only a few grains of sorghum appearing during the second phase (400 BC-700 AD). At Mege the assemblage is characterised by a very low number of cultivated crops through time (≈ 2.5%, pearl millet, sorghum and cowpea), with water lily decreasing over time (from 38% in phase 1 to its absence from the Late Iron Age). The only major change at Mege is the appearance of a large number of cotton remains, *Gossypium sp.*, around the Late Iron Age (700-1500 AD). The presence of cotton coincided with the rise of the Kanem Kingdom that quickly controlled commercial routes in the area. Through these routes slaves, ivory and goods, like beads and salt, from the north were traded (Insoll 1997, Lange 1992). Cotton was probably a cash crop on these trade routes. The disappearance of cotton, during the Early Historic phase, 1450–1500 AD, corresponded to internal revolts that pushed the kings of Kanem to move to the Bornu region (see Section 2.1 Political entities).

For both areas, Gajiganna culture and *Firki*, the utilisation of wild rice has been proven since the earliest periods, nevertheless it seems that wild rice was never domesticated in this area in sharp contrast to the IND, despite both regions possessing similar ecologies.

In summation, the Chad Basin area show developments in two different regions that likely follow dissimilar influences and origins. For Breunig: *'the firki area was colonised from the east. The Eastern migration, on the one hand, and the Gajiganna migration on the other is reflected in a distinct frontier of the contact zone between Chadic speaking and Niger-Congo speaking people who existed around 1000 BC – the archaeological support for a linguistic model'* (Breunig and Neumann 2002:146).

In Gajiganna cultural sites, pearl millet arrived around 1500-1200 BC from a probable Saharan origin, but without being related either to roulette decorated ceramic diffusion nor with pearl millet chaff tempered ceramics. In contrast to the Tilemsi sites or those in the Hodt depression, where chaff temper is nearly exclusively composed of domesticated pearl millet chaff, here a variety of wild plants had been used and pearl millet remained only a small component. This trend illustrates the contrast with the temporally parallel diffusion that was occurring in the Niger River Basin associated with roulette-pearl millet chaff tempered ceramics. The Firki area sees later developments, but the earliest occupation sites, such as Kursakata, appear with sorghum, pearl millet and roulette decorated pottery already present, around ca. 1000 BC. The presence of a humped cattle figurine suggests that these first settlers arrived from the east (sorghum from Sudan, zebu from India/Pakistan), probably due to a second movement of people to the east, that were already pearl millet growers from the first roulette chaff temper east wave, pearl millet having passed on this way through a still early mysterious West-East corridor, that allowed crop dispersal all the way to India.

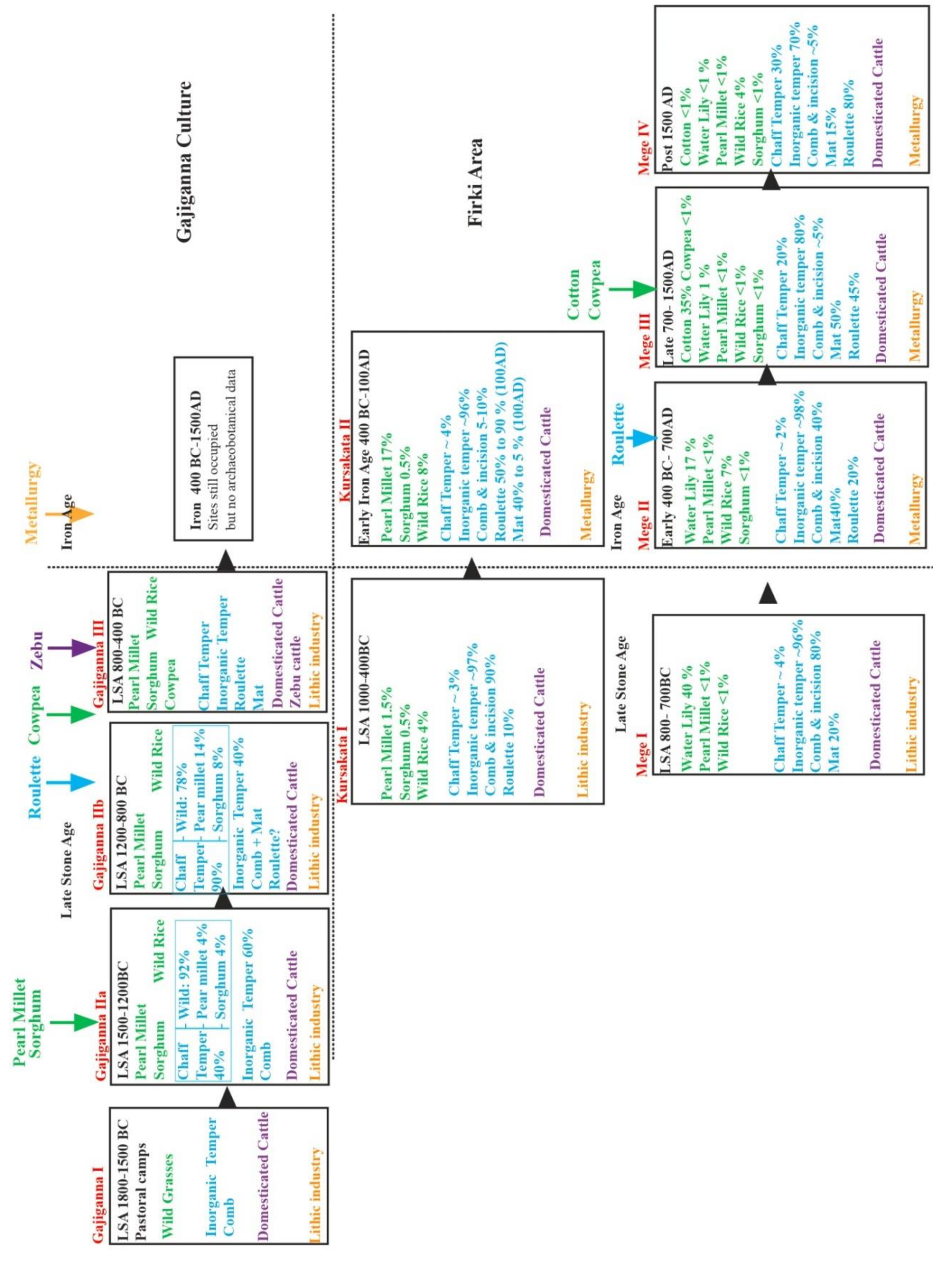


Figure 7.30 Summary of Chad Basin (Gajiganna Culture and Firki Clay region) archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and technology (in orange).

7.2.3 Ghana

The Ghanaian dataset comes from two main archaeobotanical studies. The first is composed of the samples from the Kintampo complex: B-sites dated to 1900-1400 BC and Birimi dated to 1950-1400 BC (D'Andrea et al. 2001, D'Andrea and Casey 2002). The second concerns the second millennium AD Banda area sites analysed by A. Logan for her PhD dissertation (Logan 2012). Both studies comprise a good overview of the evolution of plant use in the Savannah rainforest transition of Ghana. Thus, the archaeological sequence for Ghana starts with the Kintampo and Punpun tradition, dated between 2100 and 1400 BC, followed by several occupation phases in the Banda area (central Ghana) from 0 to 1950 AD, separated by what appears to be a hiatus in occupation. All the archaeobotanical data from the different areas are summarised by phase and sites in Figure 7.32.

7.2.3.1 Kintampo tradition 2100-1400 BC (Birimi and B-sites)

During the late third millennium BC, two Neolithic traditions appeared in Ghana, the Punpun culture and the famous Kintampo tradition. The Kintampo tradition spreads from the drier wooded savannah in the north to the humid rainforests in south Ghana. Yet despite this broad distribution, covering several different ecological zones, Kintampo material culture is remarkably homogenous throughout.

The origins and developments of Punpun and Kintampo traditions are still controversial. Indeed, relations between both traditions are the subject of four different interpretations:

- Flight suggests the Punpun were composed of hunter-gatherers, which were quickly replaced by the Kintampo (Flight 1968).
- Based on radiocarbon dates and material culture, Stahl suggested both traditions coexisted but the Kintampo shifted towards societies based more on economic production and progressively replaced the Punpun (Stahl 1985, 1994, 2005).
- Recently, Watson proposed than the Punpun and Kintampo were contemporaneous and social boundaries created differences between the two, the former being hunter-gatherers, the latter agro-pastoralists. Further based on the presence of elements of Sahelian/Saharan groups, such as polished stone axes, adze blades, arm bands and comb-stamped ceramics in the Kintampo tradition,

Watson has suggested a Niger Bend Sahel/Sahara border origin for the Kintampo (Watson 2010).

- Based on the presence of everted-rimmed vessels with geometrical decorations in the Gajiganna and the Kintampo culture, another hypothesis suggests a Lake Chad origin for the Kintampo (Wendt 1997, Ozainne 2013).

The Kintampo tradition is characterised by a settlement heterogeneity ranging from temporary rock shelters to semi-sedentary villages. Kintampo pottery decoration techniques are characterised by rocked spatula, channelling, incision and rocked comb styles. Roulette decoration is also present, but in very low frequency (4%) at Birimi and less the 1% at B-sites. Ceramic fabrics are essentially made of inorganic temper but some chaff temper has been noted (Figure 7.31; Watson 2005, 2010, Stahl 1985). Studies show that the Kintampo were using a wide array of subsistence strategies, even if they leaned more towards wild resources, they were also in possession of domesticated species including pearl millet, cowpea, caprines and N'dama cattle (*Bos Taurus*). Currently two areas have been sampled for archaeobotanical purposes: **Birimi (1950-1400 BC)** situated in a dry woodland savannah in northern Ghana (D'Andrea et al. 2001); and the B-sites rock shelter group, located in the semi-deciduous forest/savannah area in central Ghana. The **B-sites (1900-1400 BC)** comprise six rock shelter loci that probably represent a single multi-component site occupied at various times (D'Andrea et al. 2006).

Archaeobotanical analysis at B-sites shows that oil palm (*Elaeis guineensis*) remains represent 83% of the assemblage (Figure 7.32). This would imply that the Kintampo people had knowledge of specialised techniques involving arboricultural practices for the exploitation of oil palm. Fragments of cowpea were also revealed, and so far this represents the earliest evidence of domesticated cowpea found in all Africa (See Section 8.7 Cowpea). A single pearl millet grain was discovered at Boase (B-sites). However, the presence of pearl millet, along with cord roulette ceramics in very limited quantities (0.5-0.7% of the total ceramic assemblage) (see below) is more often interpreted as proof of trade among the different Kintampo communities (e.g. Birimi) rather than the evidence of local cultivation (D'Andrea et al. 2001, 2006, Ozainne 2014).

The Birimi macro-botanical assemblage is completely different from those of the B-sites. Indeed, Birimi is largely dominated by pearl millet remains (60%) with only a few remains of wild Poaceae and tree fruits (Figure 7.32). In sharp contrast to the B-sites there is no evidence of oil palm trees or indeed cowpea at Birimi (D'Andrea et al. 2001, D'Andrea and Casey 2002, Chia and D'Andrea 2018).

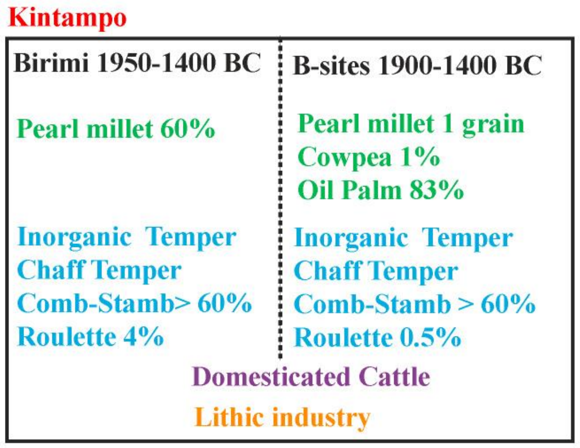


Figure 7.31 Summary of Kintampo (Birimi and B Sites) archaeological sequence with main characteristics of ceramic (in blue), plant remains (in green) and technology (in orange).

In conclusion, Kintampo food production appears as an amalgamation of northern savannah and indigenous forest zone foodways. The forest groups (B-sites) were exploiting incense trees, hackberry, but mainly focused on oil palm arboriculture while savannah groups (Birimi) were cultivating pearl millet. The presence of pearl millet, even in very low quantity, among the forest group seems to indicate that a system of regional trade was operational between Kintampo sites. Moreover, within a broader spectrum, the early dates for the evidence of pearl millet in the Kintampo tradition indicate a quick millet agricultural expansion from their putative domestication area in the Sahara.

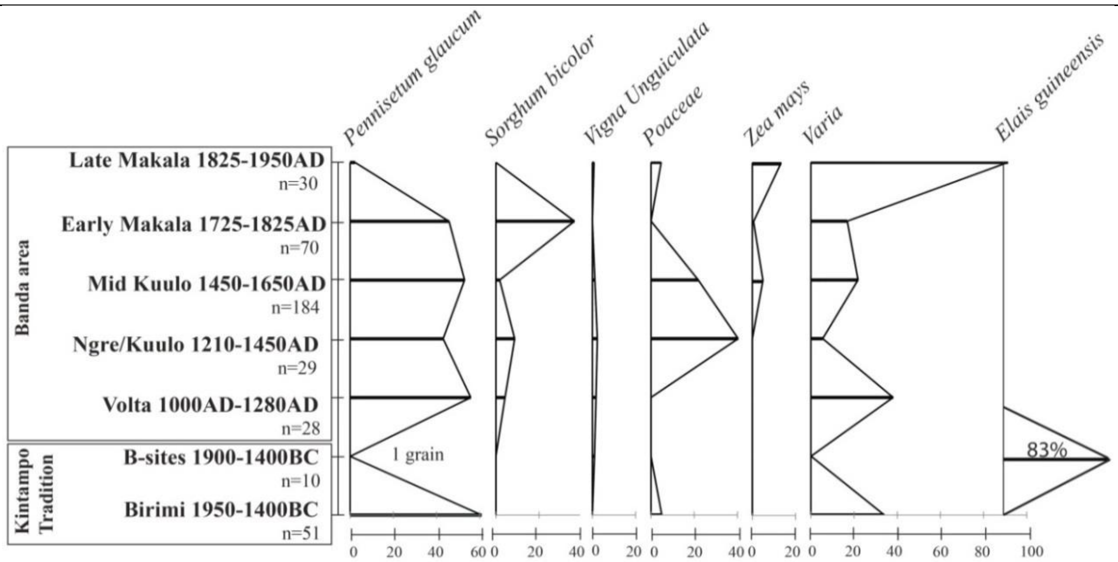


Figure 7.32 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data in Ghana. 402 archaeobotanical samples comprised the dataset study here. n being the number of samples by phase. Data combined and calculated from D'andrea et al. 2001, 2006, 2007 and Logan 2012

7.2.3.2 Banda area Sites 1000–1950 AD

The Kintampo tradition is followed by a long hiatus of over a millennia (1400 BC – AD 0) in the Ghanaian archaeological sequence. This hiatus probably reflects a lack of archaeological data for this period rather than a true absence of occupation following the settlements of the Kintampo tradition. This artificial hiatus preceded a long settlement phase located in the Banda area in Central Ghana. The sites excavated are split into six phases dated from 1 AD to 1950 AD with a small hiatus between 400 AD and 1000 AD. The first, the **pre-Volta phase** dated to 0–400 AD is composed of undecorated red painted, eroded ceramics and iron material. The four archaeobotanical samples obtained from these layers were devoid of any plants material.

Ceramics from the succeeding **Volta 1000 – 1280 AD** phase were locally manufactured red-painted pottery with geometric designs. Evidence for iron working is present in low quantity, but there is no evidence of long distance trade connections. The earliest evidence for intensive iron smelting and smithing, as well as copper alloy working, appears during the **Ngre/Kuulo phase (1210–1450 AD)**. Copper alloy is the first tangible evidence of a northern oriented trade. The ceramics from this new phase still incorporate red painted pottery, but mica paint or slip pottery appeared in parallel with the intensification of a decor made with roulette impression (mainly cord roulette). The faunal analysis showed a high level of consumption of wild animals, carnivores, fish turtles and large rodents, although domesticated bovids and dog appear to have been eaten as well. The presence of steamers, perforated pots, also called *couscoussière*, suggests steaming of millet or other crops was a new trend among the local population. The **Mid Kuulo phase (1450–1650 AD)** is a continuity from the previous phase, but with evidence of horse remains and locally made Clay pipes. From 1650 to 1750 AD, during a period of instability, the populations from the Banda areas seem to disperse. This instability was followed by a period of re-occupation during the **Makala phase (1725–1950 AD).** While sites previously occupied during the Kuulo phase seem to be re-settled during this time, a discontinuity with previous material cultures is observed. Most of the previous ceramic decorative techniques vanished to be replaced with maize cob roulette decoration. With the appearance of laterite floors domestic architecture changed too. Also the faunal remains have fewer remains of dangerous carnivores and more opportunistic and garden-hunting animals present (Logan 2012).

Throughout the archaeological sequence, with the exception of the late Makala phase, archaeobotanical remains (Figure 7.32) are largely dominated by pearl millet (average of 50%), followed by wild Poaceae and domesticated sorghum (*Sorghum bicolor*). Also, during the mid-Kuulo phase (1450–1650 AD) American corn (*Zea mays*) appeared and with some oscillation became the staple crop until fairly recently. In terms of evolution pearl millet remained the main cultivated crop throughout the early Makala phase before completely vanishing during the final part of the Makala phase. Sorghum is also present from the early Volta phase (4.2%), and some fluctuation is noted through the sequence with a peak in the early Makala phase (36%). As illustrated in Figure 7.33, Logan (2012) suggests that sorghum and pearl millet's relative fluctuations are due to corresponding shifts in rainfall. Base on climate reconstruction and the preference for dry land for pearl millet and more humid conditions for sorghum, he proposes that the fluctuation of wet and dry conditions correspond to fluctuations in sorghum and pearl millet (Logan 2012).

Around 1825 AD to 1950 AD, during the late Makala phase, a considerable shift in the botanical assemblage occurred. This is marked by a marked reduction in pearl millet cultivation, from 46% in early Makala, to 2% in the late Makala, and the abandonment of sorghum. However, corn utilisation rose to 12%, but more importantly the collection of wild plants, Poaceae grains and fruit, dominated the late Makala assemblage (81%). These drastic changes are probably related to political rather than environmental fluctuations. Between 1820 and 1890 AD the internal slave trade led to political and economic instability that forced people to flee their farms and turn to collecting wild leaves and fruits. After 1890, the situation became more stable with the arrival of the British and the local population returned to corn cultivated (Logan 2012).

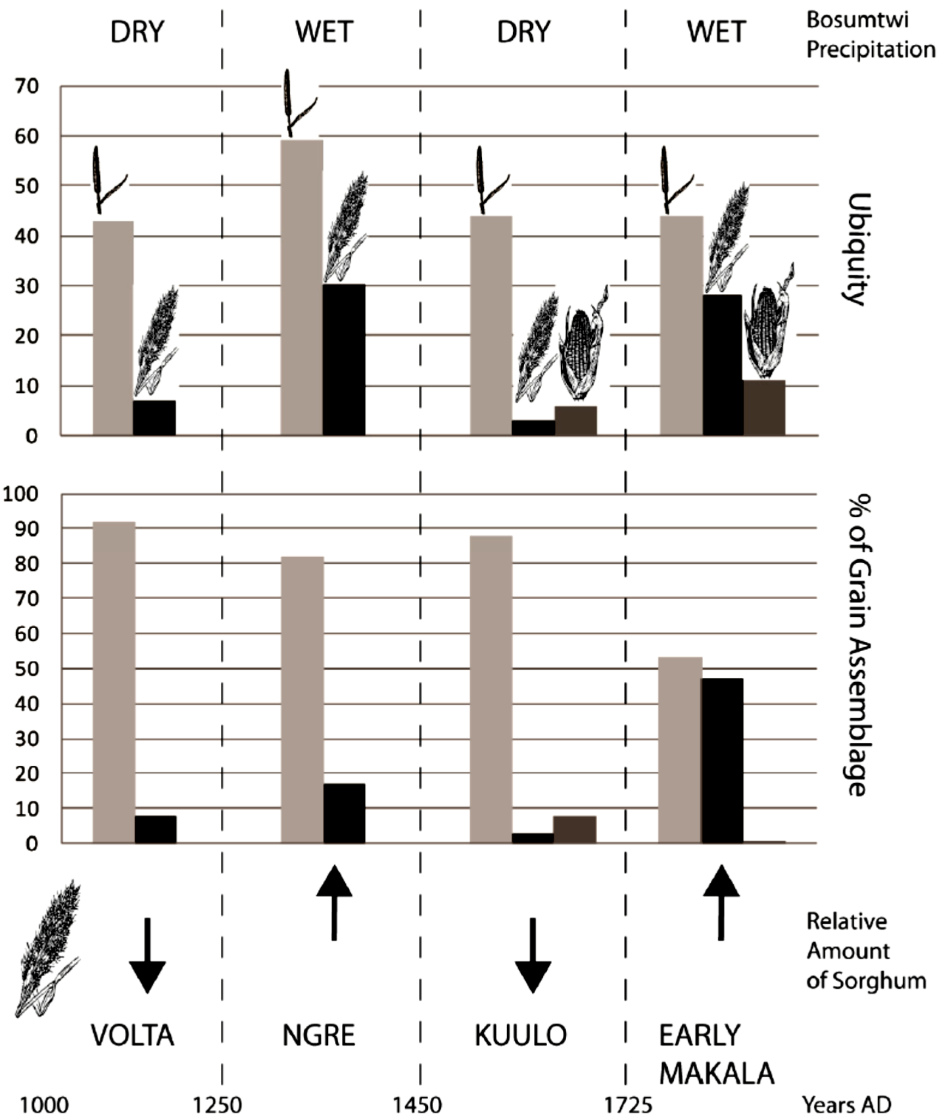


Figure 7.33. Climatic conditions and grain ubiquity and frequency by phase (with the exception of the late Makala phase) with special attention to sorghum. Frequency calculated on pearl millet and sorghum reported not on the total archaeobotanical remains. (From Logan 2012:315)

7.2.4 Senegambia

Senegambia is not directly related to the main study area in this PhD. Nevertheless, in order to understand the Niger River Basin specificities, a brief overview of the regional agricultural evolution is developed here. Based on available archaeobotanical data, one of the main differences between this region and the main study area is that rice doesn't appear before 1500 AD in Casamance and Gambia (Figure 7.36). Also, sorghum cultivation doesn't seem to be present before 500 AD. However, remains of cotton have been across a number of different sites: Payoungou in Casamance (late Kaabu phase, 1500–1800 AD), Juffure in Gambia (1700–1900 AD) and Djoutoubaya in east Senegal (900-1400 AD) (Figure 7.36 & Table 7-10).

The Senegal River Valley has provided archaeobotanical evidence for ancient agricultural practices. Assemblages from Walaldé, Cubalel, Sincu Bara and Arondo sites highlight the dominance of domesticated pearl millet (*Pennisetum glaucum*) since 800-500 cal. BC until 1900 AD (Figure 7.35; Murray et Déme 2014; Murray 2008; Murray et al. 2007; Gallagher et al. 2018). As shown in Figure 7.35 archaeobotanical assemblages are pretty stable through time with the appearance of fonio and sorghum around 400–500 AD

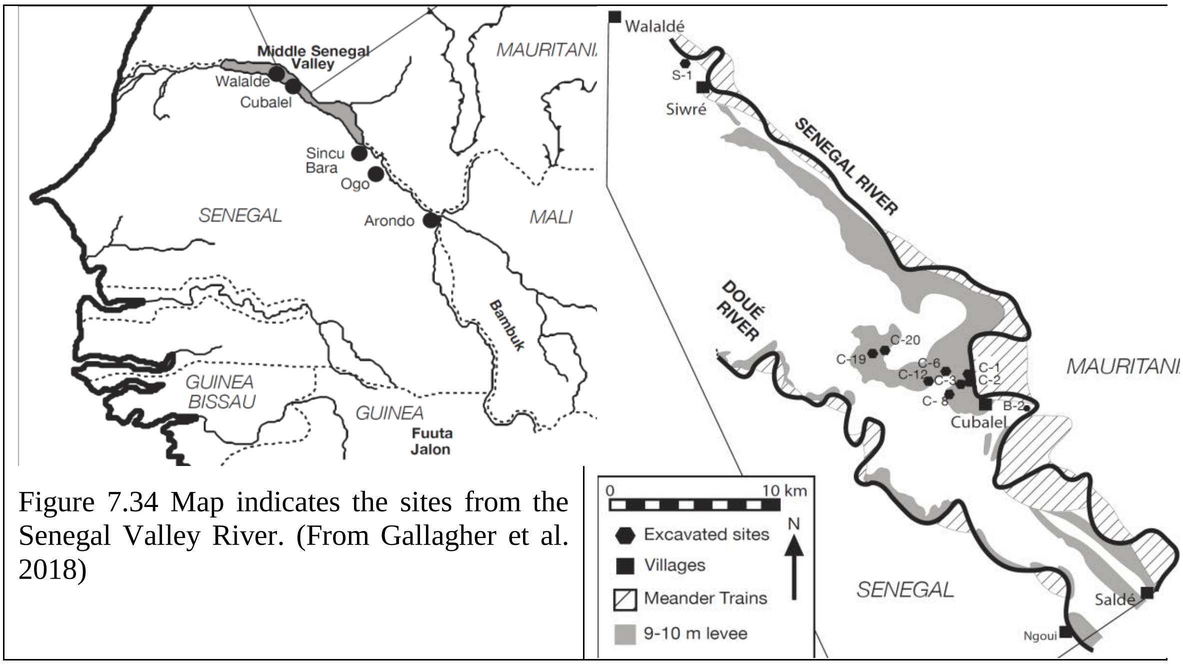


Figure 7.34 Map indicates the sites from the Senegal Valley River. (From Gallagher et al. 2018)

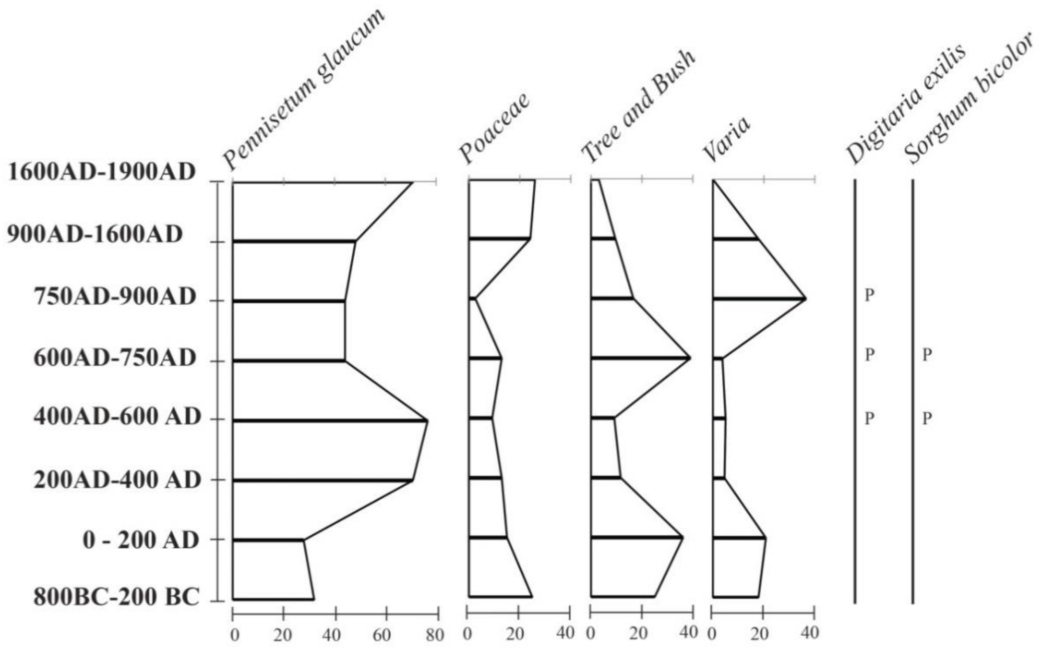


Figure 7.35 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data from Senegal River Valley sites. 315 archaeobotanical samples of soil composed the data set studied here. n being the number of samples by phase. Data combined and calculated from Gallagher et al. 2018, Gallagher 2012, Murray et al. 2007, Murray and Deme 2014.

7.2.4.1 Gambia and Casamance

From an archaeobotanical perspective, Senegambia is an area full of promise. Currently, Juffure in Gambia, 1700 AD – 1900 AD, has yielded macro-botanical remains with evidence for pearl millet, sorghum, rice and one of the few remains of maize in Africa to date (Gijanto and Walshaw 2014). Sites in Casamance, Payoungou (700-1900 AD) and Korop (1200–1900 AD), also revealed rice, pearl millet, sorghum and cotton remains (Stricker 2016). Taken together, Juffure on the Gambia River, studied by Sarah Walshaw, and the sites of Casamance (Senegal), analysed by Leah Stricker (UCL MSc) constitute a good regional overview of agricultural practice and the evolution of plant use (Figure 7.36). Archaeobotanical analysis of samples from the villages of Payoungou (600 –1900 AD) and Korop (1200 – 1900 AD), which were excavated by Canós-Donnay in 2013, indicate that agriculture was dominated by domesticated cereals of sub-Saharan savannah origin; pearl millet (*Pennisetum glaucum*), followed by sorghum (*Sorghum bicolor*), were the most frequent crops at both sites. African rice (*Oryza glaberrima*) appears only in low frequency during the late Kaabu phase at Payoungou (Figure 7.36). A mixture of wild weeds seeds and grasses were also identified including *Digitaria* sp., *Eleusine* sp., *Eragrostis* sp., *Panicum laetum*, and *Brachiaria* sp., additionally various species are known to have been introduced through trade, including aubergine (*Solanum melongena*) and more importantly cotton (*Gossypium* sp.).

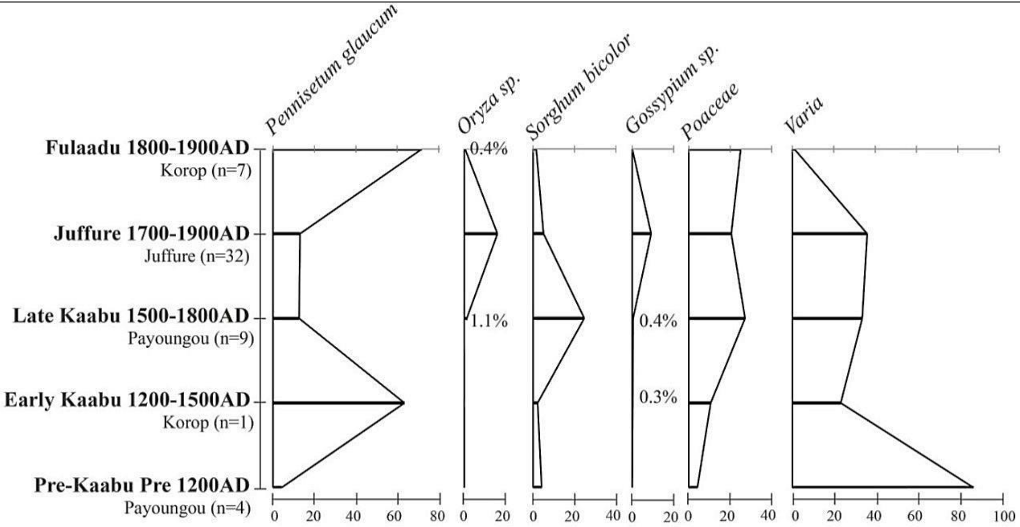


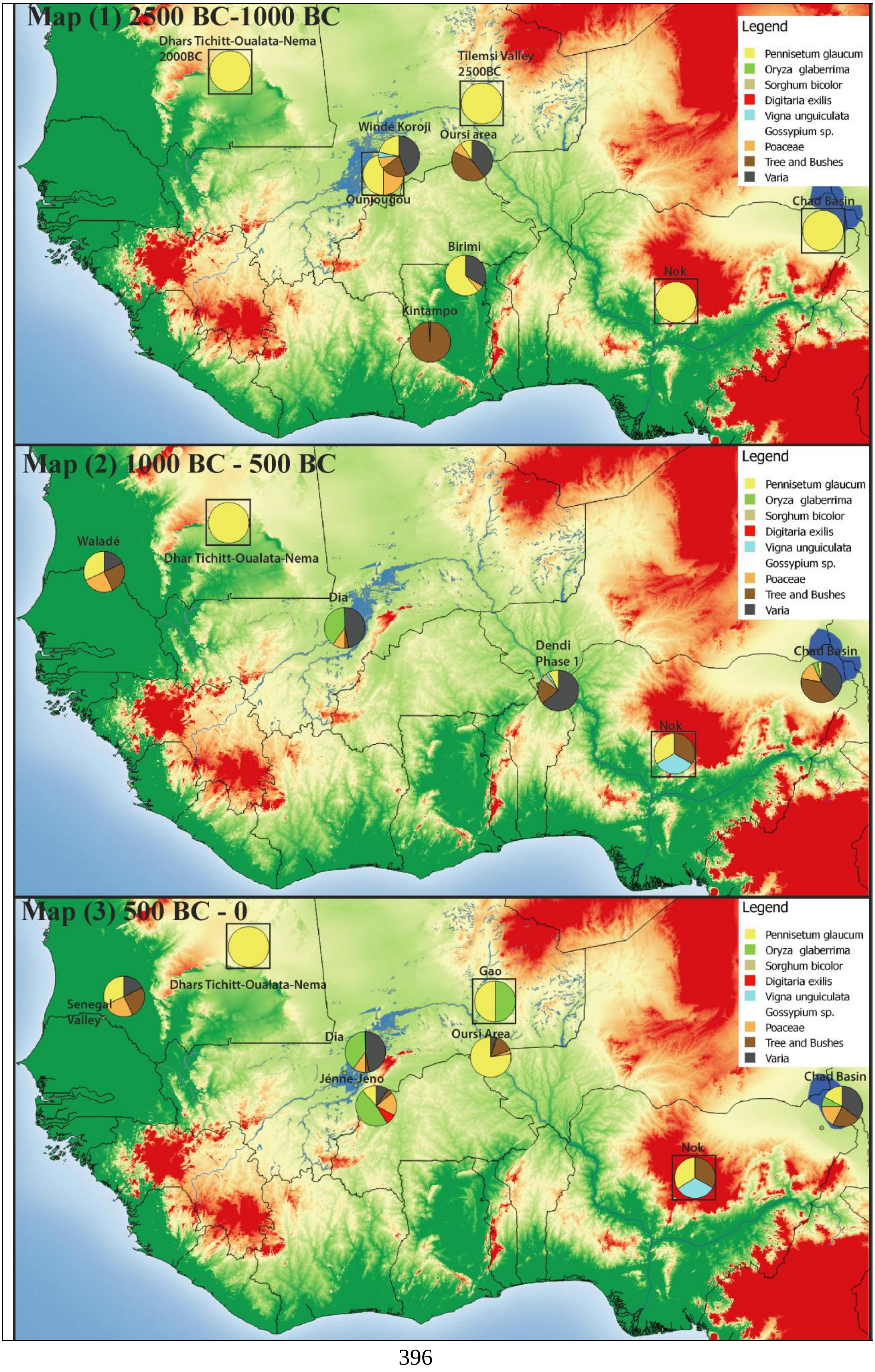
Figure 7.36 **Frequency** (% remains of any individual species as a comparison with the whole assemblage) for the archaeobotanical data from Gambia/Casamance region. 53 archaeobotanical samples comprised the dataset here. n being the number of samples by phase. Data combined and calculated from Gijanto and Walshaw 2014 for the site of Juffure and Stricker Master dissertation 2016 for Payoungou and Korop site.

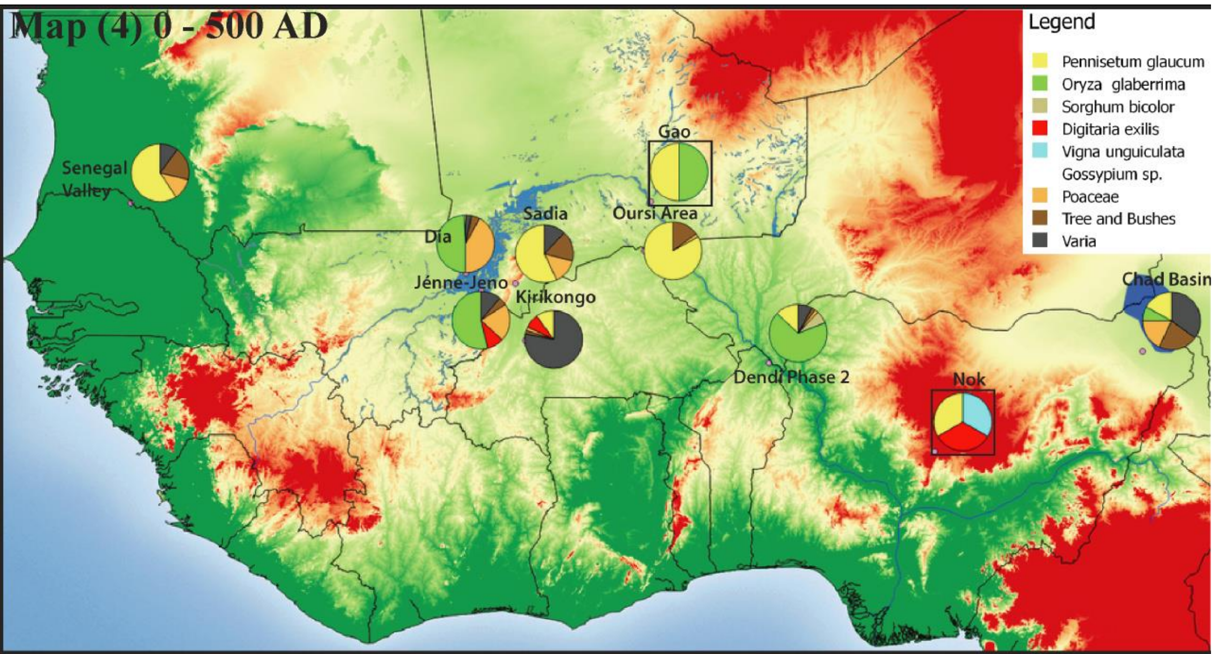
7.2.4.2 Faleme River Valley

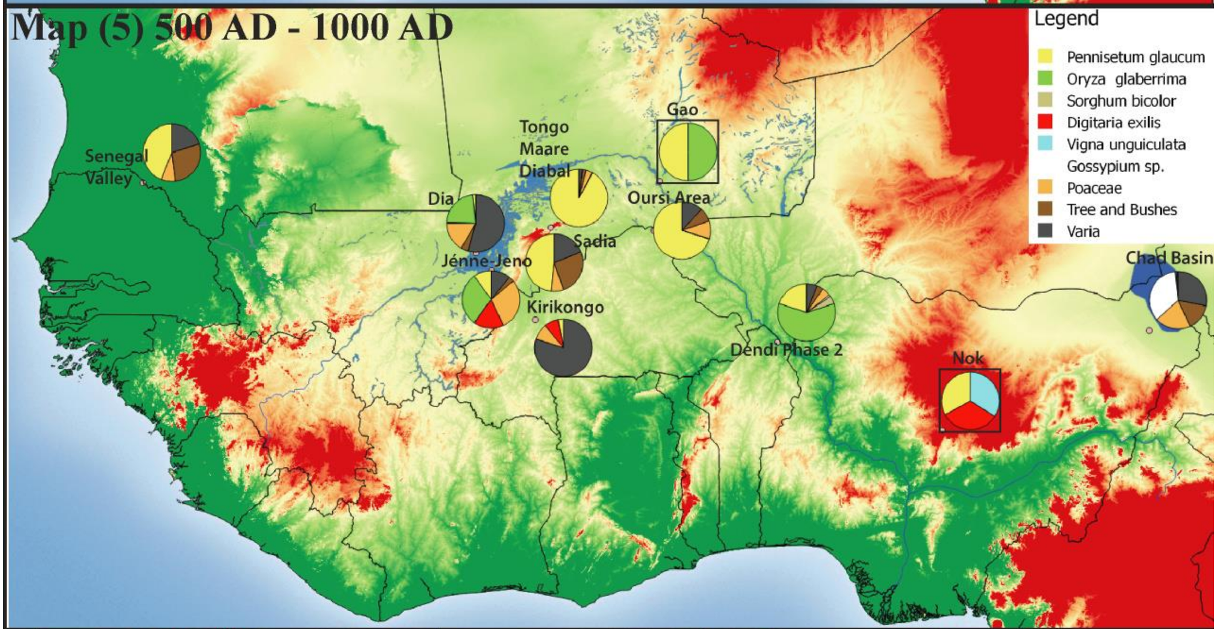
The Falémé River Valley was also the subject of a preliminary study at the site of Diouboye, excavated by Cameron Gokee. The archaeobotanical assemblages are dominated by baobab, but also with pearl millet and jujube (*Ziziphus* sp.) (Gokee 2012). Very preliminary archaeobotanical results from the Falémé river excavation (Champion in Mayor et al. 2018) revealed the presence of sorghum, pearl millet and fonio cultivation (Table 7-10). Cotton grains were also found at Djoutoubaya in an archaeological context dated to 1000–1400 AD. During the Toumbounto (1600–1900 AD) excavations, a burnt granary was found with several storage jars in place. Each jar was filled with specific plant taxa. Fourteen jars were sampled, five contained peanuts remains (*Arachis hypogaea*), four had baobab grains, one with cowpea, while the others were filled with the same indeterminate fruit remains. Currently, the peanut remains constituted one of the only peanut remains found in West African to date.

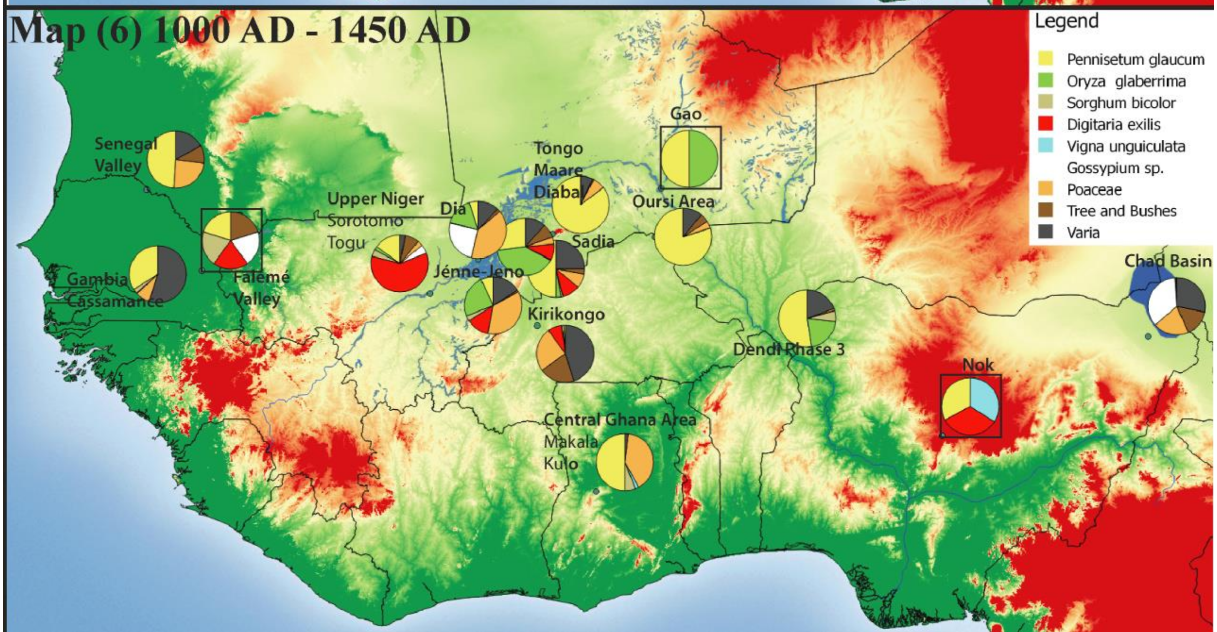
		Cereal				**Others**			**Tree**		
Site	Phase	Pearl Millet (*Pennisetum glaucum*)	Sorghum (*Sorghum* sp.)	Rice (*Oryza* sp.)	Fonio (*Digitaria exilis*)	Cowpea (*Vigna unguiculata*)	Peanut (*Arachis hypogaea*)	Cotton (*Gossypium* sp.)	Baobab (*Adansonia digitata*)	Jujubier (*Ziziphus* sp.)	*Vitex* sp.
Toumbounto	1600–1900 AD		X			X	X		X		X
Djoutoubaya	900-1300 AD		X	(x)	X			X	X	X	
Diouboye	1000–1400 AD	X	(x)						X	X	
Alinguel	650–800 AD									X	

Table 7-10. Presence/absence of macrobotanical remains from the Falémé River Valley region, including results from Diouboye (Gokee 2012, Gallagher 2012) and from Toumbounto, Djoutoubaya, Alinguel (Champion in Mayor at al. 2018).


Map (1) 2500 BC-1000 BC
Dhars Tichitt-Oualata-Nema
2000BC
Tilemsi Valley
2500BC
Windé Koroji
Oursi area
Ounjougou
Birimi
Kintampo
Nok
Chad Basin
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia
Map (2) 1000 BC - 500 BC
Waladé
Dhar Tichitt-Oualata-Nema
Dia
Dendi
Phase 1
Nok
Chad Basin
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia
Map (3) 500 BC - 0
Dhars Tichitt-Oualata-Nema
Senegal
Valley
Gao
Dia
Oursi Area
Jénne-Jeno
Nok
Chad Basin
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia


Map (4) 0 - 500 AD
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia
Senegal Valley
Gao
Sadia
Oursi Area
Dia
Jénne-Jeno
Kirikongo
Chad Basin
Dendi Phase 2
Nok


Map (5) 500 AD - 1000 AD
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia
Senegal Valley
Tongo Maare Diabal
Gao
Dia
Oursi Area
Sadia
Jénne-Jeno
Kirikongo
Chad Basin
Dendi Phase 2
Nok


Map (6) 1000 AD - 1450 AD
Legend
Pennisetum glaucum
Oryza glaberrima
Sorghum bicolor
Digitaria exilis
Vigna unguiculata
Gossypium sp.
Poaceae
Tree and Bushes
Varia
Senegal Valley
Gao
Tongo Maare Diabal
Upper Niger Sorotomo Togu
Dia
Oursi Area
Sadia
Gambia Cassamance
Falemé Valley
Jénne-Jeno
Kirikongo
Chad Basin
Dendi Phase 3
Nok
Central Ghana Area
Makala Kulo

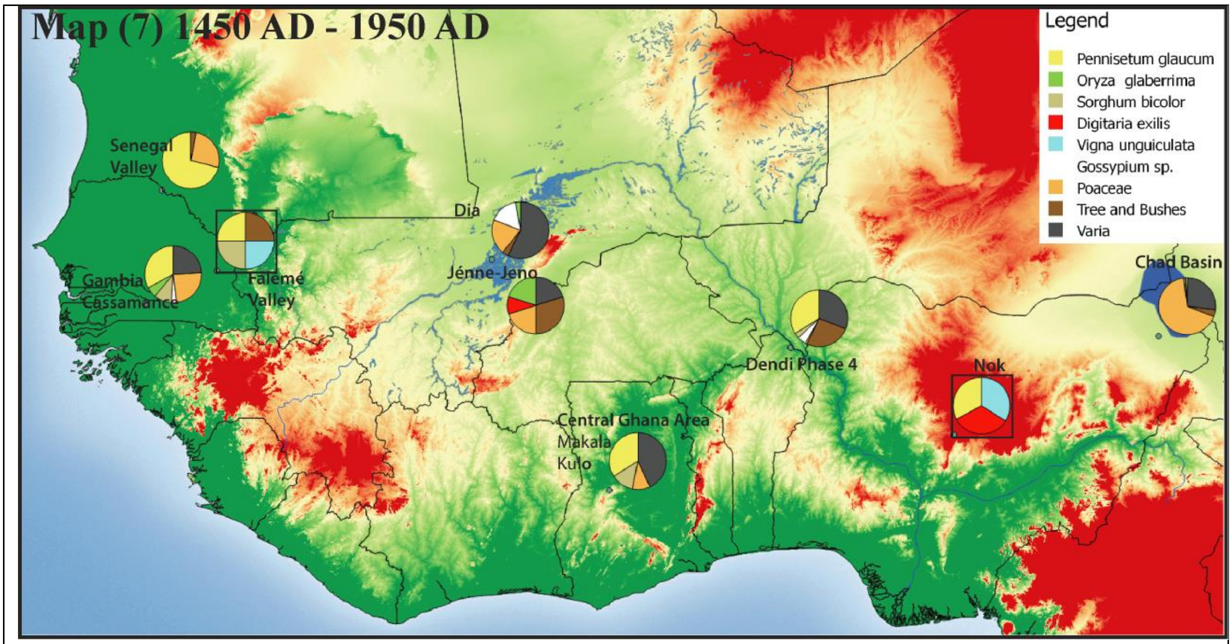


Figure 7.37 Maps summarizing agricultural diffusion for West Africa by time period starting at before 2500 BC until modern time. So far, 2500 BC correspond to earliest pearl millet agriculture evidence for West Africa. Each map shows the available archaeobotanical data by site in pie chart form. By map, each site is located by a pie chart indicating the mains crops frequency. When the frequency was not published it is symbolised by circular chart into a square where pie fraction does not represented frequency but only presence. The Data presented in these seven maps come from the literature presented in Chapter 7 and from the new data provided by this PhD.

7.3 Discussion

This chapter presents a review of the known archaeobotanical data across the wider region, bringing together a large body of information from a range of sources. The level of detail presented is variable, reflecting the available published archaeological and archaeobotanical results (Table 7-11). Where possible the plant remains have been considered alongside other supporting evidence including technology, animal resources, pottery types, to provide a broader perspective. Table 7-11 provides an indication of how variable current published data is, especially concerning the sampling and sorting of finer fractions. Indeed the small fraction (smaller than 1 mm) where present are often not analysed. However, it is these finer fractions that often contain the chaff remains of many cereals, including rice spikelet bases, pearl millet involucres and spikelet bases and sorghum spikelet bases and husks, as well as potentially smaller seeded grasses such as *Eleusine* and fonio. The absence of this small fraction analysis has two direct implications on the total results and discussion. Firstly the density (number of items recovered by litres of soil) will be different and by consequence the comparison of samples from different sites may be less accurate. Indeed, when the smaller fractions were sorted the density of remains often doubled; for example, at Kursakata and for Oursi area sites, where the small fraction was analysed, the seed densities per litre of sampled sediment were 21.1 and 24.8 respectively, but for other sites where the finer fraction was not analysed the density dropped to around 5 to 10 seeds per litre. Secondly, the presence of chaff in the archaeobotanical samples can be related to social organisation (see Chapter 4 and 5). As chaff remains are predominately recovered from the finer fraction, the absence of the <1mm fraction therefore prevents any real discussion not only on the presence of chaff, but by extension agricultural practices and the organisation of agricultural labour upon these sites. As set out in Table 7-11, there are very few West Africa sites where the small fraction has been sorted and analysed (the best example is Oursi area sites). By consequence it is currently not possible to have a conclusive discussion on proper social and agricultural practices.

Site	Country	Period	Sample	Volume litres	Density Items/litres	small fraction	Nisp	Frequency %	Ubiquity %	Archeobotanist	References
Dia	Mali	800BC-1900AD	500	3403	2.5	A	Yes	Yes	No	Murray S.	Bedaux et al.2005
Jenné-jeno	Mali	250BC-1400 AD	115	?	?	?	No	No	Yes	Harlan	McIntosh 1995
Tato à Sanouna	Mali	250BC-1400 AD	224	1344	0.8	A	Yes	Yes	No	Murray S.	Stone 2015
Thièl	Mali	250BC-1400 AD									
Toguéré Doupwil	Mali	1200-1450 AD	6	45	5.8	A	Yes	Yes	Yes	W van Zeist	Bedaux et al. 1972
Toguéré Galia	Mali	1000-1200 AD	3	22.5	11.8	A	Yes	Yes	Yes	W van Zeist	Bedaux et al. 1972
Gao Saney	Mali	650-1200 AD	26	?	?	?	No	No	Yes	Gallagher D.	Cissé et al. 2013
Gao Gadei	Mali	1400-1450 AD	1	?	?	Sorted	Yes	No	Yes	Fuller D.Q.	Fuller 2000
Oursi Region sites	Burkina Faso	2000BC-1950AD	47	6424.5	24.8	Sorted	Yes	Yes	Yes	Kahlheber S.	Kahlheber 2004
Kirikongo	Burkina Faso	450-1450 AD	71	130	?	A	Yes	Yes	No	Gallagher D.	Gallagher and Dueppen in press
Kursakata	Nigeria	1000BC-100AD	30	300	21.1	Sorted	Yes	Yes	Yes	Klee and Zach	Klee and Zach 2000
Mege	Nigeria	800BC-1500AD	22	6300	4.5	?	Yes	Yes	Yes	Kahlheber S.	Bigga and Kahlheber 2011
Kitampo B-sites	Ghana	1900-1400 BC	40	268	3.2	NO	Yes	Yes	No	D'andrea A.C.	D'andrea et al. 2002 and 2006
Birimi	Ghana	1950-1400 BC	51	394	7	?	Yes	Yes	No	D'andrea A.C.	D'andrea et al. 2001
Banda Area Sites	Ghana	1000-1950 AD	327	~2000	~3.3	NO	Yes	Yes	Yes	Logan A.	Logan 2012
Senegal River Sites	Senegal	800BC-1900AD	315	~2500	~10.4	Sorted	Yes	Yes	Yes	Gallagher D.	Gallagher et al. 2018
Juffure	Gambia	1700-1900AD	32	~200	~3.5	Sorted	Yes	Yes	Yes	Walshaw S.	Gijanto et Walshaw 2014
Korop	Senegal	1200-1900 AD	10	?	?	Sorted	Yes	Yes	Yes	Stricker L.	Stricker 2016
Payoungou	Senegal	1200-1800AD	13	?	?	Sorted	Yes	Yes	Yes	Stricker L.	Stricker 2017
Ounjougou	Mali	2200-400 BC	Only presence/ Absence: Have to be analysed							Eichhorn B.	Ozainne et al. 2009
Nok Region	Nigeria	1500BC-1900AD	Only presence/ Absence: Have to be analysed							Kahlheber S.	Höhn and Neumann 2016
Zilum	Nigeria	800-400BC	Only presence/ Absence: Have to be analysed							Kahlheber S.	Magnavita et al. 2004
Diouboye	Senegal	1000-1400 AD	Only presence/ Absence: Have to be analysed							Gallagher D.	Gokee 2012
Djoutoubaya	Senegal	900-1300 AD	Only presence/ Absence: Have to be analysed							Champion L.	Mayor et al. 2018
Gajiganna	Nigeria	1800 BC-400BC	Ceramic impression							Klee and Zach	Klee and Zach 2004
Tilemsi Region Sites	Mali	2500-1800 BC	Ceramic impression							Fuller D.Q.	Manning et al. 2011
AZ22	Mali	5000 BC	Ceramic impression							Champion L.	unpublished
Tichitt Region Sites	Mauritania	2300-400BC	Ceramic impression							Fuller D.Q. and Munson	Munson 1971; MacDonald et al. 2009
Kolima	Mali	900BC-1300AD	Have to be analysed								Cissé 2016

Table 7-11 Hygiene sites or area mentioned in the Chapter 7. A = available but not sorted NA= Not available; ?= Information not published

Within the main archaeobotanical studies of the Inland Niger Delta (Dia, Jenné-jeno, Tato à Sanouna and Thièl) there is no evidence for cereal chaff remains, such as rice spikelet bases, pearl millet involucres or sorghum spikelet bases and husk fragments. So how can we interpret their absence? As mentioned in the methodology chapter of this thesis, plant part remains are a good indicator of post-harvesting processing and treatment of the crop. Thus the absence of husks and other key chaff elements, could suggest that post-harvesting crop processing was being done directly in the field outside of the settlement away from fires. Also, this absence of evidence is not necessarily an evidence of absence. African archaeobotanical analysis is still in development and indeed, as noted in the introductory chapter only a few archaeological sites have been properly studied and many more have not received much, if any, consideration in terms of archaeobotanical sampling and analysis. Thus, as seen from the perspective of a specialist field still in development in African archaeology, proper systematic methodologies are currently still lacking at many sites in the regions examined in this thesis. Hence, the absence of plant parts, like chaff, can result from a lack of identified material, especially from smaller size fractions, or time constraints, that prevent the full sorting of smaller fractions. Plant chaff remains as noted are generally small, between 0.5 to 1mm, and the sorting of the finer fractions are often more time consuming, and under current academic pressures, time and financial constraints, these finer fractions are often are left unanalysed.

While this chapter has provided an overview of agricultural developments throughout West Africa it also highlights how little is currently known about agricultural origins and development in West Africa. However, it is possible from the collected data to highlight at least four West African regions of agricultural development (Figure 7.37). The greater Niger River Basin (1), including the Tilemsi valley can be regarded as parallel to, but also in interaction with the Hodt depression in Mauritania (2). The Senegal River Valley, with the diffusion of pearl millet was probably also connected to the Hodt depression, but likely had its own development. In the Eastern Sahel (3) at the woodland savannah border, the Nok culture area appears to have had from an agricultural economy, based on pearl millet but can be distinguished as a different tradition from the Tilemsi valley, where roulette decoration accompanies the introduction of pearl millet. Finally, the Chad Lake Basin (4) had at least two distinct, and potentially more, cultures which embraced agricultural practices during the first millennium BC. There are probably more cultures to be discovered as most of the botanical research in West Africa is focused on the Sahel area. The forest area still has to be explored along with many other places included in the Sahel.

Most of the data, results, interpretations and re-interpretations presented in this chapter are integrated with the new data obtained by this study in Chapter 9, in order to develop interpretations and discussion.

8. Key components in West African agriculture: integrated evidence on the crops

This chapter reviews the crops and other main food plants from the study region in order to provide a broad overview of the traditional agricultural systems, including major food systems and utilisation. The Beninese and Malian data generated from this study are incorporated in the review. For each plant, we first summarize the current state of knowledge of its origins alongside a map of all associated important archaeological sites. Secondly, I describe the archaeobotanical identification criteria used for each plant taxa. Finally, I briefly discuss the utilisation of the plant though time, from the present day through the historic era (including ethnographic evidence) to the prehistoric periods.

8.1 Pearl Millet – Pennisetum glaucum (L.) R.Br.

Pearl millet is the common English name for cultivated millet, *Pennisetum glaucum*. Other names for this crop of West African origin include bulrush millet in Australia, cattail millet in in the United States, *mahangu* in Namibia, *bajra* in India, *dukhn* in Arabic, and *maiwa*, *gero*, and *sanyo* in West Africa (Brunken et al. 1977; Harlan 1971). The genus, *Pennisetum*, is in the plant family Poaceae and in the subfamily Panicoideae. Today, in terms of global production, it is the sixth most important cereal crop in the world, and amongst the millets sorghum is the only millet consumed more globally (Brunken et al. 1977). Today, pearl millet is the staple food crop for over 100 million people in tropical Africa and India and is grown mostly in the arid and semi-arid tropical regions of Africa and Asia. The country with the largest production is India, followed by Niger, Mali, and mainland China (Food and Agriculture n.d.; www.prota.org). The success of pearl millet as a crop today is largely due to its minimal water requirements, and because of this, pearl millet as a crop, has played a major role in the economy of early mobile pastoralists of West Africa and the spread of other West African domesticates to other parts of Africa and India (Manning et al., 2011; Zohary and Hopf 2000).

***Pennisetum glaucum* (L.) R.Br.**

Description: a free-threshing, erect, annual grass usually between 50 and 300 cm tall. Root systems are extremely profuse. The inflorescence is a cylindrical contracted compact panicle up to 200 cm long. Pearl millet possess a large hilum and scutellum with a tip which is often projecting. The pearl millet's scutellum is often deeper than that found on sorghum. Also, sorghum grains are usually bigger in size than pearl millet grains (Fuller 1999, D'Andrea et al. 2001; Neumann et al. 1996).

Distribution: Pearl millet is widely distributed across the semi-arid tropics of Africa and Asia.

Agronomy: In Africa it can be found growing 1200 m above sea level but in Asia and America it occurs at much higher altitudes. Pearl millet grows in areas where rainfall ranges between 200 to 1500 mm and mostly occurs in areas receiving 250-700 mm. It is very drought resistant, but unlike sorghum, it cannot become dormant during drought periods. It is tolerant of various soil conditions but it performs poorly in clay soils and does not tolerate waterlogging.

Yields: It is worth noting the relative productivity of the staple crops under traditional cultivation techniques. Irvine (1969) reports that traditional rainfed west African pearl millet yields from 270-900 kg/ha, with an average of perhaps 450 kg/ha (Acland 1971)

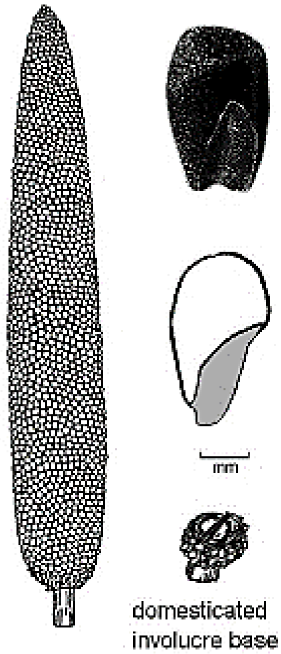


Figure 8.1 Pearl millet by D.Q Fuller.

Production and consumption

The details of the production *chaine opératoire* has already been described in Chapter 5. However, to briefly summarize pearl millet cultivars vary in time to maturity from 55 to 280 days. The field preparation before sowing is limited to a light hoeing for the short duration that cultivars are sown during the first days of the rainy season but a more thorough hoeing is needed for longer duration cultivars. As pearl millet is a tall crop (up to 300 cm) no weeding is needed after the second week of growth. The immediate effect today is the absence of weed seeds within the harvested crop assemblage. Moreover, pearl millet is often intercropped with several crops, mostly cowpea, sorghum or Bambara groundnut.

Pearl millet can be processed and consumed in a variety of ways including in Africa as a thick porridge (e.g. *tô* in Mali), a thin, fermented porridge (e.g. *koko* in Benin), a deep-fried pancake (Rao et al. 1985), as couscous, as a blend with pulses, as a fermented and non-fermented beverage, or as a flat, unleavened bread called *chapatti* in India. For the Dogon in Mali, most of the pearl millet varieties are brewed into *Dolo* beer (Jolly 2004).

Origins and Dispersal

Pennisetum glaucum was likely domesticated in the south-western fringes of the Sahel zone of West Africa in northeast Mali to Lake Chad beginning before 2500 BC, and from this region rapidly spread, within less than 1000 years of domestication, eastwards across the Sahelian/north Savanna zone to India, with archaeobotanical remains providing evidence for the spread of other African crops by 1700 BC (Brunken et al. 1977; Fuller 2003; Harlan 1977; Manning et al. 2011). The wild progenitor of the cultivated species has been identified as *P. violaceum* (D'Andrea and Casey 2002) and the natural distribution of this species is restricted mainly between the Saharan zones of West Africa (Harlan 1992, Tostain 1998, Fuller 2003) and southeast Mauretania (Tostain 1998) (Figure 1), where it thrives in the dry Sahelian and semi-desert zones of the savannahs.

Domestication

The primary traits of pearl millet that evolved under domestication include grain size increase and changes in the dispersal mechanism, specifically the change from a brittle to non-brittle rachis e.g. non-shattering. In domesticated pearl millet the pedicelled spikelets containing the grains remain attached at maturity, as opposed to releasing when ripened (Neumann et al. 1996).

However, unlike changes under domestication that are seen in other cereal crops, including wheat, barley, and rice, where grain size increase accompanies the transition from shattering to non-shattering spikelets, the dispersal mechanism of pearl millet appears to have changed before most evidence for grain size increase club shape. Furthermore, once domesticated, non-shattering forms spread from sub-Saharan Africa they appear to have undergone two episodes of grain-size increase, one in Africa and the other in India (Manning et al. 2011). Another trait that evolved early during domestication was the change from a single grain contained in each involucre to multiple grains (Fuller et al. 2007) and there is evidence of this trait in the origin of domestication, prior to the spread of this crop (Manning et al. 2011).

The archaeobotanical evidence is most often present either in the form of plant parts and grain impressions in pottery or as charred seeds, followed by involucre bases, rachis and bristle fragments, and spikelets. The seeds of pearl millet are identified based on morphology which is broadly club-shaped and circular in transverse section (Figure 2). There are morphological differences between the grains of the wild *P. violaceum* and domesticated *P. glaucum*, and there is an intermediate form between the two, which has been identified as *P. sieberanum* (shibra or shibra-like grains). The wild forms are more elliptical in shape and dorsally compressed, the domesticated forms are club-shaped and deeper and wider on the apical ends, whereas the intermediate grains are obovate to elliptical, with the narrower part being the embryo end, and are only somewhat compressed (D' Andrea et al. 2001; Neumann et al. 1996).

Based on the grain shape and partly on the pearl millet cultivation distribution, Brunken et al. (1977) identified four races/cultivar groups (Figures 8.2, 8.3; Table 8.1) which presumably represent differentiation after domestication, although it is possible that traits of *Leonis* come from a separate regional population.

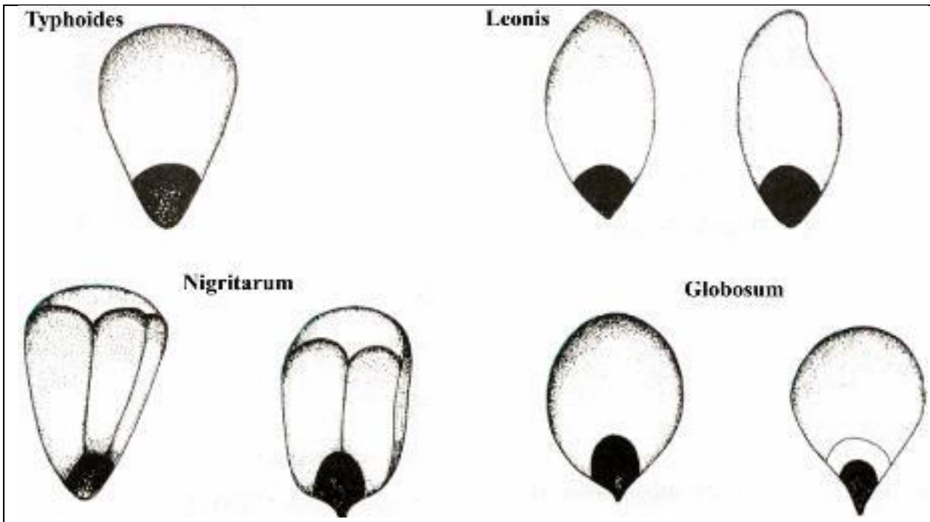


Figure 8.2 Comparison of the different pearl millet crops based on caryopses morphology (De wet 1977, Bruken et al. 1977, Portères 1962).

Figure 8.3 Diversity of archaeological *Pennisetum glaucum* grains from Tongo Maaré Diabal site in Mali. Photo: Champion Louis

Table 8-1 Current varietal diversification on grains forms of *Pennisetum glaucum* landraces following Brunken 1977 and map after De Wet 1977.

Groups	**Length (mm)**	**Width (mm)**	**Grain Form**	**Cross-section form**	Note	Distribution
Typhoides	2.5-5.5	1.5-3	Obovate	Obtuse & terete		Africa & Asia
Nigritarum	3-5	1.7-2.5	Obovate	Angular 3 to 6 facets	Apex truncate	Western Sudan to Senegal
Globosum	>2.4	>2.4	spherical	Obtuse & terete		Nigeria to Senegal
Leonis	4-6.5	2-2.5	oblanceolate	terete		Sierra Leone

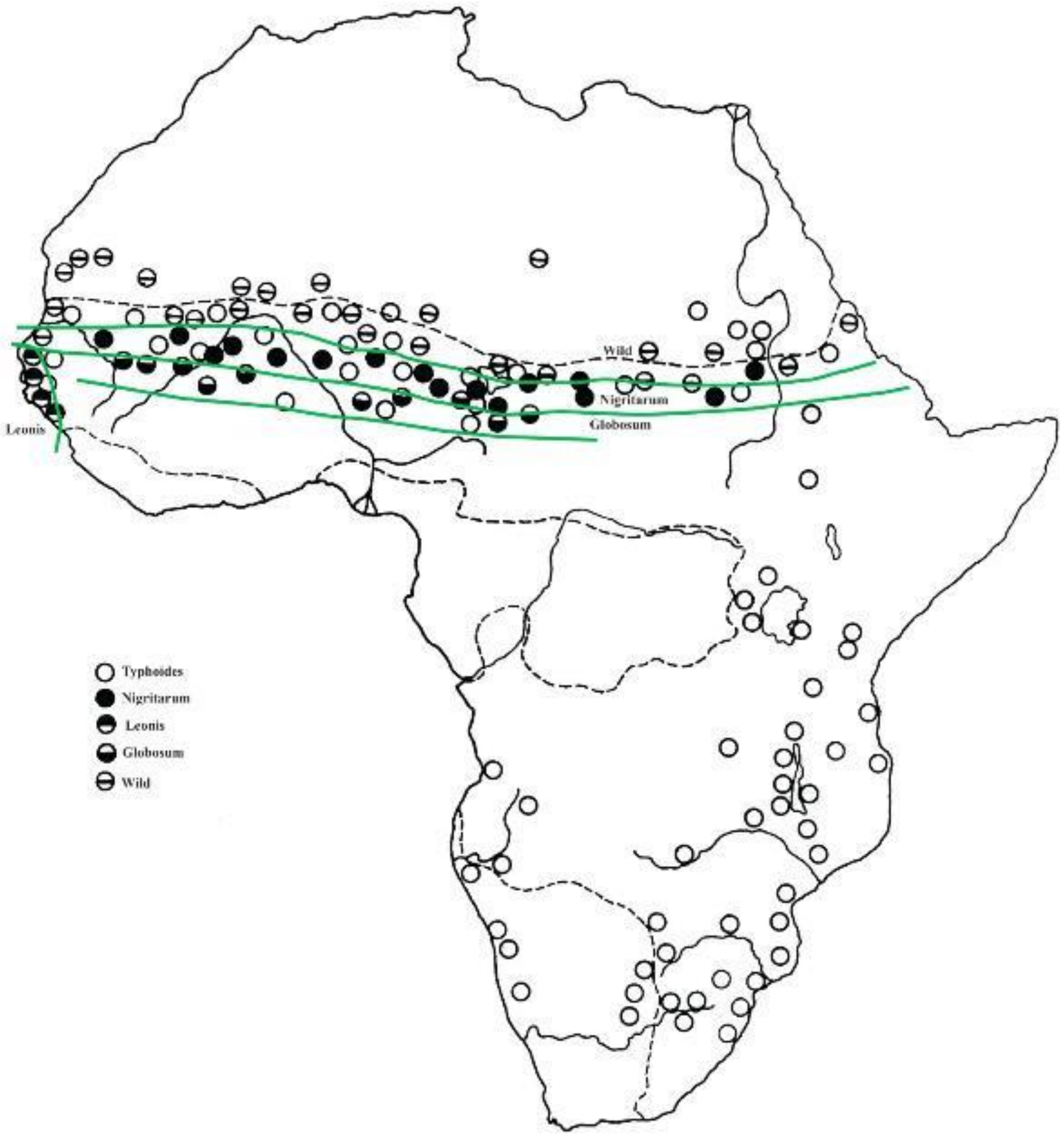


Figure 8.4 Distribution Map for the Pearl Millet Landraces modified from De Wet 1977

Within those races, Typhoides is the most widely distributed, from South Africa to North and West Africa and it is also the only pearl millet race found outside Africa and the predominant race grown in India. This large geographic distribution suggests an earlier diffusion from the west Sahel region (Brunken et al. 1977), imply that this was the most primitive race with other races differencing later in different regions.

Origins

Using linguistic evidence Murdock (1959) was the first to propose a West African origin for pearl millet. He postulated that pearl millet was domesticated by the Mande people near the Inland Delta region. In 1962, Clark suggested that pearl millet cultivation spread from the central Sahara to the Sahel zone following the drying of the Sahara (Figure 8.5). For Portères (1962, 1976), the wide range of pearl millet botanical diversity was the product of multiple domestications.

Most of the genetic studies have suggested a monophyletic origin for pearl millet but have never agreed on a single origin area (Figure 8.5). First, based on isoenzyme analysis Tostain (1998) suggested a far-west centre located in the north, north east of the Senegal River. Secondly, Oumar et al. (2008) using a neighbour-joining tree reconstruction inferred a single potential domestication area located between eastern Mali through western Niger. This method is widely used for inferring numbers and locations of domestications based on modern genetics but for Allaby et al. (2010: 154) this *"is not the most appropriate method for analysing genomic data because it assumes that crossing is non-existent"*. Thus, this hypothesis must be employed with caution. And lastly, a recent study provided evidence that wild-to-crop gene flow increased cultivated genetic diversity leading to diversity hotspots in western and eastern Sahel. Using coalescent models, this supports a single pearl millet origin located in central Sahara. They also noticed two hotspots of diversity, one in the western Sahel and the second in the eastern Sahel. These two hotspots are probably the result of a secondary contact, or introgression, between the domesticated and local wild relatives (Figure 8.5, Figure 8.6; Burgarella et al. 2018). Based on this newly published study the two domestication centres posited by Harlan and de Wet (Figure 8.5) could be what Burgarella et al. proposed to be introgression zones after domestication took place in the central Sahara.

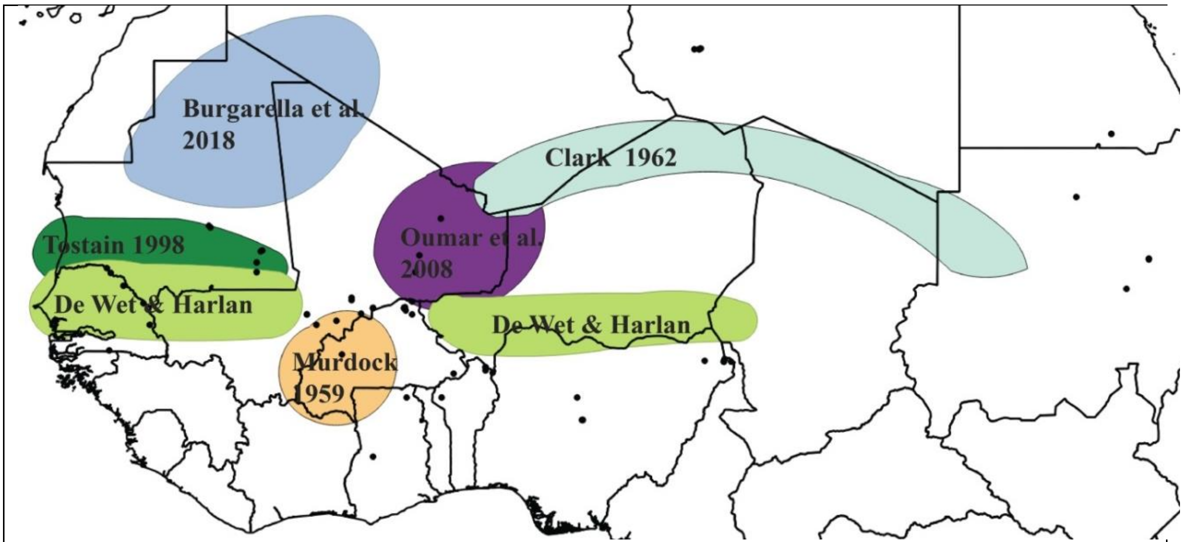


Figure 8.5 Summary of the suggested different pearl millet center of domestication origin.

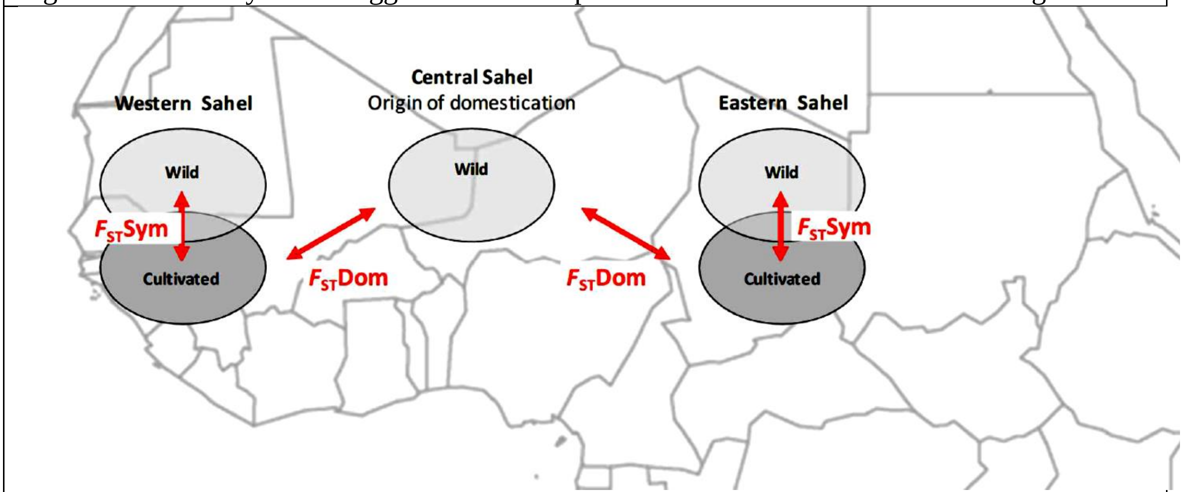


Figure 8.6 Pearl millet diversity hotspots. From Burgarella et al. 2018 Supplementary figure 15.

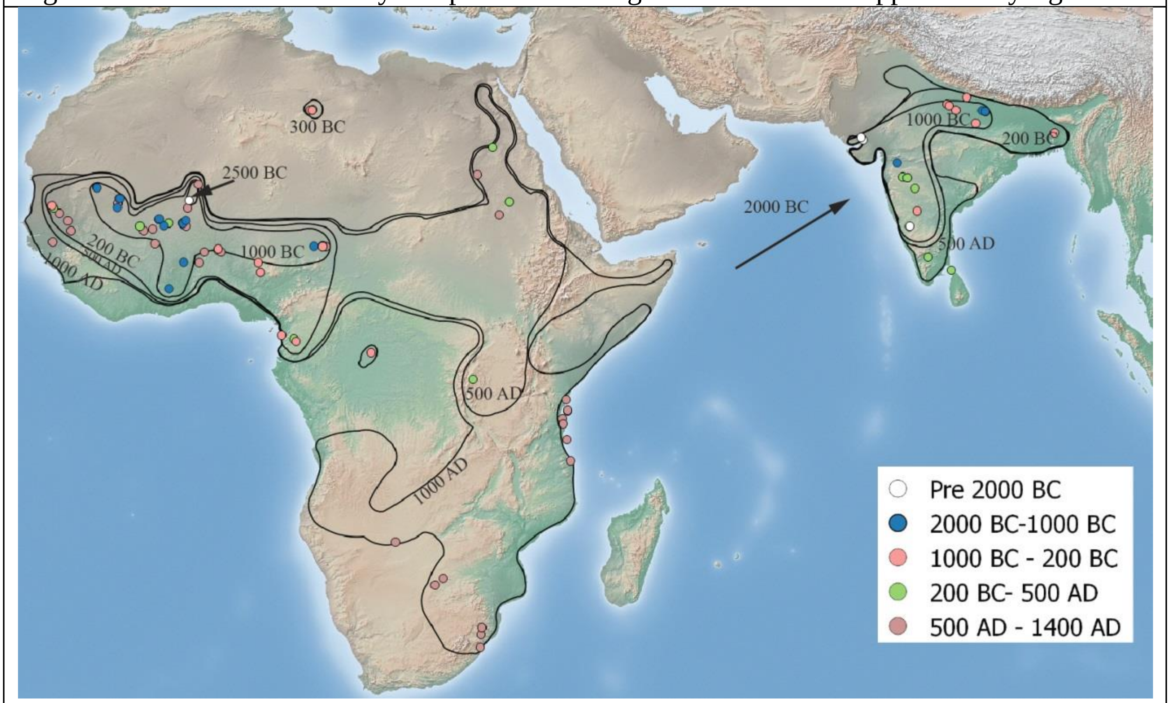


Figure 8.7 Pearl Millet Diffusion.

Archaeology

So far, the first archaeological evidence for pearl millet consists of a couple of charred grains and seed impressions in ceramics that date to ca. 2500 BC and were found in the lower Tilemsi valley (Manning et al. 2011; Manning and Fuller 2014; Neumann 2018). This evidence supports domestication in or around the Tilemsi Valley and subsequent spread southwards in the savannas and through the Sahel. Archaeobotanical finds from Ounjougou and Windé Koroji south the Niger river, and Birimi in Ghana, attest to the rapid spread of pearl millet cultivation by ca. 1700 BC (D'Andrea et al 2001; Manning et al 2011). Nevertheless, the possibility of a second independent domestication of pearl millet in Mauretania associated with the Tichitt-Oualata Neolithic cultures remains plausible (MacDonald et al 2009; Manning and Fuller 2014). Regardless of the number of origins, pearl millet was established in the Neolithic as the primary staple grain in West Africa and has since continued to be a staple crop in many of these same areas into modern times. The spread of domesticated pearl millet was widespread and rapid, reaching India via maritime contact within less than 1000 years of the first archaeobotanical evidence for pearl millet and evidence for the non-shattering domestication trait. The dispersal route was likely across the Sahelian, North Savanna zone, but evidence from this region is lacking to date. However, evidence of its spread southwards across Western Africa from the first half of the second millennium BC is more substantial, with data recovered from Dhar Tichitt, (Maurentania), Birimi (Ghana), Burkina Faso, and Nigeria (Manning et al. 2011, Fuller et al. 2007 D'Andrea et al. 2001, D'Andrea and Casey 2002). Pearl millet reached the Ganges Basin in India during the second millennium BC, and it is here that there is also evidence for substantial grain-size increase. During the first millennium BC pearl millet reaches Senegal, West Africa, with evidence dating to the West African Iron Age, and Central African rainforest shortly after, and not reaching East Africa and the Comoros until the first millennium AD with the initial stages of the East African Iron Age (Manning et al. 2011) (Figure 1).

In the Sahel zone, two regional trajectories for the spread of pearl millet cultivation are commonly accepted (e.g. Champion and Fuller 2018 a, b; MacDonald et al. 2017, Manning et al. 2011). These trajectories will be discussed in the next chapter of this study.

Linguistics

Terms or names for pearl millet do not seem to form a significant pattern over a wide area. Linguistic data indicates at least four major roots for pearl millet in Africa. Two are related to the Bantu language, one to the Central Nigeria and one to the central Chadic language (Bosteon 2007, Longtau 2008, and Blench 2016).

The widespread root **mar(d)a* attested for both Chadic and Plateau languages of central Nigeria (Table 8-2) seems to be related to the Nok sites region (Blench 2016, Longtau 2008). So far the origin of pearl millet in the Nok region from archaeological sites is still unknown. Indeed, as presented in the preceding chapter, the Nok area archaeobotanical evidence for pearl millet, dated to *ca.* 1500 BC, has not correlated, yet, to any other pearl millet evidence or diffusion waves in West Africa. Thus the term **mar(d)a* could represent a latter independent pearl millet diffusion wave from the Nok Area to the Ivory coast where the same term is still currently used (Figure 8.9).

Another unrelated root occurs in the central Chadic languages from Northern Cameroun (Table 8-3): **heya*. This term could probably be related to the pearl millet archaeological remains found in Cameroun (Kahlheber 2009), but more linguistic data will be necessary to prove it. Also, the single Berber root for pearl millet (Table 8-4) seems to indicate that pearl millet was introduced into the Berber world during an early period before the diffusion and split of the main Berber languages (Blench 2014).

Bantu shows two widespread pearl millet roots: **-cáng*ṹ, and **-bèdé*. For K. Bosteon (2007) this suggested than pearl millet was introduced at least twice into the Bantu-speaking world. Also, the phonological regularity of those terms across the Bantu area indicates an early diffusion into the Bantu before the major extension had taken place. “[…] *the diffusion of pearl millet in the Bantu area is the result of the steady expansion of Bantu-speaking farming communities”* (Bosteon 2007:201). The East-Bantu term *-*bèdé*, as a loanword from the western Nilotic languages suggested that pearl millet was once introduced to Bantu speakers via eastern Africa. The case for **-cáng*ṹ roots is more debatable. The term has a nearly exclusive western distribution (Figure 8.9 ; Bosteon 2007). For Vansina (2004) and Ehret (1974) this distribution is probably due to a loanword term from the East Bantu. However, for Bosteon all **-cáng*ṹ reflexes are phonologically regular and can be reconstructed into at least proto-narrow West Bantu suggesting an independent western introduction via the rainforest during a secondary nucleus of Bantu expansion.

Thus, linguistic data clearly indicates several roots for pearl millet established between several major language group expansion (including Chadic, Bantu and Berber language families). Nevertheless documentation of pearl millet terms in Africa remains weak and more data is needed to develop firmer conclusions on its possible origins and diffusions (Figure 8.8).

Table 8-2 #*mar(d)a*, a West African root for pearl millet (from Blench 2016:22)

Language	*Attestation*	Language	*Attestation*	Language	*Attestation*
Afro-Asiatic : **Chadic**		Niger-Congo: **Kwa**		Niger-Congo: **EBC (Plateau)**	
Hausa	*maiwa*	Ga	*nmãã*	Ninzo	*amar*
Bole	*mòrdo*	Adyukru	*máy'*	Ningye	*mwan*
Ngamo	*mòrdò*			Anib	*àmɛ̧n*
Geji	*marda*	Niger-Congo: **Volta-Niger**		Nyankpa	*imala*
Ngizim	*mardû*			Ashe	*i-ma*
Karekare	*màrdo*	Nupe	*mãyì*	Idù	*imara*
Kushi	*moodo*	Niger-Congo: **Bantu**		Shang	*mara*
Miya	*màywá*	Mbula	*mara*	Jili	*amo*
Mwaghavul	*mààr*	Mbat	*máár*	Sambe	*tìk àmâr*
Fyer	*mar*			Kwan	*mɛ̧r*
Sirzakwai	*marday*	Niger-Congo: **Adamawa**		Yankam	*marak*
Zaar	*màrwá*	Yoti	*múri*	Tarok	*imar*
				Sur	*mre*
				Pe	*ime*

Table 8-3 A central Chadic root for millet (Compiled by R. Gravina from Blench pers. com.)

Language	*Attestation*
Central Chadic	
Podoko	*hiyá,-e*
Hdi	*hiya*
Mandara	*hiá*
Lamang	*xíyá*
Sharwa	*hayne*
Tsuvan	*he*
Ouldeme	*hay*
Moloko	*hay*
Vame	*aháy*
Gidar	*haya*
Psikye	*xá*
Bana	*xà*

Table 8-4 Berber terms for pearl millet (from Blench pers. com.)

Language	Attestation
Berber	
Tashelhiyt	anili,Aynli
Ntifa	illan
Kabyle	ilni
Ouargla	inelli
Ghadames	alele
El Foqaha	anäli, elli
Awdjilah	ílli, élli
Tuareg	enale
Zenaga	i'llän

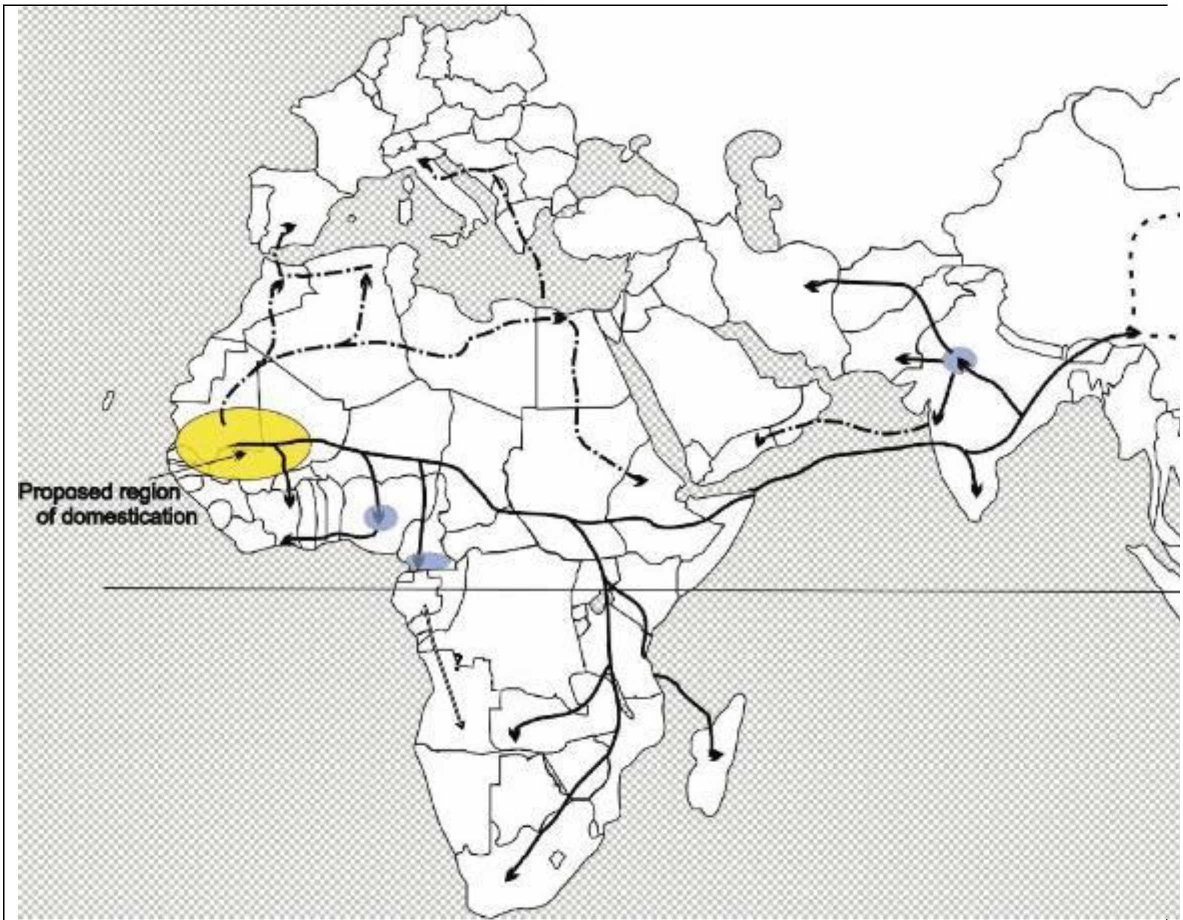


Figure 8.8 Diffusion of pearl millet cultivation using linguistic data (After Blench 2016:23).

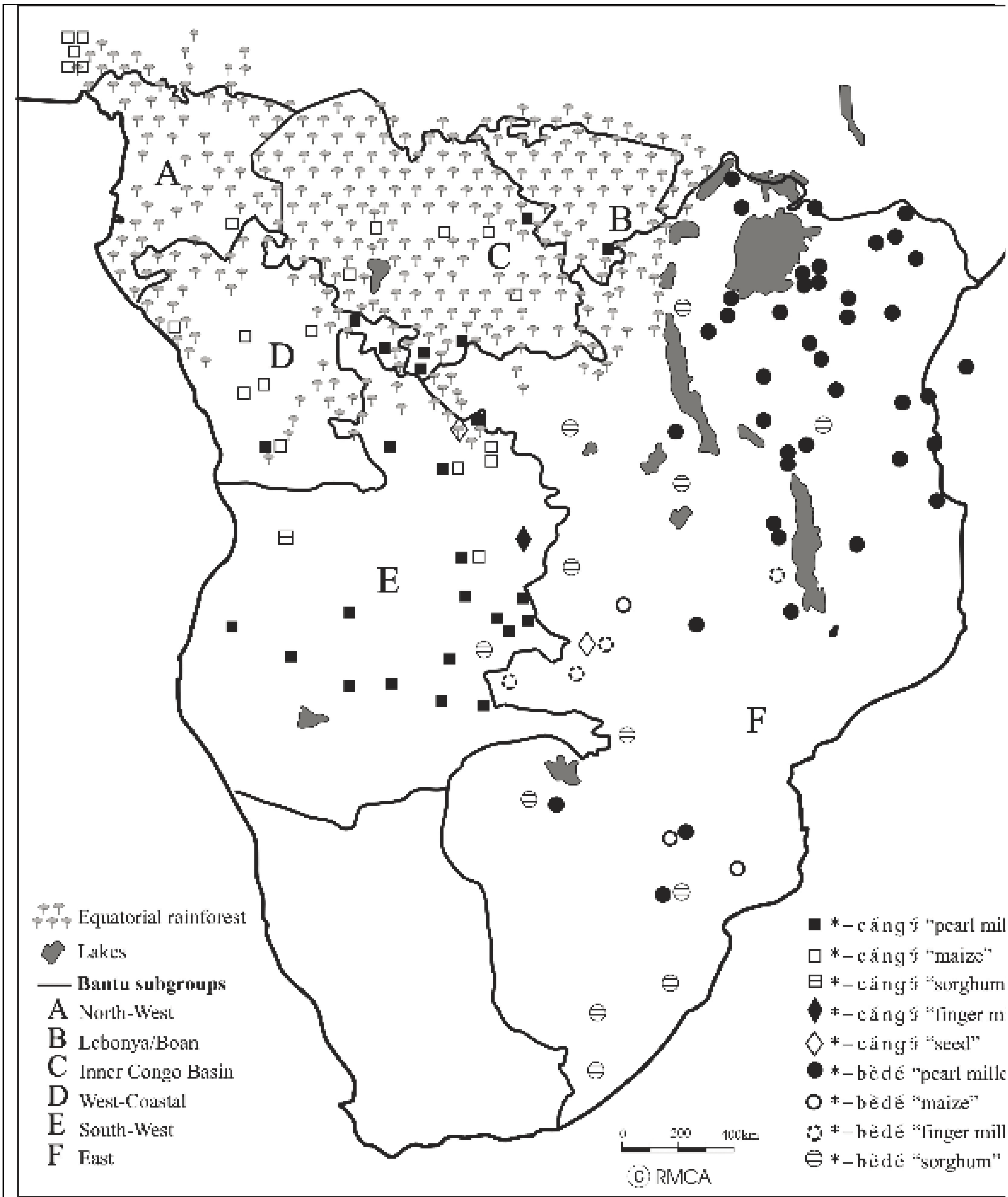


Figure 8.9 Distribution map of *-*bèdé and* *-*cáng*ɨ́ with their respective meanings in present-day Bantu languages (From Bostoen 2007:213).

8.2 Sorghum bicolor

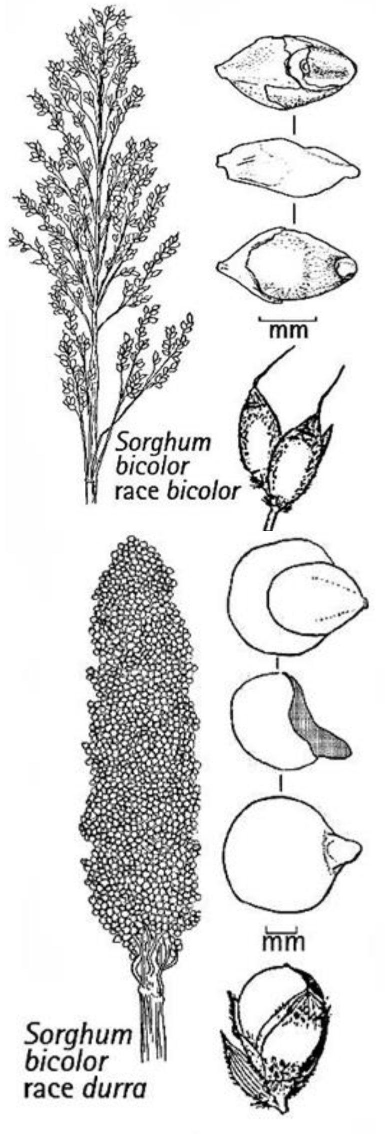
Sorghum bicolor

Description: *Sorghum bicolor* is an annual grass up to five metres tall and can produce a long inflorescence with a 60 cm long panicle.

Distribution: Sorghum can tolerate a wide range of temperatures, from 21°C to 45°C and ecological niches from the Sahel to the high mountain, to a maximum of up to 2400 metres in altitude. The rainfall ranges vary from 400 to 800 mm with some more resistant varieties up to 1200 mm.

Agronomy: Seedling emergence takes 3-10 days after sowing and early maturing varieties take 100 days to grow whereas long maturing varieties take up to 7 months.

Yields: Sorghum might also have been grown on the margins of décrue, with drier areas focused on rainfed pearl millet. Rainfed sorghum can be expected to produce at least 550-1000 kg/ha but up to 1700 kg/ha reported from some traditional cultivation (Irvine 1969; Acland 1971).



Sorghum has a multitude of uses. It is used most regularly in the production of beer consumed in large quantities in Africa. Sorghum can also be eaten as the main form of flour boiled into porridge or cakes. These cakes can be fried, grilled or boiled (De Wet 2006; McCann 2009). *Sorghum bicolor* subsp. *bicolor* are divided into 5 groups (De Wet 1978, 1966; Harlan 1992, Snowden 1936), "races", based on tendencies in morphological characters, which are often geographically restricted. These five groups, which belong to the same species, are all capable of interbreeding and their offspring are fertile. Thus, there is a great diversity of viable hybrids in this taxon.

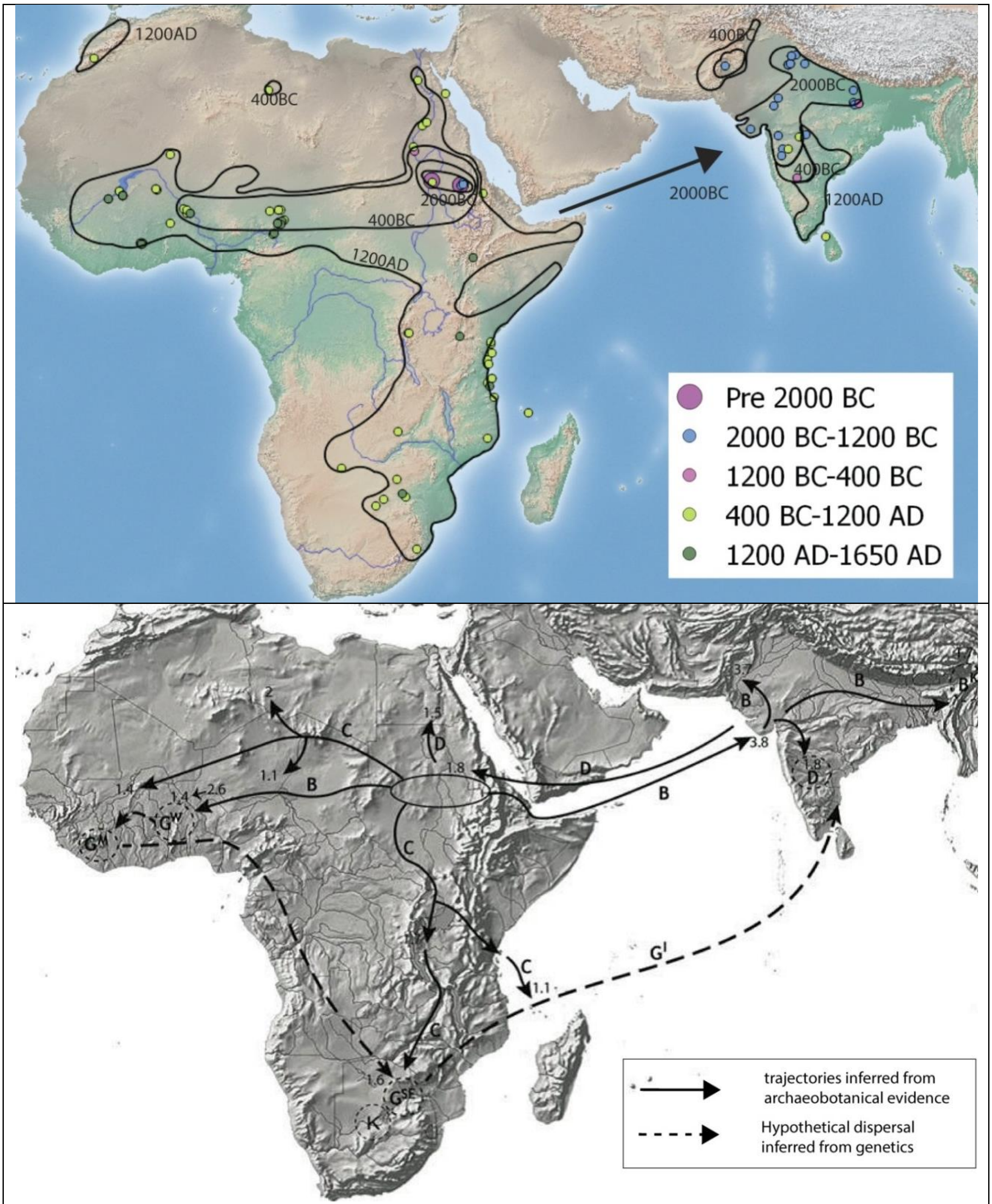


Figure 8.10 Diffusion and diversification of domesticated Sorghum. **Top Map**: Archaeobotanical remains by time period. **Bottom Map**: Numbers indicate approximate age in years before AD 2000 for arrival time or evolutionary event. Letters on arrows indicate races or varietal groups inferred for each dispersal trajectory: B = bicolor race, BK = Chinese kaoliang sorghum group within race bicolor, C = caudatum race, D = durra race, GW = race guinea, west African group, GM = race guinea, margaritiferum varieties (= S. margaritiferum Stapf.), GSE = race guinea, southeast African group, GI = race guinea, Indian group, K = race kafir (= S. caffrorum Snowden). Note that race bicolor types should be regarded as co-dispersing along most, if not all trajectories, but these are only indicated where no advanced races are involved (after Fuller and Stevens 2018).

Sorghum did not originate in West Africa but arrived from East Africa. Its origin is still controversial. Genetic studies provide evidence of an African centre of domestication.

Current genetic data and recent archaeobotanical reports support this and point towards a domestication trajectory that was underway before 3000 BCE and completed probably after 2000 BCE (Winchell et al. 2017; Beldados et al. 2018; Fuller and Stevens 2018). Data from sorghum chaff and spikelet impressions in ceramics indicate that morphologically domesticated forms were close to half the population before 3000 BC around the upper Atbara river east of Khartoum (Winchell et al. 2017), with a slow increase in domestication characteristics evident in material from near Kasala (eastern Sudan) at ca. 1850 BC (Beldados et al. 2018). Already between 2000 and 1700 BC sorghum appears to have been introduced to India (Fuller and Boivin 2009; Fuller and Stevens 2018). The first sorghum evidence in West Africa are inferred to date by 650 BC from Alibori sites in North Benin (this study and Champion and Fuller 2018a & b), and sorghum is reported from sites near Lake Chad in the later first millennium BC, such as Mege and Kursakata (Zach and Klee 2003; Bigga and Kahlheber 2011; Fuller and Stevens 2018). By the early centuries AD sorghum is more widespread, including finds from Mali. However, wild sorghum use as a subsistence staple has not been documented in western Africa.

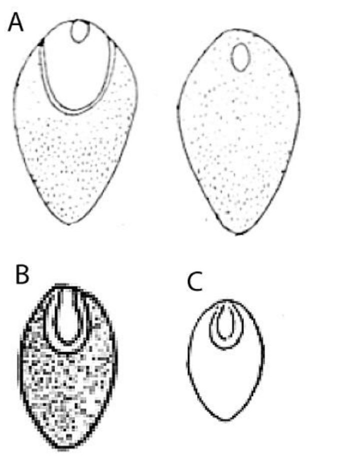
Thus, sorghum domestication took place around 3500-3000 BC in the eastern Sudan. Early domesticated race bicolor (B in Figure 8.10 bottom map) spread to India around 2000 BC and to the Niger River Basin after 1000 BC. The framework of five cultivated races remains useful, with the original domesticated race bicolor being characterized by tight-fitting hulls requiring dehusking and the other races representing subsequent parallel evolution for free-threshing and larger-grained cultivars. This took place at least three times, including race caudatum focused initially on the Sahelian region race ‘durra’ that evolved probably in India, and race ‘guinea’ that evolved in forested West Africa (Fuller and Stevens 2018).

8.3 *Fonio* - Digitaria exilis, Brachiaria deflexa, Panicum laetum

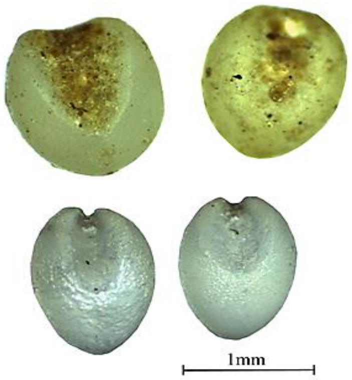
Currently in West Africa there are several kinds of cereals named "Fonio", and in the literature there is considerable confusion surrounding these 'fonios'. The most common "Fonio" cereal is *Digitaria exilis* (commonly named true fonio, white fonio or hungry rice) domesticated from *Digitaria longiflora* (Hilu et al 1997; Adoukonou-Sagbadja et al 2007). A second is the Iburu fonio (*Digitaria iburua*), which is restricted to traditional cultivation in a small part of Nigeria (Porteres 1976; Aliero and Morakinyo 2001); this is thought to be domesticated from *D. ternata* (Adoukonou-Sagbadja et al 2007). A third type is big fonio (*Brachiaria deflexa*) which is currently cultivated in two small areas in Benin and Nigeria (Porteres 1976). A forth is commonly named 'wild' fonio or "haze" (*Panicum laetum*) a wild grass that grows in the Gourma region in Mali and Mauritania; morphologically domesticated forms are unknown (Portères 1976; Stapf 1915; Cruz et al. 2011; Kahlheber 2004)

Table 8-5 Comparison of the different Fonio crops based on caryopses morphology. (Portères 1976; Stapf 1915; Cruz et al. 2011; Kahlheber 2004 & author's personal observations).

Species	**Length (mm)**	**Width (mm)**	**Weight seeds/gr**	**Grain Form**	**Scutellum**	**Scutellum Length**	**Hilum**
Digitaria exilis [domesticated]	0.8-1.5	0.4-0.7	1700-2200	ovoid to oblong ellipsoid	ovoid	30-40%	Oval to roundish
Digitaria longiflora [wild]	0.6-1.2	0.3-0.6	1900-2500	oval to ovate	oval to ovate	Ca.50%	roundish to oval
Brachiaria deflexa	0.8-1.4	0.4-0.6	1700-2300	Ovoid to oval	oval	40%	Oval to roundish
Digitaria iburua [domesticated]	1.5-2.2	1-1.2	250-400	Ellipsoid	Broad elliptic	40%	Oval to roundish
Panicum laetum [wild gathered]	1.8-2.5	1-1.4	500	Globular to ovoid	ovoid	<50 %	ovoid



(A) *Digitaria iburua* (B) *Brachiaria Deflexa* (from Staph 1915:382) (C) *Digitaria exilis* (staph 1915:385)



Modern *Panicum laetum* (Top) and *Digitaria exilis* (Bottom). L. Champion

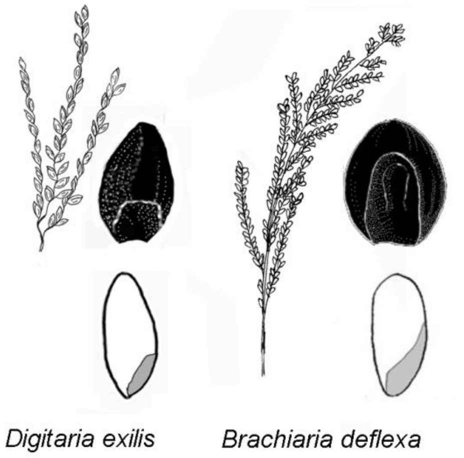


Figure 8.11 Difference between the "Fonio" grains.

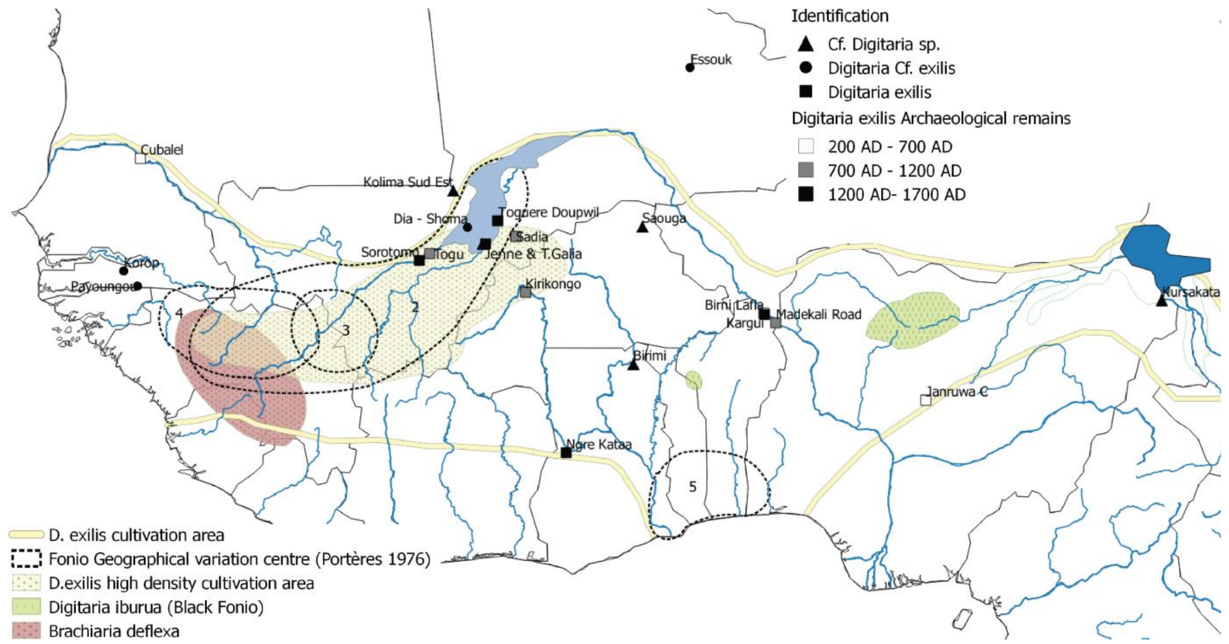


Figure 8.12 Map showing the location of sites with *Digitaria sp.*, *Digitaria exilis* and *Digitaria* cf *exilis* archaeobotanical evidence. Modern fonio (*Digitaria exilis*) distribution outlined in yellow, with high density cultivation area stippled. In green: black fonio, *D.iburua*, cultivation distribution. In Brown: *Brachiaria deflexa.* Doted areas are the geographical centers of varietal diversification of *Digitaria exilis.* 1: Var. *strica*; 2: Var. *rustica*; 3: var. *gracilis*; 4: var. *mixta*; 5 : var. densa (Table 8-6) (Data from Portères 1950, 1976, 1980; Harlan 1976; 1992; Harris 1976 and Cruz 2011)

8.3.1 Fonio – *Digitaria exilis* (Kippist) Staph.

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Digitaria exilis (Kippist) Staph.

Description: *Digitaria exilis* is a highly variable free tillering annual grass that grows generally between 30 and 75 cm with deep roots (up to a 1m). Its finger-shaped panicles have 2-5 racemes which can be up to 15 cm long.

Distribution: From the Coastal zone of Sierra-Leon to the Niger River Valley in Nigeria (Figure 8.12)

Agronomy: Whilst fonio can be grown at sea level, it is more often cultivated at elevations of 600-1500 m in altitude. Fonio is extremely tolerant of high rainfall, with a recorded growing range of between 250 mm and 3000 mm. It is more commonly grown within the 900-1000 mm isohyet and only drought resilient varieties are cultivated in dry conditions. It is grown mainly in infertile, sandy soils but is highly adaptable to all terrains and exposures; one of its most valuable traits is that it is productive on poor soils (Cruz et al. 2011, Vodouhè & Achigan Dako 2006, Portères 1955). The growing season ranges from as a short as 40 days up to 81 days, making these crops extremely quick growing (Aliero and Morakinyo 2001).

Yields: A study in Nigeria reports modern fonio yields between 22 kg/ha and 322 kg/ha (Aliero and Morakinyo 2001). The lowest yields (<100 kg/ha) are reported from the longer maturing forms (>70 days). Thus it produced quite good yields (122-322 kg/ha) in under 60 days.

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The term Fonio is a French loanword from the Bambara '*Fonyo'* and it used to designate the cereal *Digitaria exilis*. It is also called fundi or hungry rice. The first historical mention of Fonio, as *funi*, was written by Al-Umari, the Arab geographer, in 1337-1338 AD. Around 1354 AD Ibn Battua also mentions its cultivation (Levtzion and Hopkins 1981, Blench 2006, Portères 1976).As show in Figure 8.12, fonio is currently cultivated from Cape Verde to Lake Chad. Higher varietal diversity occurs in the upper Niger Valley (Fouta Djallon, Guinea and Mali) and the number of varieties decreases sharply heading eastwards towards Chad (Harris 1976, Portères 1976). Whilst the exact timing of this domestication event is still unknown, fonio is recognised as one of the oldest African domesticated plants. Indeed, some French researchers have suggested that the domesticated form of fonio, *Digitaria exilis,* could be as old as 3000 BC, although this was not based on any empirical evidence (Chevalier 1922; see also Blench

2006) However, and more likely, Portères has suggested that it was domesticated more recently in the Inland Niger Delta during the last millennium BC (Portères 1959, 1955, 1976), and this fits with current archaeobotanical evidence which all dates from the first millennium AD (Champion and Fuller 2018).

Production to Consumption

Whilst it can be grown as a regular crop, fonio is often grown as an 'insurance crop' during dry years when wetland rice would fail to produce a good yield. It tends to be grown in the same fields as rice, sometimes following the rice harvest. Cultivated fields of fonio are un-intensively managed, with little ground preparation, tillage, weeding or manuring. It can produce a crop in a very short growing season, even as short as less than two months (Aliero and Morakinyo 2001). The ripe crop is usually harvested with sickles rather than knocking the mature panicles with a gathering basket (*contra Panicum laetum*, cf below and Figure 8.14). It has been suggested that the use of sickles to harvest imposed a non-shattering selective pressure on *Digitaria longiflor*a, whereas the absence of tillage has allowed this species to maintain near wild seed size. Fonio quickly grows up to 75 cm, especially in poor and dry soils, and may produce as much as 600 kg/ha to 800 kg/ha under modern agronomy, although traditional yields are probably closer to between 120 and 350 kg/ha (Aliero and Morakinyo 2001). In richer soils fonio is less productive and yields more straw and fewer seeds. Poorer soil fields are usually located farther from settlements. It is commonly men's occupation to sow and till fonio. Women keep garden vegetables in manure enriched soils nearer the settlement. Nevertheless, they contribute along with their children to fonio weeding (normally one month after sowing), harvesting and processing. Depending on fonio varieties, harvesting happens between 70 to 130+ days after sowing (Table 8-5&Table 8-6). After harvest, women (and children) dehusk and winnow the crop. They commonly complain about the long and hard dehusking labour (1 kg/hour). Due to the grain smallness it is impossible to sieve or winnow to separate fonio from sand impurities and it has to be washed with copious amounts of water (10 L/kg fonio). All these characteristics that make fonio cultivation a long and hard process, are used to explain why it is less cultivated today than in the past. It is also why fonio is considered a 'slave crop', as lower status members of society often only have access to this low status food (Cruz 2011, Burkill 1985). During his exploration of Mauritania in 1824, René Caillé described fonio as a specialty crop of slave women, the lowest social rank at that time. Reflecting its continual low status as a crop in modern times, one of our informants from Dimbal (village in Dogon Country, Mali) explained that due to the difficulty of fonio cultivation (and processing), and the laziness of the younger generation (who prefer having fun in town), cultivators now sow less fonio. They now cultivate it for tradition rather than for need, preferring to cultivate rice and cash crops. Fonio is reported to be consumed mainly as a couscous or as a beer base. Currently, with the exception of the Dogon in Mali, fonio and black fonio are generally cultivated for beer making (Jolly 2014). After dehusking, naked grains are steamed inside a "*couscoussière"*. Traditional *Moro coscoçoû* (couscous) associated with North African tradition consists of domesticated steamed fonio made up of broken smooth wheat seeds or small grained pasta. However, in the Savannah (Sahelian zone) *coscoçoû* has a far wider texture and smell, it is made from steamed dehusked fonio, which has been described as 'unctuous, vitreous, gastronomic for the more difficult mouth and the more fragile stomach'; the most appreciated cereal of the West African nomads gathers. Whilst it is traditionally considered a low status crop, an interesting dichotomy occurs when fonio is cooked; cooked fonio is considered to be a high status food stuff. Through the act of cooking this crop transforms from the lowest into one of the highest status foods. In cities, steamed fonio is dried and then sold in the market. In the village household, dehusked fonio is generally steamed and directly served with a sauce of herbs, spices and gombo (okra). A special preparation to Guinean Fouta Djallon involves boiling grilled seeds in water or oiled soup: this requires considerable skill so as to not over-boil the seeds and create a pudding.

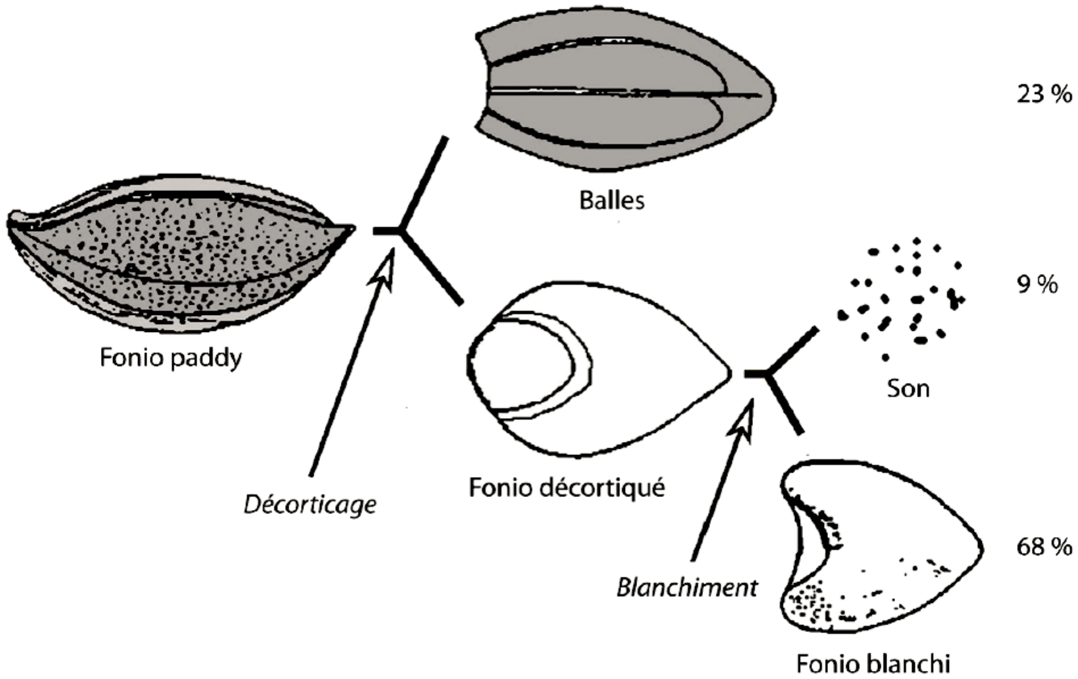


Figure 8.13 Dehusking of fonio from a hulled seed to ‘white’ or clean fonio (Cruz et al. 2011:88).

Figure 8.14: Harvesting of *Digitaria exilis* (Left) and *Panicum laetum* (Right). Drawing by T. Meudic reproduced from Cruz 2011: 52&63.

The grain also has a seasonal identity in Mali. Women steam fonio more often in the 'soudure' period (August-September), in the middle of the rainy season when just-maturing early 70-day fonio becomes available. The more productive 130-day fonio is more common south of the Islamic influence area (south of 12th parallel or 60 km to 70 km south of a line passing through Ouagadougou, Bamako, Koundara in Nord East Guinea). Here, this highly appreciated fonio is eaten all year long, and not only in the soudure period. From the middle 14th century, Berber explorer Ibn Battûta, relates in his Voyage au Soudan (Mali), "there the coscoçoû stuff is foûni, looking like mustard seeds". His guest marabou added that foûni (gathered by his slaved women) was far better than rice, which is indigestible for white men like him (Cruz 2011, Rouch 1950, Burkill 1985, MacLean and Insoll 1999)

Fonio can also be ground into a flour and baked or eaten as porridge, but the second most important use is to ferment it into beer, like the '*tchapalo'* in Togo. Usually, in Nigeria on the Jos Plateau, the first harvest is brewed into beer which serves as payment for the people who helped with the harvest (Burkill 1985). Fonio beer is well-known locally for its high quality and taste. The development of hydrolytic enzymes, central to the fermentation process, is significantly higher in pearl millet and fonio than in sorghum. The specific starch degrading enzyme found in germinated *Digitaria exilis* is similar to the one found in barley (Nzelibe 1995, 2000)

In the cosmogony of the Dogon people, who escaped the Mali empire centralisation and Islamisation by taking refuge in cliffs bordering IND, a grain of *Digitaria exilis* is the seed of the universe (Dieterlen 1958, Griaule 1948):

"Le fonio est la première et la plus ancienne des graines cultivées. II est l'image de l'atome initial d'où est sorti l'univers / fonio is the first and oldest of the cultivated cereals. It is the image of the initial atom from which the universe was created". (Dieterlen 1958:125).

Domestication

Due their morphological similarities, Stapf (1915) suggested that *Digitaria exilis* was domesticated from *Digitaria longiflora,* which is supported by more recent studies although genetic work has been limited (e.g. Adoukonou-Sagbadja et al. 2007). The main morphological difference between the two taxa is the pubescence of the lemma, opposite to *D. longiflora, D. exilis* is completely glabrous (Figure 8.11;Stapf 1915, Hilu 1997). Based on the same glabrous characteristic, however, Henrard (1950) proposed *Digitaria fuscescens* as the progenitor for *Digitaria exilis*. Recent genetic analysis shows that *Digitaria longiflora* shares up to 67% of RAPD bands with domesticated *Digitaria exilis*. This supports the general hypothesis of *Digitaria longiflora* as the putative wild progenitor of fonio (Hilu 1997; also, Adoukonou-Sagbadja et al. 2007). However, Portères (1976) has raised doubts that the ancestral species of fonio has remained within its current geographical distribution as fonio landraces have a centre of varietal diversification (Table 8-5 Table 8-6 Table 8-7) focused on the upper Niger River Basin from the river's source to the Inland Delta, leading Portères (1976) to suggest domestication in this region.

Table 8-6 Current varietal diversification on grain forms of *Digitaria exilis* landraces following Portères (1955, 1976), Cruz (2011).

var. *gracilis* Portères: leaf margin curled, inflorescence with 2 primary branches, each with 50–100 spikelets per 10 cm, spikelets in groups of (2–)3(–4) and in 1–2 rows, stalks rough; early-maturing.
var. *stricta* Portères: leaf margin slightly curled, inflorescence with 2 primary branches, each with 50–100 spikelets per 10 cm, spikelets in groups of (2–)3(–4) and mostly in 1 row, stalks smooth; early-maturing.
var. *rustica* Portères: robust plants, inflorescence with (2–)3–4(–5) primary branches, each with 90–120 spikelets per 10 cm, spikelets in groups of (3–)4 and in 2–3 rows, stalks smooth; late-maturing.
var. *mixta* Portères: robust plants, vegetative parts reddish pigmented, inflorescence with (2–)3–4(–5) primary branches, each with 90–120 spikelets per 10 cm, spikelets in groups of (3–)4 and in 2–3 rows, stalks smooth; late-maturing.
var. *densa* Portères: tall, strong plants, with a long vegetative cycle, inflorescence with 3–4 primary branches, each with 120–140 spikelets per 10 cm, spikelets in groups of 2(–3) and in 2–3 rows; late-maturing.

Table 8-7 Summary of the five fonio varietal groups distinguished by Portères, from Vodouhè and Achigan Dako (2006) Due to morphological variability of *Digitaria exilis*, this table presents an average of the five main fonio races or groups (Table 8-6for main group diversity).

Variety	**Grain Form**	**Weight seeds /grams**	**Maturing In Days**	**Geographical distribution**						
				Upper Niger valley	**Inland Niger delta**	**Dahomey Gap**	**South Togo/ Benin**	**Mali**	**Guinea**	**Senegal, Sierra Leone**
Densa 5	Globular	2100	Late >130			X	X			
Rustica 2 &1	Elliptical	1800	Late >130		X			X	X	
Mixta 4	Roundish to ovoid	1900	Semi-hasty 110-130	X					X	X
Stricta 1	ovoid with a narrow tip	1800	Early 70-90					X	X	X
Gracilis 3	Ovoid to ovate	1700	Hasty 90-110	X				X	X	

Archaeology

Currently the oldest archaeological evidence for fonio was found at the site of Janruwa C in Nigeria. This site is related to the Nok culture and fonio grains were directly dated to 94-338 cal. AD (1800±40 bp, Beta-278001) and 236-386 cal. AD (1740±30 bp, Beta-297287), archaeobotanical analysis is still ongoing for this site (Frank 2016; Höhn and Neumann 2016). Fonio was also found at Cubalel Phase II, in Senegal, dating to 400-600 AD (Gallagher In press, Murray, Capezza and Fuller 2007).

Table 8-8 Archaeological site with fonio remain.

site	Country	Date (cal. AD)	Rice	Fonio	Reference
Janruwa C	Nigeria	94-338	-	x	Höhn and Neumann 2016
Cubalel	Senegal	400-600	-	x	Gallagher in press Murray, Capezza and Fuller 2007
Jenne-Jeno	Mali	300-1000	x	x	McIntosh 1995
Birnin Lafiya	Benin	300-1400	x	x	This study
Kantoro	Benin	1000-1400	x	x	This study
Kargui	Benin	1000-1400	-	x	This study
Madekali road	Benin	1000-1400	x	x	This study
Sadia	Mali	900-1300	x	x	This study
Sorotomo	Mali	1200-1450	x	x	This study
Togu	Mali	1000-1300	-	x	This study
T. Doupwil	Mali	1200-1400	x	x	Bedaux et al. 1978
T. Galia	Mali	1000-1200	x	x	Bedaux et al. 1978

Linguistic evidence

Linguistic data shows that words for fonio have widespread roots in the Mande and Atlantic languages (Table 8-9).This is the same for rice, which also seems to have a heartland origin area around the inland Delta and the high valley of the Niger (Mali, Guinea). Indeed, terms for African rice and fonio have a comparable linguistic pattern suggesting that two species were probably cultivated and domesticated in the same area around the first millennium BC or even before (Blench 2006). The Central Nigerian term for fonio appears to have unrelated roots, which suggests a potential early cut off from the main zone of cultivation (Blench pers. com.).

Table 8-9 Common names for Fonio in Mande and Atlantic languages (Vydrin 2002, Blench 2006).

Language **Mande**	*Attestation*	Language **Mande**	*Attestation*	Language **Atlantic**	*Attestation*
South-West Mande		**South Mande**		**Northern Atlantic group**	
Mende	*póté*	Dan	*pŷŋ̰*	Wolof	*Fini/foonyo*
Loko	*pénî*	Guro	*fní*	Sereer	*foonyo*
Looma	*pɔ̰dɛ̰*	Mona	*fíí*	Fulfulde	*fonyo*
Kpelle	*miniŋ̰*	Wan	*fẽ̃ŋ̰*	Jola-Fonyi	*finya*
Jallonke	*fʋndén*			Bedik	*fɔ̰ndƐŋ̰*
Soso	*fundeny*			Basari	*funyáŋ̰*
Mandinka	*findi*			Manjaku	*findi*
Xasonka	*fundi*			Konyagi	*fae-fune*
Kagoro	*híni*			Jaad	*ponye*
Bamana	*fíí/fíni*			**Mel group**	
Maninka	*fónî/fani*			Kisi	*kpendo*
Soninke	*fuŋ̰aN/fuŋ̰aŋ̰ŋ̰e*			Bulom	*peni*
Bobo	*fē pl. fā̈*				

From these data (Table 8-9), the most important question relates to whether Fonyi, Fini (...) has a Mande or an Atlantic stem. And, by extension, whether fonio cultivation has a Mande or an Atlantic origin? The Russian linguist, Vydrine (2002) has suggested that fonio has Mande roots based on three main arguments. First the stem word is present in nearly all the branches of the Mande family. Secondly, it seems highly improbable that it was borrowed from Atlantic by Mande speakers, as Mande speakers were politically superior in the first millennium BC. Hence, it is questionable how a word from a politically inferior group would or could penetrate so many languages spoken by a politically superior group. Ethnographic evidence outlined above, however, shows that fonio is considered a low status crop. The main flaw with this argument is that the continued cultivation, consumption and availability of fonio within a low status group that interacts with a high status group (through trade etc.) will obviously bring the crop into contact with the higher status group. And lastly, because the Mande form has a better phonetic regularity (for more details see Vydrine 2002).

Thus looking at the linguistic data, it would seems that Fonio has at least two different roots, and hence at least two centres of origin, leading to distinct Mande and Nigerian forms.

Discussion & interpretation

The use of marginal and poor soils is suggested by the presence of fonio (*Digitaria* cf *exilis*) within the archaeological record, which may represent agricultural diversification and extensification within the drier areas of West Africa. Previously, there have been suggestions that these fonios are very ancient crop, with widespread and patchy modern distribution reflecting relict populations (e.g. Portères 1976; Blench 2006). Alternatively, the hypothesis that the fonios are later secondary domesticates, taken into cultivation to complement rice, pearl millet and sorghum as risk-buffering crops for poor soils plausibly more than one time and place, must be considered. Much as oat (*Avena sativa*) and rye (*Secale cereale*) were domesticated in Europe from the Late Bronze Age/Iron Age to suit some more marginal regions (Zohary et al. 2012), the fonio millets may have been taken up secondarily, probably more than once, to suit the more marginal agricultural conditions across the west African savannas. In this model, the evidence for fonio in the Mema region of northwestern Mali (Takezawa and Cisse 2004) from the first half of the first millennium BC may be seen as a local development of cultivation at the interstices of established pearl millet agriculture and perhaps of early rice as well along the Inland Niger Delta.

8.3.2 Black Fonio or Iburu – *Digitaria iburua*

Digitaria iburua **Staf.**
Common Names: Black fonio, black acha, fonio noire, Manne noire, iburu
Description: *Digitaria iburua* is a loosely tufted annual grass may reach 1.4 m. It has 2-11subdigitate racemes up to 13 cm long.
Distribution: In limited but disparate localities in Ivory Coast to Nigeria with two main small areas of cultivation in Benin and Nigeria.
Agronomy: Iburu fonio grown between 400 to 1000 metres of altitude within a range of rainfall between 900-1000 mm
Yields: Good yields are normally 600-800 kg per hectare, but more than 1,000 kg per hectare has been recorded. In marginal areas, yields may drop to below 500 kg and on extremely poor soils may be merely 150-200 kg per hectare.

Currently, black fonio, *Digitaria iburua*, is cultivated in only two small areas: the Atacora in North Benin and in North Nigeria (Figure 8.12; Cruz 2011; Portères 1950). In Benin, black fonio is often associated with shallow African rice cultivation Cruz 2011). Portères (1950) observed that black fonio was no longer used as a food stuff but as a grain for beer preparation, which is used in important cultural traditions and social practises. For Cruz (2011) and Portères (1956) the arduousness of *Digitaria iburua* processing is directly connected to its progressive disappearance. The seeds are extremely small, around 1.2x0.7x0.5 mm, to be easily processed for food. They require laborious dehusking (unlike pearl millet) to be processed into cooked grains or flour (see Fuller and Weber 2005). On the other hand, brewing can be achieved with some or all grains remaining in their husks. Thus, one may argue that if people still cultivate *Digitaria iburua* for beer preparation then is may have a significant social meaning. And if this is true in modern areas of cultivation, we might hypothesize that this assumption may be extended back into the past. For Portères (1956) black fonio culture appears to be linked to much older traditional practices. The two current cultivation areas (Figure 8.12) are potentially fragments of a formerly much larger (ancient) cultivation areas (Portères 1950; 1956; Harlan and Stemler 1976; Harlan et al. 1976; Cruz 2011). Although it is more widespread, the patchy distribution of fonio (*Digitaria exilis*) cultivation has also been taken to suggest that it was more widely cultivated in the past (Blench 2006; see Figure 8.12).

8.3.3 Animal millet or “black fonio” – *Brachiaria deflexa*

Brachiaria deflexa (Schumach.) Robyns
Common Names: Big fonio or black fonio
Description: *Brachiaria deflexa* is a loosely tufted annual of 70 cm high.
Distribution: it is growing on disturbed land in the margins of riverine forest with some shade in the Region from Gambia to Nigeria but it is also dispersed across Africa to Madagascar.
Agronomy: *B. deflexa* grown between 800 to 1400 metres of altitude within a range of rainfall between 900-1000 mm.
Yields: In Sierra Leone, it produces between 150 to 450Kg/ha and it matures in 60 to 130 days.

Brachiaria deflexa has been confused with true fonio *D. exilis* because it has similar sized grain when dehusked and related common names. However, it is fast growing but requires rich soil and good drainage. Currently, the only region where cultivars are noted is Sierra Leone and Fouta-Jalon. Usual *B.deflexa* is sown later, normally after the sowing of Fonio and it produces 2 to 3 times more crops. *B.deflexa* is normally consumed steamed as couscous or crushed with milk (Burkill 1977, Porteres 1976).

8.3.4 “Wild” Fonio – *Panicum laetum*

Despite the name wild fonio, this is not the wild form of domesticated fonio, *Digitaria exilis*.

Panicum laetum Kunth
Common Names: Wild Fonio, desert panic, Haze, fonio sauvage
Description: It is a loosely tufted annual grass may reach 75 cm in height.
Distribution: *Panicum laetum* grows from Senegalese coast line to Eritrea with some pocket in Tanzania.
Agronomy: It is growing on periodically humid soil in grassy savannah, in the river valley and up to 1000-1300 in Tanzania (Harlan 1989, Cruz 2011)
Yield: Gathered from the wild, yield is unknown to date.

Due to natural shattering, fonio gathering is “free threshing” and is usually collected by balancing a small ovoid basket in a field of mature plants, in which the matured seeds then fall into the basket (Figure 8.14). In Rouch (2005:18): for the Songhay the fonio is growing on the edge of the humid ‘bas fond’ (shallows wet field). The seeds are collected with a small basket ‘zetu’ as wild seeds, the seeds fall naturally into the basket

8.4 African Rice – Oryza glaberrima

Oryza glaberrima steud.

Common Names: African rice, riz africain, vieux riz, riz flottant.

Description: *Oryza glaberrima* is a highly variable annual grass that grows generally between 60 and 350 cm (for the floating type). Even if the flowers are self-fertilized, inter- and intraspecific cross-pollination is usual.

Distribution: African rice is cultivated from the Coastal zone of Sierra-Leon to the Niger River Valley in Nigeria (Figure 8.17)

Agronomy:

Some African rice varieties, mainly upland, can grow with a minimum of rainfall about 700 mm. The rice can be found from sea level to 1700 metres of altitude. The optimal temperature to grow rice is between 25°C - 30°C but it can support larger fluctuation from 20°C - 35°C. (e.g. Jacquot and Courtois 1987), (Bezançon 1995).

Yields *O. glaberrima* can yield 1000-3000 kg/ha (Borlaug et al 1996, Rodenburg et al. 2014). Upland rice in sierra Leone yield 1000-1200kg/ha (Richards 1986)

With regards to agriculture, farming, and food systems, the development of rice systems and domestication and the spread of African rice, is currently understudied; but, is one of the most important agricultural innovations in Western Africa. The antiquity of rice farming systems and how such systems developed or how widespread they were is completely unknown. Today African rice (*Oryza glaberrima*) is being replaced by the Asian species introduced to Africa around the middle of the 16th century AD by the Portuguese (Linares 2002). The presence of rice fields (African rice fields) are documented by the Portuguese on arrival to the African coast in the 15th century: In 1446 the chronicler Gomes Eanes de Azurara states, *"they found the country covered by vast crops, with many cotton trees and large fields plant with rice…"* (Linares 2002:16360). In 1506-1510, another writer, Valentim Fernandes (cited in Linares 2002) remarked that *" this land is rich in food, to wit **rice**, millet and beans, cows and goats, chickens and capons and numerous wines and other food products"* . Thus, African rice was part of the agricultural food systems in the past but today it is rarely grown and when it is, (e.g. the Jipalom in Senegal and the Jola in Guinea-Bissau) it appears to be used only in rituals (Linares 2002, Davidson 2016).

It is thought to have been domesticated from the wild progenitor *Oryza barthii* perhaps three thousand years ago. Portères (1962, 1976) placed the original domestication in the IND (Figure 8.17) as in the modern domestic varieties he recognised genetically dominant traits. Harlan, for his part, envisaged various localities, while Coursey suggested domestication amongst the Yam growers in a more forested setting. However, the current state of archaeological knowledge surrounding the origins of African rice is too poor at this time to confirm his hypothesis. Today African rice is most often boiled or steamed whole, which contrasts with how sorghum or pearl millet are prepared, usually pounded into coarse flour. But African rice can also be used in other ways such as rice flour, which in turn can be fermented (McCann 2009).

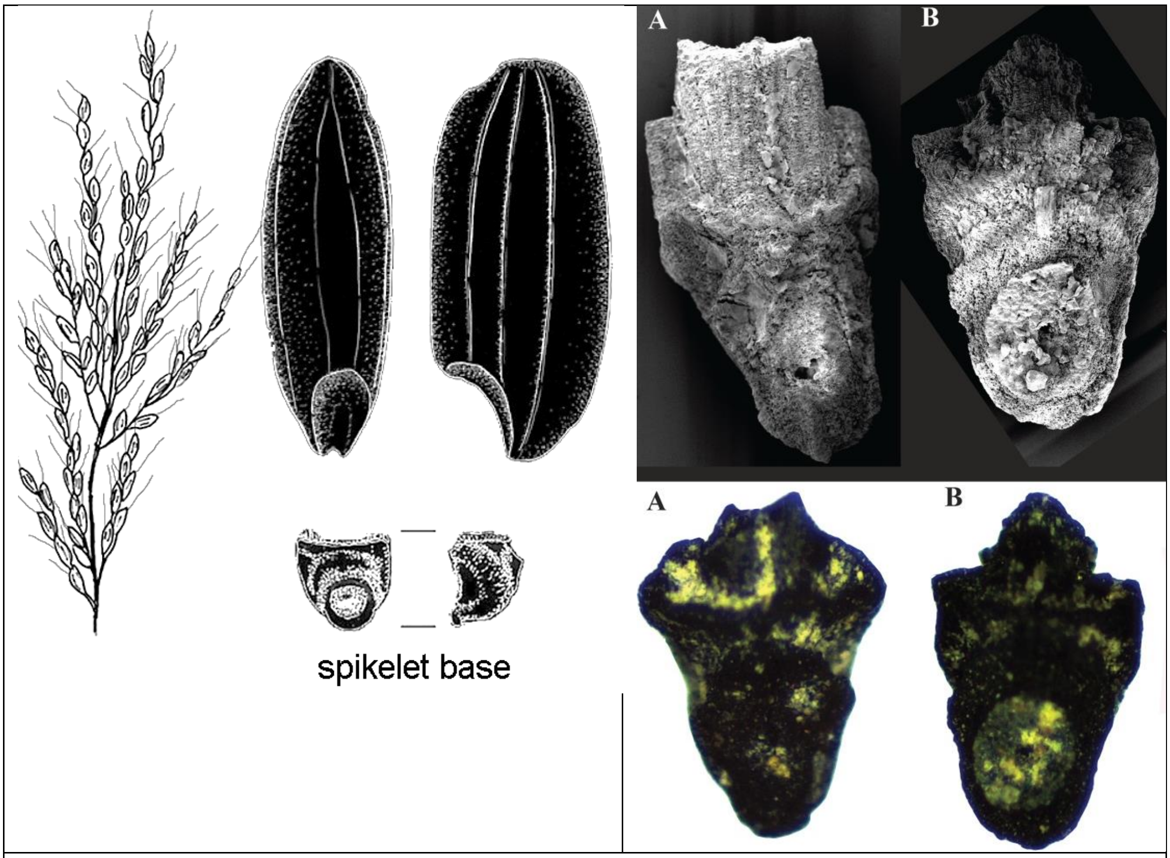


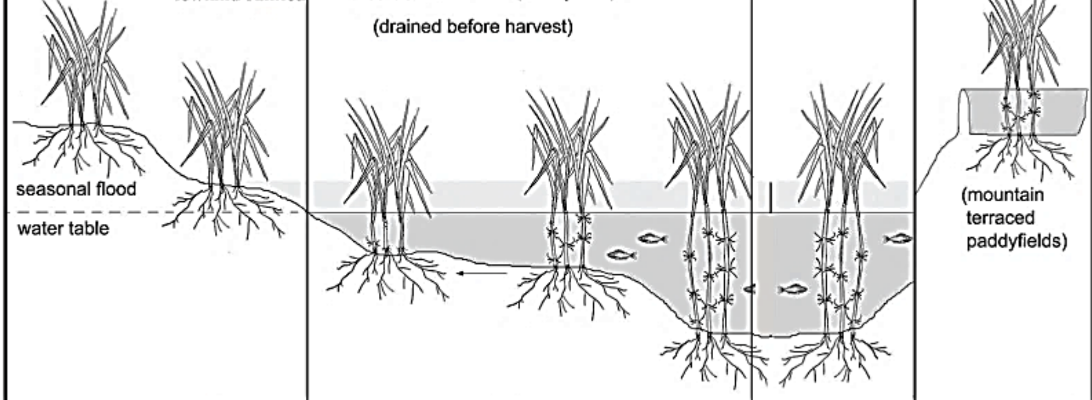
Figure 8.15 African rice grain and spikelet base (drawing by D.Q. Fuller). SEM and pictures of spikelet base: (A): Domesticated Forms. (B): Wild Forms.

The Rice growing environments

African rice growing ecosystems can be classified following the source of water for cultivation: rainfall water, phreatic water, floods, irrigation and tidal flow.

Following this classification, we can also add the cropping system: shifting (pluvial) and permanent (wet rice) (Figure 8.16).

	Dry Rice	Wet Rice			
	Upland; Ground water/ lowland rainfed	Flooded/ Decrue; Irrigated (Paddyfield) (drained before harvest)	Deepwater Down to 4 m	Tidal	Upland irrigated



	Dry Rice	Wet Rice			
Water Sources	Rainfall; Rainfall Watertable	Rainfall & Watertable Flood water	Flood Water	Tidal Salty Water	Irrigation
Ecological zone	Guinea Savannah Equatorial Humid Forest	Sudan Savannah Equatorial Humid Forest	River Valley	Mangrove Swamp Coastal zone	Guinea Savannah Sudan Savannah Humid Forest
Distribution	Sierra Leone Guinea Senegal Ivory Coast Atacora Mountain (North Benin)	River Valley Niger River Gambia River Chad lake Bassin; On Niger River, downstream from Inland Niger Delta to North Nigeria, 2 fields seasons/year	Main River Valley Niger River Chad lake Bassin?	Coast Line from Gambia to Guinea	Sierra Leone Guinea Senegal Atacora Mountains (North Benin)
Yields	270-900 Kg/ha	1000-3000 Kg/ha	1500-2000 Kg/ha	1500-3500Kg/ha	500-2000 Kg/ha
Maturing	120-160 Days	Early 120 -180 Days Late 180-220 Days	Early 120 -180 Late 180-220	120-160 Days	120-160 Days
Major Weeds	*Paspalum scrobiculatum* *Ageratum conyzoide* *E. pyramidalis* *Digitaria exilis* *Digitaria longiflora* *Digitaria horizontalis* *Brachiaria deflexa* *Panicum laetum* *Commelina benghalensis* *Sorghum arundinaceum* *Cyperus* species *Borreria ocymoides*	*Paspalum scrobiculatum* *Ageratum conyzoide* *Echinochloa colona* *E. pyramidalis* *Digitaria exilis* *Digitaria longiflora* *Brachiaria deflexa* *Commelina benghalensis* *Commelina rotundus* *Commelina dactylon* *Sorghum arundinaceum* *Cyperus* species *Physalis* species *Phyllanthus* species	*Echinochloa colona* *Echinochloa stagnina* *E.crus-pavonis* *Panicum repens* *Panicum laxum* *Oryza barthii* *Oryza longistaminata* *Cyperus esculentus* *Ischaemam rugosum* *Ipomoea aquatica*	*P.vaginatum* *A.sessilis*	*Echinochloa colona* *E. pyramidalis* *Digitaria exilis* *Digitaria longiflora* *Brachiaria deflexa*

Figure 8.16 Schematic diagram of the spectrum of rice ecologies in African Rice (Fuller et al. 2011, Portères 1976, Bezançon 1995, Rodenburg et al. 2014, Agyen-Sampong et al. 1991, Andriesse and Fresco 1991, Gallais 1959, Agnoun et al. 2012, Nyoka 1980, Richards 1986).

Domestication

African rice is thought to have been domesticated from a wild progenitor, *Oryza barthii,* around 2500 years ago. Portères (1976) placed the original domestication in the Inland Niger Delta . Currently in many regions African rice (*Oryza glaberrima*) is being replaced by the Asian species (*Oryza sativa*) introduced to Africa around the middle of the XVIth century AD by the Portuguese (Linares 2002). In addition, in a few areas there are hybrids between *O.glaberrima* and Asian *O.sativa* that are cultivated (Nuitjen et al. 2009). In some regions as African rice has declined, it has remained a minor crop of ritual importance, for example amongst the Jipalom in Senegal (Linares 2002) and t the Jola of Guinea-Bissau (Davidson 2016). Amongst the plenitude of genetic research undertaken on African rice published during the last decade, the two most recent papers summarize the most fully-developed hypothesis. First, Cubry et al. (2018) have suggested a single African rice domestication area. Indeed, using 246 whole genome sequences they inferred the cradle of domestication to be found in the Inland Niger Delta, or more specifically, in area comprising the Hodt Depression in Mauritania and Méma and Macina region in Mali (A in Figure 8.17). Secondly, Choi et al. (2018) using the same methodology on 282 other whole genomes, suggest a more complex history and proposed three different areas of domestication. They posit that rice domestication was a long diffuse and protracted process involving multiple centres. The three proposed centres were the Uplands of Sierra Leone, the Inland Niger Delta and surprisingly the Lake Chad basin (B in Figure 8.17). Also Meyer et al. (2015) suggested a single core region located between the two western zones of Choi et al. 2018.

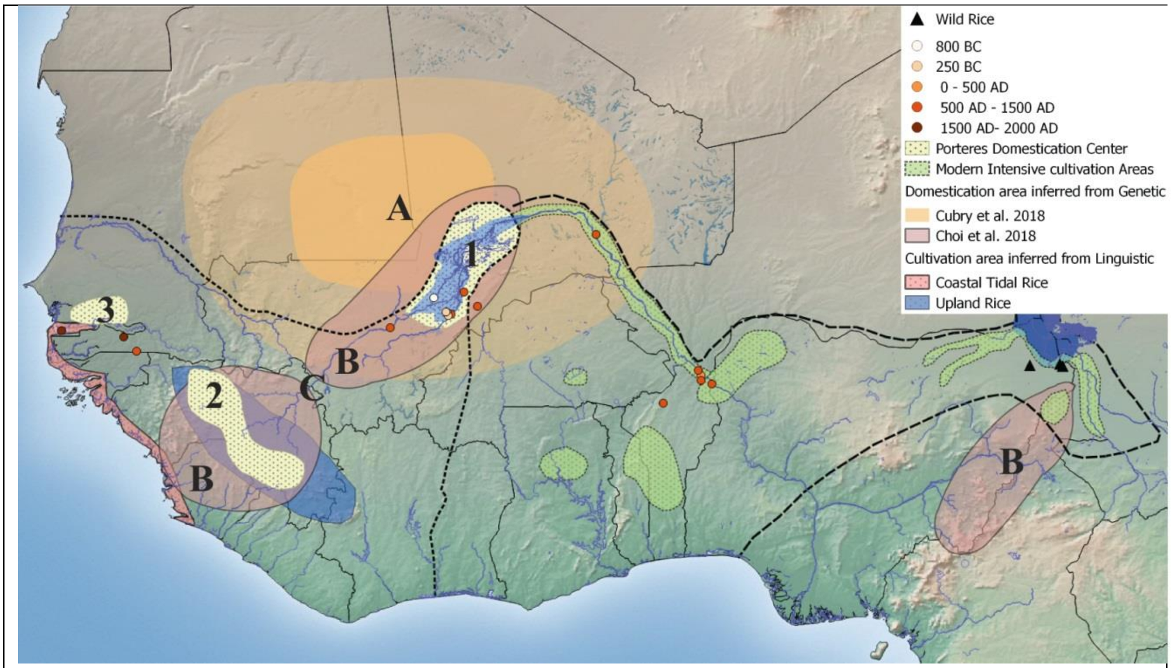


Figure 8.17 African Rice origin and diffusion. Sites with archaeobotanical remains (circle= domesticated rice, triangle = wild rice). Domestication (1) and differentiation (2&3) for Portères (1950, 1956 a,b & c,1962,1976,1980). Domestication centre inferred from genetic studies (A) Single origin for Cubry et al. 2018; (B) Multi origins for Choi et al. 2018 and (C) Single origin for Meyer et al. 2015.

Morphology

Rice grains are identifiable by their relative uniformity in their shape, almost rectangular with rounded corners and either rounded or slightly pointed ends, and two parallel grooves down each broad side. Grain metrics can be used to separate domesticated *O. glaberrima* from its congeneric wild African relatives (Murray 2007 a). However, rice spikelet bases offer a better way to differentiated between wild and domesticated rice. One of the most important key effects of plant domestication is a shift from natural seed dispersal to human seed dispersal. Mature wild grains fall naturally from the plant creating a smooth, round and regular abscission scar with a small distinct vascular port on the spikelet base (B in Figure 8.15). On the other hand, domesticated non-shattered grain needs human threshing to fall apart (A in Figure 8.15). The result of this labor is creating a less symmetrical scar with a dimpled appearance (Fuller et al. 2009, Fuller and Weisskopf 2011, Ishii et al 2010). Rice shattering is controlled by abscission layers, where the spikelet attaches to the rachilla, and two or three genes that control this are known to have been selected during domestication in Asian rice (Ishikawa et al. 2010, Htun et al. 2014). There is now evidence that variation in at least two of these loci have been selected within various domesticated African *O. glaberrima* lineages (Lv 2018). This indicates that different degrees of non-shattering have evolved in different landraces of African cultivated rice and suggests that more highly non-shattering forms may have been favoured on more arid northern regions. In terms of origins, these data sets are consistent with the early evolution of domesticated African rice around the Inland Niger Delta or its upstream tributaries.

Archaeobotanical data

Table 8-10 Archaeological site with African rice remain.

site	Country	Date (cal. AD)	Reference
Dia	Mali	800 BC-400 BC	Murray 2007
Jenne-Jeno	Mali	250 BC	McIntosh 1995
Thièl	Mali	250 BC	Stone 2015
Tato à Sanouna	Mali	250 BC	Stone 2015
Gao	Mali	500-1000	Fuller 2000, Cissé et al. 2013
Sadia	Mali	900-1300	This study
Sorotomo	Mali	1200-1450	This study
T. Doupwil	Mali	1200-1400	Bedaux et al. 1978
T. Galia	Mali	1000-1200	Bedaux et al. 1978
Birnin Lafiya	Benin	300-1400	This study
Kantoro	Benin	1000-1400	This study
Tintin	Benin	1000-1400	This study
Madekali road	Benin	1000-1400	This study
Niyanpangu-bansu	Benin	1400-1600	This study
Korop	Senegal	1500-1800	Stricker 2016
Payoungou	Senegal	1800-1900	Stricker 2016
Juffure	Gambia	1700-1900	Gijanto and Walshaw 2014

Currently, the domestication of African rice (*Oryza glaberrima* Steud.) remains problematic, as little evidence is available (see Porteres 1976, Agnoun 2012, Murray 2007a). As put by Murray (2004: 53): *"Archaeological data on the place and timing of African rice domestication remain virtually non-existent".* Archaeological excavations in the area of Lake Chad and the Niger Valley provide evidence of African rice around 1000 BP. Older evidence of wild rice, with shattering spikelet bases, comes from ceramic impressions in Kursakata (ca. 1000BC) and Gajiganna (around 1800-800BC) (Klee et al. 2004). Evidence of domesticated rice is more recent. The earliest evidence for *Oryza glaberrima* comes from the Inland Niger Delta and the site of Dia. Indeed, with AMS dates on rice grains from the earliest occupation of Dia, placed in the 800-400 BC bracket (Murray 2007a). Further chronological resolution is difficult as these dates fall in the Iron Age calibration plateau, and thus a date of 5th century BC is just as probable as one from the 8th century BC. This rice is regarded as already domesticated, on the basis of rice grain measurements, as spikelet bases were not recovered (Murray 2007a). Given the data it is not clear whether an earlier domestication process in the Inland Niger Delta should be hypothesized (as per Porteres 1976) or whether rice had spread to this area from a domestication event elsewhere, such as the tributaries to the Inland Delta to the Southwest, as implied by the inferences from modern genetics (Meyer et al. 2016). Interestingly, the first divergences within African rice is inferred to be between the western Guinea coast and hill rice and those of the Niger basin (Meyer et al. 2016), but currently with the exception of the sites of Juffure (Gambia), Korop and Payoungou (Casamance Senegal) dated to 1500-1900 cal AD (Gijanto & Walshaw 2014, Stricker 2016), all the sites with domesticated African rice are coming from within the Niger River Basin itself, including the Inland Niger Delta and from the Dendi region in North Benin (Figure 8.17; this study Bedaux 1978, Champion and Fuller 2018 a &b, McIntosh 2005, Murray 2007a). This suggests that even if there was an early rice dispersal to the Guinea Coast it may not have become a major crop for some time, or it remained in the southern Guinea area (which lacks empirical archaeobotanical data). This is surprising given how prominent rice cultivation is ethnographically on the Guinea coast (e.g. Richards 1986, Davidson 2016) and has been since at least historical time for which there are European records (Carney 2001).

Linguistic data

Terms for rice in African Languages can be split into two layers, an old one related to African rice and linked to the Niger-Congo languages, probably the proto-Mande, and a later one associated with the introduction of Asian rice by the Portuguese on the coast of West-Central Africa. Usually this late introduction is known by loanwords incorporating *arroz* but due to the older presence of African rice prior to the arrival of Asian rice the terms for African rice have been transferred to the Asian species. The most widespread rice term is embedded to proto-Mande, a Niger-Congo language, and has been borrowed by the Nilo-Saharan (Songhay: *mó*) which reveals the old utilisation of rice in West Africa (Blench 2006). At present there is no archaeological evidence for the dispersal and diversification of rice into the Guinea highlands and coast (see Fields-Black 2008), although this is likely to have occurred in parallel to that dispersal along the Niger river. The expansion of rice cultivation to the west coast, Senegal River, and Guinea highlands is based on linguistic analysis (Carney 2001). Linguistic evidence specifically indicates the development of coastal mangrove rice farming systems in the Rio Nunez region on the northern coast of Guinea between approximately AD 500 and 1000 (Pink in Figure 8.17; Fields-Black 2008a; Fields-Black 2008b). It then follows that the mosaic of paddy rice, flood recession, and upland rice systems must have been established in the region by 500-1000 AD. Many sites along the Niger River in Benin, including Tintin, Birnin Lafiya, Kantoro, and Madekali Road contained evidence of both African rice from flood recession cultivation and diversified rain-fed systems dating to 500-1000 AD (this study, Champion and Fuller 2018).

Table 8-11 A widespread root for rice in West African languages. (Combined from Blench 2006:219; Vrydine pers. com. and personal observation among the Kyenga speakers (Tyenga) in North Benin).

Language **MANDE**	*Attestation*	Language **ATLANTIC**	*Attestation*	Language **KRU**	*Attestation*
South-West Mande					
Soso	*Màalée*	Jola-Kajamutay	*maano*	Dewoin	*mɔɔ*
Manding	**màaló (?)*	Fulfulde	*maaro(ri)*	Basa	*mɔɔ*
Mandika	*màani*	Palor	*maalo*		
Xasonka	*màalu*	Manjaku	*û-maani*		
Bamana	*màló*	Mankanya	*maanan*		
Marka-Dafin	*maro*	Pepel	*umanu*		
Kong Jula	*mari*	Badiaranke	*pamāno*		
Soninke	*maaru/o*	Nalu	*mmar*		
Bobo	*miri*	Kisi	*mààlóŋ̰*		
		Mansoanka	*maal*		
		Bijogo	*Ɛman*		
South Mande		**NILO-SAHARAN**		**KWA**	
Dan	*mlŵ*	Songhay	*mó pl. móà*	Twi	*Ɛmõ*
Tura	*míní*	Kanuri	*esmalli*	Fante	*Omõ*
Mona	*mlɔ̰*			Ga	*Omõ*
Wan	*mãŋ̰*			Ewe	*molũ*
Ben	*mānú*				
Eastern Mande				**GUR**	
Bokobaru	*mɔree*			Moba	*mori*
Boko	*mólé*			Sisaala	*miiriŋ̰*
Souther San	*mɛlɛ*			Nawdm	*miri*
Norther San	*mila*				
Kyenga	*mù* or *mɔ*				

In the Dendi area, North Benin, the Tyenga group who speak Kyenga, a language of the Niger-Congo, Mande, East, Busa familly, use the **Mù* or **Mo* to designate rice. They also have around 25 varieties of rice, (including at least 2 Asiatic *Oryza sativa* types). The oral tradition linked the archaeological sites of Birnin Lafiya, Tintin, Madekali and Kantoro (this study) to a Kumate or Tyenga origins. The Kumate and Tyenga were Muslim merchant families who were probably part of the Wangara group (Gosselain *pers. com.*). It is noticeable than every sites from North Benin which give evidence of African rice (*Oryza glaberrima*) remains are by oral tradition linked to the Mande (Soninke/Wangara) population diaspora along the Niger River (Gosselain *pers.com.*). Like the Nono and Marka in Mali, the Mande diaspora in the Dendi seem to have been with African rice cultivators.

The words for 'rice' MARO/MOLO are represented in almost every group of the Mande family, and at the same time, similar forms appear in the languages of neighbouring families (e.g. Atlantic and Kru languages). The big question is: should we reconstruct something like *mɔ̀lɔ (or rather *ɓɔ̏lɔ̏) for the Proto-Mande and regard the forms in modern Mande languages as reflexes of this proto-form, or should we explain these forms by a relatively recent diffusion, i.e. by borrowing amongst the languages? If we opt for the first hypothesis, that would mean that speakers of the Proto-Mande language were acquainted with rice as early as in the 4th millennium BC (although it could have been as wild rice, and not necessarily cultivated). Otherwise, we assume that domestication of rice took place more recently (yet to be specified by whom), with subsequent borrowing of this know-how across Mande sub-groups. Theoretically, linguistic methods could provide some clues, but there is a huge impediment: there is still no phonological reconstruction of the Proto-Mande language or for that matter not even reconstructions of the proto-languages of most of the groups within the Mande family. Therefore, they are no reliable criteria which would allow one to know which of the two scenarios is more probable. It is evident, at the same time, that even if a word for 'rice' existed already in Proto-Mande (and the forms in modern Mande languages are its reflexes), it was most probably borrowed from the languages of neighbouring families. A non-Mande origin of this word (with subsequent borrowing to Mande) cannot be excluded, but it seems less probable, because in Atlantic languages, the canonical structure of a root is CVC, and the fact that in most Atlantic languages this word seems to have CVCV root indicates that the Mande origin is more plausible. Concerning the Proto-Eastern Mande word for 'rice' **mù/mɔ*: In Bokobaru, 'rice' is *mɔree*; in Boko, *mólé*; in Souther San, *mɛlɛ*; in Norther San, *mila* (Table 8-11). It is evident that the Kyenga (north Benin) forms *mù* or *mɔ* result from the reduction of the final syllable, and the Proto-Eastern form was dissyllabic (something like **mɔlɛ* or **mɔrɛ*). Although it cannot be excluded either that there was no word for 'rice' in the Proto-Eastern Mande or that it was borrowed in all the languages of the group at a more recent stage (Vrydin Valentin. pers. Com; Vydrin 2009).

8.5 'Kreb" Grasses

Kreb is perhaps the most famous food of the Sahel/Sahara. A complex of a dozen (or more) different wild grains, it was harvested from natural meadows. Its composition varied from place to place and probably from year to year depending of the mix of grasses that grew that season. Kreb consists of several species growing together and whose grains are harvested and used together. Here, I describe the main grains archaeobotanically identifiable in Kreb. However this represents only a fraction of the Kreb species. Most of the species found in the Kreb are not present yet in any reference collection. Indeed future research is still needed to fully comprehend wild plant utilisation in West Africa and specifically on small grasses and weeds.

8.5.1 Paspalum Species (*P.vaginatum, P.scrobiculatum*)

In West Africa, *Paspalum* species are common wild grasses usually found in humid habitats. Currently most of the *Paspalum* species found in West Africa have a tropical American origin and were inadvertency introduced into Africa after 1600 AD (Harlan 1989, Burkill 1977, Portères 1959, 1976). However the two most common *Paspalum* species, *P. scrobiculatum* and *P. vaginatum*, have an old world origin and by consequence have a longer presence in Africa.

P. vaginatum (or silt grass) is a perennial grass that extensively creeps over tidal flats, foreshore and inland marshes and is a good indicator of salty soil. It is usually found in the mangrove and tidal estuaries of the West African coastline (mostly Senegal, Gambia, Sierra Leone, and Ghana). Also, it is the most common weed growing with tidal rice. It is rarely used as a food for humans but as pasturage for stock and compost a very good material for agricultural manure (Burkill 1977, Portères 1976, Nyoka 1980, Fields-Black 2008).

P. scrobiculatum or "African Bastard Millet Grass" or black rice in guinea (Kodo millet in India), is a short-lived perennial grass or a cultivated annual common to the moist and wet niche of West Africa. The grain of the wild perennial plant is, in general, not edible because of its toxicity but the annual cultivar has been changed into a non-toxic form. In the non-toxic form it is a cereal that is generally gathered during periods of famine. In Malinke, a Mande family language from Mali, it is named 'birds fonio'.

Between Sierra Leone and Nigeria, it grows as a wild species weed within flooded rice fields. It is also eaten mixed with rice (Harlan 1989, Portères 1976, Fields-Black 2008, Nyoka 1980, Dalziel 1937). When the rice is harvested bastard millet is gathered at the same time. Due to similar grain dimensions, it is almost impossible to separate these grains from those of rice. It is thus stocked directly in granaries as a mixture generally composed of one-third *P. scrobiculatum* and two-thirds rice. One of the few peoples who directly cultivated the bastard millet are the Kurankos of Sierra Leone. They grow it in the hillside where soils are quite impoverished and barely able to sustain rice (Portères 1959, 1976).

8.5.2 *Echinochloa* Species (*E.stagnina, E.pyramidalis, E.colona*).

In West Africa, *Echinochloa* sp. is represented by five different species. The grains present very similar characteristics making it difficult to distinguish one species from another. Most of the *Echinochloa* species are associated with wet places and water edge niches (Hutchinson and Dalziel 1927-1936) .The most economically important is *E.stagnina,* the deep water burgu grasses that usually grows associated with deep water rice. In the Inland Delta, grains of a swamp grass named burgu are often prepared like rice. It is an important grass used for food purposes not only in times of scarcity. It constitutes also a rich pasture, a green fodder or excellent hay and its stems are used for making a beer. *E. Stagnina* is also appreciated as a minor cereal that in some areas is the object of a kind of proto-cultivation (Boré 1983; Cissé 1991; Dalziel 1937). *E. pyramidalis* is a Sahelian arid grass widely gathered along water courses as part of Kreb (Burkill 1994). *E. colona* is also gathered and occurrence in areas from wetlands (shallow/damp) to savanna. All the species are usually prepared in a similar manner to rice and are sometime used to produce beer.

The three main *Echinochloa* (*E. stagnina*, *E. pyramidalis* and *E. colona*) species are wild grass weeds. *E. stagnina* is the burgu grass growing in deep water (up to 4 meter of water) and is usually gathered at the same time as rice harvesting and as the *Paspalum* species are difficult to separate from rice. It is considered the most common weed for floating rice types. However, burgu is more often gathered as fodder for animal stock than as a grain for human consumption. In the Inland Niger Delta, this plant is claimed to be the most useful of all wild plants, providing, as well as food and drink, fodder, thatch, caulking for boats, vegetable salt after calcining which is used to make soap and indigo dye. Also, it is the most common plant (domesticated or wild) that populates the Niger River flood-plain (Burkill 1977, Chevalier 1932, Dalziel 1937, Portères 1952, Cissé 1991). *E. colona*, jungle rice, is also a wild weed grass commonly found in irrigation ditches or near waterways but never in deep water. More common in the Senegal valley than in the Niger valley but usually misidentified as *E.Stagnina*. It is used more for the grain than for the fodder. *E. colona* is so appreciated as a minor cereal that in some areas it is the object of a kind of proto-cultivation as in some place like in Sierra Leone it is cultivated (Burkill 1977,). *E. pyramidalis* is a Sahelian grass widely gathered on river edges. It is a weed of sorghum and irrigated rice cultivation (Burkill 1977, Portères 1959, Boré 1983, Cissé 1991, Dalziel 1937, Maliki 1981).

In conclusion, usually weeds present in archaeobotanical assemblages could indicate evidence of local cultivation. Before being sold or stored crops are often separated from the weeds, and by consequence, the weed seeds remain at the site where they were processed. However, the remains of *Paspalum* and *Echinochloa* species cannot be used as indicators of rice cultivation due to the factors listed above, i.e. that they might be forced resources

8.6 Cotton – Gossypium sp.

One of the major "cash crops", not just recently in Africa, but in prehistory is cotton. Unlike most annual seed crops, which are primarily caloric foods for people or livestock, cotton is primarily grown as a raw material. It is crop which requires careful attention to its environmental needs and beyond cultivation requires substantial labour investment for processing (ginning, combing, spinning, and weaving). Thus, investment in cotton implies both surplus land (removed from the needs for subsistence crops) and surplus labour. When cotton appears in the archaeological record it implies a certain level of social complexity and long-distance trade, and thus a more diversified agricultural system. We see this correlated with urbanization in Mali, in Benin, in Saharan oases (Essouk, Jarma), in Meroitic Nubia and Axumite Ethiopia, and in the Middle Iron Age of the Swahili islands of eastern Africa.

***G.herbaceum* L.**	***G.arboreum* L.**
Common Name: Cotton, Arabian cotton, coton africain.	**Common Name**: Cotton, Tree cotton, coton rouge.
Description: *G.herbaceum* is a perennial small shrub that has 3 to 5 years duration. Annuals forms are present in middle east Asia. Cotton can be grown as a perennial and be cut back and ratooned.	**Description:** *G.arboreum* is a perennial large shrub up to 5 metres with pollarding. Annual forms are observed in china and India.
Seed weight: 5.5-11.1 g	**Seed weight:** 3.7-9.2 g
Agronomy: It require between 19-35°C and rainfall of 750-1400 mm. In Africa it occurs from sea level up to 1200m.	**Agronomy:** *G.arboreum* occur in the same ecological niches than *G.herbaceum* but in lower altitude (max 900-1000m) with a preference for rainfed or decrue area.
Yields: In Africa the yield for seed is around 1t/ha with maximum 3t/ha. After ginning it yield 20-25% fibre to 40% for the best cultivar. It produces longer fibres than *G.arboreum*. More generally it is grown in fields.	**Yields:** The yield for *G.arboreum* is approximately 50 to 25% less than *G.herbaceum.* However his production is constant for 2 or 3 years, whereas production of *G.herbaceum* is dropping after the first year. It is more often found in gardens and orchards than fields.

Four cotton species were domesticated independently through time and space. The current most cultivated species, *G.hirsutum* and *G.barbadense* were domesticated in the new world and the two others, *G.herbaceum* and *G.arboreum* have old world origins.

Cotton seeds are quite diagnostic being obovate and asymmetrically depressed on their long sides, and having a small, squarish, woody protuberance at the narrow end, with a woody/fibrous beak at the narrow end, and often preserving fragments of the base of charred fibres. Although the seeds often fragment during or after charring, one structure on the inside of the seed coat at the hilum end appears to survive well and to be diagnostic: this is referred as the funicular cap (e.g. Fuller 2008, Fig. 1F; Boivin et al 2014, Fig. 13d). However, identification beyond the genus level remains an unsolved challenge, i.e. whether this represents *G.arboreum* or *G.herbaceum*, or even one of the two new world cottons that were brought to the Old World by the Spanish and Portuguese (*G. hirsutum*, *G. barbadense*) cannot be determined to date (see Wendell et al.1995). *Gossypium arboreum* L. was probably domesticated in Pakistan/Northeast Indian where there is evidence that cotton commercialization was established since the 3rd millennium BC (Fuller 2008). Secondly, *Gossypium herbaceum* L. seems to be domesticated in Africa. The earlier evidence of cotton in Africa comes from Nubia and southern Egypt during the Roman/ Meroitic era (Clapham and Rowley-Conwy 2007, 2009), and at least some of this from Nubian has been proven as *G. herbaceum* based upon ancient DNA (Palmer et al 2012).

In West Africa, cotton introduction is related to two potential roads (Figure 8.18):

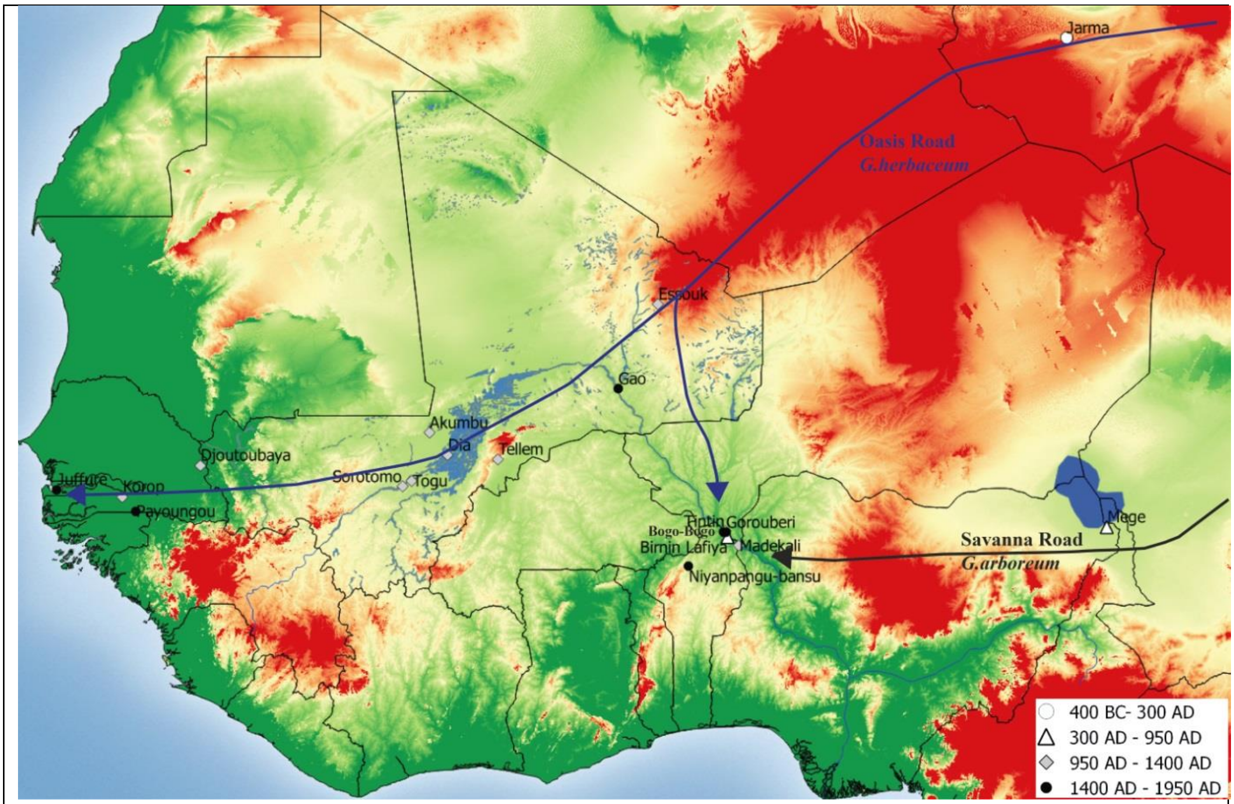


Figure 8.18 Cotton origin and diffusion in West Africa.

- The Savanna road

Currently, the Savanna road is linked with two sites, Birnin Lafiya in Benin (this study) and Mege in Nigeria (Bigga and Kahlheber 2011) dated to 300-900 AD. Based mainly on the distribution of relict population recorded by Chevalier (1936; 1939) and Hutchinson (1959), the cotton remains from both sites could eventually be attributed to *G.arboreum*. This road is associated with the local emergence of social hierarchy, tiered and elite identities linked to trade and crafts transferred via peripheral cultivation along the Meroitic/Axumite areas.

In the Chad lake area, the archaeobotanical assemblage of Mege shows the appearance of a large number of cotton remains, *Gossypium sp.*, around the late Iron Age (700-1500 AD). The presence of cotton coincided with the rise of the Kanem Kingdom that quickly controlled commercial routes in the area. Through these routes slaves, ivory and goods like beads and salt from the North and East were traded (Insoll 1997). Cotton was probably a cash crop on these trade routes. The disappearance of cotton, during the Early Historic phase, 1450–1500 AD, corresponded to internal revolts that pushed the kings of Kanem to move to the Bornu region (figure 6.28)

- The Oasis road

The Oasis road corresponds to cotton remains associated with Islam introduction in West Africa from the east via the main trans-Saharan trade's roads. Finds of cotton come from the early Islamic period along the Niger River, in Senegal and in the Saharan caravan city of Essouk (Figure 8.18 Table 8-12)

Table 8-12 West African Archaeological site with cotton remain

Site	Country	Date (cal. AD)	Reference
Jarma	Libya	400 BC	Pelling 2005
Essouk	Mali	950-1400	Nixon et al. 2011
Dia	Mali	1000-1400	Murray 2007
Gao	Mali	500-1000	Fuller 2000, Cissé et al. 2013
Togu Missiri	Mali	1200-1300	This study
Sorotomo	Mali	1200-1450	This study
Tellem	Mali	1000-1400	Champion 2018
Akumbu	Mali	1200-1400	This study
Birnin Lafiya	Benin	300-1400	This study
Bogo-Bogo	Benin	1400-1600	This study
Tintin	Benin	1000-1400	This study
Madekali	Benin	1400-1600	This study
Niyanpangu-bansu	Benin	1400-1600	This study
Korop	Senegal	1500-1800	Stricker 2016
Payoungou	Senegal	1800-1900	Stricker 2016
Juffure	Gambia	1700-1900	Gijanto and Walshaw 2014
Djoutoubaya	Senegal	950-1400	Champion 2018 c
Mege	Nigeria	700-1500	Bigga and Kahlheber 2011

Historical sources suggest that clothing and the use of cloth, presumably much of it from cotton, became important during the Islamization of western Africa, and urban centre of the Islamic era (Kriger 2005; Candotti 2010). "Wearing clothes became an indication of the conversion to Islam and belonging to the Islamic *umma* (community)" (Candotti 2010, 189). This fits the archaeobotanical evidence for cotton from all Islamic era urban centres that have had archaeobotanical sampling (see Nixon et al. 2011, Table 3), from ca. AD 1000 onwards. The extent to which cotton was cultivated elsewhere in western Africa prior to this is unclear (cf. Kriger 2005). Sets of loan words in several language groups suggest borrowing from Arabic speakers (Kriger 2005), while early finds of clay spindle whorls suggest two zones for the development of textile production, one northeast of Lake Chad from the 8th century AD and the other in the middle and upper Niger valley from the 10th century (Kriger 2005, Fig. 1). In this regard it is surprising that there was such a long delay before we have evidence in the Dendi region, although cotton was presumably widely traded, and from the 13th century was associated with Wangara traders who likely imported this eastwards into Hausaland (Candotti 2010). Linguistic evidence suggests that *shigge*, a term for cotton cloth, was used in West Africa (Mali) in the 11th century and since the 9th century there was a cotton market in Kano, Nigeria (Dalziel 1937; Fuller 2000). In the Dendi area, in the 1960s the French introduced a new cotton variety (such as *G. hirsutum*); before then the population cultivated "*indigenous cotton*" (Van Driel 2001). The presence of cotton and African rice fields is documented by the Portuguese on their arrival on the African coast in the 15th century: In 1446 the chronicler Gomes Eanes de Azurara states, *"They found the country covered by vast crops, with many cotton trees and large fields' planted with rice…"* (Linares 2002:16360).

8.7 *Cowpea* – Vigna unguiculat*a*

Cowpea, or black-eyed pea, is the common English name for *Vigna unguiculata.* In West Africa it is often named “Niébé” or “Pois Dolique” in French. The numbers of Vigna unguiculata remains found in West Africa are rather few, although it is expected to have been a domesticated pulses crop in this region (Smith 1990). Due to the morphological characteristics of the cowpea seed it is very easy to identify this taxon. Indeed, the seed is flat with a sub-rectangular shape. The hilum is ovate and generally placed asymmetrically on the hilum edge (Fuller 2003; Fuller and Harvey 2006). As this is free-threshing pulse (see Fuller and Harvey 2006), it is likely that processing took place shortly after harvest and may have been offsite, leading to fewer opportunities for preservation. In addition, cooking by boiling will also reduce the likelihood of specimens been preserved in recognizable form by charring.

Cowpea is one of the most important pulse crops of the savannah area in west and central Africa, and is also present in the eastern and southern parts of the continent. It also a major pulse crop in South Asia (Fuller 2006, 2003). Cowpea has a wide range of uses. The seeds can be boiled and eaten with a mixture of boiled rice, or can be ground and used as a flour and fried with onion. The leaves can be used as the base for soups or sauces. Different parts of the plant also have medical purposes and can also be used for making textiles. Finally, it is given to livestock as forage (personal observation; see also Logan 2012; Fao 2013; D’Andrea 2007).

A very important characteristic of cowpea, from an agronomic perspective, is that it is very fast growing and relatively easy to cultivate. It is a versatile crop that can be intercropped with pearl millet and sorghum (D’Andrea 2007, Fuller 2003), and its seeds and leaves can be collected several times before the plant dies. As with other Fabaceae (legumes) it fixes atmospheric nitrogen and therefore helps to boost soil nitrates. Thus its cultivation in rotations can to a degrees substitute for fallow cycle (Smith 1990).

Linguistic evidence suggests that cowpea was possibly domesticated in the West African grassy woodlands, with a second hypothetical centre of domestication in Botswana (Fuller 2003). Genetic data, on the other hand, indicates the probable origin to be West Africa (D’Andrea 2007; Fuller and Hildebrand 2013). Currently the earliest evidence yet found in Africa comes from the Kintampo culture in Ghana. Indeed a direct AMS date from the site B6B in Ghana gives a date of 1830–1595 cal. BC (3410 ± 40 uncal. BP; or 3780–3545 cal. BP) (D'Andrea and Casey 2002; D'andrea 2007).

8.8 Fruits and Trees

Most of the main Sahelian trees have already been described in Chapters 6 & 7. Here only the imported fruits produced from trees that grow in the rainforest are discussed. These fruit remains recovered from archaeological sites can be interpreted as the result of trade rather than local cultivation.

8.8.1 Cola nut – *Cola acuminata* (Vent.) Schott et Endl. & *Cola nitida* (P.Beauv.) Schott et Endl.

In West Africa, the most common species providing Cola Nuts are *Cola acuminata* and *Cola nitida* (Figure 6.3). Their fruits, the Cola Nut, do not really serve as food but are chewed as a stimulant and have particular uses in traditional religious and social practises (Bostoen 2014, Lovejoy 1980). For instance, in North Benin it is offered as a welcome gift to the village chief before starting an ethnographical interview. Also, it is sometime referred to as money. Usually after an interview, people ask to be paid by asking for "*la cola"*, in which case it can be translate as 'small money' but in other situations it can be 'Baksheesh' (personal observation). Cola trees are indigenous to the West African forest (Figure 8.19). There are more than forty varieties and four are used for their edible fruit: *C. nitida, C. acuminata, C. veticillata* and *C. anomala*. Cola nuts are used as stimulants and for pain relief, as they contain large amounts of caffeine, and also theobromine, kolatin and glucose (Lovejoy 1980, Burkill 1985, Bostoen 2014, Blench 2006).The cola trade is historically well-known. Ibn Fadl, Allah al-'Umari (*ca* 1349 AD) mentioned some bitter nuts that were chewed only by people from Mali. Also, around the 10th to 15th century AD, the Hausa controlled the cola nut trade routes from modern Ghana to the Hausa area (see Chapter 2 and Figure 2.12). During the same time, confirmed by linguistic data (see below) the Songhay were probably using two roads to trades cola nut, the Hausa road but also the north-south road from Jenné to the Akan region around the Volta River (Lovejoy 1980, Burkill 1985).

Linguistically cola names turn out to be re-constructible to considerable time depths. Williamson (1993) showed that terms for cola could be reconstructed in many West –

African proto-languages. Blench (1996) indicated that one of those terms is common among the Benue-Congo languages of Nigeria and spread into the Bantu area of Cameroun. One of those roots designing a special type of Cola was borrowed into Hausa as *ibii*. But more generally, the Hausa used the term *gooro* from Songhay (Blench 1996). In Bantu, the single ancestral form is **~bèdù*. This term shares the same distribution as the roots **~càkù* that designated *Dacryodes edulis* (The Safoutier). Both terms are also widely found among non-Bantu Benue-Congo languages what allows reconstruction in proto-Bantu and some have even hypothesized that it was inherited from an older language phase. This hypothesis supposes that early Bantu and Benue-Congo speakers exploited these trees (Bostoen 2014).

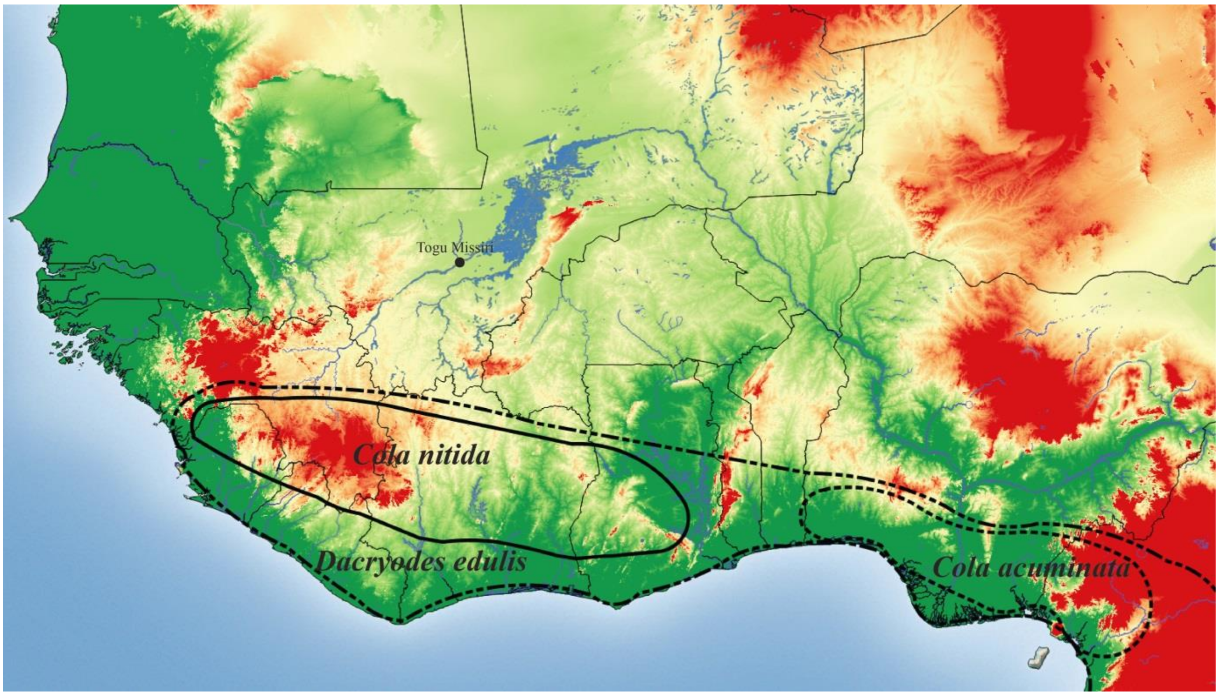


Figure 8.19 Distribution of main production area for *Cola nitida*, *Cola acuminata* and *Dacryodes edulis*. (Lovejoy 1980, Burkill 1985) and archaeological site (Togu Missiri) that provides *Cola* sp. and *Dacryodes edulis* fruit remains.

8.8.2 Safoutier, African Pear – *Dacryodes edulis* (G.Don) HJ Lam

Dacryodes edulis developed naturally in the countries bordering the Gulf of Guinea but was cultivated (and naturalized) from Sierra Leone to Angola in the South and from Uganda in the East (Figure 8.19). This tree is mainly grown for the fruit (Safou). In Cameroun where safou is a daily staple, it is usually boiled in water and consumed as a side plate. The fruit is an ellipsoid drupe of 8-12 cm by 3-6 cm that usually supports one oblong seed up to 6 cm long (Burkill 1985, Bostoen 2014).

The archaeological remains of Cola nut and Safou fruit found at Togu Missiri are the first found in West Africa.

8.8.3 Oil Palm and Incense tree – *Elais guineensis* & *Canarium schweinfutrhii*

The incense tree, ***Canarium schweinfutrhii***, has the same main utilities as the oil palm and their fruits can be very similar (see Table 8-13 for the main criteria use to identified them) There are several varieties of oil palm. The main one is *E.guineensis* var. *communis* which has five main fruit forms (Figure 8.20). Oil palms are grown in the secondary forest region between the deciduous forest and the savannah. There is no diagnostic morphological change with domestication (D'Andrea 2006). The first step towards domestication is more due to its abilities as a 'camp follower" as a result of human collection of the fruit (Zeven 1967:28; D'Andrea 2006). The oil palm is indigenous to West Africa. In cooking, oil palm is used for its oleaginous fruit but the whole tree is used for other purposes such as food and construction. The kernel and the mesocarp oil are the primary food product. Oil palm can also use to distil alcohol or fermented beverages, i.e. one kind of palm wine (D'Andrea et al. 2006), distinct from the *Raphia* palm wines also used throughout central Africa.

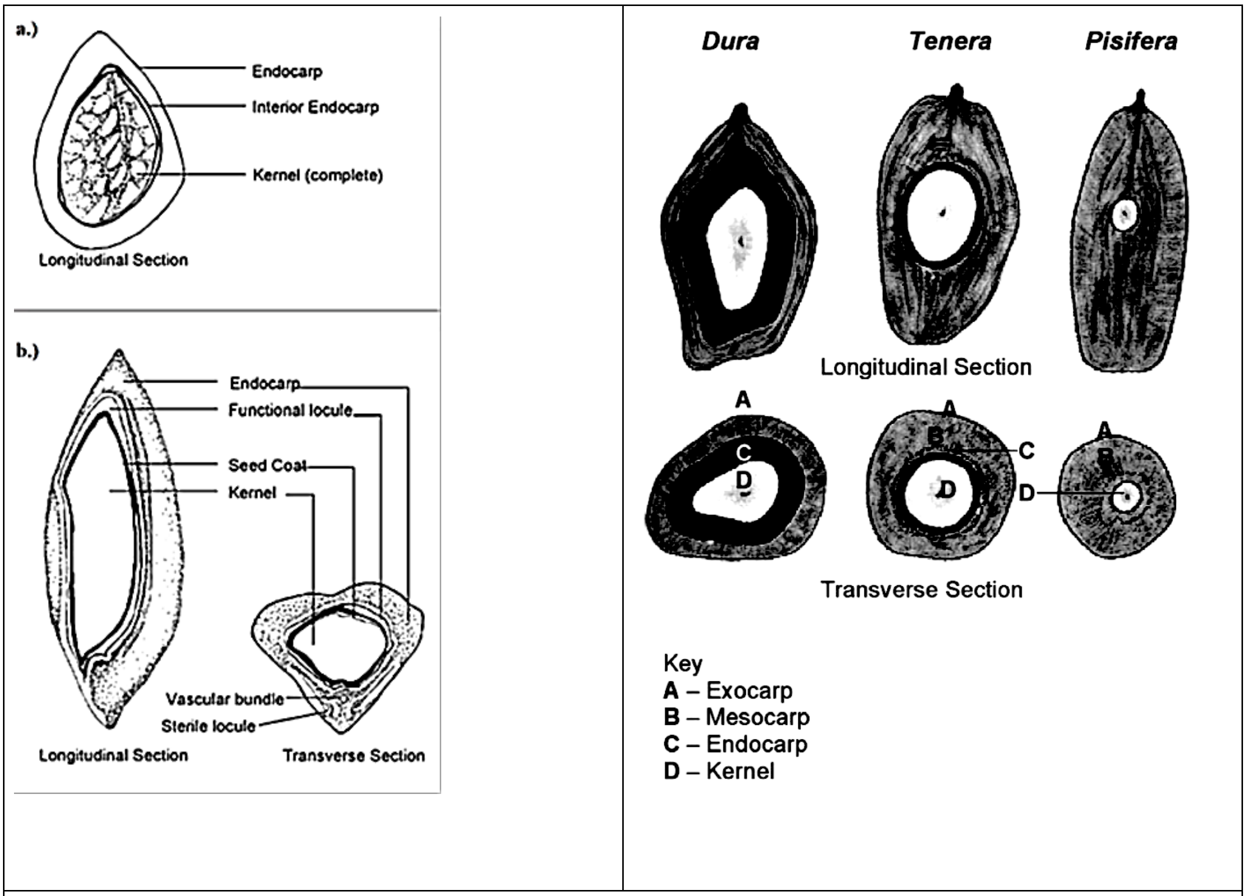


Figure 8.20 Major oil palm fruit types (on left). Anatomical features of oil palm (B.) and incense tree (A.) (on right). Reproduced from D'Andrea et al. 2006:198-199

Table 8-13 Identification criteria of oil Palm and incense tree. (After D'Andrea et al. 2006: 205)

Feature	***E. guineensis***	***C .Schweinfurthii***
Exterior surface of endocarp	Striated	Smooth
Interior surface of endocarp	Clear network of vein-like reticulations	Smooth, with clear cell structure at high magnification
Endocarp cross section	Dense, sporadic pores, rarely layered	Dense, with linear layers sometimes present in endocarp
Shape of nut	Bulbous, irregular	Sharply angular, elongated
Thickness	Variable, usually1.4-3.7mm	Variable, usually 1.2-4.3 mm
Other	Germ pores (2-3)	None

9. Interpretation and Discussion

The main goals of this research have been to not only to characterize the nature of past agriculture in the Niger River Basin but also to study its origins and developments through time. In addition, a secondary aim was to try to understand the impact of these agricultural developments on the urbanization of this region. This interpretative chapter combines the archaeobotanical data obtained as part of this research (Chapter 6) with the already published data described and discussed in Chapter 7, together with the multidisciplinary data discussed in Chapter 8. The developments and spread of agriculture are herein broken down in a series of waves that punctuate the long-term history of the region.

West African agricultural developments begin with pearl millet domestication, and its pre-domestication process, which probably occurred in the Central Saharan Mountains/Massifs (Figure 9.1), between 6500-2500 BC. This corresponds to the first wave **(wave 0)** of agriculture. However, this phase still needs to be studied further, as there is no direct evidence yet available to support the beginnings of the domestication process; although hypotheses could be developed further based upon the excavation of the cattle burials of central Sahara (see below **wave 0**). Pearl millet, *Pennisetum glaucum* (L.) R. Br., was the earliest domesticate of western Sahelian Africa. Once domesticated, pearl millet was integrated within the pastoralism subsistence system providing a potent economic package ready for dispersal. Pearl millet's earliest and most rapid spread was perhaps eastwards across the Sahara (**Wave 0**), reaching eastern Sudan by approximately 1850 BC (Beldados et al 2018) and India, via maritime links, by ca. 1700 BC (Boivin and Fuller 2009).

The first documented agricultural phase, **wave 1** (Figure 9.1 and 9.2), has several direct lines of evidence for fully domesticated pearl millet dated from 2500 BC to 1000 BC. This phase is associated with seasonal camp settlements and the diffusion of roulette-decorated, chaff-tempered ceramics. This second agricultural phase, **wave 1,** quickly diffused throughout the Niger River Basin, from the Tilemsi Valley in Mali to the Rainforest of Ghana, and possibly further, but this latter possibility has still yet to be explored. In the Niger River Basin Wave 1 ceases abruptly, with many site showing evidence of abandonment, followed by a gap in the occupation record, from around

1000 BC. The second documented agricultural phase, **wave 2** (Figure 9.4), is related to the diffusion of a package of social complexity (Clustered organisation, Tell type sites, urban-sized, metallurgy, roulette decorated ceramic and pearl millet) from the Tichitt area (Hodt depression in Mauritania) into the Inland Niger Delta around the middle to late first millennium BC, and then more generally to the entire Niger River Basin. **Wave 2** is associated with urbanisation, and pre-urbanisation processes, and agricultural diversification and extensification. During this phase, large sites (e.g. Dia, Jenné-Jéno, and Birnin Lafiya) developed and grew and can be associated with the arrival of a much more diversified agriculture than previously existed, consisting now of African rice, fonio, and sorghum. The end of **wave 2** coincides with Islam's introduction into this region around 1400-1500 AD, which then initiates **wave 3** (Map 6). In terms of botanical remains this is marked by the arrival of evidence for cotton in the form of seed and caps remains. Cotton can be associated with new clothing traditions, including those suitable for Islamic prayer. Archaeologically speaking this phase corresponds with large abandonment events (mainly associated with violence) and re-settlement within new sites, sometimes close to the destroyed former villages/towns (e.g. Jenné-jeno). Theses abandonments are probably linked to the introduction of a new way of life that was more hierarchical than those that had existed previously. This is also the era of the emergence of the Songhay, a strong hierarchical military polity. Around 15-17th century AD, **wave 3** was augmented by the introduction of New World crops (e.g. maize, peanut) and became **wave 4**. However, introduction of New World crops in Africa is still very poorly documented.

The following sections describe the better documented waves (1 to 3) in more detail and finish with a discussion on the more speculative **wave 0**.

Wave 1 - Late Stone Age Settlements (~2500-1000 BC)

Agro-pastoralist Package :	**Diffusion wave**
- Pearl millet - Chaff temper ceramics - Roulette decorated ceramics - Livestock (cattle) introduction and diffusion - Seasonal settlement - Fishes remains (Fishers association)	Wave 1 Central from Tilemsi to Ghana via Windé Koroji to Ounjougou Wave 1 West from Early Tichitt sites to Faïta phases in the Méma region and will be transformed in Wave 2 (Urbanisation)

Current evidence for wave 1 starts with the earliest domesticated evidence for pearl millet in the Tilemsi valley (≈ 2500-2200 BC). The archaeological record is more robust, when it comes to the spread of pearl millet within West and Central Africa (occurring either during wave 0 or wave 1, but it is currently unclear), where pearl millet made steady progress southwards into ever wetter and more tropical ecological regions, eventually extending into open gaps within the rainforest zones by ca. 400 BCE (Kahlheber et al 2014). This diffusion is associated with the development of a new archaeological cultural assemblage, characterised by fibre roulette decorated chaff temper pots with a large diversity of different forms. Katie M. Manning (2011:83) outlines a change from comb to roulette décor with the addition of "*chaff tempering with near exclusive use of pearl millet through a temporal continuity of sand, grit and grog as other tempering material"* and argues *"that pots played an important role in the constitution of social change"*. Wave 1 also coincides with diffusion of domesticated livestock, mainly cattle from the central Sahara (Linseele 2013).

Wave 1 can be divided into two main branches, a central (from Tilemsi, 2500 BC) and a western (from Tichitt, 2000 BC) division (Figure 9.1). The origin of Tichitt pearl millet is still unknown, but it could be the direct result of a central Saharan introduction (wave 0) or Tilemsi diffusion (wave 1). On the western branch of wave 1, Kevin C. McDonald (2011:54) refers to the "*pottery main trend from Early Tichitt to Classic Tichitt as one of extreme diversification… It is tempting to think that the dominant pearl millet chaff-tempering of Tichitt's pottery results from activities scheduling, with most pots being made directly after harvest*". The importance of chaff is well-illustrated in later Mande mythology and it is likely that wave 1 was probably at the origin of the Mande diaspora. The Mande's interpretation of this epic oral history of Sunjata the founder of the Mali Empire in the 13th century AD, and of the "hidden" chaff's importance, may be reflected in the traditional song celebrating Sunjata's triumph over his childhood paralysis, (*Sunjata seems larger than life because he is larger than life)* (Bird et al. 1995: 34-35):

"Nyama, nyama, nyama;
Fen bee b'i dogo nyama de koro ;
Nyama t'i dogola fen koro"

"Chaff, chaff, chaff;
All things hide under chaff;
Chaff hides under nothing"

[Translation by Massa M. Diabaté.]

"Nyama", loosely translated as "chaff", is a paradoxical double-sense word, very much discussed as a key element of Mande philosophy. Nyama means simultaneously both 'life force' [autocatalytic force] and 'having the property of **chaff,** refuse, garbage'. This linguistic *tour de force* is explained by students of Mandekan (Bird et al. 1995: 29): '*Nyaga' means* ***chaff,*** *the part to be thrown away; speakers drop the g and pronounce 'Nyaa'. 'Ma' is then added as a suffix meaning 'having the property of'. In this version, nyama means 'having the property of* ***chaff'.***

To summarize the western branch of wave 1 originates at the transition of early to classic Tichitt Late Stone Age (≈ 2000BC) and mainly diffuses into what later becomes the Mandekan, Mande speaking region or area.

To the east (Figure 9.1 and 9.2), the Central branch of wave 1 diffusion extends from the lower Tilemsi valley (≈2500BC) toward Oursi (≈2000BC; Burkina), Windé Koroji (≈2100BC; Mali), Ounjougou (≈2000BC; Bandiagara escarpment, Mali) and Birimi (≈1900 BC Ghana). With the exception of Birimi, each site shows the same pattern of seasonal camps associated with chaff tempered ceramic, pearl millet, fish but with no larger animal bones (and by extension no evidence of herders). Thus, I would suggest than the main agents of wave 1 were female potters creating chaff temper roulette decorated pots, and not the herders. The female potters were perhaps often married to fishermen or to other less archaeologically visible proto-casts (e.g. the bards/Griots). This association between female potters and strong proto-cast members also forms an important characteristic of the wave 2 metallurgist-potters promoting associations of different casts. Also in some cases, e.g. Windé Koroji, Alibori, and Birimi, the pearl millet wave 1 diffusion is associated with cowpea remains. Cowpea was probably intercropped with pearl millet. However, cowpea remains are usually processed directly in the field and are therefore less common archaeological remains compared to pearl millet that was routinely processed on site and used in ceramic temper.

The site of Windé Koroji (see Chapter 6) offers a similar pattern of roulette decoration and early pearl millet evidence, appearing by 2200-2000 BC. While the later Dhar Tichitt Naghez phases (1600-1250 BC) witnesses an important increase in twisted cord roulette motifs, associated with the presence of domesticated pearl millet, which could represent a westward extension of this pearl-millet cultivating, roulette-decorating tradition. Later, around 1250-800 BC, Tichitt derived people spread to the Inland Niger Delta, representing another extension of this wave into the region, but also deriving from the same ultimate Saharan origin.

Two other more easterly branches of wave 1 are represented by the emergence around Lake Chad of the Gajiganna complex by about 1500 BC and an isolated early Nok plateau tradition, both groups also representing the extension of pearl millet cultivation during the second millennium BC.

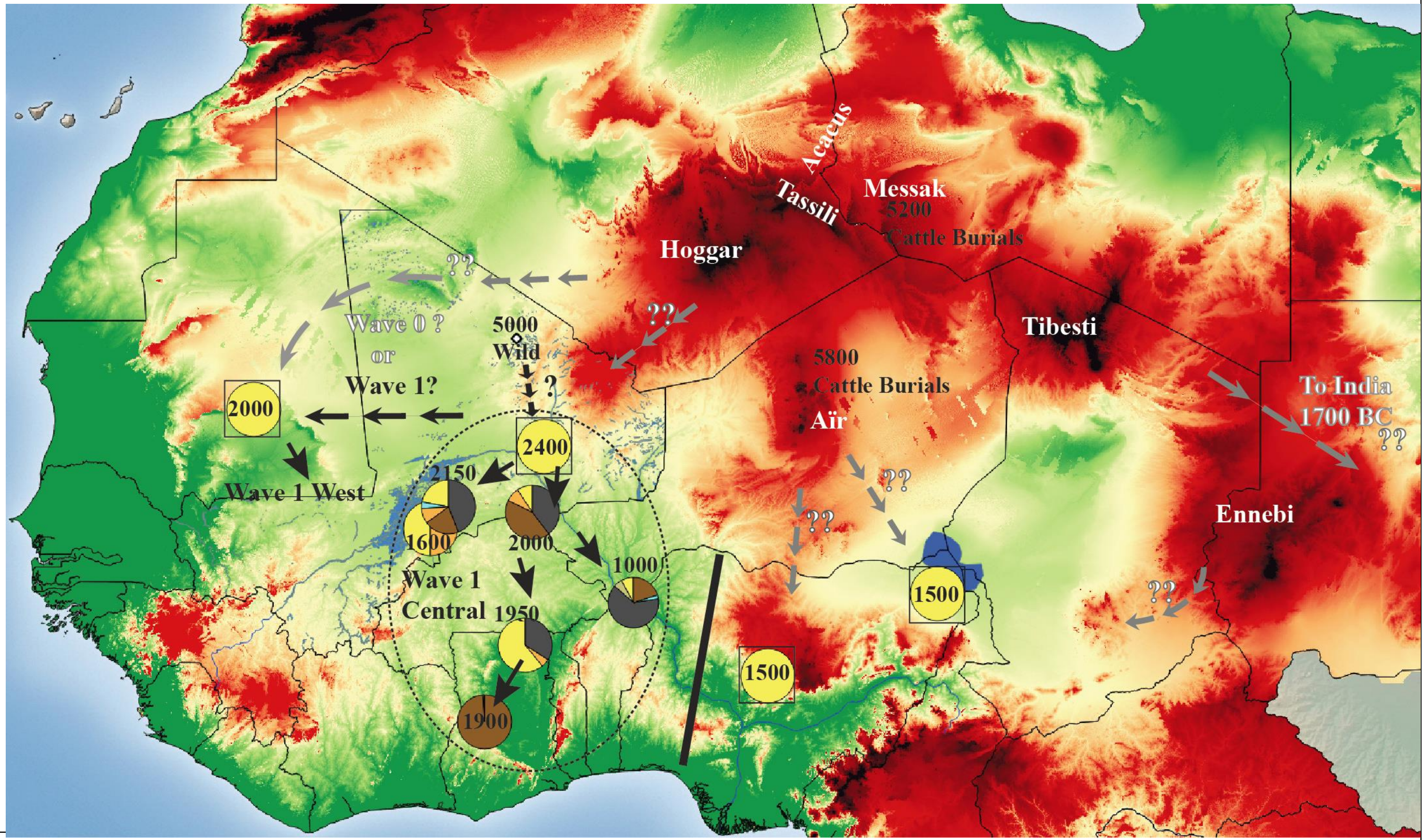


Figure 9.1 Diffusion of early agriculture in Wes Africa: Wave 0 and Wave 1. (Date In BC)

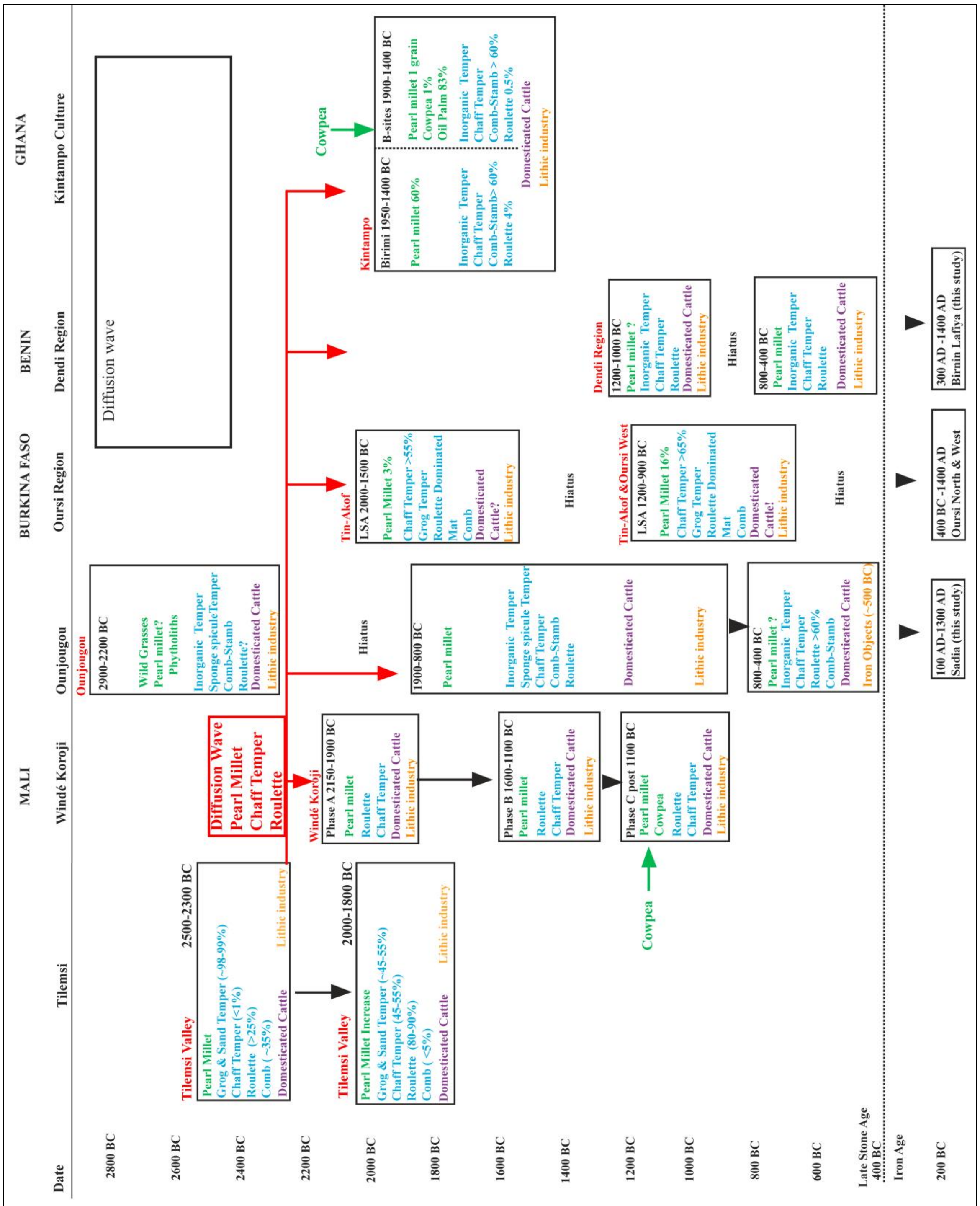


Figure 9.2 Summary of Wave 1 sequence with main characteristics of ceramic (in blue), plant remains (in green), technology (in orange) and animal remain (in purple) by sites.

Wave 2: Complexification and Urbanization (1000-800BC-1300AD)

Wave 2 Package:	**Diffusion wave**
- Wave 1 Package - Large permanent settlements organised in clusters (origin of the Tell sites) - Potsherd pavements - Metallurgy - Agricultural diversification (African rice, fonio, sorghum) - Steamers	Wave 2 starts after the late Tichitt diffusion (i.e. after ca. 1000 BC, Early Faïta) to the Niger River Basin (e.g. Dia, Jenne-Jeno, Birnin Lafiya)

The second wave coincided with the arrival of iron production knowledge (i.e Robion 2008), renewed pearl millet cultivation and development of village networks connected to important proto-urban trade centers. This might be related to a wave of diffusion from Southeast Mauretania associated with the Late Tichitt tradition. As in the neighbouring Inland Niger Delta, this wave has diversified into a complex agricultural system that included several domesticated crops (rice, sorghum, fonio and cowpea). In summary, in the Hodh depression pre-Tichitt seasonal hunter-gatherers were gradually replaced by Tichitt migrants after *c.* 1900-1800 BC. The origin of the Tichitt tradition is still unclear, but it shares similarities with the Tilemsi (roulette decoration, pearl millet chaff temper, domesticated cattle, sheep and goats) and probably originates in the central Sahara. Supported by pearl millet cultivation, the Tichitt tradition grew with settlements characterized by clusters of stone walled compounds, and some urban-sized settlements. By the first half of the first millennium BC, iron ores were reduced and smelted to produce iron blooms, the appearance of which can be tied to pearl millet cultivation. The Tichitt then diffused west (Tagant region) and probably introduced pearl millet to the Senegal River valley and to the east via Néma, in southeast Mauritania, Méma, Mali and Macina, in which the Faïta ceramic facies cultural tradition becomes predominant. During these migrations and diffusion of cultural packages, integration occurred with other previously established cultural traditions as indicated by earlier divergent ceramics. When the Tichitt reached the IND (≈1000-800BC) they appear to have been integrated into existing traditions by Kobadi hunter- fishers living at seasonal camps subsisting off deep-water fish and aquatic animals, crocodiles, hippos. These people reproduced the classic, clustered urban patterns of the Tichitt, but instead of building stone-walled compounds, used earthen clay brick architecture, partly a response to a lack of readily available stone. Sites displaying this new construction tradition grew in size and number, becoming more permanent, and mound sites (tells) are noted for the first time in the Mema region (e.g. Kolima, Akumbu; 1000-400 BC). Their arrival coincides with the diffusion of iron technologies. This diffusion/migration continued into the IND, as seen in the creation of the settlement at Dia *c.* 800 BC (first horizon with pearl millet, iron, mound clusters), and continued to expand to Jenné-jeno, Thièl, Tato à Sanouna (250 BC) and later Toguéré(1000 AD), probably throughout a larger area in the IND and the Niger Valley, possibly even to North Benin (300 AD) via the Niger Valley. Within this tradition as populations grew agricultural innovations included new crops, perhaps adopted from adjacent traditions, including rice, fonio, sorghum and cowpea (the latter first known from the Kintampo culture in Ghana). Rice is perhaps to be seen as adopted from a tradition of early Mande speakers (see Section 8.4 African rice).

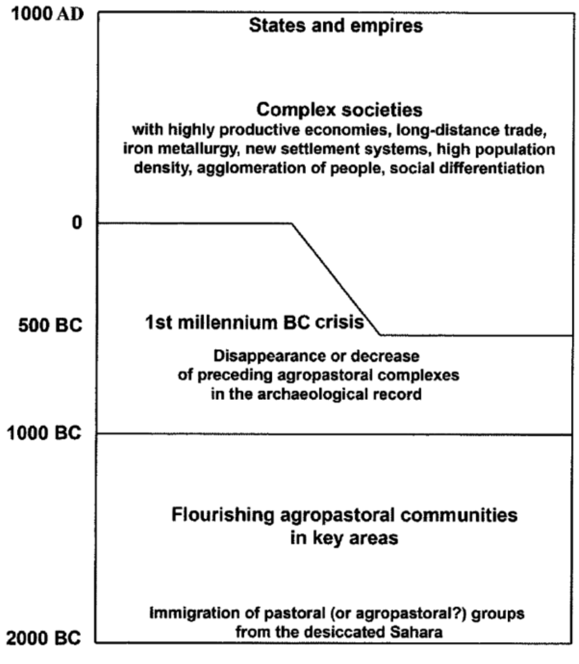


Figure 9.3 Schematic representation of the development of the early phases of food production in the West African Sahel. (Breunig 2013: 567)

One of the significant findings of the research conducted for this thesis was that isolated iron working sites (Tongo Maaré Diabal, Kantoro, Pekinga and Kouboukoukourou) were exclusively associated with pearl millet remains, and this has resonance with, and supports documented ethnographic patterns. As Robion-Brunner (2010) indicates in her ethnographic study of Dogon villages in Mali that include metallurgist communities found that outcast smiths received a part of the pearl millet harvest as an annual allocation. However, some metallurgists grew their own millet crops during the rainy season, and in return some metallurgists are aided in the dry season by millet farmers in the excavating of ores [and likely also assistance in charcoal production although this point has received less ethnologic attention and requires further clarification]. These farmers received for their labours some of the bloomery iron. Within this exchange system, iron is not utilised as product that is traded with currency or integrated into the market exchange, but rather forms part of a routine domestic cycle that links millet growing and the labour of the millet growers. At the same time millet chaff is incorporated into ceramic production. Thus, the typical couple, a potter wife and metallurgist husband, are fully intertwined and entangled with cycles of agriculture, as well as craft production, both of iron and pots. The long history of this entanglement may account for some of the widespread and *longue durée* patterns in the archaeological record of western and sub-Saharan Africa. For example, Alexandre Livingstone Smith (2007:190) traces roulette pottery as it diffused eastwards from Tilemsi (2500BC) and states "[*w*]*ith exception of this initial 2500-1000BC phase, a correlation seems to appear between 'Iron age' advent and roulette décor with a strong pot similitude between very distant sites in very numerous archaeological contexts"*.

Firing pearl millet chaff tempered clay into ceramics by the Late Stone Age and Iron Age female potters and Iron Age fire reduction of lateritic ores into iron blooms by metallurgist males can be regarded as complementary, like the bonds of an endogamic marriage. Remarkably, iron-working appears to have been a catalyst to Late Stone Age farming, which spread quickly after the break in settlement during the first halve of first millennium BC (Figure 9.3). The same autocatalytic double function of pearl millet was at work as had been the case in the Late Stone Age, namely the primary product (grain) in the pot, and the secondary product (chaff temper) in the wet clay of the pot, decorated by fibre roulette impressions. Indeed, new iron metallurgists and smiths (*Numu*) appear to have been exclusively bonded to the pearl millet as a staple food and to these food containers with chaff temper, as seen at *Numudugu* (isolated metallurgy villages), such as Tongo Maaré Diabal, Oursi, Pekinga, which have produced archaeobotanical charred assemblages that comprise nearly exclusively of pearl millet. This suggests a pattern in which iron workers (male) performed exclusive endogamous marriages with chaff tempering potters (females), whose pots were exchanged exclusively for grain (La Violette 1995). Ethnographic records show that iron metallurgists and smiths typically receive a portion of the pearl millet harvests for their services as a public servant on a yearly allocation. Caroline Robion-Brunner (2010:66) further indicates that "*Ouin iron reduction furnaces are detected by systematic use of lozenge bricks in foundation structure[s], [and] interestingly these non-utilitarian lozenge bricks are exactly [the same as] those used in [the] ancient granary structures of [the] Ouin, Bolimmba, Pa, Niongono and Dogo villages of [the] Bandiagara escarpment.*. ". Numu 'potter wife and metallurgist husband' couples thus form a functional pair at the heart of the economic and social organization of this society.

While iron producing communities may have been strongly tied to pearl millet production and consumption, across the wider landscapes of early urbanization agriculture underwent diversification during wave 2. This diversification included a range of highly tolerant wild food plants (such as *Panicum laetum, Echinochloa, Paspalum*), as well as newly adopted crops such as sorghum, of eastern African origin, and more widespread evidence for cowpea and various tree fruits or nuts. An important and highly productive crop that appeared and started to become widespread at this time was African rice (*Oryza glaberrima*). Currently, including the four Benin sites (and the two Malian sites) analyzed in this study, there about a dozen African archaeological sites that have provided firm archaeobotanical evidence for African rice. This means that we are still some way from adequately documenting the origins and early diffusion of African rice agriculture, and as discussed above (Chapter 8.4) it is unclear whether this rice was domesticated in the Inland Niger Delta, somewhere further west or south, or indeed if it was domesticated more than once.

During this phase in the Inland Niger Delta region, fonio (*Digitaria exilis*) cultivation appear for the first time .The use of marginal and poor soils is suggested by the presence of fonio within the archaeological record, which may represent agricultural diversification and extensification within the drier areas of West Africa. Previously, there have been suggestions that these fonio are a very ancient crop, with widespread and patchy modern distributions reflecting relict populations (e.g. Portères 1976; Blench 2006). Alternatively, I support a hypothesis that the fonios are later secondary domesticates, taken into cultivation to complement rice, pearl millet and sorghum as risk-buffering crops for poor and shallow soils plausibly in more than one time and place. The fonio millets may have been taken up secondarily, probably more than once, to suit the more marginal agricultural conditions across the West African savannas and to help expand grain crop production as population centres grew. In this model, the evidence for fonio in the Seno plain and Sadia, but also in Dendi and Ségou region may be seen as a local development of cultivation at the interstices of established pearl millet agriculture and early rice expansion along the Inland Niger Delta. Fonio appears to be a later addition to agriculture in West Africa that helped to diversify agricultural production and therefore buffer against failures that might affect an agricultural mono-culture.

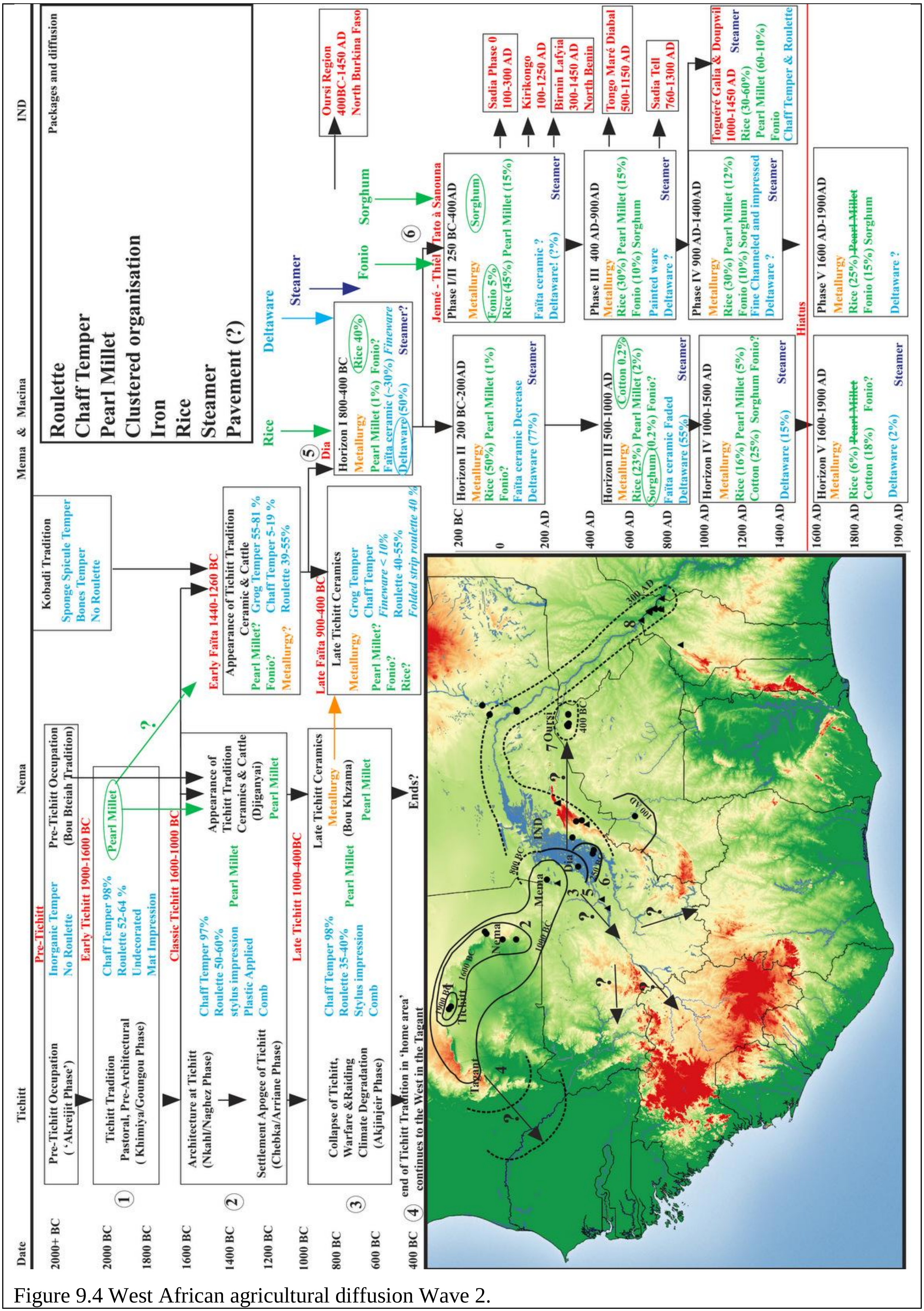


Figure 9.4 West African agricultural diffusion Wave 2.

Wave 3 Cotton, Islam and Hierarchy (1200-1800 AD)

Hierarchical package	**Diffusion wave**
- Cotton - Tran-Saharan trade - Slaves - Military caste - Defensive site (Walls, ditches) - Local elites	From the Arabic world via two roads (oasis and Sahelian) via Essouk and Gao (and others) to the Niger river Basin but also quickly reached Senegal and Gambia

This third wave is associated with the introduction of strongly hierarchical military groups (e.g. Songhay). Most of the previous Niger River Basin sites were destroyed or abandoned (e.g. Sorotomo & Togu) for the profit of new settlements. The case of Jenné-jeno and Dia are good illustrations, former settlements destroyed and new settlements rebuilt around a mosque. So far the reasons for the abandonment of these former sites remain unknown. Different hypotheses have been posited: climatic change, wars, or even plague events. Looking at the climatic record, the area suffered much greater significant temperature and precipitation variation between 500 AD and 1300 AD when compared with the period from 1300 to 1500 AD. The plague hypothesis lacks any direct evidence and rests largely on the timing of known plague events in Europe. Indeed, this can be seen as a form of Euro-centric bias i.e. as the plague was in Europe by that time why not also in Africa at the same time. Despite trade links with the Mediterranean across the Sahara, this seems unlikely to have allowed the easy transmission of rats and their fleas to the same extent as established maritime routes and caravans along the Silk Road.

Instead, I would suggest that the large abandonment phase that occurred during wave 3 was due to new ideals of living and thinking bought about by the arrival of these newcomers, and their ideas (about religion and hierarchy). These new ways of life, included Islam and an enlarged and a much increased slave trade, associated with high levels of violence, increased conflict and unrest. Thus former villages might become subject to raiding by slavers and its inhabitants enslaved, or to general raiding as a result of unrest. Further it is probable that the inhabitants of some villages under such conditions might convert to Islam and move into larger urban settlements. During that period much of the ethnic group names changed to more Islam-related name (e.g. the Marka, the Bambara) and former castes and craft groups were renamed Nyamakalaw.

The archaeobotanical marker of this phase is the widespread appearance of cotton (Map in Figure 8.18). Every site that had evidence of cotton, however, was short-lived and these sites were abandoned or destroyed quite quickly, suggesting that these new crafts and economic specializations did not bring social stability. One the reasons cotton is of particular interest is that it is a “cash crop” par excellence. By *cash crop*, we follow the definition of Sherratt (1999), which does not require a monetary economy, but rather means that a crop is grown primarily for turning it into a trade commodity rather than for community subsistence. Unlike most annual seed crops, which are primarily caloric foods for people or livestock, cotton is primarily grown as a raw material. It is crop which requires careful attention to its environmental needs and beyond cultivation requires substantial labour investment for processing (ginning, combing, spinning, and weaving). Thus, investment in cotton implies both surplus land (removed from the needs for subsistence crops) and surplus labour. When cotton appears in the archaeological record it implies a certain level of social complexity and long-distance trade, and thus a more diversified agricultural system, as argued for spread of cotton in the Indian subcontinent (Fuller 2008) and implied by this syntheses on the Niger River basin.

This third wave 3 was shortly followed by wave 4 and the arrival of more new incomers, European traders, which once again quickly impacted the organisation of the area.

Wave 4 Peanuts, Atlantic trade and Europe (1600AD-1900AD)

Hierarchical package	**Diffusion wave**
- Atlantic trade - Slaves - New world and Asian crops - Taxation system - Market gardening	The dynamics of the area change to profits of westward trade routes from the Atlantic coast. As with wave 3 the main trade object was the acquisition of slaves.

This wave is more evident near coastal sites than inland sites. However, very few excavations of post-European settlement sites have been undertaken. Nevertheless, the sites in north Benin dated to 1700-1900 AD do not show evidence of any new world crops. More generally, the late period from 1500 AD onwards remains poorly documented in terms of archaeology (Map 7 in Chapter 7). **Wave 3** is followed by European trans-Atlantic traders whose main focus was on the slave trade. **Wave 4** is marked by a dynamic change from trans-Saharan trade to trans-Atlantic trade. In terms of archaeobotany, this is evident with the appearance of American crops (e.g. peanut, maize) and Asian rice introduction.

Today, in many regions, African rice (*Oryza glaberrima*) is being replaced by the Asian species (*Oryza sativa*), introduced to Africa around the middle of the 16th century AD by the Portuguese (Linares 2002). In addition, in a few areas, there are hybrids between *O. glaberrima* and Asian *O. sativa* that are cultivated (Nuitjen et al. 2009). In some regions as African rice has declined, it remains a minor crop of ritual importance, for example amongst the Jipalom in Senegal (Linares 2002) and the Jolas of Guinea-Bissau (Davidson 2015). Nevertheless, in the context of Niger river urbanization, the potential for rice to produce very high yields and to provide a new range of cooked foods may have contributed to its increasing popularity, as it was both high productive in some areas, but also as it plausibly supplied a new luxury food that helped mark social differentiation from the ubiquitous and "common" pearl millet.

It is also during this wave 4 that market gardening appears for the first time. The oldest record of market gardening in the Dendi (Benin) area is dated to the 1980s. However, in West Africa its roots likely stretch back further. For example in Mali it began with the French colonisation, where the origin of such gardening can mainly be attributed to the levying of taxes by the French colonial administration and the need for cash resources.

Also in Mali, in Dogon country, most payments were originally done in millet grain, mainly in the form of beer; however, with the arrival of foreign taxes local people were forced to develop new practices to obtain cash currency. Thus, the market gardening was born. Indeed, most of the products were directly sold to the local market in exchange for money used to directly pay French taxes (Bouju 1984). Today market gardens still remain the main source of cash income revenue for women in Dendi, and within most of the Sahelian region.

Wave 0 Back to the beginning: Pearl Millet origin discussion (6500-2500 BC)

Central Saharan Herder package	**Diffusion wave**
- Cattle burials - Pearl millet domestication process (including non-shattering) - Mineral-tempered pottery	From Central Sahara to: - Tilemsi (!) - Tichitt (?) - Chad lake area (?) - Nok area (?) - Central Sudan and India (?)

Pearl millet domestication can be inferred to have taken place in the later mid Holocene, as the Sahara expanded and as pastoralism spread throughout the Sahara. Data from the Tilemsi valley in Mali, 2500-2000 BC, and from the Tichitt archaeological tradition in Mauretania, 2000-1300 BC, provide evidence that marks the end of the domestication episode in this species (Manning and Fuller 2014; Burgarella et al 2018). Following other known cereal domestications presumably cultivation and the evolution of non-shattering had begun some 1000-3000 years earlier. Nevertheless, the association of the earliest domesticated finds with pastoralism is clear, and this suggests that pearl millet domestication may have taken place amongst forager-pastoralists. Of importance may be that pearl millet constitutes a poor food species (van Wyk & van Oudtshoorn 1999), and one in which the grains are protected from grazers by a bristly inflorescence. This represents a contrast to *Sorghum* spp., which makes excellent fodder (e.g. Snowden 1955). Thus livestock would have been detrimental to early sorghum cultivation in contrast to pearl millet cultivation that had inherent protection from overgrazing (Winchell et al 2018). Along similar lines, Mercuri et al (2018) has suggested that early cultivated millets of the Central Sahara (Libya), such as *Echinochloa colona* and *Panicum laetum*, lent themselves to cultivation because of weedy traits such as resilience to animal grazing.

The presence of pastoralist groups is well attested in the central Sahara since at least 8000-5000 BC and during the third millennium BC, the south edge of the actual Sahara was progressively populated by central Saharan herders and foragers (e.g. Sawchuk et al. 2018, di Lernia 2001, 2006, di Lernia et al. 2013, Roset 1987). As proposed by Fiona

Marshall and Elisabeth Hildebrand (2002), these mobile foragers and pastoralists moved with domesticated cattle and small livestock without any domesticated plants. These sites are characterized by the presence of cattle burials and were occupied by seasonal herders that followed the seasonal movements of the still green Sahara. Like in the Messak region (5200-4800 BC, Libya) where the "[…] *Middle Pastoral human groups settled along the lake shores of the Edeyen of Murzuq during the rainy season, moved with the arrival of the dry months towards the higher and water-richer areas of the Messak plateau"* (di Lernia et al 2013:25). The situation was potentially similar between Tenere and Aïr-Hoggar and in other Saharan massif (Roset 1987, di Lernia 2001, 2006, Paris 2000). The cattle burials are represented by constructed monuments, often in stone, associated with stone tools and potsherds. They are sometimes reopened or revitalized generation after generation (di Lernia et al. 2013, di Lernia 2001, 2006, Roset 1987). Thus far, they have been interpreted as a cattle ritual (i.e. associated with transhumance) which happens around May. However, I proposed that they are perhaps better understood as a ritual associated with both transhumance and early sowing.

For Goody a ritual is '*a category of standardized behaviour [custom] in which the relationship between the means and the end is not "intrinsic" i.e. is either irrational or non-rational'.* For Sawchuk et al. 2018, *"Because ritual life and social networks maybe harder to "see" archaeologically, we must carefully consider the role of burial grounds and other enduring features within the broader context of ancient societies".* Also, as stated by Paris (2000:114) « *The Bos inhumations are the ones most likely to be linked to a ritual but it is not possible to affirm whether this ritual concerns the Bos itself, like the Egyptian bull tombs, or whether they were an offering to a separate individual or entity".* And for Dieterlen (1950:359) "*Cultures rituals (sowing, growing, weeding, harvests, storage in granary) operate parallel with birth and death rituals, serial of transfers and withdrawals of water's soul".*

For herders in the early stages of cultivation, a metaphorical link between seed and bovine was enshrined in the earth; a foundation sacrifice of the yearly cycles of renewal. Sowing millet under the symbolic shielding of the cattle burial is likely projecting vegetable and animal yearly cycle renaissance through the same earthly passage. It is coupling same timings independently of space and places. Thus, this ritual took the well-established cattle herd reproduction and linked it with the nascent secondary agricultural cycle, thereby metaphorically entangling and combining the two traditions.

"*Archaeobotanical data indicate–at least for the* [cattle burial] *monuments analysed–the performing of the rituals at the very end of the dry season: sorrels and many daises bloom in winter and spring, and we may indicate April/May (for the overlap of the flowering of Asteraceae and the fructification of Rumex), as an approximate time frame. Presence of fruits and total lack of Rumex pollen in the samples studied also indicates the end of its blooming season (late spring) … One floret of Pennisetum* sp. [presumably wild] *has been found."* (di Lernia et al. 2013:25).

Late spring is the ideal period for sowing pearl millet, indeed it can germinate in approximately two days after the first rain, but then requires further rains, to avoid withering during its deep rooting phase. Pearl millet agriculture's most hazardous and perilous phase is during this first growth, when there is a chance that the rains sufficient for the desert's daises ephemeral bloom will be insufficient to allow the pearl millet crop to establish its essential deep rooting system. In this sense, the presence of stone tools in the cattle burials, so far interpreted as stone maces for animal butchering (Figure 9.5), could be seen instead as billhooks or sickles for the harvesting of pearl millet spikes. In such early agriculture of pearl millet, lithic hoes or weeding tools may not have been necessary, but cutting tools for the harvesting of ripening spikes may have been useful and possibly could have played a role in the selection of non-shattering involucres. These tools may have functioned as something between a small axe and a sickle (Fig. 9.5).

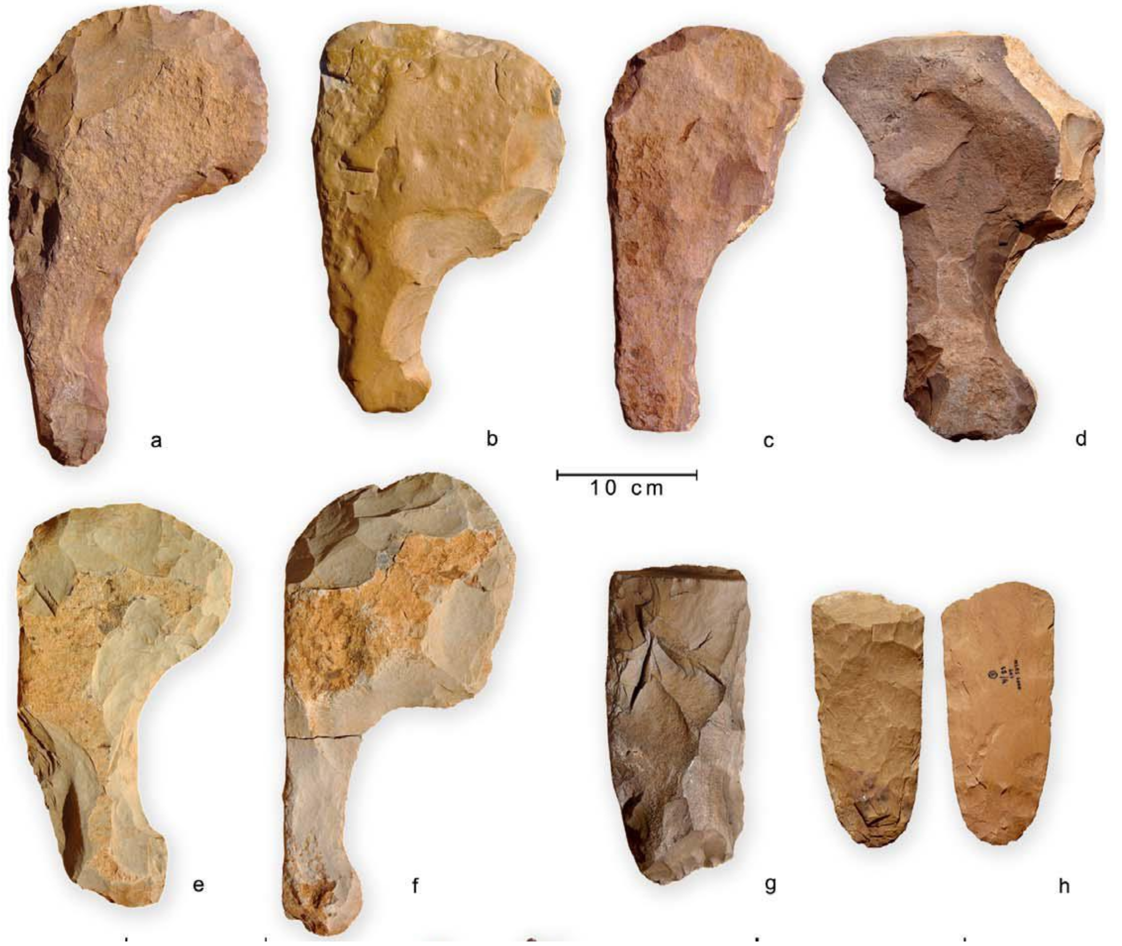


Figure 9.5 Archaeological materials from cattle burials excavated in the Messak area. Selection of stone maces or sickles/billhook (a–f) and other stone tools (gouges, g). (di Lernia et al. 2013: 11, fig. 6)

Scholars have debated why millet stalks (pearl millet or sorghum) are so tough and leathery to the point that the harvesting of their non-shattering cultigen forms required the use of iron tools. Nevertheless, domesticated pearl millet evolved and persisted for several millennia in the Late Stone Axe. If cattle burials were connected to early pearl millet sowing rituals, herders would likely not have loaded themselves down with specialized hacking tools during periods of transhumance, and so they might have hidden them near the sown fields, such as safely placed with known locations of cattle burials. In this reinterpretation and working hypothesis, these tools are reinterpreted as early millet harvest tools rather than for cattle butchering. Di Lernia (2006) points to a similar interpretation by contrasting the *‘**heavily used** concave blade’ with a ‘**very scarcely used** ‘convex cutting edge for axillary usage’*. In one case, Site 301, located on the wadi Tin Einessnis, [Libya], the stone tumulus included *“Two big stone axes were also found, likely related to a ritual deposition. According to a wear traces study (made by C. Lemorini), the artefacts show a strong unbalance in use between the handle* *(heavily used) and the cutting edge (very scarcely used), indicating rejuvenation immediately before its abandonment in the stone monument"* (di Lernia 2006: 56-57). Thus, the central Saharan massif represents one possibly location for pearl millet domestication by pastoral groups who were sowing and cultivating the millet around May, with associated ritual celebrations and cattle burials in these Central Saharan plateaus (Hoggar, Messak, Aïr…).

In order to follow the changing climatic conditions associated with the aridification of the Green Sahara occupational phase (wave 0) is followed by a slow migration towards the southern edge of the Sahara to locations such as the Tilemsi valley. Cattle burial rituals were carried with these groups. As Manning (2011) notes: *"In Lower Tilemsi site KN05 a fully articulated juvenile cow was discovered in the primary occupation levels. A complete absence of cut marks, and lack of any burning suggests the animal was not butchered prior to burial. A set of post-holes surrounding the pit also reveals an associated wooden structure… A high number of disarticulated cattle remains and abundance of fish remains suggest it may have been used in association with the burial feature, possibly as a feasting pit… goats and sheep present across all the sites are absent in the primary occupation level at KN05, notably in the subterranean pit where cattle and fish dominate… the two AMS dates from this feature and the single date from the associated burial are predating the overlying deposit* [2500BC] *by c. 100 years"*. Cattle burial traditions that were established in the Saharan highlands by 4000BC arrived in the Tilemsi ca. 2500BC and at the Tichitt and Nema sites (DN4, DN40, DN50) dated to 1520-1440 BC (Manning 2011, Person et al. 2012).

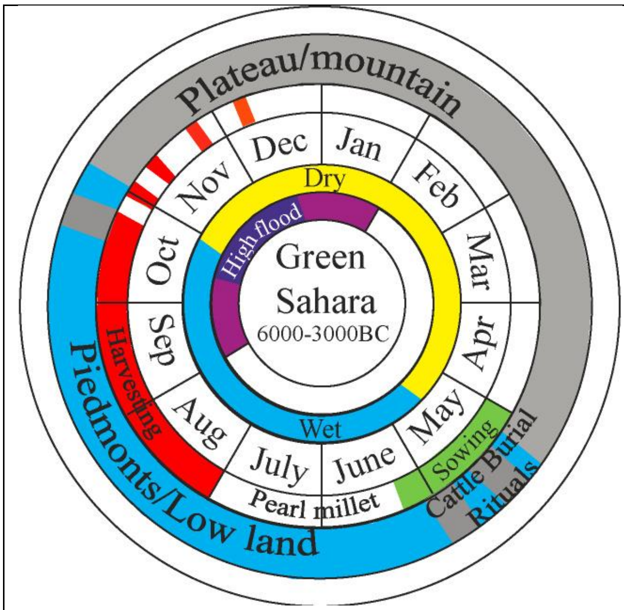


Figure 9.6 Seasonality for Pastoralist groups in the Central Sahara from 6000 BC to 3000 BC. (After di Lernia 2001,2006, di Lernia et al. 2013, Roset 1987, Paris 2000)

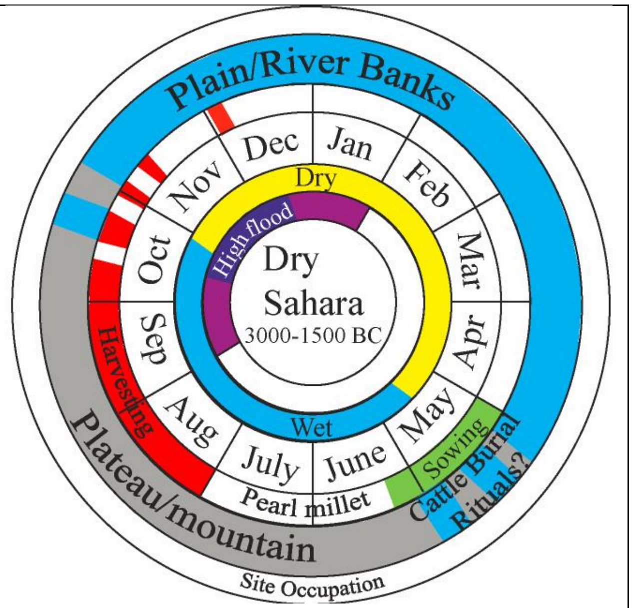


Figure 9.7 Seasonality for Pastoralist groups in the South Saharan edge from 3000 BC to 1500 BC.

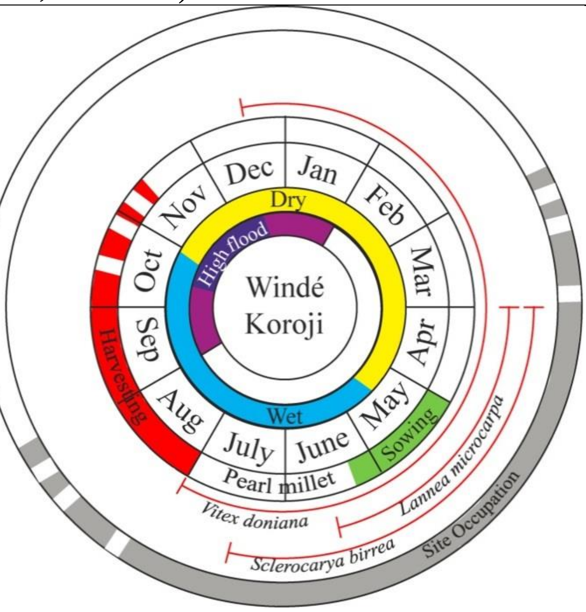


Figure 9.8 Seasonality and site occupation at Windé Koroji

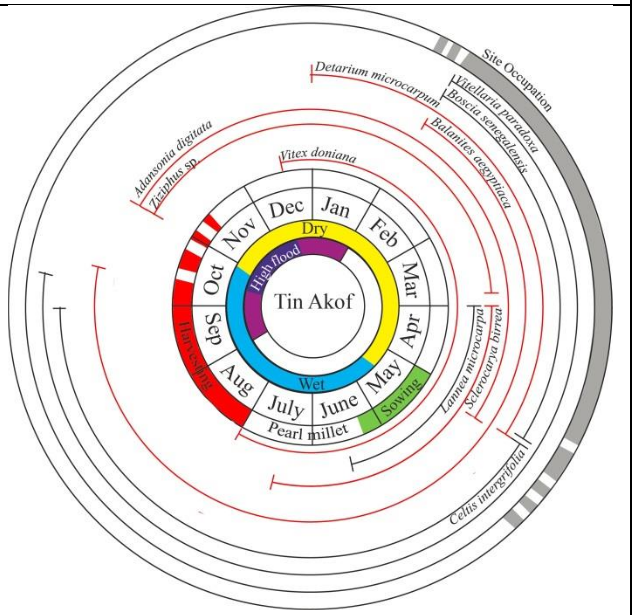


Figure 9.9 Seasonality and site occupation at Tin Akof (After Kahlheber 2002)

The dispersal of pastoralist and cultivator groups out of the Sahara involved new adaptations in terms of seasonal cycles relating to subsistence activities (Fig. 9.6, 9.7, 9.8, 9.9). As groups moved south, wet season transhumance probably became more frequent in more upland zones, and involved their retreating in the dry season to well-watered river valleys in the Sahel. Manning (2011) suggests that such areas would likely have been clear of tsetse during the dry season, at Tilemsi, 2500 BC (Manning 2011), as well as at Tichitt, 2000BC (Person 2012). Fish assemblages attest to both shallow and deep water fishing (Manning 2010, 2014), and thus conditions were comparable to parts of the Niger River valley today. Dry warm levees are and were likely to have been in the past excellent places for seeding pearl millet with minimal labour input after the dry season, just before the herds' departure for monsoon transhumance in the hills. This represents an inversion of the upland-lowland transhumance that has been inferred for the earlier Sahara with herds pastured in hills during the rainy season and along rivers and ponds during the dry season With a subset of society presumably focused more intensively on lowland pearl millet farming during the wet season. In the earlier Sahara, pearl millet may have growing massifs largely during the herders' absence; later in the Tilemsi as domesticated millet and more developed agricultural economies emerged, as well as having more permanent settlements, cultivation and herding became increasing specialized. The herders and cultivators in turn developed a symbiosis with the existing fishing focused societies, such as the Tiabel Goudiodié fishers site dated to 2000-2500 BC or also the Kobadi fisher folks (Togola and Raimbault 1991, MacDonald 1996).

In the Neolithic symbiosis is the potential original source of this kind of symbiosis that persisted amongst the fishers and herders, such as the Bozo/Nono and the Fulani.

Conclusion

> *The great conceptual importance of the limit cycle comes from its 'ergodicity'. Whatever the initial conditions, the final state is always described by the same periodic trajectory…. The same effects responsible for the occurrence of periodic trajectories such as limit cycles can also under almost identical conditions induce spatial pattern when diffusion is taken into account.* - Y. Prigogine and P. Glansdorf (1971)

This thesis has attempted to trace the unfolding trajectory of economies and societies in western Africa, particularly in the greater Niger Basin, from the existing archaeological evidence starting with the initial conditions of the first pastoralists that began to manage pearl millet in the middle Holocene Sahara. While annual seasonal cycles and subsistence constraints were similar across a wide geographical zone, a number of parallel trajectories unfolded as cultivation, domestication, agriculture and agro-pastoralism were established and spread. With the growth and spread of agriculture was an associated increase in population densities that facilitated and promoted the emergence of urban centres and later cities in some areas.

In very general terms, we can infer that herders, following a southward shift in the inter-tropical convergence zone over the millennia at the end of the Middle Holocene, arrived at this patchy Sahel-Sahara border, relocating their winter settlements near water sources or on piedmonts and began long-term interactions with pre-existing hunter-gather or herders societies that were reliant on fishing in the area. From these interactions emerged simultaneously pearl millet staple agriculture and chaff tempered pottery traditions. Within a few centuries more sedentary settlements emerged, and self-organizing processes created heterachical structures integrating farmers, herders, hunters, fishers, and hunter-gathers, each more or less specialized in their niche by lineage and 'ethnicity', and sometimes by sex or by age. These settlements continued to grow, cluster, and spread throughout the Central West Savannah during the Late Stone Age (wave 1), with a high predominance of pearl millet farming (*Pennisetum glaucum*), and some limited intercropping in some areas with cowpea (*Vigna unguiculata*). Archaeological and archaeobotanical visibility declined in the first half of the first millennium BC. In a second wave (wave 2) sedentary sites re-emerged in the late first millennium BC, boosted by new iron-working technology, especially taking advantage of lateritic ores in those geographic zones that had fewer good lithic sources for stone tools. In this era agriculture diversified, including the addition of new indigenous cultigens like rice and fonio, in addition to introduced and an imported crops as sorghum. This era was marked by resilient, heterachical social structures and large, clustered urban sites that persisted for ~1700 years (Fig. 9.8). In this context agricultural innovations were numerous but also the reliability on traditional patterns of subsistence established in the Neolithic (pearl millet, pastoralism, and fishing) persisted. This period only came to an end with the imposition of strongly hierarchical societies, such as the Songhay and Segou, which emerged under the general influence of Islam and trans-Saharan trade around 1400-1500 AD.

Archaeological evidence first suggested than Jenné-jeno was the earliest site to rise (around 250 BC) and was followed later (400 AD) by clustering around Jenné-jeno of several large, intermediate and small sites in the vicinity. As a consequence, Jenné was interpreted as the market centre around which clustering organically (as per the McIntosh, heterachy interpretation) emerged. However, recent excavations at the sites of Thiél and tato à Sanouna, have suggested that Jenné was not the earliest site within this grouping. Both sites' foundations are dated to ca. 250 BC, like Jenné, and the material culture remains, in the ceramics, burials, houses or food remains do not show any differences with those found at Jenné. This seems to indicate that the region was not organised around a single central market, but rather represents a more densely populated region that was structured in community clusters. All of the sites shared the same material culture and evidence of some shared food practises, thus suggesting a shared cultural milieu, even if there might have been some ethnic diversity between settlements. To date, nothing so far indicates any clear hierarchical organisation at the beginning of this urbanization period. Therefore, this cluster of sites would appear to be a strong candidate for the heterachical process of urbanization.

This trajectory of social change differs from the pattern known from other world regions, such as the Near Eastern trajectory that informed Gordon Childe's (1950) understanding of urbanisation (Maisels 1998), in which the accumulation and control of staple surplus and land to produce that surplus was fundamental to hierarchical social structures. This West African "exception" to "the rules" of social evolution led to the astonishment of R. McIntosh (2005: 152) that the « *Middle Niger should be a morass of inter-ethnic hostility"* but yet it is not.

These ancient supra-regional agencies, theoretically regarded as endogamic, have been diplomatically and ambiguously termed Nyamakalà, since the 13th century AD (Tamari 1995), in the high epoch of the Mande, and represent a subtle resistance to Islamic male hierarchies. These ancient agencies were supra-regional, focused neither on herds nor crops, but on transforming raw materiality into products (pots, iron) and thus falling outside the strict urban hierarchies with a king as the head and slave labour at the base. They have been further reduced in terms of the conceptualisation to the Medieval Ethnic Corporation within the western conceptualisation. Thus this has led to a gender imbalance in our interpretations, in which the free women's corporations, prevalent as matrimonial agencies for/of women, have tended to be overshadowed in Western academic interpretations by their husbands' more market-oriented activities, and their associated corporations in recent centuries.

The West African Iron Age polities are good examples of the variety of alternative developmental processes, and represent a spectrum of urbanisation trajectories. At one end of the spectrum are cases of African urbanization where coercive hierarchies emerged (e.g. Egypt, Meroe), and others where heterachical processes were at the origin of the main polities, including possible examples from West Africa (e.g. Jenné-jeno). Even so, some hierarchical systems were more prone to segmentation and fragmentation, such as Meroitic Sudan, than others and where power seems to have worked through interpersonal relationships of tribute and gift exchange rather than bureaucratic hierarchies (e.g. Edwards 1996; 1998; Fuller 2003). In such cases regional differences in agriculture may have fostered integration in some periods via regional complementarity (such as Meroitic North and South), while agricultural innovations could have promoted separation and regional independence (Fuller 2014). Heterachical systems may also achieve periods of integration over wider areas, such as Classic to Late Tichitt in Mauretania (1500-600 BC) or the Inland Niger Delta (including Jenné-jeno and Dia), from ca. 250 BC-ca. 1400 AD. In the Tichitt case this was based largely on only pearl millet cultivation together with pastoralism, fishing and the emergence of Iron Working. In later IND case, we witness a phase agricultural diversification with a wide range of crops from highly productive rice and sorghum to crops like fonio augmenting pearl millet, pastoralism and fishing. Interestingly, some specialized communities focused on iron production in this period (e.g. Tongo Maaré Diabal, Oursi, Pekinga, Kantoro) remain focused on the reliable, less demanding pearl millet cultivation, with innovation focused solely on craft production. It was only after ca. 1400 AD, with the destruction of Sorotomo and Togu Missiri, when there clear evidence for the founding of cities (e.g. Segou) and new states based upon coercion and well-structured hierarchy. This new phase of hierarchical societies took advantage of recently established production of cotton, a key fibre crop for commodity production and wealth generation in the Islamic period.

Perspectives and general conclusions

While narratives of the spread of agriculture are central to interpretation of African history, hard evidence of past crops and cultivation practices are few and far between. The new data analyzed here contribute to the major aim of filling in the broader patterns of agricultural evolution in West Africa. Currently, the available data comes from less than 100 archaeological sites and this research offers results from 19 of them, increasing the number of West African sites with archaeobotanical data by 20%. While these data allow us to begin to summarize the distinct, but inter-related histories, of agriculture and crop-use across the major biomes of West Africa there is still much that awaits further investigation and still much to be discovered.

By plotting every available site on a map (Figure 9.10), it becomes evident how little geographical area these 100 sites cover on a scale as large as West Africa. However, they have within this thesis provided a basis that allows us to define nine main areas of potential future research (Figure 9.10). While each area is interconnected they all have the potential to answer some specific questions concerning the domestication, spread and use of crops in West Africa.

Exploration of the Mauritanian and Malian Sahara region (**Region A** in Fig 9.10) would certainly provide answers on the areas of domestication of pearl millet and its subsequent diffusion. That is especially true to our understanding of the link (if a true link there is) between the areas of the Tilemsi and Tichitt (Wave 0 or Wave 1 in figure 9.1 and 9.2), and could probably contribute to and potentially confirm the genetics hypotheses presented in chapter 8. This region could also provide new evidence on the African rice domestication.

In term of archaeobotany, the Niger (**Region B** in fig 9.10) is still totally unknown. Further work in this region has the potential to give us evidence about pearl millet diffusion from the Sahara (Wave 0 in Fig 9.1) and also insights into a possible secondary pearl millet domestication zone. Further, the south of Region B, the Niger River Valley, is an important area for the diffusion of African rice around the beginning of our era.

With the exceptions of sites around Lake Chad and within the Nok area, most of Nigeria (**Region C** in fig 9.10) still awaits to be studied archaeobotanically. As with Region B, the exploration of this region will provide us not only with information on the diffusion of pearl millet, but also on more recent (early first millennium AD) crop domestications, diversifications and diffusions, such as fonio (*Digitaria exilis*) and in particular black fonio (*Digitaria iburua*). With the center of Region C, **Region D (**The Atacora Mountains in Benin and Togo) is the only one where black fonio is still cultivated today and by consequence can therefore inform us on the importance and potential origin of black fonio.

Region E (Burkina Faso, Ivory Coast and North West Ghana) is an interesting and large region, where each new archaeobotanical study can bring new data which will contribute to our knowledge of pearl millet diffusion (Wave 1 in Fig 9.1 and 9.4), and on the agricultural diversification (Fonio, African rice, etc.) that has been recorded during Wave 2 (400BC-1300AD), and also about the diffusion of cotton within West Africa (Wave 3).

The small **Region F**, the Mema region, is an important area to understand the dynamics between the Tichitt area and the Inland Niger Delta, especially during the pearl millet diffusion in Wave 1 (Figure 9.1 and 9.2) and could eventually provide some general information on the domestication of African rice.

Region G is also an area where additional data would allow us to further explore the connections between the Tichitt and Senegal River Valley where pearl millet appeared around 400 BC.

Linguistic, genetic and botanical studies show that **Region H** (centered on the Guinean High Plateau) was an important area for agricultural diversification (Fonio and African rice specific and unique varieties) in the past, and as with the other regions any new archaeobotanical study can help us in the understanding of the more general picture of the West African agricultural past.

And last but not least the coastal area (**Region I**) which still awaits exploration from an archaeobotanical perspective, which potentially will give us more information on the introduction of American crops (Wave 4) and on the diversification of African rice and the adaptation and emergence of tidal varieties.

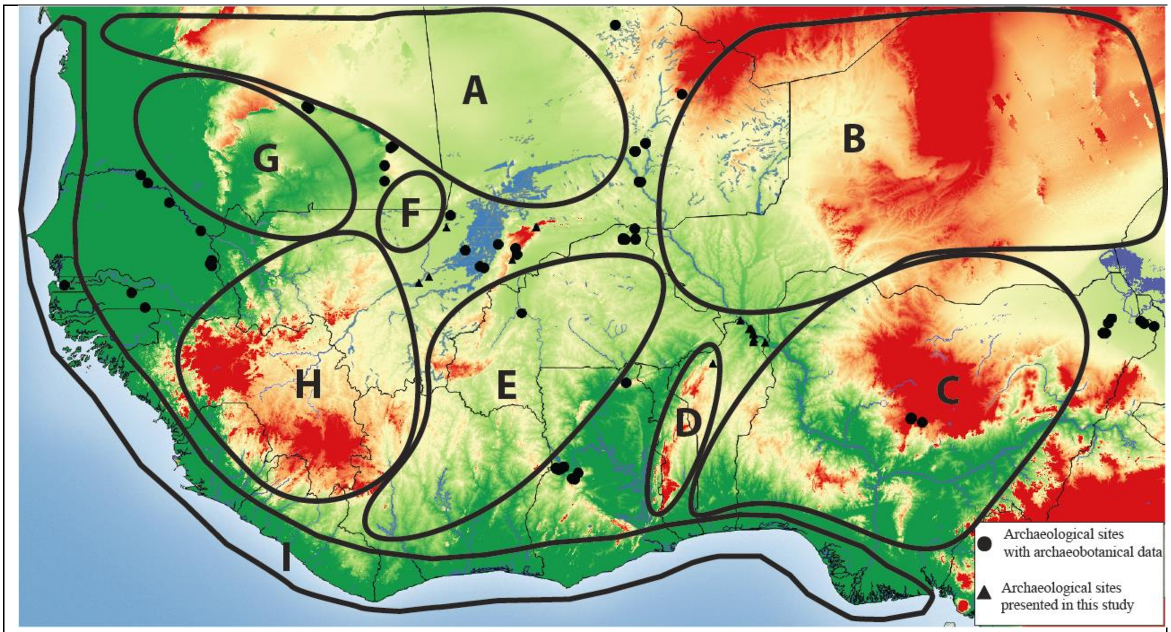


Figure 9.10 Potential areas for future archaeobotanical researches in West Africa.

Within the preceding sections I have presented only the main questions that each region could eventually answer, but it is certain that with more data, both more integrate and perhaps more regionally specific questions will be developed. Thus while this PhD with around 20% of new sites, has contributed greatly to our knowledge of the West African agricultural past there is still much that within West African archaeobotany remains unknown.

As a general conclusion, while this Ph.D. often raises as many questions as it has answered it demonstrates that archaeobotany is very much possible in tropic and sub-tropical West Africa and that it offers great potential for further research in this field. However, such potential can only be achieved through sampling for surviving plant material during archaeological excavations. As such I would really hope that future archaeological projects will take archaeobotanical studies more in consideration than has previously been the case.

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Appendix

Appendix A : Sorotomo macro-botanical remains.

Sorotomo (n=27)	Phase		Context		Context type	Volume (litres)	Indet seed	*Pennisetum glaucum*			*Oryza glaberrima*			*Sorghum bicolor*			*Digitaria exilis*	*Vigna unguiculata*	*Gossypium sp.*	*Eleusina indica*	Poaceae	Tree and Bushes	*Sclerocarya birrea*	*Adansonia digitata*	Nisp by Sample
								Total	*Grain*	*Bristle*	*Total*	*Grain*	*Spikelet*	*Total*	*Grain*	*Involucre*									
Sortomo Phase III (n=20)	III	15th	BC (8)	from P11	pot	14	0	0			0			0				0	0	0	0			0	0
	III	15th	B (2)	from P1	pot	14	0	0			0			0				0	1	0	0			0	1
	III	15th	BC (22)	from P28	pot	14	0	0			0			0				0	0	0	0			1	1
	III	15th	BC (8)	from P5	pot	14	0	0			3	2	1	0			4	0	1	0	1			0	9
	III	15th	BC (19)	from P17	pot	14	0	1		1	0			0			5	0	2	0	0			2	10
	III	15th	BC (19)	from P21	pot	14	0	2		2	0			0			2	0	5	0	0			1	10
	III	15th	BC (19)	from P19	pot	14	0	4	1	3	1		1	1		1		0	5	0	0			1	11
	III	15th	BC (19)	from P18	pot	14	0	6	5	1	1		1	0			5	0	2	0	1			2	12
	III	15th	BC (19)	from P20	pot	14	1	0			0			0			6	0	2	0	1			2	12
	III	15th	BC (8)	from P3	pot	14	5	2	1	1	1		1	1		1	2	0	3	0	1			0	14
	III	15th	BC (19)	from P16	pot	14	0	3	1	2	2		2	0			4	0	3	1	2			0	14
	III	15th	BC (22)	from P13	pot	14	10	0			0			0			5	0	3	0	4			0	22
	III	15th	BC (22)	from P26	pot	14	10	0			0			0				0	2	0	10			0	22
	III	15th	BC (8)	from P2	pot	14	0	2		2	2		2	0			7	0	3	0	5			5	24
	III	15th	BC (27)	from P29	pot	14	0	1	1		2		2	1			16	0	2	1	5			1	28
	III	15th	BCS (37)	from P33	pot	14	0	7	2	5	0			0			15	0	7	0	1			1	29
	III	15th	BC (8)	from P6	pot	14	0	10		10	3		3	0			9	0	5	0	3			5	35
	III	15th	BC (19)	from P15	pot	14	0	41	6	35	4		4	2	1	1	15	0	4	0	0			0	60
	III	15th	BE (27)	from P36	pot	14	0	2		2	2		2	0			214	0	2	0	0			2	222
	III	15th	BE (22)		pit	20	10	20	15	5	19	1	18	18	18		575	5	39	2	3			20	696
Nisp Phase III						**286**	**36**	**101**	**32**	**69**	**40**	**3**	**37**	**23**	**19**	**3**	**884**	**5**	**91**	**4**	**37**	**0**	**0**	**43**	**1232**
Frequency Phase III (%)							**2.9**	**8.198**	**2.6**	**5.6**	**3.2**	**0.2**	**3**	**1.87**	**1.5**	**0.2**	**71.8**	**0.4**	**7.39**	**0**	**3**	**0**	**0**	**3.49**	**100**
Sorotomo Phase II (n=4)	II	14th	A (15)		midden	0.1	0	0			0							0	0	0	0			0	0
	II	14th	A (23)		ashy	0.1	2	0			0			0				0	0	0	0			0	2
	II	14th	A (22)		hearth	10	0	1		1	1		1	0			3	0	2	0	6			0	13
	II	14th	A (16)		midden	10	0	6	2	4	7		7	2	2		29	0	7	0	3			5	57
Nisp Phase II						**20.2**	**2**	**7**	**2**	**5**	**8**	**0**	**8**	**2**	**2**	**0**	**32**	**0**	**9**	**0**	**9**	**0**	**0**	**5**	**72**
Frequency Phase II (%)							**2.8**	**9.722**	**2.8**	**6.9**	**11**	**0**	**11**	**2.78**	**2.8**	**0**	**44.4**	**0**	**12.5**	**0**	**13**	**0**	**0**	**6.944**	**100**
Sorotomo Phase I (n=3)	I	13th	A (35)		posthole	10	0	0			0			0				0	1	0	0			0	1
	I	13th	A (31)		hearth	10	1	0			0			0				0	1	0	0			3	5
	I	13th	BE (35)		burnt earth	10	0	64	12	52	9		9	13	5	8	50	2	9	0	7		3	5	150
Nisp Phase I						**30**	**1**	**64**	**12**	**52**	**9**	**0**	**9**	**13**	**5**	**8**	**50**	**2**	**11**	**0**	**7**	**0**	**3**	**8**	**156**
Frequency Phase I (%)							**0.6**	**41.03**	**7.7**	**33**	**5.8**	**0**	**5.8**	**8.33**	**3.2**	**5.1**	**32.1**	**1.3**	**7.05**	**0**	**4.5**	**0**	**1.92**	**5.128**	**100**
Nisp total						336	39	172	46	126	57	3	54	38	26	11	966	7	111	4	53	0	3	56	1457
Frequency total (%)							2.7	11.81	3.2	8.6	3.9	0.2	3.7	2.61	1.8	0.8	66.3	0.5	7.62	0	3.6	0	0.21	3.844	100

Appendix B: Togu macro-botanical remains.

Togu (n=12)	Phase	Context		Volume (litres)	Indet seeds frag.	Indet TypeR	Indet seed	*Pennisetum glaucum*			*Sorghum bicolor*			*Digitaria exilis*	*Vigna unguiculata*	*Vigna subterranea*	CF. *Vigna unguiculata*	*Gossypium*	*wild digitaria*	*Echinochloa sp.*	*Paspalum*	**Tree and Bushes**	*Lannea microcarpa*	*Sclerocarya birrea*	*Adansonia digitata*	*Ziziphus sp.*	*Vitellaria paradoxa*	*Celtis intergrifolia*	CF. *Vitex doniana*	*indet fruit*	TOTAL
								total	*grain*	*Bristle*	Total	*grain*	*involucre*																		
Togu Phase B (n=5)	B	A5	flot	5	2			0			0			1				0				0									3
	B	A5	Vase 2	5	3		2	4	2	2	0			25				1		2					11		8				56
	B	A6	flot	5	2		0	5	2	3	0			7				1												1	16
	B	A10	80 cm	5				0			0			1				0							32						33
	B	A10	flot	5	5			3		3	0			24				35	1					1	1					3	73
Nisp phase B				**25**	**12**	**0**	**2**	**12**	**4**	**8**	**0**			**58**	**0**	**0**	**0**	**37**	**1**	**2**	**0**	**53**	**0**	**1**	**44**	**0**	**8**	**0**	**0**	**4**	**181**
Frequency Phase B (%)					**6.6**	**0**	**1.1**	**6.6**	**2.2**	**4.4**	**0**			**32**	**0**	**0**	**0**	**20**	**0.6**	**1.1**	**0**	**29**	**0**	**0.6**	**24**	**0**	**4.4**	**0**	**0**	**2.2**	**100**
Togu Phase C (n=3)	C	A13	pot 2	5	4		2	55	25	30	12	10	2	18										1	2			1	1		96
	C	A13	Vase 3	5	5			5	1	4	1		1	22										1	2			2			38
	C	A14	depotoir flot 3	5	5	10	4	43	7	35	22	15	7	296					5					41	8			4	2		440
Nisp phase C				**15**	**14**	**10**	**6**	**103**	**33**	**69**	**35**	**25**	**10**	**336**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**65**	**0**	**43**	**12**	**0**	**0**	**7**	**3**	**0**	**574**
Frequency Phase C (%)					**2.4**	**1.7**	**1**	**18**	**5.7**	**12**	**6.1**	**4.4**	**1.7**	**59**	**0**	**0**	**0**	**0**	**0.9**	**0**	**0**	**11**	**0**	**7.5**	**2.1**	**0**	**0**	**1.2**	**0.5**	**0**	**100**
Togu Phase D (n=4)	D	A17	depotoir	5	13		1	92	22	70	10	8	2	221			1		9		1		1	5	2	1		5	1		363
	D	A21	Vase 4	5	3		2	33	12	21	1		1	25					5					1							70
	D/E	A24	depotoir	5	13			35	15	20	2	1	1	69	1				3	2											125
	D/E	A24	flot	5				1		1	1		1		1	1															4
Nisp phase D				**20**	**29**	**0**	**3**	**161**	**49**	**112**	**14**	**9**	**5**	**315**	**2**	**1**	**1**	**0**	**17**	**2**	**1**	**16**	**1**	**6**	**2**	**1**	**0**	**5**	**1**	**0**	**562**
Frequency Phase D (%)					**5.2**	**0**	**0.5**	**29**	**8.7**	**20**	**2.5**	**1.6**	**0.9**	**56**	**0.4**	**0.2**	**0.2**	**0**	**3**	**0.4**	**0.2**	**2.8**	**0.2**	**1.1**	**0.4**	**0.2**	**0**	**0.9**	**0.2**	**0**	**100**
Nisp total TGO2					**55**	**10**	**11**	**276**	**86**	**189**	**49**	**34**	**15**	**709**	**2**	**1**	**1**	**37**	**23**	**4**	**1**	**134**	**1**	**50**	**58**	**1**	**8**	**12**	**4**	**4**	**1317**
Frequency Total TGO2 (%)					**4.2**	**0.8**	**0.8**	**21**	**6.5**	**14**	**3.7**	**2.6**	**1.1**	**54**	**0.2**	**0.1**	**0.1**	**2.8**	**1.7**	**0.3**	**0.1**	**10**	**0.1**	**3.8**	**4.4**	**0.1**	**0.6**	**0.9**	**0.3**	**0.3**	**100**

Appendix C: Akumbu macro-botanical remains

Akumbu (n=3)	**Phase**	**Context**	Indet seeds frag.	Indet seed	*Pennisetum glaucum*			*Gossypium sp.*	*Echinochloa sp.*	Poaceae	*Sclerocarya birrea*	*Ziziphus sp.*	*Plantago*	*Varia*	TOTAL
					Total	*Grain*	*Bristle*								
	1000-1300 AD	AK1 16	25	8	40	20	20	3	0	14		1	1	35	127
Nisp Phase 1000-1300 Cal AD			25	8	40	20	20	3	0	14	0	1	1	35	127
Frequency phase 1000-1300 (%)			20	6.3	31	16	16	2.4	0	11	0	0.8	0.8	28	100
	780-1000 AD	AK3 12	35	12	6	2	4		69	10	25			47	204
		AK3 20	25	8	9	3	6		12	9	37	1		34	135
Nisp Phase 780-1000 Cal AD			60	20	15	5	10	0	81	19	62	1	0	81	339
Frequency phase 780-1000 (%)			18	5.9	4.4	1.5	2.9	0	24	5.6	18	0.3	0	24	100
Nisp Total			85	28	55	25	30	3	81	33	62	2	1	116	466
Frequency Total			18	6	12	5.4	6.4	0.6	17	7.1	13	0.4	0.2	25	100

Appendix D: Windé Koroji macro-botanical remains.

WKO (n=10)	**Phases**	**Context**	**Volume (litres)**	Indet seeds frag.	*Pennisetum glaucum* grain	*Panicum* Sp.	Poaceae	CF. *Vitex doniana*	*Lannea microcarpa*	*Sclerocarya birrea*	*Legume*	CF.*Chenopodium*	CF.*Vigna unguiculata*	CF. *Diospyros mespiliformis*		Total	Indet fruit frag.
	Horizon A	8	2	1				1	3	1						*6*	8
		7	4	13	2	1		6	1		2					*12*	5
		7A														*0*	8
		7B														*0*	8
		6	6	1	3			3								*7*	10
Nisp Phase A			12	15	5	1		10	4	1	2					*38*	39
Frequency Phase A (%)				39	13	2.6	0	26	11	2.6	5.3	0	0	0		100	
	Horizon B	9	2	1												*1*	
		5	8	1	6									1		*8*	20
		4	2	1												*1*	20
		3	2													*0*	
Nisp Phase B			14	3	6									1		*10*	40
Frequency Phase B (%)				30	60	0	0	0	0	0	0	0	0	10		100	
	Horizon C	2	1	9	1	1						1	3			*15*	10
		1	1	7	5		3									*15*	30
Nisp Phase C			2	16	6	1	3					1	3			*30*	40
Frequency Phase C (%)				53	20	3.3	10					3.3	10			100	
Nisp Total			28	34	17	2	3	10	4	1	2	1	3	1		78	119
Frequency Total (%)				44	22	2.6	3.8	13	5.1	1.3	2.6	1.3	3.8	1.3		100	

Appendix E : Tongo Maaré Diabal macro-botanical remains (Phase 5 part 1)

TMD (n=114)	Test pit	Context	Volume (litres)	indet II	TMD-01	TMD-02	indet	indet I	Indet seeds frag.	Pennisetum glaucum						Sorghum bicolor			Panicum Sp.	Brachiaria/setaria	cf digitaria	Digitaria cf ciliaris	wild digitaria	Urochloa	Gramineae	Dactylacterium aegyptium	commelina sp.	Poaceae total	CF. *Vitex doniana*	Sclerocarya birrea	*Legume*	CF.Vigna unguiculata	*Cyperaceae*	*Caryophyllaceae*	*ziziphus*	*tree and shrubs*	*lamiaceae*	*malvaceae*	Total	estimation from nut frag	Indet nut frag.
										Spikelet	embryo	involucre	immature	Grain	Total	Spikelet	Grain	Total																							
Phase 5 Part 1	95 B	21	5						15			69		60	129			0							10	3		13								0			*170*		
	95 B	31	5						3			180		53	233			0			2							0								0			*238*		5
	93	32	5						27			36		13	49		1	1			2							0								0			*79*		
	93	33	5						1					1				0										0								0			*2*		
	93	34	5						1			1		15	16			0										0								0			*17*		
	96 D	13	5						18			9		25	34			0			2							0								0			*54*		
	96 D	D8 26	5						16			1		26	27		2	2			6							0								0			*51*		
	96 B	10	5				15		30	30	25	986	150	762	1953		6	6	1	59	35		35		69	25		154		5	19	2			9	14			*2416*	*5*	500
	10	unit E P7	1						1						0			0	1									1						13		0			*16*		
	10	unit F P21	1						0	0		0		0	0	0	0	0	0	0	0				0			0	0	0	0	0		0		0			*0*		
	10	Unit ? P11	1						5					3	3			0			20							0								0			*28*		
	10	Unit F P 20	1						3					1	1			0										0								0			*4*		
	10	Unit F P29	1						2					2	2		1	1			5							0								0			*10*		
	10	Unit F p 27	1						2					1	1			0										0			10					0			*13*		
	10	unit F p 24	1												0		1	1										0								0			*1*		
	10	Unit F P31	1						0	0		0		0	0	0	0	0	0	0	0				0			0	0	0	0	0		0		0			*0*		
	10	Unit F P 26	1						0	0		0		0	0	0	0	0	0	0	0				0			0	0	0	0	0		0		0			*0*		
	10	Unit GB 16	1											1	1		1	1										0								0			*2*		
	10	Unit? P20	1											1	1			0										0								0			*1*		
	95 B	10	5						5			4		10	14			0			2	1	1		10			10								0			*43*		
	95 B	8	5						1					8	8			0										0								0			*9*		
	95 B	15	5						3			16		6	22			0										0								0			*25*		
	95 B	19	5						2			2		17	19			0										0								0			*21*		
	95 B	20	5						4					10	10			0			1							0								0			*15*		6
	95 B	24	5									15		10	25			0										0								0			*25*		1
	95 B	23	5									156		75	231			0			1							0								0			*232*		
Nisp Phase 5			226	0	0	0	15	0	237	30	25	1809	150	1248	3261	0	13	13	2	59	81	1	36	1	89	28	0	179	0	15	32	2	0	14	11	26	0	0	4088	5	531
Frequency Phase 5 (%)				0	0	0	0.37	0	5.8	0.73	0.61	44.25	3.67	30.5	79.77	0	0.32	0.32	0.05	1.44	1.98	0.02	0.88	0.02	2.18	0.68	0	4.38	0	0.37	0.78	0.05	0	0.34	0.27	0.64	0	0	100		

Appendix E’: Tongo Maaré Diabal macro-botanical remains (Phase 5 Part 2)

TMD (n=114)	Test pit	Context	Volume (litres)	indet II	TMD-01	TMD-02	indet	indet I	Indet seeds frag.	Pennisetum glaucum Spikelet	Pennisetum glaucum embryo	Pennisetum glaucum involucre	Pennisetum glaucum immature	Pennisetum glaucum Grain	Pennisetum glaucum Total	Sorghum bicolor Spikelet	Sorghum bicolor Grain	Sorghum bicolor Total	Panicum Sp.	Brachiaria/setaria	cf digitaria	Digitaria cf ciliaris	wild digitaria	Urochloa	Gramineae	Dactylacterium aegyptium	commelina sp.	Poaceae total	CF. *Vitex doniana*	Sclerocarya birrea	*Legume*	CF.Vigna unguiculata	*Cyperaceae*	*Caryophyllaceae*	*ziziphus*	*tree and shrubs*	*lamiaceae*	*malvaceae*	Total	estmation from nut frag	Indet nut frag.
Phase 5 Part 2	95 B	3	5											1	1			0																					*1*		
	95 B	5	5									1		1	2			0																					*2*		
	95 B	6	5											1	1			0																					*1*		
	95 B	7	5											1	1			0																					*1*		
	93	9	5											2	2			0																					*2*		
	93	10	5											2	2			0																					*2*		
	93	8	5						7			12		1	13			0			1							0								0			*21*		
	93	11	5						4					3	3			0						1				1								0			*9*		2
	93	12	5									2			2			0										0								0			*2*		
	93	13	5									5			5			0																					*5*		
	93	14	5									15			15			0																					*15*		
	93	15	5												0			0																					*0*		
	93	16	5									10			10			0																					*10*		
	93	17	5												0			0																					*0*		
	93	18	5						14			28		4	32			0			3							0							2	2			*53*		
	93	19	5												0			0																					*0*		
	93	20	5												0			0																					*0*		
	93	21	5						6			4		3	7		1	1										0								0			*14*		
	93	22	5						5			9		2	11			0										0		1	2					1			*20*		
	93	23	5						12			69		22	91			0										0		1						1			*105*		
	93	24	5						9			23		25	48			0										0								0			*57*		
	93	25	5						6			2		17	19			0										0								0			*25*		2
	93	26	5						5			90		8	98			0										0								0			*103*		
	93	27	5						7			13		8	21			0										0								0			*28*		1
	93	28	5						12			28		6	34			0			1							0		2						2			*51*		10
	93	29	5						4			4		8	12			0										0		1						1			*18*		1
	93	30	5						3			12		20	32			0										0		3				1		3			*42*		3
	93	31	5						4			7		13	20			0										0		2	1					2			*29*		
Nisp Phase 5			226	0	0	0	15	0	237	30	25	1809	150	1248	3261	0	13	13	2	59	81	1	36	1	89	28	0	179	0	15	32	2	0	14	11	26	0	0	4088	5	531
Frequency Phase 5 (%)				0	0	0	0.37	0	5.8	0.73	0.61	44.25	3.67	30.5	79.77	0	0.32	0.32	0.05	1.44	1.98	0.02	0.88	0.02	2.18	0.68	0	4.38	0	0.37	0.78	0.05	0	0.34	0.27	0.64	0	0	100		

Appendix E'': Tongo Maaré Diabal macro-botanical remains (Phase 4)

	93	35	5						20					3	3		2	2										0		1	2					1			*29*		5
	93	36	5						0			5		2	7			0										0								0			*7*		
	93	40	5						3			23			23			0			6				22			22	1						2	3			*82*		
	93	37	5									1			1			0																					*1*		
	93	38	5												0			0																					*0*		
	93	39	5												0			0																					*0*		
	96 D	D86 26	5											37	37		2	2			2							0								0			*41*		
P	**95 A**	33	5		40	120			25			1769		728	2497			0		0	22	10	10	1	14	2		18		3		12			2	5		1	*2622*	*5*	400
h	**95 A**	32	5						54			269		125	394			0										0			4		1			0			*453*		15
a	**95 A**	37	5		110		20		31			106		258	364			0			25	21	4		25	2		27		8	1	3				8			*519*	*4*	32
s	**96 A**	39	5												0			0																					*0*		
e	**95 A**	26	5						28			12		30	42		2	2										0					1			0			*73*		15
	95 A	35	5						6			150		50	200			0			10							0								0			*216*		11
4	**95 B**	27	5						38			76		62	138		7	7			12							0						8		0			*203*		
	95 B	25	5									90		11	101			0			10	0	5			3	1	4								0			*124*		
	95 B	34	5						36			8		6	14			0			4							0								0			*54*		4
	95 B	36	5						15			10		54	64	2		2										0								0			*81*		
	95 B	37	5						40			69		52	121			0							4	3	3	10								0			*181*		
	95 B	41	5						10			180		190	370			0			10							0								0			*390*		10
	95 B	42	5						6			80		157	237		1	1			3							0								0			*247*		15
	95 B	48	5						11					38	38			0										0								0			*49*		
Nisp Phase 4			105	0	150	120	20	0	323	0	0	2848	0	1803	4651	2	14	16	0	0	104	31	19	1	65	10	4	81	1	12	7	15	2	8	4	17	0	1	5372	9	507
Frequency Phase 4 (%)				0	2.79	2.23	0.37	0	6.01	0	0	53.02	0	33.6	86.579	0.04	0.26	0.3	0	0	1.94	0.58	0.35	0.02	1.21	0.19	0.07	1.51	0.02	0.22	0.13	0.28	0.04	0.15	0.07	0.32	0	0.02	100		

Appendix E’’’: Tongo Maaré Diabal macro-botanical remains (Phase 3,2 and 1)

Phase 3	95 B	52	5						3			4		13	17			0										0								0			20		7
	95 A	56	5	2				1				269		142	411			0								39		40	1	2					1	4		1	499		
	95 A	51	5						22			2318		115	2433			0			10		10			2		2	1	2						3			2485	1	25
	95 A	46	5						17	4		243		32	279			0			2		2		9	4		14	1							1	31	1	361		
	95 A	44	5											15	15			0										0								0			15		
	95 B	44	5						6			315		214	529		3	3			2							0								0			540		33
	95 B	47	5						3			440		328	768			0			66							0								0			837		26
	95 B	49	5						48			49		34	83		2	2										0				7				0			140		50
	95 B	56	5									51			51			0																					51		
	95 B	58	5												0			0																					0		
	95 B	59	5											1	1			0																					1		
	95 B	66	5									2			2			0																					2		
	95 B	54	5							2		210		41	253			0			3	0	3			1	5	6								0			271		
	95 B	57	5									2		8	10			0			1	0	1					0								0			12		
	95 B	67	5						15			21		25	46			0			1	0	1					0		300						300			663		
	95 B	55	5						13			229		172	401	9		9			1							0								0			424		
	96 B	74	5											1	1			0																					1		
	96 B	75	5											1	1			0																					1		
Nisp Phase 3			90	2	0	0	0	1	127	6	0	4153	0	1142	5301	9	5	14	0	0	86	0	17	0	9	46	5	62	3	304	0	7	0	0	1	308	31	2	6323	1	141
Frequency Phase 3 (%)				0.03	0	0	0	0.02	2.01	0.09	0	65.68	0	18.1	83.837	0.14	0.08	0.22	0	0	1.36	0	0.27	0	0.14	0.73	0.08	0.98	0.05	4.81	0	0.11	0	0	0.02	4.87	0.49	0.03	100		
Phase 2	95 A	54	5				10		50	15		1602		184	1801						11	0	11		40	12		52	2	5	12				10	17			2023	10	350
	95 A	58	5												0																								0		
	95 A	61	5									5			5																								5		
	95 A	63	5											5	5																								5		
	95 A	41	5												0																								0		
	95 A	42	5											5	5																								5		
	96 B	86	5											15	15													0								0			15		
	96 B	90	5									1		15	16													0								0			16		
	96 B	91	5						15			2		31	33						29							0								0			77		
Nisp Phase 2			45	0	0	0	10	0	65	15	0	1610	0	255	1880	0	0	0	0	0	40	0	11	0	40	12	0	52	2	5	12	0	0	0	10	17	0	0	2146	10	350
Frequency Phase 2 (%)				0	0	0	0.47	0	3.03	0.7	0	75.02	0	11.9	87.605	0	0	0	0	0	1.86	0	0.51	0	1.86	0.56	0	2.42	0.09	0.23	0.56	0	0	0	0.47	0.79	0	0	100		
Phase 1	96 B	98	5						5					12	12													0								0			17		
	95 A	65	5					1				84		85	169							2	2	2		4	2	8	1						3	4			197		
	95 A	66	5						2			31		175	206										10	4		14		3						3			242		
	95 A	97	5																																				0		
Nisp Phase 1			20	0	0	0	0	1	7	0	0	115	0	272	387	0	0	0	0	0	0	2	2	2	10	8	2	22	1	3	0	0	0	0	3	7	0	0	456	0	0
Frequency Phase 1 (%)				0	0	0	0	0.22	1.54	0	0	25.22	0	59.6	84.868	0	0	0	0	0	0	0.44	0.44	0.44	2.19	1.75	0.44	4.82	0.22	0.66	0	0	0	0	0.66	1.54	0	0	100		
																												0								0			0		
Nisp Total			486	2	150	120	45	2	759	51	25	10535	150	4720	15480	11	32	43	2	59	311	34	85	4	213	104	11	396	7	339	51	24	2	22	29	375	31	3	18385	25	1529
Frequency Total (%)				0.0	0.8	0.7	0.2	0.0	4.1	0.3	0.1	57.3	0.8	25.7	84.2	0.1	0.2	0.2	0.0	0.3	1.7	0.2	0.5	0.0	1.2	0.6	0.1	2.2	0.0	1.8	0.3	0.1	0.0	0.1	0.2	2.0	0.2	0.0	100.0		

Appendix F Sadia macro-botanical remains (Phase 1 and 0)

Sadia (n=146)	#	Test pit	structure	Decapage	Volume (litres)	Indet seeds frag.	*Pennisetum glaucum* Spikelet	*Pennisetum glaucum* involucre	*Pennisetum glaucum* Grain	*Pennisetum glaucum* Total	*Oryza glaberrima* Lemma	*Oryza glaberrima* SPK ?	*Oryza glaberrima* SPK IM	*Oryza glaberrima* SPK WILD	*Oryza glaberrima* SPK DOM	*Oryza glaberrima* *Spikelet*	*Oryza glaberrima* Seed	*Oryza glaberrima* Total	*Sorghum bicolor* Spikelet	*Sorghum bicolor* Grain	*Sorghum bicolor* Total
Phase 0	AB93	Sadia I		27	10	1			2	**2**											
	AB85	Sadia I		25	10	2															
	AB89	Sadia I		26	10	2		2		**2**											
	AB86	Sadia I		23	20	3		18	51	**69**											
	AB83	Sadia I		24	20	5		25	5	**30**											
	AB72	Sadia I		21	20			30	12	**42**											
	AB70	Sadia I		20	0.7			10		**10**											
	AB79	Sadia I		22	0.7	2		1	1	**2**				1		*1*		**1**			
	AB76	Sadia I		22	20	4		3	2	**5**											
Nisp Phase 0					111	19	0	89	73	162	0	0	0	1	0	1	0	1	0	0	0
Frequency Phase 0 (%)						6.376	0	29.9	24.5	54.36	0	0	0	0.3	0	0.3	0	0.3	0	0	0
Phase 1	AB96	Sadia II		25	10	3		3		**3**											
	AB92	Sadia II		24	10	14		8	2	**10**											
	AB90	Sadia II		23	10	27		9	1	**10**											
	AB88	Sadia II		22	10	3		11	1	**12**											
	AB67	Sadia I		19	20	27		82	22	**104**											
	AB64	Sadia I		19	3				2	**2**											
	AB66	Sadia I		19	3	10		81	3	**84**											
	AB69	Sadia I		20	20			8	5	**13**											
Nisp Phase 1					86	84		202	36	238	0	0	0	0	0	0	0	0	0	0	0
Frequency Phase 1 (%)						12.59	0	30.3	5.4	35.68	0	0	0	0	0	0	0	0	0	0	0

Sadia (n=146)	#	*Digitaria exilis*	*CF digitaria exilis*	*wild digitaria*	*Echinochloa sp.*	*Brachiaria*	*Commelina Cf. benghalensis*	*trianthema Pentandra*	*borreira*	*Paspalum*	Graminae	*eleusine*	*Caryophyllaceae*	*Lamiacaea*	*limnophyton sp.*	*ZALEYA*	*Celtis intergrifolia*	*Gynandropsis gynandra*	*Vigna unguiculata*	*CF.Vigna*	*CF. Vitex doniana*	*Lannea microcarpa*	*Sclerocarya birrea*	*Adansonia digitata*	*Tamarindus andica*	*acacia*	*Ziziphus*	*Hibiscus cf sabdariffa*	*vittelaria*	Total	Indet nut frag.
Phase 0	AB93								2		2													2						9	
	AB85																				1		1	1					1	6	
	AB89										1																			5	
	AB86	5		3		1					10												3	2						96	
	AB83			5							5						1	1			1		5	2			2	1	2	60	
	AB72								5														2	4	2	5	5	4	5	74	
	AB70			1	2																									13	
	AB79										2																			17	10
	AB76			1							5										1		1	1						18	
Nisp Phase 0		5	0	10	2	1	0	0	7	0	25	0	0	0	0	0	1	1	0	0	3	0	12	12	2	5	7	5	8	298	
Frequency Phase 0 (%)		1.68	0	3.4	0.7	0.3	0	0	2.3	0	8.4	0	0	0	0	0	0.3	0.3	0	0	1	0	4	4	0.7	1.7	2.3	1.7	2.7	100	
Phase 1	AB96																													11	5
	AB92																													61	37
	AB90																													64	27
	AB88																													25	10
	AB67			2										1	1						6		4	5			5		2	157	
	AB64			1																										3	
	AB66	2		3							5										2	5		69			2		5	187	
	AB69			1							5										1	4	4	9					2	159	120
Nisp Phase 1		2	0	7	0	0	0	0	0	0	10	0	0	1	1	0	0	0	0	0	9	9	8	83	0	0	7	0	9	667	
Frequency Phase 1 (%)		0.3	0	1	0	0	0	0	0	0	1.5	0	0	0.1	0.1	0	0	0	0	0	1.3	1.3	1.2	12	0	0	1	0	1.3	100	

Appendix F': Sadia macro-botanical remains (Phase 2)

Sadia (n=146)	#	Test pit	structure	Decapage	Volume (litres)	Indet seeds frag.	Pennisetum glaucum				Oryza glaberrima								Sorghum bicolor			Digitaria exilis	CF digitaria exilis	wild digitaria	Echinochloa sp.	Brachiaria	Commelina Cf. benghalensis	trianthema Pentandra	borreira	Paspalum	Graminae	eleusine	Caryophyllaceae	Lamiaceae	limnophyton sp.	ZALEYA	Celtis intergrifolia	Gynandropsis gynandra	Vigna unguiculata	CF.Vigna	CF. Vitex doniana	Lannea microcarpa	Sclerocarya birrea	Adansonia digitata	Tamarindus andica	acacia	Ziziphus	Hibiscus cf sabdariffa	vittelaria	Total	Indet nut frag.
							Spikelet	involucre	Grain	Total	Lemma	SPK ?	SPK IM	SPK WILD	SPK DOM	Spikelet	Seed	Total	Spikelet	Grain	Total																														
Phase 2	AB30	sadia III		10	20	2		6	1	7																																	2							21	10
	AB17	sadia III		7	20	12		32	12	44																																	1							57	
	AB39	sadia III		12	20	1			2	2																																		2						5	
	AB36	Sadia III		11	20	7		15	10	25					1	1		1																									1							34	12
	AB26	Sadia III		9	20	3			1	1																																								4	10
	AB18	Sadia III		8	20	4		10	3	13																																								17	16
	AB16	Sadia III		6	20	22		22	7	29										1	1																						8	1						61	8
	AB87	Sadia II		21	20	9		26	11	37															2																		4							52	4
	AB82	Sadia II		20	20	26		19	7	26										2	2				2														1				2							59	15
	AB78	Sadia II		19	20	35		35	32	67	2	1	1	1	1	4		6		4	4	1			10											1														124	15
	AB75	Sadia II		18	20	42		19	34	53		1		1	5	7		7				4		10	8					5			5								1		2							137	10
	AB71	Sadia II		17	20	33		3	76	79					2	2		2				2		3	20				2	7				1						1			1	1						152	3
	AB68	Sadia II		16	20	69		40	103	143												10		5	49				5											1	2		1							285	9
	AB65	Sadia II		15	20	56		29	69	98		1			2	3		3				10			13		12	1	4	10	23							1	1	1			6							239	40
	AB63	Sadia II		14	20	45	1	30	42	73					1	1		1	2		2		2		21					2													3							149	30
	AB62	Sadia II		13	20	17		2	12	14										2	2				7				2														4				2			48	50
	AB60	Sadia II		12	20	32		13	31	44			1			1		1							5							2											5				4			93	40
	AB57	Sadia II		11	20	50		12	44	56															5														1				2							114	10
	AB54	Sadia II		10	30	20		7	17	24					1	1		1							8							3											2							58	22
	AB51	Sadia I		15	20	10		152	52	204																					20										10		5	2				2	4	257	
	AB47	Sadia I		13	20	60		191	69	260		3	1	3	11	18		18						5	10			5	4	1											4		5	5				5		382	
	AB43	Sadia I		11	20	101		103	69	172		1			3	4	3	7							5		1	1	2												1		4						4	298	
	AB23	Sadia I		8	30			69	12	81		3				3	1	4				4																					3	4						96	
	AB7	Sadia I		6	30	50	6	134	25	165		2				2		2				5									20										3		5			1	1			252	
	AB21	Sadia I		8	0.55	1		1	1	2																														1										4	
	AB44	Sadia I		11	0.8	1			1	1																																								2	5
	AB52	Sadia I		15	0.6																																												10	10	
	AB38	Sadia I		10	1	7		5	2	7															10																		7							31	
	AB58	Sadia I		17	0.7	5		5	1	6														1																			7	7						26	
	AB20	Sadia I		8	0.7	15			2	2																														1			1							19	
	AB50	Sadia I		14	20	25		123	55	178	1	5	7	1	7	20		21	6	1	7	1		4	8		3	1	1	3	10									1	3	1	5	2						274	
	AB40	Sadia I		10	1				1	1																																								1	
	AB55	Sadia I		16	20			15	15	30		1				1	1	2																								4	8							44	13
	AB27	Sadia I		8	3			3	4	7	1							1																									8							16	4
	AB22	Sadia I		8	0.7				1	1																																	1							2	2
	AB42	Sadia I		10	1.1			4	2	6		2				2		2						8	9																		2						2	29	2
	AB 35	Sadia I		10	30	10		128	69	197		3	3	2	3	11		11	2		2			2	24		1			1	5		1			5														259	15
	AB61	Sadia I		18	20			15	1	16																															2	2	6	6						32	10
	AB45	Sadia I		12	20			69	77	146							1	1						1	4																1		3							156	
	AB29	Sadia I		9	30			67	32	99	1	2	5	1	12	20		21						3	27		1	2	2	1											2		6							164	
	AB31	Sadia I		9	0.7							1				1		1							1																									2	
	AB34	Sadia I		9	1.6	5	5	12	10	27					1	1		1							1																									34	
Nisp Phase 2					662	775	12	1416	1015	2443	5	26	18	9	50	103	6	114	10	10	20	37	2	42	249	0	18	10	22	30	78	5	6	1	0	6	0	1	3	6	29	7	120	30	0	1	7	7	20	4099	
Frequency Phase 2 (%)						18.91	0.3	34.5	24.8	59.6	0.1	0.6	0.4	0.2	1.2	2.5	0.1	2.8	0.2	0.2	0.5	0.9	0.05	1	6.1	0	0.4	0.2	0.5	0.7	1.9	0.1	0.1	0	0	0.1	0	0	0.1	0.1	0.7	0.2	2.9	0.7	0	0	0.2	0.2	0.5	100	

Appendix F”: Sadia macro-botanical remains (Phase 3 part 1)

Sadia (n=146)	#	Test pit	Structure	Decapage	Volume (litres)	Indet seeds frag.	*Pennisetum glaucum* Spikelet	*Pennisetum glaucum* involucre	*Pennisetum glaucum* Grain	*Pennisetum glaucum* Total	*Oryza glaberrima* Lemma	*Oryza glaberrima* SPK ?	*Oryza glaberrima* SPK IM	*Oryza glaberrima* SPK WILD	*Oryza glaberrima* SPK DOM	*Oryza glaberrima* Spikelet	*Oryza glaberrima* Seed	*Oryza glaberrima* Total	*Sorghum bicolor* Spikelet	*Sorghum bicolor* Grain	*Sorghum bicolor* Total
Phase 3	AB1	Sadia 11	1	1	7	14		7	4	**11**									1		**1**
	AB2	Sadia 11	2	1	3.5	5															
	AB3	Sadia 11	3	1	10	10															
	AB4	Sadia 11	4	1	14	20		9	7	**16**											
	AB5	Sadia 11	26	2	15	13			2	**2**											
	AB6	Sadia 11	5	2	15	21			3	**3**							1	**1**			
	AB7	Sadia 11	28	3	15	25		6		**6**										1	**1**
	AB8	Sadia 11	28	3	2																
	AB9	Sadia 11	26	3	15	51		45	10	**55**	1					7	1	**9**		4	**4**
	AB10'	Sadia 11	3	2	15	8		2	2	**4**											
	AB10	Sadia 11	2	2	15	7		1	2	**3**											
	AB11	Sadia 11	26	4	15	8		10	5	**15**	1					5	1	**7**		8	**8**
	AB12	Sadia 11	35	2	15	13			5	**5**											
	AB13	Sadia 11	35	3	15	54															
	AB14	Sadia 11	5	3	15	81			9	**9**										9	**9**
	AB15	Sadia 11	1	2	15			5	4	**9**									1	1	**2**
	AB16	Sadia 11	39	2	15	11		12	2	**14**											
	AB17	Sadia 11	40	1	12.5	34		27	14	**41**									1	5	**6**
	AB18	Sadia 11	7	2	15	15		14	7	**21**									2		**2**
	AB19	Sadia 11	12	2	15			20	10	**30**										2	**2**
	AB20	Sadia 11	7	3	15	19		5	12	**17**									1		**1**
	AB21	Sadia 11	7	4	15	15			6	**6**										6	**6**
	AB22	Sadia 11	41	1	15	23		59	16	**75**											
	AB23	Sadia 11	42	1	15	47		32	16	**48**											
	AB24	Sadia 11	38	2	15	5		14	2	**16**									1		**1**
	AB25	Sadia 11	37	2	15	9		69	9	**78**						4		**4**		1	**1**
	AB26	Sadia 11	38	3	15	48		60	18	**78**	1					5	1	**7**	5		**5**
	AB27	Sadia 11	45	1	15	9		7	3	**10**						1		**1**			
	AB28	Sadia 11	46	1	7	6		3		**3**											
	AB29	Sadia 11	52	1	15	7		2	2	**4**						2		**2**			
	AB30	Sadia 11	51	1	10	6		7	2	**9**											
	AB31	Sadia 11	53	2	1											1		**1**			
	AB32	Sadia 11	28	4	15	42		48	10	**58**									5		**5**
	AB33	Sadia 11	54	3	15	2		2	2	**4**											
	AB34	Sadia 11	55	2	7	2		2	2	**4**						1		**1**			
	AB35	Sadia 11	58	3	5	1		19	1	**20**										1	**1**
	AB36	Sadia 11	66	2	15	9		6		**6**						1		**1**			
	AB37	Sadia 11	19	3	15	11		4	1	**5**											
	AB38	Sadia 11	60	3	15	52		103	39	**142**						6		**6**	1	9	**10**
	AB39	Sadia 11	57	3	10	13		12	10	**22**											
	AB40	Sadia 11	71	3	15	10		1	2	**3**											
	AB41	Sadia 11	72	3	15	6		2		**2**											
	AB42	Sadia 11	73	3	15	7		2	3	**5**											

#	*Digitaria exilis*	*CF digitaria exilis*	*wild digitaria*	*Echinochloa sp.*	*Brachiaria*	*Commelina Cf. benghalensis*	*trianthema Pentandra*	*borreira*	*Paspalum*	Graminae	*eleusine*	*Caryophyllaceae*	*Lamiaceae*	*limnophyton sp.*	*ZALEYA*	*Celtis intergrifolia*	*Gynandropsis gynandra*	*Vigna unguiculata*	CF.*Vigna*	CF. *Vitex doniana*	*Lannea microcarpa*	*Sclerocarya birrea*	*Adansonia digitata*	*Tamarindus andica*	*acacia*	*Ziziphus*	*Hibiscus cf sabdariffa*	*vittelaria*	Total	Indet nut frag.
AB1																													26	
AB2																							1						6	
AB3																													10	25
AB4	380																												416	6
AB5																													15	9
AB6	2																						3						30	40
AB7																													32	1
AB8																													0	
AB9	5																		21										145	52
AB10'	4																						4						20	
AB10	1																						2						13	100
AB11	174																												212	5
AB12																													18	12
AB13																							1						55	
AB14																							2						101	
AB15	8																												19	3
AB16				1																									26	
AB17	1				1																								83	9
AB18	1																						2						41	16
AB19	12																		3										47	10
AB20	12				?														2										51	10
AB21																						2							29	
AB22	15				1																								114	10
AB23	15				?															1									111	15
AB24	12				?																		1						35	5
AB25	1																						1						94	
AB26	1				?																								139	
AB27																													20	
AB28												1																	10	
AB29	1				3																								17	
AB30	1																												16	
AB31																													1	
AB32	2				?														1										108	
AB33																													6	
AB34																													7	
AB35					1																								23	
AB36	2																												18	
AB37	3				1																								20	
AB38	3				4																	1							218	
AB39																						1							36	
AB40																													13	
AB41	2																												10	
AB42					?																	1							13	

Appendix F''': Sadia macro-botanical remains (Phase 3 part 2)

Sadia (n=146)	#	Test pit	structure	Decapage	Volume (litres)	Indet seeds frag.	*Pennisetum glaucum*				*Oryza glaberrima*								*Sorghum bicolor*			*Digitaria exilis*	*CF digitaria exilis*	*wild digitaria*	*Echinochloa sp.*	*Brachiaria*	*Commelina Cf. benghalensis*	*trianthema Pentandra*	*borreira*	*Paspalum*	*Graminae*	*eleusine*	*Caryophyllaceae*	*Lamiacaea*	*limnophyton sp.*	*ZALEYA*	*Celtis intergrifolia*	*Gynandropsis gynandra*	*Vigna unguiculata*	*CF.Vigna*	*CF. Vitex doniana*	*Lannea microcarpa*	*Sclerocarya birrea*	*Adansonia digitata*	*Tamarindus andica*	*acacia*	*Ziziphus*	*Hibiscus cf sabdariffa*	*vittelaria*	Total	Indet nut frag.
							Spikelet	involucre	Grain	**Total**	Lemma	SPK ?	SPK IM	SPK WILD	SPK DOM	*Spikelet*	Seed	**Total**	Spikelet	Grain	**Total**																														
Phase 3	AB43	Sadia 11	74	3	15	9			2	**2**												2																		2										15	
	AB44	Sadia 11	75	3	15																																													0	
	AB45	Sadia 11	76	3	15	15		14		**14**	1							**1**																																30	
	AB46	Sadia 11	77	3	15	5			2	**2**																																								7	
	AB47	Sadia 11	78	3	15	5		3	3	**6**												1																												12	
	AB48	Sadia 11	79	3	7			3	5	**8**																																								8	2
	AB49	Sadia 11	80	3	15	15		13	12	**25**												5				4																								49	
	AB50	Sadia 11	81	3	10	3		1		**1**																1																								5	
	AB51	Sadia 11	82	3	15	1		3	1	**4**												2				1																								8	7
	AB52	Sadia 11	83	3	15	10		2	2	**4**																3																			2					19	7
	AB53	Sadia 11	87	3	15	4		1		**1**																																								5	
	AB54	Sadia 11	88	3	15	4		7		**7**						*2*		**2**									1																							14	
	AB55	Sadia 11	47	4	15	10		5	2	**7**												1				2																								20	
	AB56	Sadia 11	91	1	15	22		7	2	**9**																					?													1							32	
	AB57	Sadia 11	93	1	15	14		5	3	**8**						*1*		**1**																																23	
	AB58	Sadia 11	92	1	15	21		51	10	**61**						*1*	1	**2**				2																						1							87	
	AB59	Sadia 11	94	1	5																																							1							1	1
	AB60	Sadia 11	95	1	5	6		4		**4**												7				?																								17	
	AB61	Sadia 11	96	1	15	7			4	**4**																																								11	
	AB62	Sadia 11	89	3	15	17		15	4	**19**									1		**1**	8				?																		4							49	10
	AB63	Sadia 11	90	3	15	7		15		**15**						*1*		**1**				5				?																								28	
	AB64	Sadia 11	97	4	15	25		59	7	**66**												4				?																		1							96	
	AB95	Sadia V			10	25	52	2	18	**72**					1	*1*		**1**	4		**4**																														102	10
	AB10	Sadia III		2	20	4			4	**4**																																		1							9	
	AB13	Sadia III		5	20	16		37	13	**50**												2																						3							71	15
	AB12	Sadia III		4	20	16		35	4	**39**												12							53																			3			123	12
	AB11	Sadia III		3	20	4		6	3	**9**												3			15				14										1					3							49	15
	AB8	sadia III		1	20	12		5	6	**11**												5			5				10															1							44	
	AB53	Sadia II		10	0.7						0	5			5	*10*		**10**												1																					11	
	AB49	Sadia II		9	30	35		71	25	**96**																																						1			132	100
	AB48	Sadia II		9	1	3		4	1	**5**																																									8	
	AB41	Sadia II		6	2.5																																														0	
	AB46	Sadia II		8	30	50		26	63	**89**				1	1	*2*		**2**				24	10	5	34							1												2							217	
	AB37	Sadia II		7	30	30		12	43	**55**					1	*1*		**1**				80	8		172							1		9										6							362	42
	AB24	Sadia II		5	1																																														0	
	AB28	Sadia II		6	30	40		7	75	**82**												22	4		143																			1							292	35
	AB19	Sadia II		5	40	25		52	17	**69**												50			69																									5	218	
	AB2	Sadia II		1	40	20		50	19	**69**												24			25						5																			4	147	15
	AB5	Sadia II		2	5				15	**15**												1									12																				28	5
	AB9	Sadia II		3	25			15	15	**30**												5			10																			1							46	6
	AB15	Sadia II		4	20	12		9	5	**14**												6			5						8																				45	
	AB25	Sadia II		5	1				1	**1**																																									1	
	AB4	Sadia I		4	40	42	7	56	15	**78**		2				*2*	1	**3**				2																		5				7							137	
	AB3	Sadia I		3	40			110	40	**150**		1				*1*		**1**						7																				4						15	177	
Nisp Phase 3					1297	1273	59	1322	683	2064	4	8	0	1	8	55	6	65	23	47	70	931	22	12	479	22	1	0	77	1	25	2	1	9	0	0	0	0	1	34	1	0	42	19	0	0	4	0	24	5179	
Frequency Phase 3 (%)						24.58	1.1	25.5	13.2	39.85	0.1	0.2	0	0	0.2	1.1	0.1	1.3	0.4	0.9	1.4	18	0.42	0.2	9.2	0.4	0	0	1.5	0	0.5	0	0	0.2	0	0	0	0	0	0.7	0	0	0.8	0.4	0	0	0.1	0	0.5	100	
Nisp Total					2157	2151	71	3029	1807	4907	9	34	18	11	58	159	12	180	33	57	90	975	24	71	730	23	19	10	106	31	138	7	7	11	1	6	1	2	4	40	42	16	182	144	2	6	25	12	61	10243	1174
Frequency Total (%)						21	0.7	29.6	17.6	47.91	0.1	0.3	0.2	0.1	0.6	1.6	0.1	1.8	0.3	0.6	0.9	9.52	0.23	0.7	7.1	0.2	0.2	0.1	1	0.3	1.3	0.1	0.1	0.1	0	0.1	0	0	0	0.4	0.4	0.2	1.8	1.4	0	0.1	0.2	0.1	0.6	100	

Appendix G North Benin (Dendi) macro-botanical sample (Multi site, Phase 1 and 4)

	Sites	Context	Volume (litres)	*Pennisetum glaucum* Spikelet	*Pennisetum glaucum* involucre	*Pennisetum glaucum* Seed	*Pennisetum glaucum* Total	*Oryza glaberima* Lemma	*Oryza glaberima* Spikelet	*Oryza glaberima* Seed	*Oryza glaberima* Total	*Sorghum bicolor* Seed	*Sorghum bicolor* seed frag	*Sorghum bicolor* Guinea	*Sorghum bicolor* bicolor	*Sorghum bicolor* immature grain	*Sorghum bicolor* Involucre	*Sorghum bicolor* Total	Indet seeds	indet seeds frag	wild grasses	*Nuts indet.*
Phase 1	ALB-14-SIII	30-40	10			5	**5**				**0**							**0**	15			2
	ALB-14-SIII	40-50	10		1	5	**6**				**0**	5						**5**	15			12
	ALB-14-SIII	50-60	20			7	**7**				**0**	10						**10**	30			30
	ALB-14-SIII	60-70	20			1	**1**				**0**							**0**	35			1
	ALB-14-SIII	70-80	60			2	**2**				**0**							**0**	6			8
	KOZ-14-SII	U5	30				**0**				**0**							**0**	10			
	NSIP Phase 1		**150**	**0**	**1**	**20**	**21**	**0**	**0**	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**	**15**	**111**	**0**	**0**	**53**
	Frequency phse 1			**0**	**0.48**	**9.662**	**10.14**	**0**	**0**	**0**	**0**	**7.2**	**0**	**0**	**0**	**0**	**0**	**7.25**	**53.62**	**0**	**0**	**26**
Phase 4	KOZ-14-SI	U4	30			15	**15**				**0**							**0**				
	KOZ-14-SI	U5	30				**0**				**0**							**0**	10			10
	KOZ-14-SII	U4	15			1	**1**				**0**							**0**				
	GOB-14-SI	60-70	5				**0**				**0**							**0**	15	1		
	GOG-14-SI	U5	5	60	182	11	**253**				**0**	3						**3**	40			32
	GOG-14-SI	U6	5		4	2	**6**				**0**	4						**4**	10			23
	KGI-14-SI	U7	5	2	2	3	**7**				**0**	1						**1**	4	2		
	KGI-14-SI	U11	5			2	**2**				**0**	1					1	**2**		5		5
	KLI-14-SI	U8	5	12	2		**14**				**0**	12	1	1			8	**20**	20	8	10	20
	KLI-14-SI	U16	5			2	**2**				**0**	2						**2**				7
	KLI-14-SI	U18	5	7			**7**				**0**							**0**	10			25
	NSIP Phase 4		**115**	**81**	**190**	**36**	**307**	**0**	**0**	**0**	**0**	**23**	**1**	**1**	**0**	**0**	**9**	**32**	**109**	**16**	**10**	**122**
	Frequency phse 4			**10**	**23.5**	**4.444**	**37.9**	**0**	**0**	**0**	**0**	**2.8**	**0.1**	**0.1**	**0**	**0**	**1.111**	**3.95**	**13.46**	**1.975**	**1.235**	**15**

Sites	Context	*Lannea microcarpa* *frag*	*Lannea microcarpa* fruit	*Lannea microcarpa* total (estimated)	*Adansonia digitata* frg	*Adansonia digitata* estimated	*Adansonia digitata* *seeds*	*Adansonia digitata* ***Total***	*Elais guineensis*	*ziziphus*	*celtis*	*Canarium shweinfurthii*	*Vitex sp.* *frag*	*Vitex sp.* *estimation*	*Vitex sp.* *fruit*	*Vitex sp.* ***total***	*cf vitellaria* *frag*	*cf vitellaria* *estimation*	*cf vitellaria* *fruit*	*cf vitellaria* ***total***	*sclerocarya*	*CF vitellaria*	*CF Vigna unguiculata*	*Vigna unguiculata*	*Gossypium sp* *caps*	*Gossypium sp* *seeds*
ALB-14-SIII	30-40																									
ALB-14-SIII	40-50																									
ALB-14-SIII	50-60																									
ALB-14-SIII	60-70																							7		
ALB-14-SIII	70-80																									
KOZ-14-SII	U5																									
NSIP Phase 1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**0**	**0**
Frequency phse 1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3.4**	**0**	**0**
KOZ-14-SI	U4						4																			
KOZ-14-SI	U5						5																			
KOZ-14-SII	U4						7																			
GOB-14-SI	60-70						3																			3
GOG-14-SI	U5						2		4																	4
GOG-14-SI	U6								6			4													1	2
KGI-14-SI	U7																									
KGI-14-SI	U11								6																	
KLI-14-SI	U8						3		23			10													4	25
KLI-14-SI	U16						1		5			1														
KLI-14-SI	U18						4		8			1														15
NSIP Phase 4		**0**	**0**	**0**	**0**	**0**	**29**	**0**	**52**	**0**	**0**	**16**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**49**
Frequency phse 4		**0**	**0**	**0**	**0**	**0**	**3.6**	**0**	**6.4**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.6**	**6**

Sites	Context	*Capparidaceae*	*cf triticum*	*Gynandropis gynandra*	*commelina*	Ceratotteca sesamoide	*Eleusine indica*	*elongated digitaria*	*digitaria Cf exilis*	*Digitaria exilis*	*Echinochloa sp (cf colona)*	*borreria sp.*	*Digitaria*	*Paspalum*	*Panicum Sp.*	*Brachiaria*	*Lamiaceae*	*Acacia*	*Moraceae*	Total
ALB-14-SIII	30-40																			22
ALB-14-SIII	40-50																			38
ALB-14-SIII	50-60																			77
ALB-14-SIII	60-70																			44
ALB-14-SIII	70-80																			16
KOZ-14-SII	U5																			10
NSIP Phase 1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	207
Frequency phse 1		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**100**
KOZ-14-SI	U4	1																		20
KOZ-14-SI	U5																			25
KOZ-14-SII	U4																			8
GOB-14-SI	60-70																			22
GOG-14-SI	U5																			338
GOG-14-SI	U6																			56
KGI-14-SI	U7							1			4					1				20
KGI-14-SI	U11	14					24	5					5			2	2		1	73
KLI-14-SI	U8																	1		160
KLI-14-SI	U16																			18
KLI-14-SI	U18																			70
NSIP Phase 4		**15**	**0**	**0**	**0**	**0**	**24**	**6**	**0**	**0**	**4**	**0**	**5**	**0**	**0**	**3**	**2**	**1**	**1**	810
Frequency phse 4		**1.9**	**0**	**0**	**0**	**0**	**3**	**0.7**	**0**	**0**	**0.5**	**0**	**0.6**	**0**	**0**	**0.4**	**0.2**	**0.1**	**0.1**	**100**

Appendix G’: North Benin (Dendi) macro-botanical sample (Multi site, Phase 2)

	Sites	Context	Volume (litres)	*Pennisetum glaucum*				*Oryza glaberima*				*Sorghum bicolor*							Indet seeds	indet seeds frag			*Lannea microcarpa*			*Adansonia digitata*				*Elais guineensis*	*ziziphus*	*celtis*	*Canarium shweinfurthii*	*Vitex sp.*				*cf vitellaria*								*Gossypium sp*																					
				Spikelet	involucre	Seed	**Total**	Lemma	Spikelet	Seed	**Total**	Seed	seed frag	Guinea	bicolor	immature grain	Involucre	**Total**			wild grasses	*Nuts indet.*	*frag*	fruit	total (estimated)	frg	estimated	*seeds*	***Total***					*frag*	*estimation*	*fruit*	***total***	*frag*	*estimation*	*fruit*	***total***	*sclerocarya*	*CF vitellaria*	*CF Vigna unguiculata*	*Vigna unguiculata*	*caps*	*seeds*	*Capparidaceae*	*cf triticum*	*Gynandropis gynandra*	*commelina*	Ceratotteca sesamoïde	*Eleusine indica*	*elongated digitaria*	*digitaria Cf exilis*	*Digitaria exilis*	*Echinochloa sp (cf colona)*	*borreria sp.*	*Digitaria*	*Paspalum*	*Panicum Sp.*	*Brachiaria*	*Lamiaceae*	*Acacia*	*Moraceae*	Total
Phase 2	BLAF-12-SIV	Pit 4 Veg 2	20			25	**25**		13	3	**16**	3						**3**	1																																											1					46
	BLAF-12-SIV	Pit 1	1			2	**2**		1		**1**																																																							3
	BLAF-12-SIV	Niv3 80-90	20			2	**2**		3		**3**		1					**1**																																				1	1	1										9
	BLAF-12-SIV	Pit 7 C23 330-365	20			2	**2**		35		**35**							**0**		5																																		1		5	30										78
	BLAF-12-SIV	Pit 4 Veg 3	5			10	**10**		130	1	**131**							**0**	5																																															146
	BLAF-12-SIV	Pit 3 Veg 4	5				**0**		117	4	**121**	3						**3**										2																																							126
	BLAF-12-SIV	Pit 9 Veg 1	20			2	**2**		1	1	**2**							**0**	10																																															14
	BLAF-13-SVIII	C 5	20			11	**11**		54		**54**							**0**	0			1																																												66
	BLAF-13-SVIII	C 2	30			15	**15**		68		**68**								35																																															118
	BLAF-13-SVIII	C10 int pot	5			1	**1**		78		**78**							**0**		1																																				1			1								82
	BLAF-13-SXI	C17 250-260	21		60	124	**184**	26	508		**534**	3		2	1	20		**23**	2			15	28		3			1					10												1		2				1			2		5											814
	BLAF-13-SXI	C18 Pot	10		2	25	**27**		35		**35**						1	**1**	0	4																																				78											145
	BLAF-13-SIX	C 8 120-150	20		138	126	**264**		543	10	**553**	7	8	1	3		8	**15**	2	34		10																															1		9	169				2						1071
	BLAF-13-SIX	C 8 240-250	40		1	5	**6**		24	2	**26**							**0**	0	5																		2	1		1														5	20											66
	BLAF-13-SIX	C8-10	20		60	7	**67**		20		**20**	11						**11**	0	2		42						3		1																	1																				147
	BLAF-13-SIX	C11 160-180	20		5	38	**43**				**0**	2		2				**2**	3	15		5									2	2		2		1	2																		2	5											86
	BLAF-13-SIX	C 11 200-210	10		4	6	**10**	17	245	2	**264**							**0**																																																	274
	BLAF-13-SIX	C 11 inf.	10		3	7	**10**		5		**5**	32						**32**	30			7																																													84
	BLAF-13-SIX	C12 120-130	40		149	137	**286**		315	2	**317**	86						**86**	5			31																							2																	5					732
	BLAF-13-SIX	C 12 Inf.	10		4	21	**25**		3		**3**	10						**10**	2			10								1																																					51
	BLAF-14-BAO FIII	30-40	15				**0**		28		**27**									8														5	1		1																2			21	2										68
	BLAF-14-BAO FIII	60-70 IN	20				**0**		18		**18**							**0**		2								1						150	15	10	25																			14											235
	BLAF-14-BAO FIII	6070 OUT	20				**0**		20		**20**									2														110	2		2	2	1		1												1			26											167
	BLAF-14-BAO FIII	80-90	15				**0**		31		**31**							**0**		5														8	1		1							1									2	1		6											56
	BLAF-14-BAO FIII	80-100STRATI	15		1	1	**2**		69		**69**							**0**		3														30	1	2	3																1	2		36											149
	BLAF-14-SXVIII	4NIV4	15		169	17	**186**	83	969	41	**1093**	69				5	286	**360**																27	2	2	4								30							3				50											1757
	BLAF-14-SXVIII	4NIV4	15				**0**		3		**3**	1						**1**																																						2											6
	BLAF-14-SXVIII	4NIV5	15		118	27	**145**	101	842	30	**973**	28	3	26	1	8	588	**624**		5														3	1		1								2											118											1902
	BLAF-14-SXVIII	9NIV7	15		12	20	**32**	12	396	5	**413**	10	5	5	4	7	25	**42**	1	5														3	1		1																			18											530
	BLAF-14-SXVIII	153CM	15		15	6	**21**	40	269	30	**339**	45				26	82	**153**																5	1		1																		7	10	1										538
	BLAF-14-SXVIII	140 CM	15		3		**3**	20	130	9	**159**	3		3		1	37	**41**	1	3		3																																		6											219
	BLAF-14-SXIII	C18 270-280	35			25	**25**		108		**108**	1					4	**5**	0	4																																				45											187
	BLAF-14-SXIII	C17 240-250	40		2	7	**9**		79	1	**80**								2	2	4	1	1		1																															31											131
	BLAF-14-SXIII	C17 230-240	40			5	**5**	1	15		**16**		2					**1**		9																																	1		1												34
	BLAF-14-SXIII	C 19 270-280	40		13	13	**26**		253		**253**							**0**	13		3	7	6	1	3																	1	1	1	0											41						0					356
	BLAF-14-SXIII	C 19 280-290	40		12	5	**17**		176	2	**178**	1					3		9	5		2				2			2					1			1							2												36											259
	BLAF-14-SXIII	C19 300-310	30		21	11	**32**		102		**102**	5	2	3	2		1	**6**	2	20	5					1			1					11	1	1	2																1			41	12	3			4						252
	BLAF-14-SXIII	C19 310-330	20		10	21	**31**		50		**50**	2	1					**3**	20	18		13						3																												2											140
	BLAF-14-SXIII	C19 350-370	10			6	**6**		69		**69**		2					**0**	2			1											6																																		86
	BLAF-14-SXIII	sample 1 C14	20		1	6	**7**		15		**15**							**0**	8																																																30
	BLAF-14-SXIII	Sample 6 C11	30		1	3	**4**		6		**6**	2	2					**2**	0																																															14
	NSIP Phase 2		**827**	**0**	**804**	**739**	**1543**	**300**	**5846**	**143**	**6288**	**324**	**26**	**42**	**11**	**67**	**1035**	**1425**	**153**	**157**	**12**	**148**	**35**	**1**	**7**	**3**	**0**	**10**	**3**	**2**	**2**	**2**	**16**	**355**	**26**	**16**	**44**	**4**	**2**	**0**	**2**	**1**	**1**	**4**	**35**	**0**	**3**	**0**	**0**	**0**	**1**	**3**	**10**	**6**	**30**	**812**	**15**	**3**	**1**	**2**	**10**	**0**	**0**	**0**	**0**	11274
	Frequency phse 2			**0**	**7.13**	**6.555**	**13.69**	**2.7**	**51.9**	**1.3**	**55.77**	**2.9**	**0.2**	**0.4**	**0.1**	**0.6**	**9.18**	**12.6**	**1.357**	**1.393**	**0.106**	**1.3**	**0.3**	**0**	**0.1**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0.1**	**3.15**	**0.2**	**0.1**	**0.4**	**0.04**	**0**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0.1**	**0.3**	**7.202**	**0.1**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**100**

Appendix G": North Benin (Dendi) macro-botanical sample (Multi site, Phase 3 part 1)

	Sites	Context	Volume (litres)	*Pennisetum glaucum*				*Oryza glaberrima*				*Sorghum bicolor*						
				Spikelet	involucre	Seed	**Total**	Lemma	Spikelet	Seed	**Total**	Seed	seed frag	Guinea	bicolor	immature grain	Involucre	**Total**
Phase 3	BLAF-12-SV	C 1B	20			15	**15**		1		**1**							
	BLAF-12-SV	C1C	20			12	**12**		1		**1**							
	BLAF-13-SXI	C2	20			45	**45**		70		**70**	1	1			1		**2**
	BLAF-13-SXI	C6	20		1	5	**6**	20	133	9	**162**	40	21	22			52	**92**
	BLAF-13-SXI	C7	10			1	**1**	5			**5**							**0**
	BLAF-13-SXI	C4	20			42	**42**		29		**29**	26					12	**38**
	PEK-12-SI	C1	17			12	**12**				**0**							**0**
	PEK-12-SI	C3	18			5	**5**				**0**	4						**4**
	PEK-12-SI	C5	14			18	**18**				**0**							**0**
	PEK-12-SI	C6	16			45	**45**				**0**							**0**
	PEK-12-SI	C8	14			5	**5**				**0**	4						**4**
	PEK-12-SI	C9	10			2	**2**				**0**	0						**0**
	BLAF-13-SIX	C6 ±100cm	30		15	69	**84**	10	20	2	**32**	10						**10**
	TTK-13-SI	C1 Niv 6-7	35			10	**10**				**0**	15						**15**
	TTK-13-SI	C 17 Niv 10	15			55	**55**				**0**	2						**2**
	TTK-13-SI	C7 Niv 7	25		3	46	**49**		31		**31**	3						**3**
	TTK-13-SI	C9 Niv 10	11		4	606	**610**		69		**69**	4						**4**
	TTK-13-SI	C14	2			19	**19**		4		**4**							**0**
	TTK-13-SI	C22 Niv 14	10			100	**100**		63		**63**	25						**25**
	TTK-13-SI	C23 Niv 16/17	11			58	**58**		42		**42**	1						**1**
	TTK-13-SI	C 19 Niv 24/25	25			35	**35**		51		**51**	1						**1**
	TTK-13-SI	C19 Niv 35/36	38			70	**70**		190	2	**192**	60						**60**
	TTK-13-SII	C 21 P 20	10			2	**2**		12		**12**							
	TTK-13-SII	C 20	1			25	**1**		10		**10**							
	TTK-13-SII	C 28	15			35	**0**		2	1	**3**							
	KLI-14-RCI	U6	5		5	26	**31**	1	46		**47**	2						**2**
	KRO-14-SI	C1 80-90	15			20	**20**				**0**			1			1	**2**
	KRO-14-SI	5-10	15		2	15	**17**					1						
	KRO-14-SI	10-20	15		1	5	**6**						1					
	KRO-14-SI	20-30	15			5	**5**											
	KRO-14-SI	30-40	15		1	12	**13**											
	KRO-14-SI	40-50	15			3	**3**		1		**1**		1					**1**
	KRO-14-SI	50-60	15		1	2	**3**		1		**1**		0					**0**
	KRO-14-SI	60-70	15			5	**5**					0	1					**1**
	KRO-14-SI	70-80	15			5	**5**				**0**							**0**
	KRO-14-SI	90-100	15			3	**3**				**0**							**0**
	KRO-14-SI	C1 100-110	15			53	**53**		3		**3**	11						**11**
	KRO-14-SI	C1 110-120	15		2	15	**17**		1		**1**	0						**0**
	KRO-14-SI	C1 120-130	15			25	**25**				**0**	3						**3**
	KRO-14-SI	C1 130-140	15			2	**2**		1	1	**2**	1						**1**
	KRO-14-SI	C1 140-150	15			15	**15**				**0**							**0**
	KRO-14-SI	C1 150-160	15			96	**96**		7		**7**	6					1	**7**
	KRO-14-SI	170-180	15			15	**15**											
	KRO-14-SI	C2 150-160	15			8	**8**				**0**	9						**9**
	KRO-14-SI	C2 160-170	15			9	**9**				**0**	11						**11**

Sites	Context	Indet seeds	indet seeds frag			*Lannea microcarpa*			*Adansonia digitata*				*Elais guineensis*	*ziziphus*	*celtis*	*Canarium shweinfurthii*	*Vitex sp.*				*cf vitellaria*								*Gossypium sp*	
				wild grasses	*Nuts indet.*	*frag*	fruit	total (estimated)	frg	estimated	*seeds*	***Total***					*frag*	*estimation*	*fruit*	***total***	*frag*	*estimation*	*fruit*	***total***	*sclerocarya*	*CF vitellaria*	*CF Vigna unguiculata*	*Vigna unguiculata*	*caps*	*seeds*
BLAF-12-SV	C 1B	5																												
BLAF-12-SV	C1C	10																												
BLAF-13-SXI	C2	52	12		5																									
BLAF-13-SXI	C6	4	22		1	1		1													1	1		1		0	2	3	0	
BLAF-13-SXI	C7	1																												
BLAF-13-SXI	C4	25	15	5	5						3																	1		
PEK-12-SI	C1	5																												
PEK-12-SI	C3	4																												
PEK-12-SI	C5	1									5																			
PEK-12-SI	C6	5									5																			
PEK-12-SI	C8	2																												
PEK-12-SI	C9	6	1		2				1		0	1																		
BLAF-13-SIX	C6 ±100cm	0	15		5						3		5			6												4		
TTK-13-SI	C1 Niv 6-7	10			25						9		6																	
TTK-13-SI	C 17 Niv 10		17		12						4																		1	
TTK-13-SI	C7 Niv 7	41			30																									
TTK-13-SI	C9 Niv 10	15									6																			
TTK-13-SI	C14	15									1																			
TTK-13-SI	C22 Niv 14	9									10																			1
TTK-13-SI	C23 Niv 16/17	12			25																									
TTK-13-SI	C 19 Niv 24/25	15																												
TTK-13-SI	C19 Niv 35/36	100																												
TTK-13-SII	C 21 P 20	3							2			2					3			1										
TTK-13-SII	C 20																													
TTK-13-SII	C 28		25																											
KLI-14-RCI	U6	0	5		9						1		7			4												1		
KRO-14-SI	C1 80-90	12																												
KRO-14-SI	5-10	2																												
KRO-14-SI	10-20	2																												
KRO-14-SI	20-30	1																												
KRO-14-SI	30-40	1																												
KRO-14-SI	40-50																													
KRO-14-SI	50-60	1	2			4		1	4	4		4									1			1						
KRO-14-SI	60-70	0	1																											
KRO-14-SI	70-80	1	2		2																1			1						
KRO-14-SI	90-100		5																											
KRO-14-SI	C1 100-110	6			51						9																			
KRO-14-SI	C1 110-120								3	3		3																		
KRO-14-SI	C1 120-130	6																												
KRO-14-SI	C1 130-140	0	5		5	2		1	8	8		8																		
KRO-14-SI	C1 140-150	8																												
KRO-14-SI	C1 150-160	4			14						6																			
KRO-14-SI	170-180																													
KRO-14-SI	C2 150-160	31																												
KRO-14-SI	C2 160-170	11														1														

Sites	Context	*Capparidaceae*	*cf triticum*	*Gynandropis gynandra*	*commelina*	Ceratotheca sesamoide	*Eleusine indica*	*elongated digitaria*	*digitaria Cf exilis*	*Digitaria exilis*	*Echinochloa sp (cf colona)*	*borreria sp.*	*Digitaria*	*Paspalum*	*Panicum Sp.*	*Brachiaria*	*Lamiaceae*	*Acacia*	*Moraceae*	Total
BLAF-12-SV	C 1B																			21
BLAF-12-SV	C1C														15					38
BLAF-13-SXI	C2									45										232
BLAF-13-SXI	C6			1	25		6		5	51										428
BLAF-13-SXI	C7																			7
BLAF-13-SXI	C4							2	3	28				1						197
PEK-12-SI	C1																			17
PEK-12-SI	C3																			13
PEK-12-SI	C5																			24
PEK-12-SI	C6																			55
PEK-12-SI	C8																			11
PEK-12-SI	C9							2	1											16
BLAF-13-SIX	C6 ±100cm							5	2	49										220
TTK-13-SI	C1 Niv 6-7									15										90
TTK-13-SI	C 17 Niv 10									2										93
TTK-13-SI	C7 Niv 7									18										172
TTK-13-SI	C9 Niv 10									511										1215
TTK-13-SI	C14									96										135
TTK-13-SI	C22 Niv 14									185										393
TTK-13-SI	C23 Niv 16/17									69										207
TTK-13-SI	C 19 Niv 24/25									45										147
TTK-13-SI	C19 Niv 35/36									8										430
TTK-13-SII	C 21 P 20																			25
TTK-13-SII	C 20																			35
TTK-13-SII	C 28							1		12	14									90
KLI-14-RCI	U6									35	3									145
KRO-14-SI	C1 80-90																			34
KRO-14-SI	5-10																			20
KRO-14-SI	10-20																			9
KRO-14-SI	20-30																			6
KRO-14-SI	30-40																			14
KRO-14-SI	40-50									12	1									18
KRO-14-SI	50-60									13										39
KRO-14-SI	60-70									25										32
KRO-14-SI	70-80									16	1									29
KRO-14-SI	90-100									10										18
KRO-14-SI	C1 100-110												4							137
KRO-14-SI	C1 110-120									27										54
KRO-14-SI	C1 120-130												2							36
KRO-14-SI	C1 130-140									24	1									67
KRO-14-SI	C1 140-150																			23
KRO-14-SI	C1 150-160									69			3							206
KRO-14-SI	170-180																			15
KRO-14-SI	C2 150-160												6							54
KRO-14-SI	C2 160-170												3							35

Appendix G''': Appendix G'': North Benin macro-botanical sample (Multi site, Phase 3 part 1)

	Sites	**Context**	**Volume (litres)**	***Pennisetum glaucum***				***Oryza glaberrima***				***Sorghum bicolor***							Indet seeds	indet seeds frag			*Lannea microcarpa*			*Adansonia digitata*				*Elais guineensis*	*ziziphus*	*celtis*	*Canarium shweinfurthii*
				Spikelet	involucre	Seed	**Total**	Lemma	Spikelet	Seed	**Total**	Seed	seed frag	Guinea	bicolor	immature grain	Involucre	**Total**			wild grasses	*Nuts indet.*	*frag*	fruit	total (estimated)	frg	estimated	*seeds*	***Total***				
Phase 3	**BLAF-14-SXVIII**	2NIV2	15			12	**12**		85	7	**92**							**0**															
	BLAF-14-SXVIII	3NIV2	15				**120**		69	5	**74**							**0**															
	KRO-14-SII	C1 0-20	15			12	**12**																										
	KRO-14-SII	C1 20-30	15			2	**2**																										
	KRO-14-SII	C1 40-50	15			13	**13**				**0**	1						**1**	25			8								2			
	KRO-14-SII	C1 30-40	15			1	**1**																										
	KRO-14-SII	C 1 50-60	15			10	**10**				**0**							**0**	18			1											
	KRO-14-SII	C1 60-70	15			1	**1**																										
	KRO-14-SII	C2 70-80	15			23	**23**			1	**1**	4						**4**	5											3			
	KRO-14-SII	C2 80-90	15			26	**26**				**0**							**0**	13			7											
	KRO-14-SII	C 3 90-100	15			41	**41**		1		**1**							**0**	24														
	KRO-14-SII	C4 100-110	15		1	50	**51**				**0**	2						**2**	35									2					
	KRO-14-SII	C4 110-120	15			45	**45**		1		**1**	15						**15**	0	8	3	25						15		1			
	KRO-14-SII	C4 120-130	15			17	**17**				**0**	1						**1**	16			1											
	KRO-14-SII	C4 130-140	15			15	**15**		1		**1**	1						**1**	13									17		10			
	KRO-14-SII	C5 140-150	15			25	**25**		2		**2**							**0**	15			12						3		2			
	KRO-14-SII	C5 150-160	15			41	**41**		4	1	**5**	6						**6**	25									3					
	KRO-14-SII	C5 160-170	15		3	60	**63**	2	5	1	**8**	7						**7**	40			15						3		6			
	BLAF-14-SXIII	Sample 2 C24	40				**0**		9		**9**	2		2				**2**	2		2	1				1	1		1				
	BLAF-14-SXIII	Sample 3 C23	30		1	1	**2**	1	1		**2**							**0**	2			4						2					
	BLAF-14-SXIII	Sample 4 C21	40			2	**2**		1		**1**	1						**1**	0	1								2					
	BLAF-14-SXIII	Sample 5 C21	40			1	**1**		1		**1**							**0**	3	2		4						2					
	BLAF-14-SNAKE	150 -180 cm	30		2	15	**17**		5		**5**	2																					
	BLAF-14-SNAKE	180-200 cm	25		4	19	**23**		12		**12**								69														
	BLAF-12-SIII	C 6	19			25	**25**				**0**							**0**	15									2					
	BLAF-12-SIII	C 9	18			13	**13**		2		**2**	1						**1**															
	BLAF-13-SX	C7 north	10			15	**15**				**0**	2						**2**	25	2													
	BLAF-13-SX	C12	25		4	1	**5**		40	2	**42**		2				16	**16**	8	13		3				3	3						
	BLAF-13-SX	C7 south	10		5	10	**15**					1						**1**	2	8													
	BLAF-13-SX	C26	10			1	**1**		1		**1**							**0**	1	2			2		1	3	2	2					
	BLAF-13-SX	Burnarea room 2	5				**0**				**0**							**0**	5														
	BLAF-13-SX	Under room 1	10			3	**3**				**0**	5	3					**5**	2	7		0				25	5	2	7				
	BLAF-13-SX	Sect° compl wall	10			3	**3**		1		**1**		1					**0**	0	5		0	17		2	1	1	3	4				
	BLAF-13-SX	C8 ext pot	2			1	**1**				**0**							**0**	0	5													
	BLAF-13-SX	Room 2 pot 7	2			1	**1**				**0**							**0**	4														
	BLAF-13-SX	Room 2 pot 8	5			1	**1**				**0**							**0**	3			1											
	BLAF-13-SX	Room 2 pot 11	5				**0**				**0**							**0**															
	BLAF-13-SX	Room 1 pot 1	2		1		**1**				**0**							**0**	0									4					
	BLAF-13-SX	Room 1 pot 3	5			1	**1**				**0**							**0**															
	ROU-14-SI	U6	5			3	**3**			0	**0**	1						**1**	35			26								5			
	BLAF-14-SXIV	F1 moy	20		42	52					**0**							**0**	5	50		11	25		5	12	7						
	BLAF-14-SXIV	F1 basse	20		24	5	**29**						1					**1**	1	25	1							8					
	BLAF-12-SVI	C1 (5-10 cm)	1			1	**1**																										
	BLAF-12-SVI	C3 (60 cm)	1			3	**3**																										
	BLAF-14-SXIX	100 CM	30			2	**2**																										
	BLAF-14-SXIX	240-250	30			1	**1**																										
	ALB-14-SII	20-30	20				**1**																										
	NSIP Phase 3		**1457**	**0**	**122**	**2250**	**2340**	**39**	**1029**	**32**	**1100**	**292**	**32**	**25**	**0**	**1**	**82**	**376**	**837**	**255**	**11**	**310**	**51**	**0**	**11**	**63**	**34**	**132**	**30**	**47**	**0**	**0**	**11**
	Frequency phse 3			**0**	**1.39**	**25.64**	**26.66**	**0.4**	**11.7**	**0.4**	**12.53**	**3.3**	**0.4**	**0.3**	**0**	**0**	**0.934**	**4.28**	**9.537**	**2.906**	**0.125**	**3.5**	**0.6**	**0**	**0.1**	**0.7**	**0.4**	**1.5**	**0.3**	**0.5**	**0**	**0**	**0.1**

Sites	**Context**	*Vitex sp.*				*cf vitellaria*								*Gossypium sp*																				
		frag	*estimation*	*fruit*	***total***	*frag*	*estimation*	*fruit*	***total***	*sclerocarya*	*CF vitellaria*	*CF Vigna unguiculata*	*Vigna unguiculata*	*caps*	*seeds*	*Capparidaceae*	*cf triticum*	*Gynandropis gynandra*	*commelina*	*Ceratotteca sesamoïde*	*Eleusine indica*	*elongated digitaria*	*digitaria Cf exilis*	*Digitaria exilis*	*Echinochloa sp (cf colona)*	*borreria sp.*	*Digitaria*	*Paspalum*	*Panicum Sp.*	*Brachiaria*	*Lamiaceae*	*Acacia*	*Moraceae*	Total
BLAF-14-SXVIII	2NIV2												150											12										266
BLAF-14-SXVIII	3NIV2												150											27										251
KRO-14-SII	C1 0-20																																	12
KRO-14-SII	C1 20-30																																	2
KRO-14-SII	C1 40-50																																	49
KRO-14-SII	C1 30-40																																	1
KRO-14-SII	C 1 50-60																																	29
KRO-14-SII	C1 60-70																																	1
KRO-14-SII	C2 70-80																																	36
KRO-14-SII	C2 80-90																																	46
KRO-14-SII	C 3 90-100																							58										124
KRO-14-SII	C4 100-110																																	90
KRO-14-SII	C4 110-120																						1	35										149
KRO-14-SII	C4 120-130																																	35
KRO-14-SII	C4 130-140												4																					61
KRO-14-SII	C5 140-150																							1										60
KRO-14-SII	C5 150-160																																	80
KRO-14-SII	C5 160-170																							1										143
BLAF-14-SXIII	Sample 2 C24									2		2												6										31
BLAF-14-SXIII	Sample 3 C23																																	12
BLAF-14-SXIII	Sample 4 C21																							2										9
BLAF-14-SXIII	Sample 5 C21																																	13
BLAF-14-SNAKE	150 -180 cm																																	24
BLAF-14-SNAKE	180-200 cm																							18										122
BLAF-12-SIII	C 6																													1				43
BLAF-12-SIII	C 9																																	16
BLAF-13-SX	C7 north												5										2											51
BLAF-13-SX	C12																				1	1	82		8									187
BLAF-13-SX	C7 south																																	26
BLAF-13-SX	C26																							5										20
BLAF-13-SX	Burnarea room 2																																	5
BLAF-13-SX	Under room 1																							58										117
BLAF-13-SX	Sect° compl wall																																	38
BLAF-13-SX	C8 ext pot																							18										24
BLAF-13-SX	Room 2 pot 7																																	5
BLAF-13-SX	Room 2 pot 8																							55										60
BLAF-13-SX	Room 2 pot 11																																	0
BLAF-13-SX	Room 1 pot 1																																	5
BLAF-13-SX	Room 1 pot 3																							12										13
ROU-14-SI	U6																																	70
BLAF-14-SXIV	F1 moy	160	5	1	6	250	4		4				2											335	16									992
BLAF-14-SXIV	F1 basse				5							1												69										140
BLAF-12-SVI	C1 (5-10 cm)																																	1
BLAF-12-SVI	C3 (60 cm)																							4										7
BLAF-14-SXIX	100 CM																							5										7
BLAF-14-SXIX	240-250																																	1
ALB-14-SII	20-30																																	0
NSIP Phase 3		**163**	**5**	**1**	**12**	**253**	**5**	**0**	**7**	**2**	**0**	**5**	**320**	**1**	**1**	**0**	**0**	**1**	**25**	**0**	**7**	**11**	**96**	**2086**	**44**	**0**	**18**	**1**	**15**	**1**	**0**	**0**	**0**	8776
Frequency phse 3		**1.86**	**0.1**	**0**	**0.1**	**2.88**	**0.1**	**0**	**0.1**	**0**	**0**	**0.1**	**3.6**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0**	**0.1**	**0.1**	**1.1**	**23.77**	**0.5**	**0**	**0.2**	**0**	**0.2**	**0**	**0**	**0**	**0**	**100**