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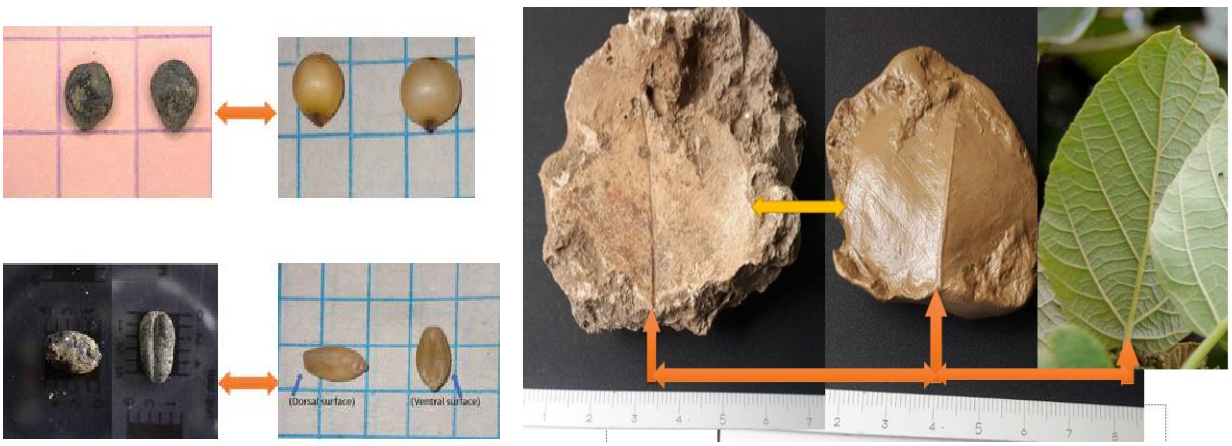

AN INVESTIGATION OF THE ARCHAEOBOTANICAL REMAINS FROM THE SITE OF HARLAA, EASTERN ETHIOPIA (MID-6TH–15TH CENTURY AD)

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An Investigation of the Archaeobotanical Remains from the Site of Harlaa, Eastern Ethiopia (Mid-6th–15th Centuries AD)

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This is the thesis presented by Endris Hussien Siraj entitled: An Investigation of the Archaeobotanical Remains from the Site of Harlaa, Eastern Ethiopia (Mid-6^{th}–15^{th} Centuries AD) submitted in partial fulfillments for the Degree of Master of Arts in Archaeology and Heritage Management, in the Department of Archaeology and Heritage Management, compiles with the regulations of the university and meets the accepted standard with respect to originality and quality.

Signed by the examining committee:

External examiner ____________________ Signature ____________ Date________________

Internal examiner ____________________ Signature _____________ Date________________

Immediate Supervisor____________________ Signature_____________ Date________________

Co-Supervisor Professor Timothy Insoll Signature T.Insoll Date 3/10/21

This thesis work is dedicated to my late brother, Yimer Hussien.

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Acronyms

AMS – Accelerated Mass Spectrometry

ARCCH – Authority for Research and Conservation of Cultural Heritage

ASL – Above Sea Level

Cal. – Calibrated

Uncal. – Uncalibrated

C_{14} – Radiocarbon

ERC – European Research Council

FAO – Food and Agriculture Organization

sp. – Species

ssp. – subspecies

UK – United Kingdom

Abstract

The archaeology of Islamic Ethiopia has been fundamentally understudied until recently, and the archaeobotany specifically has been largely neglected. This archaeobotanical investigation is part of a wider archaeological research project called "Becoming Muslim", which began work at the site of Harlaa, since 2015. The archaeological evidence from Harlaa confirms the immense importance of the site, which was an important commercial, residential, and industrial quarters between the mid-6th and 15th centuries AD. A total of 230.04 liters of soil samples during the 2016 to 2020 field seasons were collected through excavation, which are the focus of this study, with the aim of looking: at the food economy of the inhabitants, diversity and distribution of floral resources, and the environmental history of the study area. More than 718 plant remains were identified, and were grouped as cereals, legumes, oil plants, weedy plants, woods and Poaceae based on their primary use and morphological character. The finding indicates that the historic Harlaa peoples had developed food-crops-based subsistence strategy from the mid-6th to early 15th centuries AD. Based on the data recovered, it is possible to see that most of the food crops recovered at Harlaa are Middle Eastern, and are similar with the food crops of the northern highlands. Secondary sources indicate that cash crops (such as khat and coffee) were amongst the widely cultivated plants introduced to the region at a later date, probably after Harlaa was abandoned in the 15th century. The archaeobotanical data, however, is devoid of remains related to khat and coffee.

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

The Horn of Africa witnessed an early development of permanent settlement that paved the way for the formation of complex societies and subsequent civilizations. The Ethiopian highland region in particular has provided some of the earliest evidences of early food production, and is considered as one of the eight centers of early plant domestication in the world (Vavilov, 1951; Hanson, 1952; Simoons, 1958; Harlan, 1969; & De Candolle, 1985). Since then, many researchers have invested much attention to this region and have conducted comprehensive studies on the environmental conditions and food systems of early and subsequent occupants. The impact of past contexts of environmental and climatic variability on human cultural developments and mechanisms of adaptation have also been the subject of multiple intellectual discussions (Simoons, 1958, 1965; Brandt & Brook, 1984; Barnett, 1999; D'Andrea, 2008; Beldados et al., 2015).

Despite these discussions, archaeological research in Ethiopia has been impeded by the biases of archaeologists in terms of time periods and regions studied (Beldados et al., 2015). Spatially, the northern and northeastern outskirts of the country have been prioritized over other areas. Temporally, the prehistoric archaeology of Ethiopia is widely favored by researchers. Topically, lithic and osteological materials have been given more attention than other archaeological remains (e.g., Clark et al., 1984; Abbate et al., 2010; McPherron et al., 2010). Due to these biases, our understanding of the technology and behavior of prehistoric man is much better than the historic man and his environment.

Like the northern region, sites in Eastern Ethiopia, particularly those located within and along the escarpments of the Great East African Rift Valley, are sources of evidence of prehistoric occupations and cultural developments since the Pliocene epoch. Due to this fact, many researchers have conducted countless and informative studies regarding the earliest human biological developments, technological achievements, environmental dynamisms and adaptive strategies here (Clark et al., 1984; Abbate et al., 2010; McPherron et al., 2010). However, the study of historical archaeology in eastern Ethiopia, as well as the northern and southern regions (Meresa, 2012), owes its legacy to the study of conspicuous materials, such as monuments, cave dwellings and buildings. The study of smaller and microscopic materials, such as archaeobotanical remains, is lacking.

Researchers (Brandt & Brook, 1984; Pearsall, 1989; Hastorf, 1999; Marshall et al., 2009; VanDerwarker & Peres, 2010; Beldados et al., 2015) argue that archaeobotanical study is fundamental in broadening our knowledge of various phenomena including: human-plant relationships; stone tools and pottery functions; resource distributions and utilizations; peoples' ecological adaptations; and environmental and food system changes and continuity in time and space. Due to the fact that human beings have mostly tended to utilize floral resources in their livelihood, significant changes have been observed on both the cultural developments and availability of plants in their surroundings (VanDerwarker and Peres 2010). According to Beldados (2015:2), an archaeobotanical approach is increasingly crucial due to the fact that it can unlock social changes which occurred in the past, and identify modification of floral resource utilization through time, as well as environmental and climatic changes.

As indicated above, the environment and human-plant relationships in the historical archaeology of eastern Ethiopia, particularly localities out of the main Rift Valley area, have been given very little attention. Harlaa is one of these neglected sites, where we know very little about its ecological niche nor its peoples of historic period prior to the commencement of the *Becoming Muslim* project. This research, therefore, is designed to study the botanical remains collected from the archaeological site of Harlaa in eastern Ethiopia, and thus fill a major research gap in Ethiopian archaeology.

2.1. Current Environmental Setting of the Study Area

The study area is in the southern escarpment of the Afar rift some 35kms northwest of the city of Harar and 15kms southeast of Dire Dawa city. It is delimited between 9°29'10.22''N latitude and 41°54'36.96''E longitude. The site has an elevation of 1700 meters above sea level (ASL) (Figure 1).

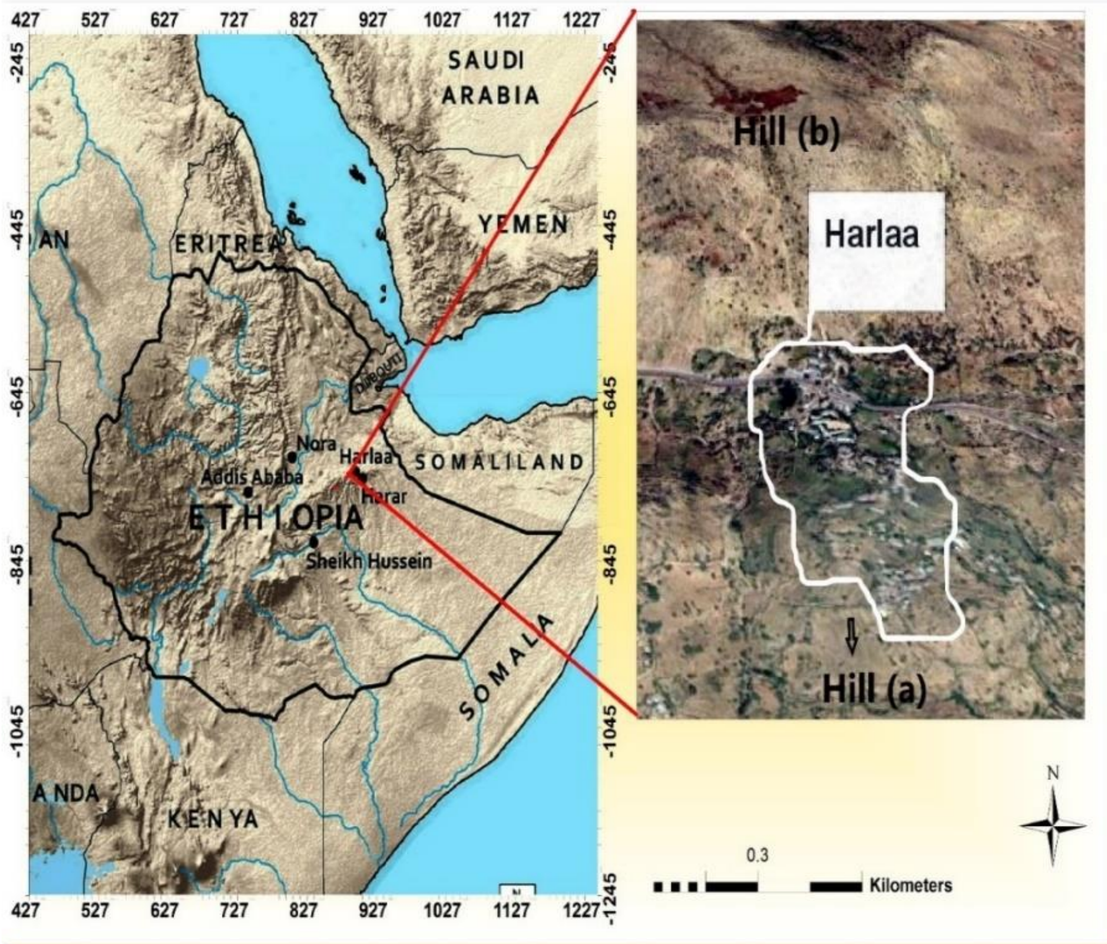

Figure 1. Map that shows the location of Harlaa (developed by: Habir Mohammed and Endris Hussien, 2020).

The contemporary village of Ganda Biyo is built on top the archaeological remains of historic Harlaa, and is managed by the Dire Dawa administrative council. According to Insoll et al, (2020: 2), it is one of the many "stone-built ruined towns and funerary monuments in the region". As shown above on the map (Figure 1), Harlaa is located between the Dengego hill (Hill A), which is less steep and where much of the archaeological remains are found and also where the majority of the current occupants live and Gara Harfattu, which is situated north of Dengego (Hill B) opposite the main road. Ganda Biyo stretches across both sides of the road at the foot of each hill, and some way up the slopes, however, Gara Harfattu is much less populated, and the structures are not built as far up. The area is characterized by an east-west oriented fault that formed parallel horsts. The main road connects the cities of Harar and Dire Dawa, which crosses the fault.

The physiography of Harlaa is characterized by mountain ranges, hills and valleys. It is also features geomorphological outcrops of Precambrian metamorphic rocks (Gneisses, pegmatites and diorites), Mesozoic sedimentary rocks (Adigrat sandstone, Hamanlei limestone and Amba Aradam sandstone), and some distant coral alluvial sediments, travertine and river sand deposits of Tertiary volcanic (basalts) and quaternary sediments (Abate 2010). The gorges drain from the top of the hills down to the village. The formation of the drainages and gorges is the main water-bearing horizon in the area.

Climatically, the study area is characterized with hot and dry conditions. The annual temperature is ranging from a minimum of 16.2 to 30.4 with an average of 16.2°C. May and June are the hottest, and November, December and January are the coldest months of the area with mean annual rainfall ranges from 500 to 900 mm (Belayneh and Bussa 2014). There are no perennial rivers that flow year-round except some seasonal flash streams along the drainage of the vicinity.

Economically, agriculture is the main basis of the community, who rear animals (such as cattle and camel) and farm a cash crop known as '*khat* (*Catha edulis*)' dominantly in both rainfed and irrigational conditions. According to information obtained from the locals, no other food crops (except *sorghum* and maize/ corn, occasionally) are grown in the study area nor anywhere in the Hararghe region in general. They said that *khat* is the only crop that resists the drought, and is more productive and profitable than food crops. They manage to buy food crops from the nearby markets, such as in Dire Dawa City, for consumption.

Regarding on the current vegetation cover, Harlaa and its surroundings is also characterized by grass lands, wood lands, scrubland and bush lands species. According to the field observation done, also indicated by Belayneh & Bussa (2014), shrubs and scrubs (dominantly) and trees such as, *Acacia nilotica* (commonly known as Babul/ Kikar), *Acacia goetzei Harms* (Purple-pod acacia), *Acacia etbaica* (Schweinf), *bussei Harms ex Sjostedt* (Galol), *Balanites aegyptiaca (L.) Del.* (Desert date), *Aloe harlana Reynolds* (Harla Aloe), *Aloe seyal Del.* (Aloe vera), *Euclea racemosa Murr*, *Euphorbia bergeri M. Gilbert*, *Aloe megalacantha Baker*, *Ficus salicifolia Vahl*., *Opuntia ficus-indica (L.) Miller*, and *Oxalis stricta Haworth* are growing in the study area.

2.2. Statement of the Problem

Similar to the northern region, eastern Ethiopia was also one of the areas where complex societies were formed, and subsequent civilizations developed. In this region, many centers of civilizations were built, and previously accepted cultures and traditions were molded and shaped, while trade networks extending from the Red Sea and Gulf of Aden up to the Somali Coast were established and extended. In terms of economic, commercial and administrative engagements, the historic Harlaa peoples represented the most important position. They built a number of elaborate stone-built urban centers throughout the Eastern Hararghe, and accumulated large amounts of wealth through their dominant involvement in trading and farming economies of the region. This has been confirmed by historical accounts (such as WoldeAragay, 1971; Braukamper, 2004; Trimingham, 2004, Mohammed, 2016) although these are limited in scope and details.

Archaeologically, none of the ruins were explored until the project began at Harlaa site (Insoll and Maclean 2016). Directed by Professor Timothy Insoll, the ERC funded archaeological research project *Becoming Muslim: Conversion to Islam and Islamisation in Eastern Ethiopia*[1] has been conducting intensive month-long archaeological investigations annually between the months of January and February since 2015.[2] Harlaa is considered as an archaeological silo, where numerous material evidence has been uncovered ranging from the large stone-built ruins of defensive walls and well-preserved mosque, workshops and civic buildings up to the very small beads and fine ashes. This points to the importance of the site as more than just a settlement, rather it was a center for trading and manufacturing. The chronology of the site occupation (mid-6th to 15th centuries AD),[3] trade connections (internal & external), architecture and local industry have been important research points for the project (Insoll, et al., 2020).

This study focuses on the investigation of the archaeobotanical remains collected from the 2016 to 2020 field seasons. However, it does not include archaeobotanical remains of the 2015 field season as it was investigated by Beldados, the project's archaeobotanist. However, this study is not comprehensive, and the archaeobotanical remains were chronologically dated between the 12th and 14th centuries AD, which limits our understanding of the food system and environmental history of the site in earlier dates. This study is designed to fill this gap, by conducting an

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[1] Al-Qasimi Professor and Director of the Centre for Islamic Archaeology, Institute of Arab and Islamic Studies, University of Exeter, UK.

[2] European Research Council Advanced Grant 694254 ERC-2015-AdG

[3] **NB**: The period "mid-6th to 15th centuries AD" falls within two categories in the way Ethiopian history is framed (Tamirat, 1972). The 'Medieval period' covers the time span from 1270 – 1855, and hence, the period before 1270 is considered as 'ancient'. In this study, therefore, following the Ethiopian framework, both terms (ancient and medieval) are used in speaking of Harlaa occupation (mid-6th-15th centuries AD) and its peoples since it touches both periods as defined in Ethiopian historiography.

intensive investigation of the archaeobotanical remains collected from the 2016 to 2020 field seasons, as the site of Harlaa is dated between the mid-6th and 15th centuries AD.

2.3. Research Questions

This study addresses the following five basic research questions:

1) What was the economic base of the historic Harlaa peoples in the study area?
2) Which plants were dominantly grown for food consumption in the area?
3) What did the environment look like during the period under consideration?
4) Is there any change in the environmental condition of the area?
5) How do we compare the ancient and medieval food consumption habits with the present?

2.4. Research Hypothesis

Regardless of the agroeconomic and environmental history of Harlaa, the following hypothesis was developed in this research.

a) The ancient and medieval Harlaa peoples' mode of subsistence pattern followed a regional pattern throughout the Mid-6th-15th centuries AD, and there has been a continuity of environmental condition since then, or:
b) Environmental change occurred, and was responsible for the abandonment of Harlaa, or at least changed the agroeconomic strategy of the inhabitants.

To test this hypothesis, various techniques were employed, such as archaeological excavations, interviews, and ethnoarchaeological surveys. Soil samples were collected in all fieldwork seasons, and recovered macrobotanical remains were carefully studied in the laboratory at the

Authority for Research and Conservation of Cultural Heritage (ARCCH) to identify and classify them in their taxa categories. The diversity, distribution, and morphology of botanical remains have been given due attention in the course of the analysis. The phytogeography and related issues were studied to develop a credible interpretation of the ecological settings of the area and adaptive strategies of the inhabitants.

Furthermore, historical documents (e.g., Pankhurst, 1972; Zewude, 1976; Wood, 1977) which mention large-scale environmental catastrophes occurred in many parts of Ethiopia were also consulted to explore whether environmental changes were evident or not in the study area. This helped to correlate the situation with the identified archaeobotanical remains.

2.5. Objectives of the Study

The overall aim of this study is to address the research questions mentioned in section 1.3 and 1.4. Accordingly, the study has a number of general and specific objectives outlined below.

2.5.1. General Objective

The main objective of this study is to reconstruct the people-plant relationship, food systems and the environmental history of the study area.

2.5.2. Specific Objectives

The specific objectives of this study are:

- To understand the subsistence strategy of the historic Harlaa peoples
- To identify and document edible and non-edible plants' species and diversity
- To explore the uses of the different plant species
- To see the change and/ or continuity of the environmental conditions in the study area

- To understand the vegetation history of the study area and its surroundings

2.6. Materials and Methods

The research quality of any study is determined by the methods applied and materials used in the course of investigation. In studying the human past, archaeology is one of the most imperative disciplines that require various materials and methods in different phases of the investigation. Ultimately, the research questions, the goals to be achieved, and the data to be obtained and investigated, determine the selection of materials, approaches and techniques required. In paleobotany, for example, the methods and materials needed for the analysis of macroremains are different from that of chemical and molecular evidence. Accordingly, the following materials and methods have been used in the pre-fieldwork, fieldwork and post-fieldwork investigations to generate data both from primary and secondary sources.

2.6.1. Pre-Fieldwork Methodology

Before going to the field, having background information about the issue under investigation is the primary and basic step to identify gaps to be filled. Accordingly, academic works (both published and unpublished) about the study area, the study itself, and the methods have been consulted. These include annual reports, journals, historical narratives, books, traveler accounts, and dissertations.

2.6.2. Fieldwork Methodology

As previously mentioned, archaeological study has different phases of investigation. Once the researcher identifies the research problem, fieldwork should be the next task. Fieldwork can be considered as the data acquisition step for this particular study since the researcher acquires the material remains and other supportive data as primary sources. In the fieldworks of this study, series of excavations were carried out, and survey was also employed from January to February annually between 2016 and 2020.

2.6.2.1. Excavations

In archaeology, excavation is one of the most fundamental approaches to unlock the resources of the past. To better understand ancient and medieval Harlaa, who its occupants were, their economic base, their settlement pattern, items they produced and traded, etc., a series of excavations have been undertaken at the site by the *Becoming Muslim* research project. Excavations were carried out annually since 2015 to 2020 in the site. Arbitrary levels were used in the courses of excavations as it was generally difficult to define stratigraphy. A large amount of material remains have been uncovered including the botanical remains all of which made the site an archaeological 'granary'.

The botanical remains were taken mostly from features with ash and charcoal deposits such as hearths and postholes. Some botanical remains were also obtained from pits, and in-situ pottery vessels with intact contents (see Appendix-II). Moreover, pottery and plaster with seed and leaf imprints, and grindstones were also collected for this study. These material remains provide indirect information about the types of plants processed and utilized in the area by the site occupants. Great care was taken to excavate each artifact intact. Sample bags were labeled with the context name, trench name, feature type, contents (ceramic, bone, etc.) and date of excavation to easily identify where and when the data was obtained.

2.6.2.2. Ethnoarchaeological Approaches

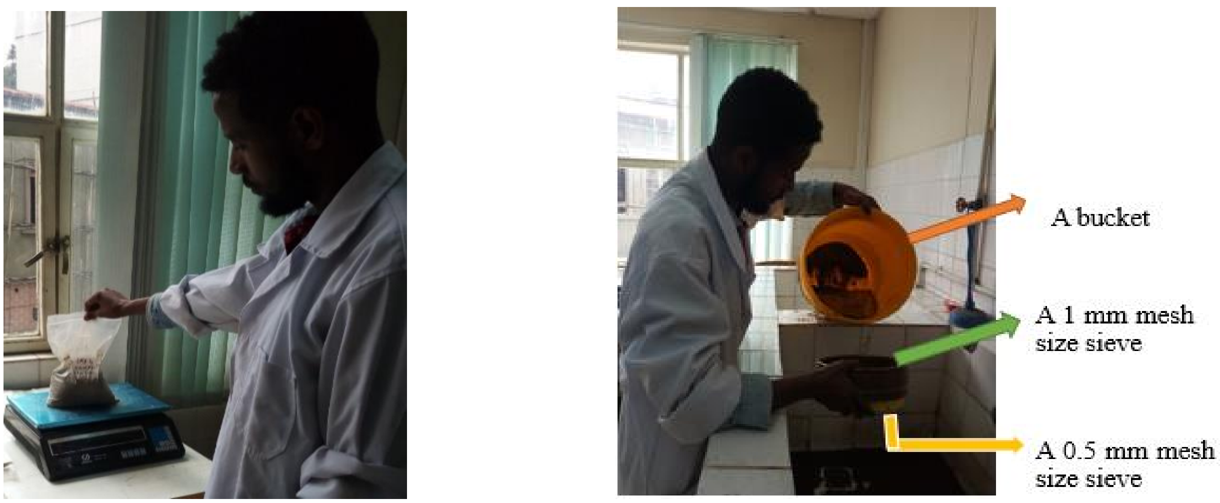
Ethnoarchaeological approaches were another data recovery techniques employed in the fieldwork of 2020 season. Ethnoarchaeological investigation is also significant to understand peoples' food production and utilization; land-use system and environmental preference of plants (Lyons and D'Andrea 2003). This approach according to many researchers (e.g. Hildebrand, 2009; Capparelli et al., 2014; Daniel & Beldados, 2018) helps to a build predictive model to correlate the ethnoarchaeological observation with past resources utilization and sequence of events. As part of this approach, information about the current vegetation of the study area was gathered as well as information on the current crops grown, and by the present occupants, through field observations and interviews. During the survey, a complete pot filled with soil from the house of Hamad Ibro was collected (see Appendix-II). Observing the variety of plants growing within the vicinity of Harlaa was also another task performed under ethnoarchaeological survey approach.

2.6.3. Post-Fieldwork Methodology

Post-field examination was another stage of investigation mostly done in a laboratory. In archaeobotany, it has different phases of recovery techniques such as hand collection (dry screening), water screening, floatation, sorting and identification. In this study, only floatation has been used as (1) there is a huge amount of soil samples (over 230 liters) that makes using hand collection recovery technique difficult and time consuming; (2) it allows the majority of botanical remains to be recovered in greater abundance and a more representative way (e.g., Payne 1972; Wright 2010). All the laboratory works were carried out at the ARCCH) in Addis Ababa, Ethiopia.

2.6.3.1. Floatation Technique

Floatation has been the most common and widely practiced method of recovering botanical remains. Many researchers (such as Wagner 1983; Watson 1976; Wright 2010) recommend the use of hand-floatation technique as the easiest of all the numerous varieties of floatation systems applicable including, for example, the Flote-Tech machine (Hunter and Gassner 1998). It allows the heavy fraction (a deposit with heavy weight) to accumulate in the bottom of the container and the light fraction (a deposit with light weight) to float over and pour off. It also avoids the potential occurrence of contamination.



(a) weighing the soil sample to be floated **(b)** floating

Figure 2. Photos showing the process of floatation (Photo by Endris Hussien and Frie Tefera, 2021).

In the process (Figure 2), a 30 kg capacity digital weighing machine (Dahongying) was used to control the amounts of the sample and water mixed. A bucket and sieves with 1mm and 0.5 mm sized mesh were used to recover all of the plant remains, including remains of a very small size.

2.6.3.2. Sorting Technique

Sorting was the process of separating the needed plant remains from the light-fractions for further investigation. It was conducted after the light-fractions were dry to minimize the fragility and abrasion of botanical remains. In the process, seeds large enough to be seen with the naked eye were easily separated from the light fractions, while a microscope with magnification power of eight times the naked eye was used for small size seeds. The sorted seeds and the light fractions were kept in separate plastic bags labeled with their contexts.

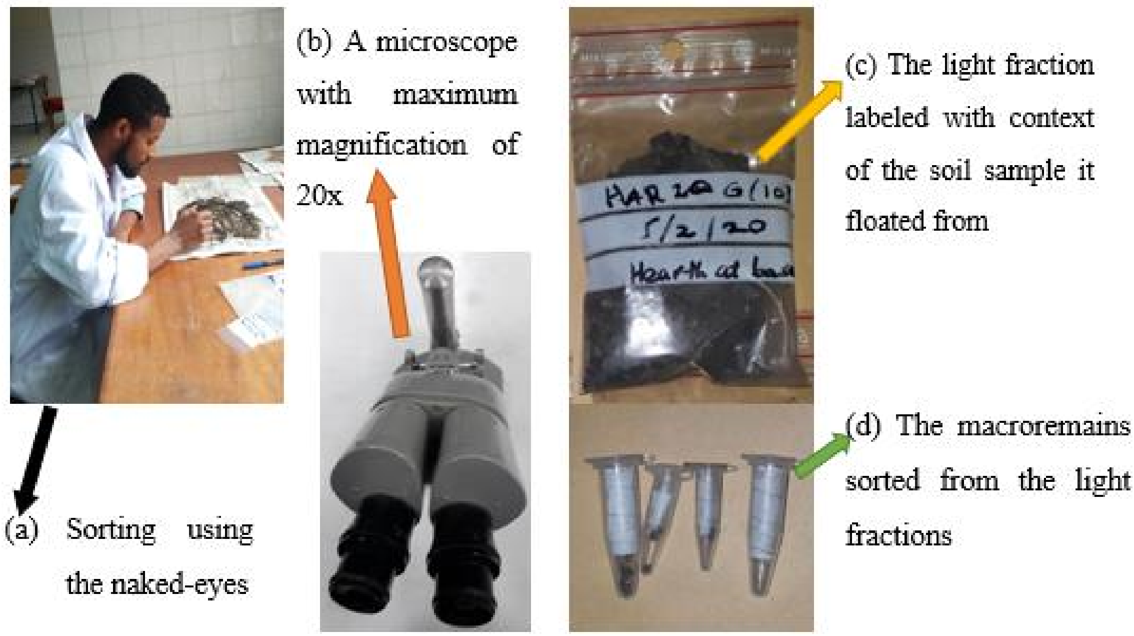


Figure 3. Photos showing the technique of sorting needed plant remains from the light fractions (photo by Tefera Tarekegn and Endris Hussien, 2020).

As shown in Figure 3 above, sorting was conducted by using the naked eye (a), and a microscope was used to find small size plant remains (b). After sorting the seeds, the light fraction was labeled with the context of the soil sample it was floated from (c), and the plant remains sorted from the light fraction were kept in separate plastic containers (d).

2.6.3.3. Identification Technique

Following the initial sorting process, the seeds were identified into each of their taxonomic categories. Identification is the process of recognizing and categorizing seeds and other needed plant remains into their taxonomic category. In this study, each seed type was classified into a species or genus or family taxon depending on its degree of conservation. According to Wright (2010), specimen identification must be accomplished by comparing the archaeological specimens to known specimens. Accordingly, comparison was made between the archaeological specimens and the colorful images of seeds in the *Digital Seed Atlas of the Netherlands*, a handbook prepared by Cappers, Bekker and Jans (2006), to better understand which species, or genera, or family taxa category the archaeological specimens belonged. This handbook was also used by Beldados, et.al. (2015) as it is important to study Ethiopian flora as well. In addition to this, comparative modern specimens were also used. The naked-eye and a microscope with magnification power of 20x and computerized digital microscope with magnification capacity up to 200x were used to identify the morphology of seeds clearly. A Dino-Lite digital microscope with magnification capability up to 220x was also used for photographing the seeds.

(a) Identification using the naked-eye (b) Dino-lite (c) Digital microscope

Figure 4. Photos showing the identification technique used to classify plant remains into species, genus and family levels (photo by Tefera Tarekegn and Endris Hussien, 2020).

As shown above in Figure 4, the process of identification was aided by a microscope with magnification power 20x the naked-eye and the *Digital Seeds Atlas of the Netherlands* handbook (a), and a dino-light with maximum magnification power of 220x (b). A computerized digital microscope with maximum magnification capacity up to 200x and an attached screen was also used during the identification task, and to take photos of the seeds (c).

2.6.3.4. Tabulation Technique

Throughout the recovery and other investigative processes conducted during the post-field analysis, each sample was tabulated with the following information: the contexts of samples, the volume of samples floated, the weight of light fractions obtained, the date of excavation, the number of seeds sorted out from each bag of light fractions, and the taxa category of seeds into species, genus and family levels. The following table is an example of how the tabulation was done.

No	Context	Vol. of sample (liter)	Weight of light fraction	Date of exc.	Identification		
					Species	Genus	Family
1	HAR19-E-12	10.7	380 g	02/2/2019	#3 *Hordium* sp.	#1 C. album	#1 poacae/ grass #1 *T. dicoccum* #1 *T. monococcum*
2	…	…	…	…	…	…	…

Table 1. An example of how the tabulation was done.

2.7. Significance of the Study

This field and laboratory-based research is significant as it provides information about the dietary systems and environmental conditions of the people who lived in historic Harlaa. It can also be used as a source for comparing the diets of other sites in the region. Furthermore, it can be used as a steppingstone for conservation of useful and indigenous plant species, the desire of re-forestation (if happens in the future) and preservation of the site from current and future natural and man-made threats. It can also be used as a spring-board for further studies related to subsistence, cultural exchange and information sharing among the Muslim communities of lowland and highland areas, and environmental change, impact and population response.

CHAPTER TWO

3. LITERATURE REVIEW

3.1. The Concept of Archaeobotany

The human past is multifarious; throughout their existence, human beings have gone through countless ups and downs. They made tools, altered their environments for resource utilization, either changed ecological occupations or developed adaptive strategies, and some species became extinct due to a number of factors. Among the various types of evidence left behind as testimony of the dynamic past, ecofacts/ biofacts [organic and environmental remains] are one of the most significant archaeological records that can provide insights regardless of environmental aspects, and dietary systems of site occupants (Renfrew 2016).

Etymologically, archaeobotany and palaeoethnobotany seem to have distinct conceptual orientations although commonly used interchangeably in practical application. Of course, it is obvious to find divergence in Western and American origin of methodological approaches and theories in cultural studies. The discipline of 'archaeology' itself is subject to debate regarding various theories and applications (Binford, 1965; Renfrew, 2016). Regarding 'archaeobotany' and 'palaeoethnobotany', scholars do not have a single approach to the interpretation and understanding of botanical remains (Hastorf and Popper 1988). For African, Asian and European researchers, archaeobotany is the study of the morphology and taxonomy of plants. Here, plant remain, whether related to human activity or not, could be identified and interpreted without taking their cultural use into consideration. For instance, Ford (1979:299) defined archaeobotany as: "*the study of plant remains from archaeological context…Archaeobotany refers to the recovery and identification of plants by specialists regardless of discipline.*"

On the other hand, palaeoethnobotany gives more consideration to the human use of plants. It underlines cultural interpretation of plant remains, and is hence defined by Renfrew (1973:1) as: *"the study of remains of plants cultivated or utilized by man in ancient times, which have survived in archaeological contexts"*.

Here for example, the ratio of cultivated plant remains recovered from a given settlement site need to be taken into account to answer specific cultural queries related to the mode of subsistence strategy and its significance in that area. It seems then, plant remains that are unrelated to human activities in the past are not necessarily the concern of palaeoethnobotany.

Although no conventional consensus has been reached among scholars, archaeobotany and palaeoethnobotany could refer to the same methodological specialization regardless of their etymological origins (Ford *et al* 1978, Ford 1979; Hastorf and Popper 1988; Wright 2010; Beldados 2015). The former grew out of Europe; and the latter was developed in America.

Both approaches can be used to investigate plant remains that would fall into different categories. As many environmental archaeologists (such as, Ford 1979; Hastorf and Popper 1988; Pearsall 2000; Wright 2010; Beldados 2015) have discussed, human-plant interactions, ecological occupations, environmental history of a given area, and other related issues could be deciphered from remains of plants ranging from micro to macro sizes. Furthermore, they categorized botanical evidence into three types as follows:

(1) Macrobotanical Remains: - these are fairly large size plant remains, such as seeds, wood, tubers, charcoals, leaves and nuts. These can be identified with the naked eye.

(2) Microbotanical Remains: - are tiny remains (such as pollen, spores, phytoliths or inorganic silica, and starch grains) which can only be recognized with a microscope of high-magnification power.

(3) Chemical and Molecular evidence: - are compounds and residues that could survive in human and animal osteological remains, sediments, remnant of plants and ceramic vessels. They are vital data for DNA, stable isotopic, and spectrographic analyses.

All three types of botanical evidence can be created by different stages and circumstances of formation processes and preservation states. In environmental archaeology, they provide information related to modes of subsistence, trading connections, dietary systems, food processing, the natural environment, climate change or climate continuity, landscape modification, plant domestication and C_{14} dating of the sites (Ford 1979; Hastorf and Popper 1988).

3.2. Theoretical Frameworks of Archaeobotanical Research

Among the approaches that emerged in the second half of the 19^{th} century, archaeobotany and palaeoethnobotany were the vital developments which revolutionized the methodological evolution of archaeology. By then, botanical remains were recognized as important in the archaeological investigation (Lodwick 2019). The methodological progress of the early 20^{th} century enabled researchers to broaden samples' contexts as far as palynological analysis (Birks 2000). The study of human-plant relationships became an archaeological focus after Jones' work on ethnobotany (1941).

Flotation as a more systemic recovery of botanical remains (Struever 1965) was undertaken as a paradigm shift of the 'New Archaeology' scientific approaches developed in the late 1960s.

Watson (1976: 79) described flotation as part of a "*recovery revolution*" that could allow researchers to recover plant remains in greater abundance. Since the 1970s, subsequent improvements and advances have been made in the techniques and interpretation of plant remains (Watson, 1976; Pearsall 2000; Wright 2010; Lodwick 2019). The improvements made on the techniques of recovery (such as, sampling and identification), and interest in archaeobotanical study greatly increased particularly in the academic umbrellas of processualists and post-processualists. In the 1970s, palaeoethnobotany has been given particular emphasis as a systematic recovery approach of plant remains in order to explore human-plants relationships in the past (Watson 1976).

Having all the above theoretical and conceptual frameworks in mind, the term 'archaeobotany' is preferred and used in this study. This is because the research is designed with the goal of reconstructing the human-plant relationships and environmental history which needs the remains of all plants, regardless of whether or not they are related to human activities.

3.3. A Glimpse of Studies on the Palaeoenvironment of Eastern Ethiopia

Eastern Ethiopia has been the subject of multiple discussions among researchers from a diverse range of specializations because of the geological and environmental diversity of the region (Philipson 2005; Brandt 1986; WoldeGabrial, et.al., 2016). The formation of the Great East African Rift System enriched the region with enormous evidence for various fields, including archaeology, palaeontology, palaeoanthropology, geology, and environmental studies. Within this wider sweep of archaeological potential, the study of the palaeoenvironment particularly in human prehistory occupied vital significances in terms of species evolution and development of adaptive mechanisms across space and time (Clark, *et al.,* 2003). A number of studies have been conducted to understand how human beings reacted to the environment, and to what extent the dynamism determined settlement preference, adaptation, migration and abandonment (Cerling 1992; Behrensmeyer 1997; Reed 1997; Beldados 2015, 2017).

Although the adaptive mechanisms developed by the populations are largely unknown, palaeoenvironmental research indicates that eastern Ethiopia has been experiencing variable climatic episodes throughout the Quaternary Period [2.588 million years to the present] (Brandt 1986; WoldeGabrial, et.al., 2016). In this regard, environmental oscillation is documented through oxygen isotope analysis, diatomic, ice core and palynological studies (Gasse, 1978; Brandt and Brook 1984; and WoldeGabrial, et.al., 2016). Some of these studies suggest that climatic change has been frequent in the region (For example, from ca. 115,000 to 70,000 years BP, the climate was warm and humid but, between 72,000- and 58,000-years BP it was arid, followed by a period of humidity between 58,000- and 31,000-years BP, with the environment again becoming arid from the early to Mid-Holocene (ca. 12,000-5,400 years BP), all of which resulted lake size fluctuations. In the broader spectrum, areas that fall within and on the escarpments of the Great East African Rift Valley experienced intensive desertification from the Early-Holocene epoch (11700-7000 years BP) onwards, but there needs to be more in-depth tempo-spatial environmental investigation to understand specific periods of climatic fluctuations and impacts on the lives of inhabitants (WoldeGabrial, et.al., 2016).

Contrary to the prehistoric time frame, historical archaeology in the lowlands of Ethiopia is sparsely studied (Beldados, 2015). Although not detailed, some historical studies indicate that climatic change had influences on the subsequent developments of food production and lifestyles of people throughout ancient and medieval Ethiopian history (Pankhrust, 1972; Zewude, 1976; Wood, 1977; Harari People Regional State Culture, Heritage and Tourism Bureau 2015). There have been prevalent climatic changes during medieval times, such as the "*medieval warm epoch*" Beldados (2017:16), accompanied by severe drought, famine and epidemics (13^{th} -19^{th} centuries AD) in the country. According to, WoldeAragay (1971), and Zewude (1976), those subsequent natural calamities caused the mass death of people and livestock, and had widespread and lasting effects, resulting in changes to administrative courts and polities.

3.4. Historical Studies in Harlaa and Its Environs

Historical study is relatively better developed than archaeological research in eastern Ethiopia in general and Harlaa in particular (Trimingham, 1965; WoldeAragay, 1971; Tamirat, 1972; Braukamper, 2002; Pleurdeau, 2006; Zeleke, 2009; Fauvelle-Aymar & Hirsch, 2011; Belayneh and Bussa, 2014; Harari People Regional State Culture, Heritage and Tourism Bureau, 2015; Insoll, MacLean and Engda, 2015; Mohammed, 2016; Leta, 2016; Insoll, 2017; Hassen, 2019; Insoll and Zekaria, 2019; Bogale, 2020**)**. As per the above studies, the medieval history of eastern Ethiopia is highly connected with Islamization and trade.

According to Tamirat (1972), autonomous and semi-autonomous Muslim sultanates were formed in eastern Ethiopia during the Medieval period. He mentioned Harar as a strategically positioned site that was quickly established as an Islamic center. Around the 13^{th} century, it became the capital of the powerful Muslim Sultanate of Adal, and took control of the caravan trade routes of the eastern provinces which were previously the economic sources of the Christian Highland Kingdom. Strengthened by the trading revenue, various Muslim provinces under the Christian Highland Kingdom (such as, Ifat, Fatagar, Dawaro and Bali) became self-governing and semi-autonomous Muslim sultanates from 1270 AD onwards. Harlaa, as one of these significant Muslim communities in the region, was an important locality for, and its people important subjects of, the Christian Highland Kingdom prior to 1358 AD, and it later became a powerful threat against the kingdom Tamirat (1972).

As far as the history of ancient and medieval Harlaa is concerned, scholars have never been in agreement upon the origin and identity of its peoples. Its history is mixed with the history of Oromo, Somali and Harari peoples (Trimingham 1965; Zekaria 1979; Harari People Regional State Culture, Heritage and Tourism Bureau 2015; Mohammed 2016; Hassen 2019; Bogale 2020).

WoldeAragay (1971) in his PhD dissertation, which focused on the relationship between the peoples of southeastern Ethiopia and the Christian kingdom during the 16th and 17th centuries, pointed out that Islam was the dominant religion particularly in the eastern reaches of the region. With particular reference to the medieval Harlaa people, he mentioned them as 'giant' Muslim traders and agrarians which occupied the area between the Chercher highlands to the Babile lowlands, who built towns with stone-built defensive walls.

Likewise, Trimingham (1965:58) mentions seven clans attributed to the Harlaa people who occupied vast areas stretching from Hararghe to the Ethio-Somali Region. These were: "*...Zerba, Zemobarah, Bazarah, Yagolah, Jazar, Arab Takha and Alga"*. Bogale (2020) also associated the origin of the medieval Harlaa peoples with one of the Somali clans known as *Darod* based on the oral traditions of Somali peoples. He identified ruins of stone-built mosques, houses, steles, beads and glass in the Ethio-Somali region, all of which are similar with the archaeological remains lying along the Chercher-Harar plateaus. He also collected information which associated divine intervention for the supposed disappearance of the civilization. In this respect, Bogale (2020:2) stated: "*Rather the Harla, as a wealthy and mighty people and frequently even* *imagined as giants, were wiped out by natural catastrophes and hunger sent by God as punishment for their inordinate pride."*

A book known as "*History of Harar and the Hararis*", published by the 'Harari People Regional State Culture, Heritage and Tourism Bureau (2015)', listed a number of rectangular ruins of stone-built houses in eastern Ethiopia, and attributed them to the Harlaa people. According to this book, the people were settled in vast areas including Darbi-gar in Chinaksen, Ganda Gola, Koremmi, Harla-Bad, Kadan, Djogola, Lange, Boko, Biyo Karaba, Biyo Waraba, Biyo Abduqe, Biyo Awale, Biyo Harla, and Biyo Salama. Cemeteries, ruined mosques, pottery sherds, and coins are also identified at these sites. These remains suggest that the sites were serving as both settlement quarters and trading centers. This book also notes that the Harari peoples (narrated as descendants of the Harlaa) had grown vegetables, cereal crops (such as sorghum) and cash crops (such as coffee and *khat*) in their farmlands outside of the walled city (Harar). These cash crops were also among the commodities and sources of revenue in the trade market developed during the medieval period. Furthermore, rock art dating circa 7000 years old depicting domesticated animals in northern Harar such as those at Laga Gafra in Garamullata, Laga Oda, Olad and Kimiat are also believed to be the works of Harlaa peoples (Harari People Regional State Culture, Heritage and Tourism Bureau 2015; Senbeto 2016).

Unlike Trimingham (1965), the Harari People Regional State Culture, Heritage and Tourism Bureau (2015:29) mentioned "*Gidaya, Awari, Wargar, Gaturi, Adish, Hargaya and Abogn*" as the Harlaa clans. These clans are claimed by the present Harari peoples as their ancestors. Moreover, the book explained the Harari people's economic basis of agriculture and trade as a continuation of the Harlaa people, namely that coffee, *Khat* and sorghum were and are the dominant crops in the region.

Likewise, Braukamper (2002) in his book entitled '*Islamic History and Culture in Southern Ethiopia: Collected Essays*' also stated that the medieval Harlaa people had managed to occupy vast areas along the Harar plateaus all the way to the Ethio-Somali Region. He attributed the ruins of stone-built houses and mosques in all locations to the Harlaa civilization. With regard to the end of the civilization, he also suggests that famine was a factor, and also the invasions of Oromo and Somali peoples into the region.

The Futuh Al-Habaša (2004): '*The Conquest of Abyssinia* [16th century]' by Šihabad-Din Ahmad bin Abd al-Qader bin Salem bin Uthman, is also one of the most vivid historical accounts that, albeit briefly, discusses the history of the Muslim populations in eastern Ethiopia. In this historical account, Ahmed Gragn's campaign against the Christian Highland Kingdom is given emphasis. The review indicated that in the wars between 1529 and 1533, Iman Ahmed appointed war leaders from the Adare (Hararis) and the Harlaa people. Unlike Braukamper (2002), Trimingham (1965), WoldeAragay (1971), and Bogale (2020), the Futuh Al-Habašha restricts the settlement areas of medieval Harlaa peoples within the Chercher-Harar plateaus. Furthermore, it indicates that an advanced form of mixed agriculture and trade were the main economic base of the Harlaa people.

Fauvelle-Aymar and Hirsch (2011) also touch upon the history of the medieval Harlaa people in their survey work "*Muslim Historical Spaces in Ethiopia and the Horn of Africa: A Reassessment.*" They articulated the chronological penetration and presence of Muslim communities in the pre-16th centuries based on conspicuous material remains and inscribed grave markers. Within the area of Muslim sites in the Chercher highlands. they recorded the ruins of two fortresses near Qulubi and Challanqo respectively, believed to be inhabited by a "g*iant"* race of Muslims, *known as* the Harlaa between the 8th and 12th centuries AD.

The medieval Harlaa civilization is also documented by Mohammed (2016) in the article entitled '*Mapping Historical Traces: Methogensis, Identity and the Representation of the Harela: A Historical and Anthropological Inquiry'*. According to this article, the site of the medieval Harlaa people has maintained its historic name till the present, and it is situated on the main Dire Dawa-Harar road. As the center of the medieval Harlaa peoples, various archaeological remains were recorded, including coins of different origins, grinding stones, water reservoir structures, a footprint on a stone, stamps, ruins of walls and more (Mohammed, 2016).

Although not historical in its content, Belayneh & Bussa (2014) has dealt with the medicinal plants used by the current Oromo occupants of Harlaa village entitled on "*ethnomedicinal plants used to treat human ailments in the prehistoric place of Harla and Dengego valleys, eastern Ethiopia*". According to this study, the historic Harlaa people built a prosperous kingdom with long-distance trade networks as far as the Middle East and East Asia through the Zeila route during the 13th to 16th centuries. It also discusses that the current habit of using plants (e.g., *Aloe harlana Reynolds*) in Harlaa village and areas along the Dengego valleys to cure various inflammatory and infectious human and animal diseases is an inherited activity from the historic Harlaa peoples.

3.5. Archaeological Studies in Harlaa

According to the archaeological investigation conducted by the *Becoming Muslim* project, much of the archaeology of Harlaa, is buried underneath the modern Oromo village of Ganda Biyo. The project has conducted surveys and excavations in Harar and Harlaa from 2014 to 2020 seasons with the objectives of (1) reconstructing the chronology and ceramics typology of the city of Harar and the outlying settlements (e.g., Ganda Harlaa), (2) testifying the legendary linkage between some settlements and populations (e.g., the Harla with the stature of '*giants*'), and (3) evaluating the material evidence to reconstruct the cultural identity, trade, and Islamisation in the region (Insoll and Tesfaye 2014). Accordingly, new knowledge has been generating about the occupational sequence, cultural developments and trade connections of the inhabitants. According to Insoll & Zekaria (2019), the establishment of Harar city post-dated Harlaa, and considered to be the last Islamic urban center in the region.

With regard to Harlaa, A series of annual excavations have been completed in six main areas (Figure 5) in the six consecutive seasons from 2015 to 2020. These are: a mosque (Area 'A'), a workshop complex (Area 'B' except labelled A in 2016), cemeteries (Area 'C' & 'D'), a house with kitchen/ industrial facility (Area 'E'), a large building complex associated with civic functions (Area 'F') and a large building portioned to a kitchen, food processing and living room (Area G) (Insoll, et.al., 2021; Tait & Insoll, 2021).

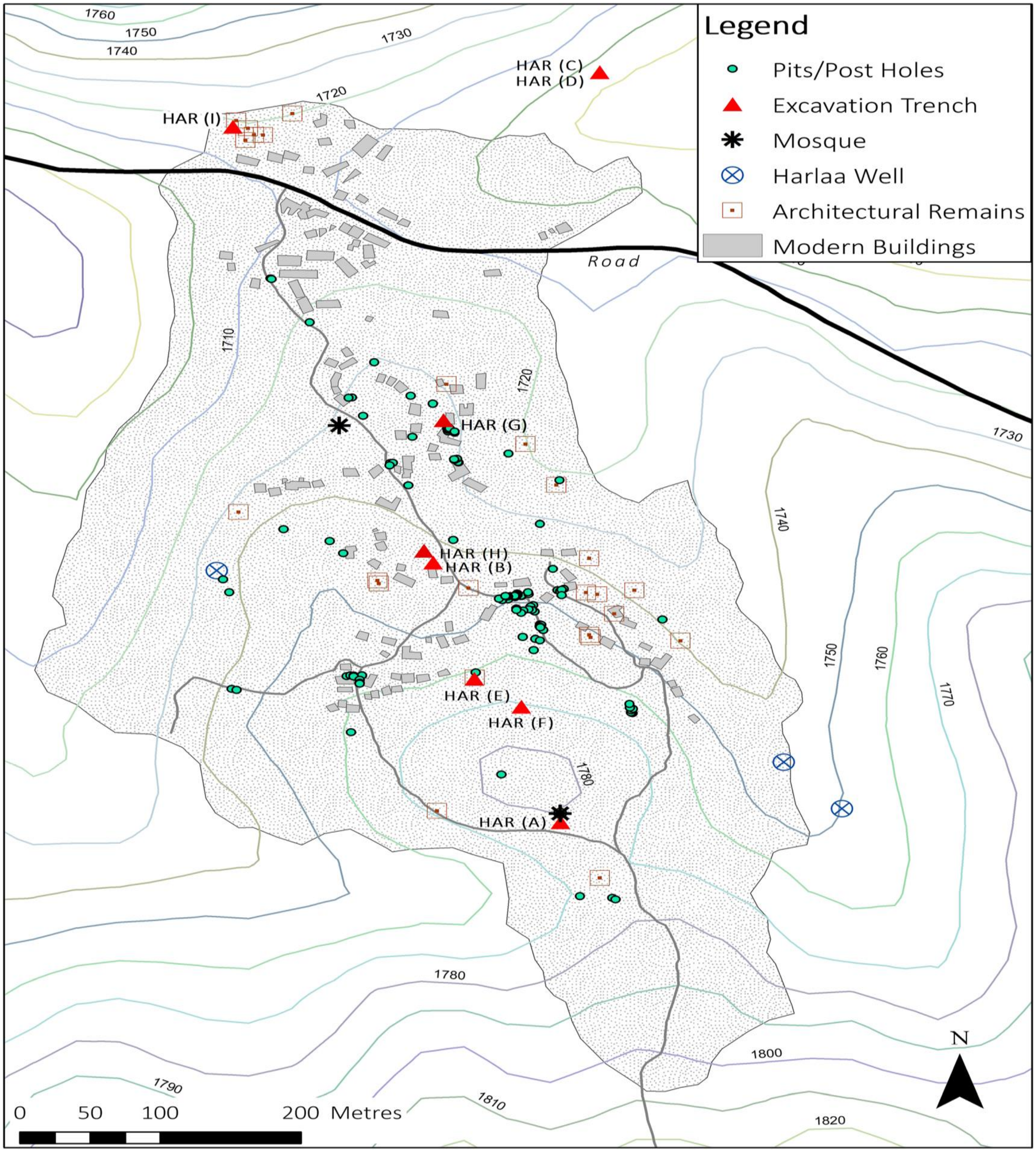


Figure 5. Map of Harlaa showing excavation areas prepared by Khalaf (from Tait & Insoll, 2021).

According to the reports (such as, Insoll & Maclean, 2016; Insoll et al., 2017), various archaeological materials were recovered from Harlaa, and show significant differences from those from Harar. Local and imported ceramics, coins of different origins, marine shells, numerous beads, walls and floors of buildings, postholes and pits, hearths and ashes, and faunal remains were some of the substantial assemblages of material evidence unearthed. The grinding stones collected are under analysis by Insoll (pers. comm.) as these needs further and detailed investigation. Many of the imported materials are missing in Harar and have shown that Harlaa was the first and most significant Islamic settlement and commercial site in the region. Trade in the site reached its peak between the 12th and 13th centuries, and according to AMS C_{14} dating, it was inhabited between the mid-6th and 15th centuries AD (Insoll et al. 2021).

The zooarchaeological analysis was made by Gaastra & Insoll (2020) in order to understand the animal economics and Islamic conversion in eastern Ethiopia with particular reference to Harlaa Harar and Ganda Harlaa. This analysis indicated that goats dominated slightly over sheep, and were the predominant domesticates during the 7th to 17th centuries AD. And, this result is contrasting with the animal economics in the northern highlands of Ethiopia (6th-9th centuries AD). According to this analysis, the similarity of the butchery technique among the three sites indicating the subsequent spread of Islam from Harlaa to Harar and Ganda Harlaa.

The evidence of marine shells recovered from Harlaa is also analyzed by (Insoll 2021). In this article, a significant assemblage of marine shells of the Red Sea origin are reported as they were used in the trade of Harlaa between the 11th and early 15th centuries AD. Similar assemblages from other sites in the Horn of Africa, such as in the Sudan, and outside of Africa, including Egypt, the Arabian Peninsula and the Persian Gulf, were found, indicating the trading connections that the Harla had maintained.

The task of remote sensing and arial photography was also completed by Khalaf & Insoll (2019) in order to generate new discoveries and identify past human activities in Harlaa, Harar and the outlying settlements. This further helps to evaluate the conservational status of the sites, and future conservation practices. It was particularly conducted to monitor the trends with regard to landscape alteration and settlement expansion that could have potential threats to the sites.

Tait & Insoll (2021) notes that local ceramics from Harlaa were used as markers of chronology and regional and long-distance contacts of eastern Ethiopia. It has also dealt with the functions of pottery in order to understand the past food ways and cultural identity of the inhabitants. Accordingly, wares, vessel forms, rims and bases were taken as significant parts of the ceramics to deal with chronology and contacts. With regard to the functions, most of the locally made ceramics demonstrates a porridge/soup/boiling-based food culture.

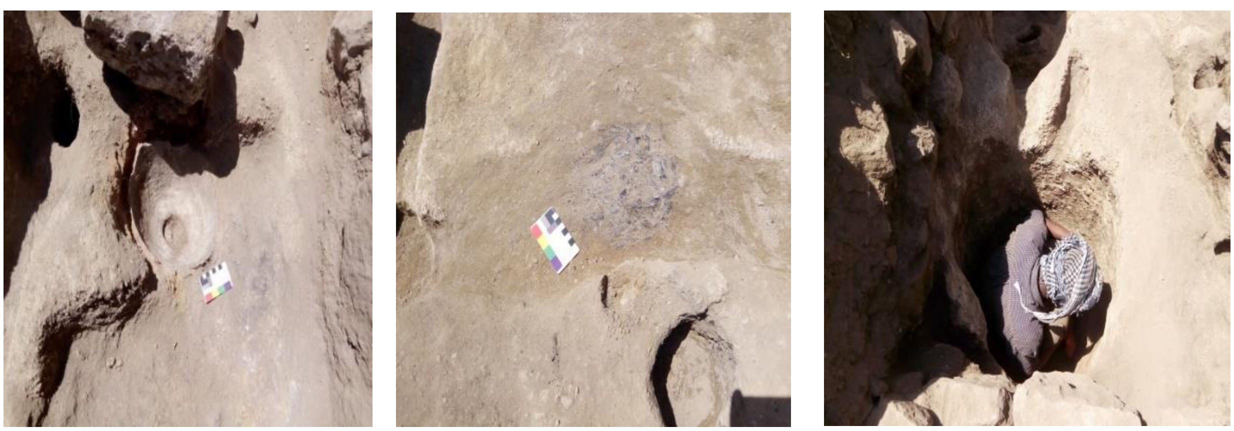
To sum up, the people of Harlaa built an important Islamic urban center and their cultural legacy has been left in the archaeological record. Given that diverse sources all agree their kingdom came to an end due to famine, their history should be studied in reference to the environmental conditions of the area and how they adapted to their environment and how they adapted the environment to them. The Becoming Muslim archaeological research project therefore, has collected soil samples since 2015 in order to study people-plant relationships and the environmental history of the site. However, the samples collected during the 2016 to 2020 seasons were not yet well studied. This research is, therefore, designed to fill this gap.

CHAPTER THREE

4. DATA PRESENTATIONS

4.1. Identification Results and their Levels of Taxa Category

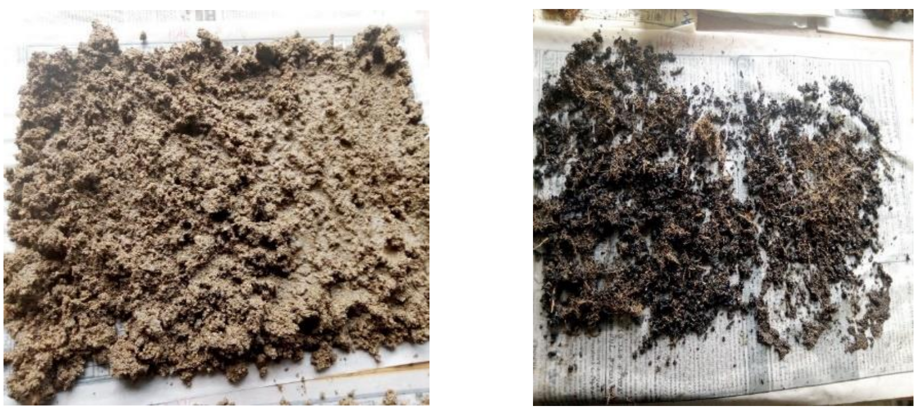
As indicated earlier in chapter 1, this study has dealt with the archaeobotanical remains from the site of Harlaa collected in five consecutive fieldwork seasons since 2016 up to 2020. The soil samples were collected from the excavations conducted in settlement areas. A large amount of soil samples, as well as plaster and pot fragments with plant imprints (1 each), were collected. As shown in Figure 6 below, most of the soil samples were collected from hearths, postholes, pits and ashes for the reason that, according to Beldados (2018), plant remains can best preserve in charred and desiccated conditions in such contexts.



a) half-pottery b) postholes filled with ash & charcoal c) storage pit for grains

Figure 1. Photos that show an in-situ half-pot and ash removed (a), an in-situ posthole filled with ash and charcoal (b), and a big storage pit for grains (c) [a, b, &c = HAR20-G] (Photo by Endris Hussien and Nicholas Tait, 2020).

A total of 230.04 liters of soil samples were collected in all the seasons under discussion. All the amounts went through the floatation recovery technique that resulted in approximately 3.5 kg of light fractions. The study is largely based on macrobotanical remains, such as seeds and stones of fruits. As discussed in the methodology, different approaches and recovery techniques were applied to differentiate the heavy and light fractions (Figure 7) initially as groups of charcoals, plant fibers, drupe and seeds; and later on, into their taxon category. As a result, a total of 718 macrobotaanical remains (particularly of seeds) were identified, and classified into family, genus and species taxa levels depending on their levels of potential identifiability with the naked-eye and a microscope.



(**a)** Heavy Fraction (b**)** Light fraction

Figure 2. Photos showing heavy and light fractions (Photo by Endris Hussien, 2021).

Remains from all the seasons are presented in tables with the following information: contexts, volume of floated soil samples, weight of light fractions, number of seeds identified and botanical (scientific) names of identified remains per taxon level. All the identified remains were also classified depending on their primary uses and morphological characters. Accordingly, cereals, legumes, oil plants, weeds and woods (trees & shrubs) are the five typological groups made, in which most of the identified remains are easily categorized. There are also ungrouped remains, all of which are categorized under the family *Poaceae*, which is one of the largest botanical family. They are said to be 'ungrouped' in this study because of their very fragmentary morphology which made the task of identification into genus and species levels difficult. Percentage ratios are also provided to show the relative abundance of identified remains as pie-charts.

4.1.1. Results of the 2016 Samples

In the 2016 season, a total of 8.17 liters of soil samples were collected from 5 contexts: HAR16-B-2, HAR16-B-3, HAR16-B-4, HAR16-B-6, and HAR16-B-9. The first 4 contexts are dated between the late 13th and early 15th centuries AD, and the last context is dated between the late-12th to late-13th century AD.

No.	Context	Vol. of floated samples (L)	Weight of light fraction (g)	No. of sorted remains	Identified plants
1	HAR16-B-2	1.4	10	6	C. cf. *album* (4), *T.* cf. *foenum* (2)
2	HAR16-B-3	0.1	25	3	C. *album* (3)
3	HAR16-B-4	4.04	105	7	C. *album* (2), C. *hybridum* (3), C. cf. *polyspermum*(1), L. *usitatissimum* (1)
4	HAR16-B-6	1.23	15	2	C. *album* (1), *Poaceae* (1)
5	HAR16-B-9	1.4	15	2	*A. digitata* (1), C. *polyspermum* (1)
TOTAL		8.17	170	20	

Table 2. The results of archaeobotanical investigation from HAR (B) of 2016 samples.

During the lab investigation, as shown in Table.2, 170 g of light fraction was recovered. From the light fraction, a total of 20 seeds were recovered and classified into 7 distinct plant taxa: *Chenopodium album* (9), *Chenopodium* cf. *hybridum* (3), *Chenopodium* cf. *polyspermum* (2), *Trigonolla* cf. *foenum* (2), A*dansonia digitata* (1), *Linum usitatissimum* (1) and *Poaceae* (1).

Identified plant taxa	No. of remains	Plant type
Chenopodium	20	Weedy plant
Trigonolla cf. foenum	2	Legume crop
Adansonia Digitata	1	Wood
L. usitatissimum	1	Oil plant
Poaceae	1	Ungrouped
TOTAL	20	

Table 3. The 2016 season identified remains grouped into their plant types.

The number of Identified remains per taxon levels, their common names and their plant types were presented in Table.3. No cereal crops were identified from any of the contexts in 2016. Accordingly, *Chenopodium* was the dominantly identified weedy plant representing 75% of the total amount of macroremains of the 2016 season (see Chart.1). Next to this, *Trigonolla* cf. *foenum*, a legume crop, constitutes 10% followed by oil plant, wood and ungrouped plants which accounts 5% each.

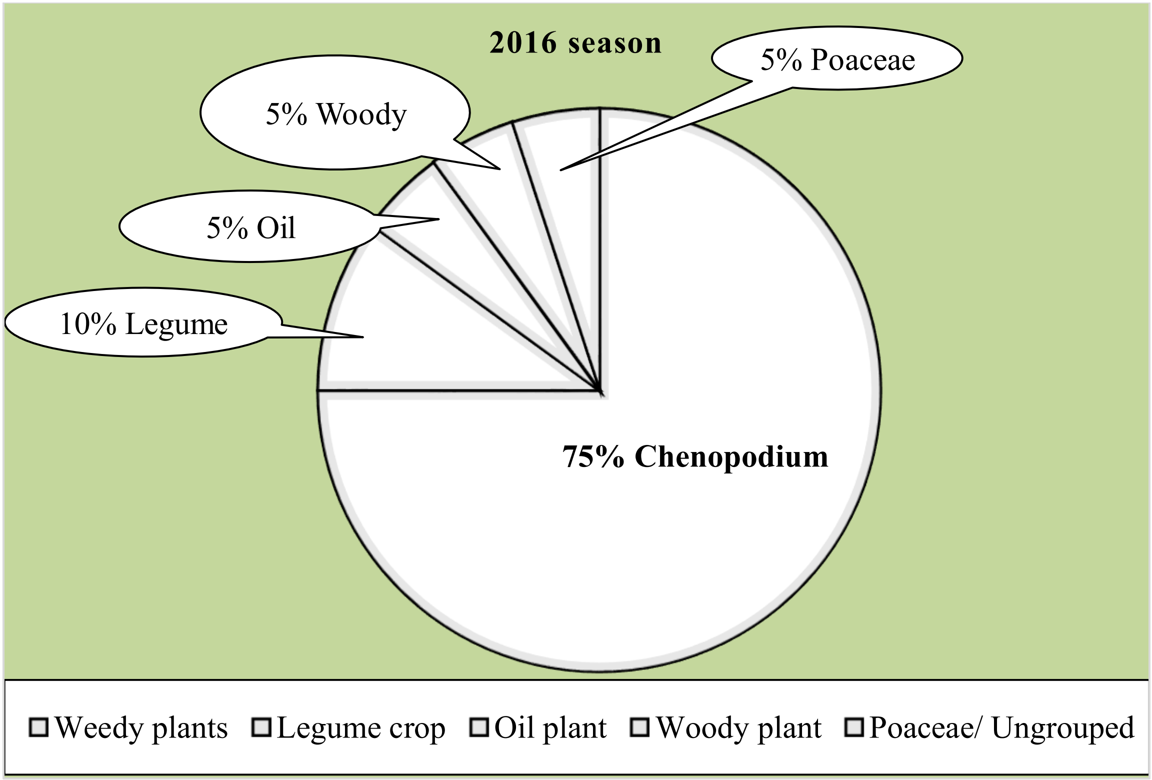


Chart.1. The percentage ratios of identified remains per plant types from the 2016 season.

4.1.2. Results of the 2017 Soil Samples

The 2017 excavations were conducted in a workshop complex and the analyzed soil sample was from 'HAR17-B-23' and valley sections labeled as HVS 1:1-110 cm and HVS 2:1-120 cm. HVS is the cut section below the plaster floor in the workshop complex. The soil samples were collected from 13 contexts as presented in Table.4. A volume of 24.96 liters of soil samples were collected. All the contexts are dated between late-8th and mid-13th centuries AD (C_{14} dating).

No	Context	Vol. of floated samples (L)	Weight of light fraction (g)	No. of sorted remains	Identified plants
1	HVS 1-10 cm	2.025	5	2	*Triticum sp*. (2)

2	HVS 1-30 cm	1.6	13	2	*Lens culinaris* (2)
3	HVS 1-50 cm	1.9	45	2	*Lolium sp*. (1), T. *monococcum* (1)
4	HVS 1-70 cm	1.9	55	16	*Triticum sp.* (3), C. *cf. africana* (1), Cicer *arietinum* (1), C. *album* (11)
5	HVS 1-90 cm	2.8	20	1	T. *dicoccum* (1)
6	HVS 1-110cm	2.14	10	1	*Astragalus sp.* (1)
7	HVS 2-20 cm	2	45	-	-
8	HVS 2-40 cm	1.5	15	3	T. *dicoccum* (1), C. *hybridum* (1), C. *album* (1).
9	HVS 2-60 cm	1.4	40	-	-
10	HVS 2-80 cm	2.3	30	2	*Triticcum sp.*(1), C. *polyspermum* (1)
11	HVS 2-100cm	1.6	15	-	-
12	HVS 2-120 cm	1.5	15	152	*Horduem sp.* (1), H. *vulgare* (2), T. *monococcum* (5), C. *africana* (1), L. *culinaris* (2), C. *album* (80), C. *hybridum* (30), *C. polyspermum* (30), T. *foenum* (1)
13	HAR17-B-23	2.24	10	8	Lolium sp. (1), H. *vulgare* (5), C. *album* (1), P. *abyssinicum* (1)
TOTAL		24.9	318	189	

Table 4. The results of archaeobotanical investigation of 2017 samples.

In the lab investigation, a total of 189 macroremains were identified from the 308 g light fraction yield. These remains were categorized into 15 taxa levels: *Chenopodium album* (93), *Chenopodium hybridum* (31), *Chenopodium polyspermum* (31), *Horduem vulgare* (7), *Hordeum sp*., (1), *Triticum sp* (6), *Triticum monococcum* (6), *Triticum dicoccum* (2), *Lolium sp*. (2), *Lens culinaris* (4), *Cordia cf. africana* (2), *Cicer arietinum* (1), *Trigonolla foenum* (1), *Astragalus* sp. (1), and *Pisum abyssinicum* (1) as shown in Table.4.

Identified plant taxa	No. of remains	Plant type
Chenopodium	155	Weedy plant
Horduem	8	Cereal Crop
Triticum	14	
Lolium	2	
Trigonolla cf. foenum	1	Legume crop
Lens culinaris	4	
Astragalus sp.	1	
Pisum abyssinicum	1	
Cicer arietinum	1	
Cordia Africana	2	Woody plant
TOTAL	189	

Table 5. The identified remains from 2017 season grouped into their plant types.

As shown in Table.5, all the remains were grouped into 4-four plant categories: namely weedy plants (155), cereal crops (24), leguminous plants (7) and woody plants (2). In these categories, *Chenopodium,* a weedy plant, was most common constituting 83% of the total identified remians from the 2017 season followed by 11.7% cereals, 3.7% legumes and about 1.6% wood plants (see Chart.2 below).

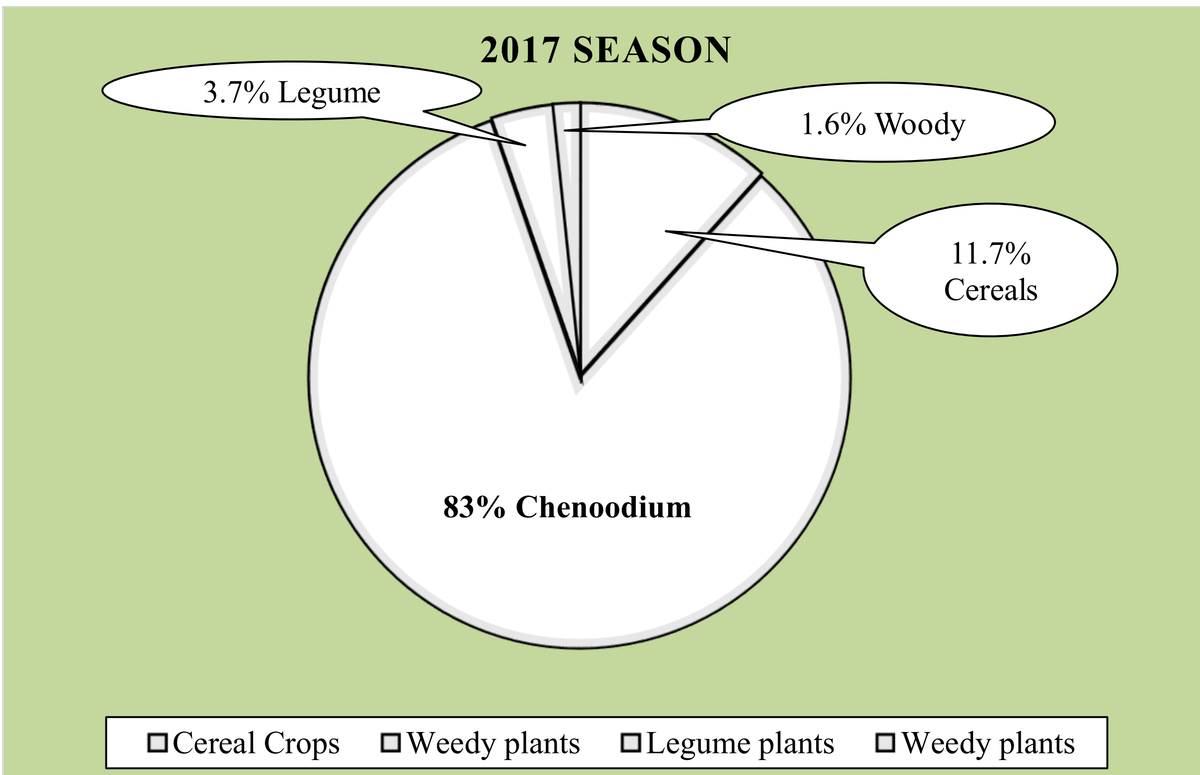


Chart.2: The percentage ratios of the identified remains per plant type from the 2017 season.

4.1.3. Results of the 2018 Soil Samples

The bulk of the soil samples were collected in the 2018 field season, almost more than all the other seasons combined, with a total of 109.84 liters collected. The samples all come from the workshop complex from eight different contexts: HAR18-B-10, HAR18-B-13, HAR18-B-18, HAR18-B-19, HAR18-B-22, HAR18-B-23, HAR18-B-24 and HAR-B-25. In terms of chronology, the first five contexts are dated between the 11th to mid-13th centuries AD, and the last three contexts are dated from the mid-6th to 10th centuries AD.

No	Context	Vol. of floated samples(L)	Weight of light fraction (g)	No. of sorted remains	Identified plants
1	HAR18-B-10	24	236	7	*Fabaceae* (1), *Lolium* sp. (3), H. *vulgare* (2), C. *cf. africana* (1)
2	HAR18-B-13	22	198.4	8	*Poaceae* (4), *Lolium* sp. (1), H. *vulgare* (1), T. *dicoccum* (2)
3	HAR18-B-18	20	168.8	5	*Poaceae* (1), *Lolium* sp. (1), H. *Vulgare* (2), C. *album* (1)
4	HAR18-B-19	3	36	68	*Poaceae* (12), *Lolium* sp. (12), H. *vulgare* (19), T. *dicoccum* (25)
5	HAR18-B-22	11	53	-	-
6	HAR18-B-23	2.24	10	2	*Triticum sp.* (2)
7	HAR18-B-24	13.6	340	26	*Astraceae* (1), A. *nilotica* (19), C. *album* (6)
8	HAR-B-25	14	65	18	*Triticcum* sp. (1), *Lolium* sp. (6), T. *dicoccum* (6), *Lens culinaris* (2), C. *africana* (2), unidentified (1)
TOTAL		109.84	1107.2	134	

Table 6. The results of archaeobotanical investigation of 2018 samples

During the lab investigation, a total of 1107.2 grams of light fraction was obtained. Out of the light fraction, 133 macro-remains were identified, and are classified into eleven plant taxa, and one was unidentifiable. These are *Acacia nilotica* (19), *Chenopodium album* (7), *Cordia africana* (3), *Fabaceae* family (1), *Astraceae* family (1), *Poaceae* Family (17), *Hordeum vulgare* (24), *Lolium sp*. (23), *Triticcum dicoccum* (33), *Triticcum sp*. (3), and *Lens culinaris* (2); and 1 remains un identifiable as presented in Table.6.

Identified plant taxa	No. of remains	Plant type
Chenopodium	7	Weedy plant
Horduem	24	Cereal Crop
Triticum	36	
Lolium	23	
Fabaceae	1	Legume crop
Lens culinaris	2	
Astraceae	1	Oil plant
Acacia nilotica	19	Woody plant
Cordia Africana	3	
Poaceae	17	Ungroued
TOTAL	133	

Table 7. The identified remains from the 2018 season grouped into their plant types.

The macroremains (Table.7) are categorized into six groups of plant types. These are: weedy plants (7), cereal crops (83), leguminous crops (3), oil plant (1), woody plants (22) and Poaceae/ ungrouped (17).

As presented in Chart.3, the cereal crops were the dominantly identified remains that constitute 62.6% of the total amount. Next to the cereals, woody plants constitute 16.7% followed by 12.45% Poaceae (others), 5.2% weedy, 2.3% legumes and 0.75% oil plants.

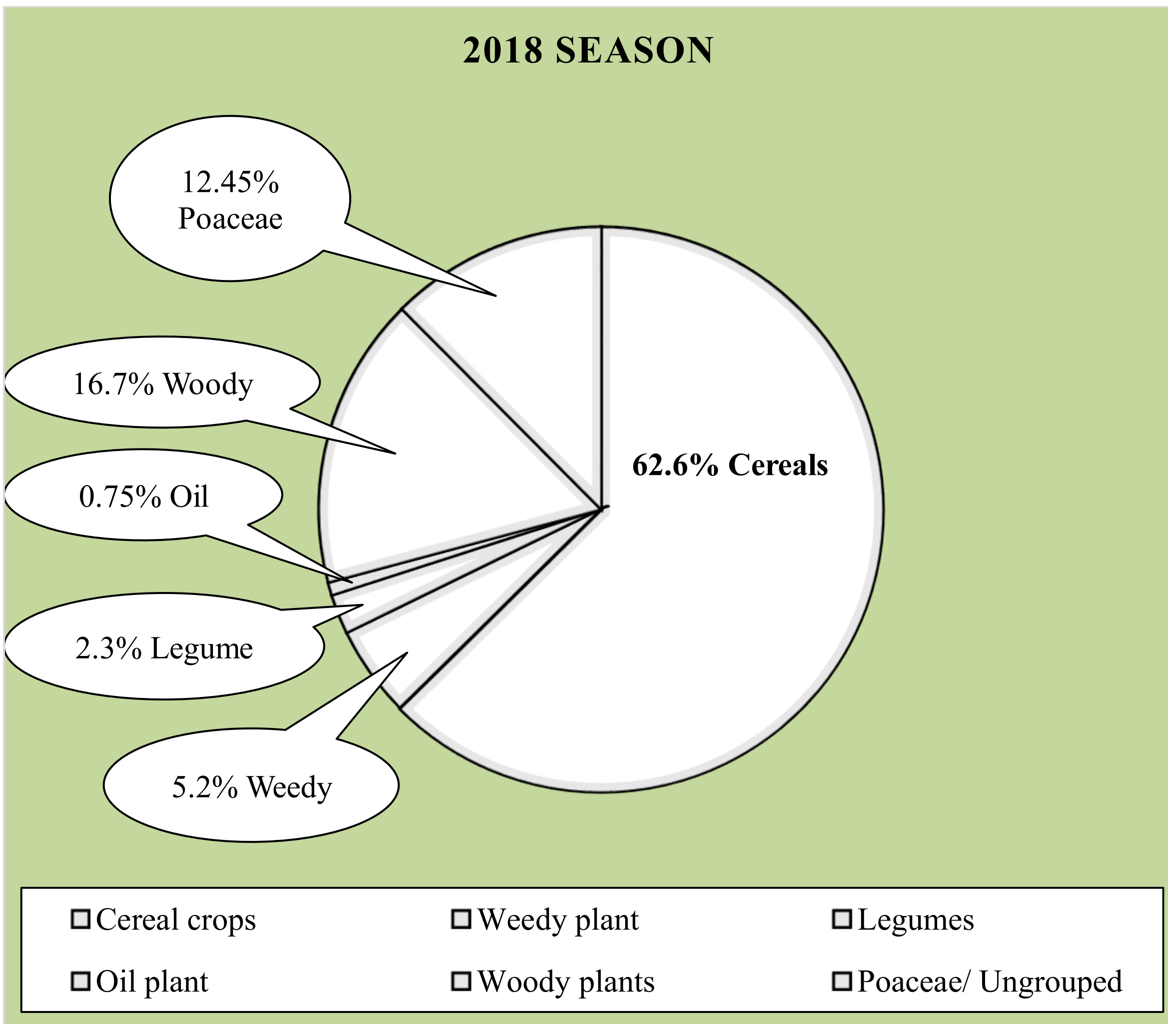


Chart.3. The percentage ratios of the identified remains from the 2018 season per plant type.

4.1.4. Results of the 2019 Soil Samples

In the 2019 field season, most of the soil samples were collected from hearths and postholes uncovered in a house associated with a kitchen and/or industrial facility (Area 'E'). A total of 60.7 litres of soil sample were collected from 7 contexts: HAR19-E-7, HAR19-E-10: Hearth, HAR19-E-12, HAR19-E-13: Posthole, HAR19-E-14: Hearth, HAR19-E-30, and HAR19-F-West of 11. According to C_{14} dating, these contexts fall between the mid-11th and early 13th centuries AD.

No	Context	Vol. of floated samples (L)	Weight of light fraction (g)	No. of sorted remains	Identified remains
1	HAR19-E-7	8.5	30	168	*Poaceae* (1), *Triticcum* sp. (7), *Ziziphus* sp. (1), C. *Africana* (3), C. *album* (156)
2	HAR19-E-10: Hearth	10	175	22	*Lolium sp* (11), T. *dicoccum* (5), C. *Africana* (4), C. *album* (2)
3	HAR19-F-West of 11	3.9	20	21	A. *moschatus* (21)
4	HAR19-E-12	10.7	380	38	*Poaceae* (1), *Hordeum* sp. (3), *Lolium* sp. (1), T. *monoccocum* (1), T. *diccocum* (1), C. *cf. macrostachyus* (4), C. *album*

					(6), O. *stricta* (21)
5	HAR19-E-13: Posthole	9.9	70	4	*Lolium sp.* (1), H. *vulgare* (1), C. *album* (2)
6	HAR19-E-14: Hearth	9.7	398	40	*Poaceae* (14), *Lolium* sp. (1), H. *vulgare* (11), T. *dicoccum* (10), O. *stricta* (3), C. *album* (1)
7	HAR19-E-30	5.8	128	30	*Poaceae* (13), *Fabaceae* (5), *Lolium* sp. (7), *Triticcum sp.* (1), C. *album* (1), T. *monoccocum* (2), C. *cf. macrostachyus* (1)
TOTAL		60.7	1201	323	

Table 8. The results of the archaeobotanical investigation of the 2019 samples

During the post-fieldwork investigation (Table.8), a total of 323 macrobotanical remains were identified from the 1201 g of light fraction. All of them were identified and classified into 14 plant taxa groups: *Triticcum sp.* (8), T*riticum monoccocum* (3), *Triticum dicoccum* (16), *Hordeum sp.* (3), *Hordeum vulgare* (12), *Lolium sp.* (21), *Poaceae* (29), *Chenopodium album* (168), *Abelmoschus moschatus* (21), *Cordia africana* (7), *Croton cf. macrostachyus* (5), *Fabacae* Family (5), *Oxalis stricta* (24), and *Ziziphus sp.* (1).

Identified plant taxa	No. of remains	Plant type
Chenopodium	168	Weedy plants
Oxalis stricta	24	
Horduem	15	Cereal Crops
Triticum	27	
Lolium	21	
Fabaceae	5	Legume crop
Croton cf. macrostachyus	5	Woody plants
Cordia africana	7	
Abelmoschus moschatus	21	
Ziziphus	1	
Poaceae	29	Ungroued
TOTAL	323	

Table 9. The identified remains from the 2019 season grouped into their plant types.

As indicated in Table.9, the 2019 season identified remains are grouped into five plant types. These are: weedy plants (192), cereal crops (63), leguminous plants (5), woody plants (34) and *Poaceae* with the 29-remaining ungrouped. From these plant-type groups, the largest share is possessed by the weedy plants with 59.75% of the total remains followed by the cereal group (19.25%), ungrouped (9%), wood (tree & shrubs, 10.5%) and legumes (1.5%) (Chart.4).

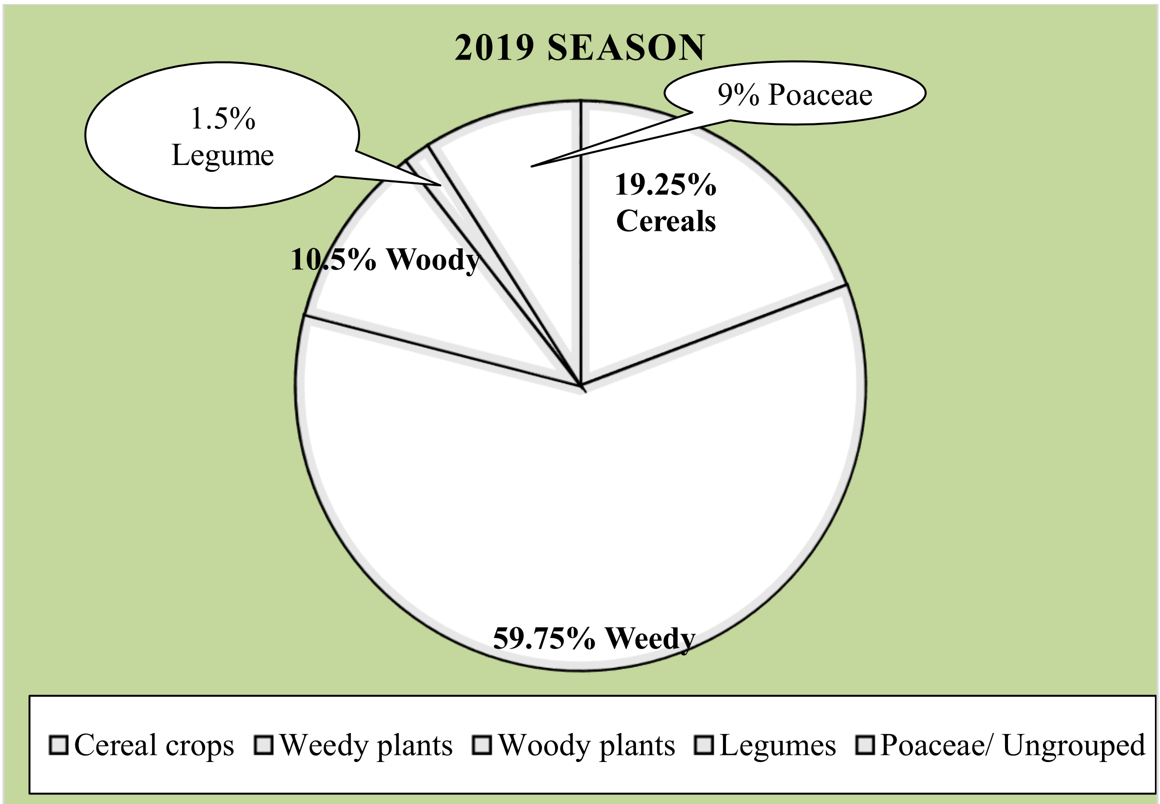


Chart.4. The percentage ratios of the identified remains per plant types from the 2019 season.

4.1.5. Results of the 2020 Soil Samples

In the 2020 season, a total of 24.798 liters of soil samples were collected from excavations at the domestic context (HAR G) from five contexts. These are: HAR20-G-10: hearth at base, HAR20-G-11, HAR20-G-12, HAR20-G-12: Post Hole, and HAR20-G-12: Charcoal from Pit. Chronologically, these contexts are dated between the early 11th and early 13th centuries AD. A sample was also obtained from an in-situ pot filled with soil which was identified during a survey of Ganda Biyo by Hannah Parsons-Morgan and Temesgen Leta in the agricultural terraces belonging to Hamad Ibro (see Appendix-II). The pot was excavated by the author and

Dr. Nicholas Tait, and a sample collected to check for seeds in the soil matrix to understand the function of the pot. Although this pot is modern, it could help us to think of and correlate the function of household materials (e.g., as food grains storage) with the historic people of Harlaa. From this pot, a total of 2.5 liters of soil was floated that yielded 349 g of light fraction. Charcoal took much of the concentration in these yields.

No	Context	Vol. of floated samples(L)	Weight of light fraction(g)	No. of sorted remains	Identified plants
1	HAR20-G-10: hearth at base	10.67	198	18	*Lolium* sp. (4), *Hordeum* sp. (3) *Chenopodium* sp. (11)
2	HAR20-G-11	7.47	51	5	? *Astragalus* sp. (1), *Lolium* sp. (2), *Poaceae* (1), *Ulmaceae* (1)
3	HAR20-G-12	4.69	39	29	*Lolium* sp. (3), *Sorghum* sp. (4)' *Hordeum* sp. (5), *Triticum* sp. (5), *Poaceae* (11), *Linaceae* (1)
4	HAR20-G-12: Post Hole	1.5	10	-	-
5	HAR20-G-12: Charcoal from Pit	0.448	9		-
6	HAR20-Hamadi Ibro-filled pot	2.5	349	-	-
TOTAL		27.298	656	52	

Table 10. The results of the archaeobotanical investigation of the 2020 samples

During the lab investigation, no seed remains were identified from the sample from the pot excavated from Hamad Ibro's land. From the soil samples collected through excavations, a total of 52 macrobotanical remains were identified and classified into 10 plant taxa groups: *Chenopodium* sp. (11), *Poaceae* (12), *Hordeum* sp. (8), *Triticum* sp. (5), *Lolium* sp. (9), *Sorghum* sp. (4), *Astragalus* sp. (1), *Linaceae* (1) and *Ulmaceae* (1) as presented in table 10.

Identified plant taxa	No. of remains	Plant type
Hordeum sp..	8	Cereal Crops
Triticum sp.	5	
Lolium sp.	9	
Sorghum sp.	4	
Chenopodium sp.	11	Weedy plant
Linaceae	1	Oil plant
Astragalus sp.	1	Legume crop
Ulmaceae	1	Woody plant
Poaceae	12	Ungrouped
TOTAL	52	

Table 11. The identified remains grouped into their plant types from the 2020 season.

The total identified remains from the 2020 season are grouped into six plant types: namely cereal crops (26), weedy plants (11), oil plant (1), legume plant (1), woody plant (1) and Poaceae/ ungrouped (12) (Table.11). Cereal crops constitute the largest share of the groups, with half, or 50%, of the total, followed by the Poaceae/ ungrouped (23.09%), weedy plant (21.15%), oil plant (1.92%), legumes (1.92%) and woody plant (1.92%) (Chart.5).

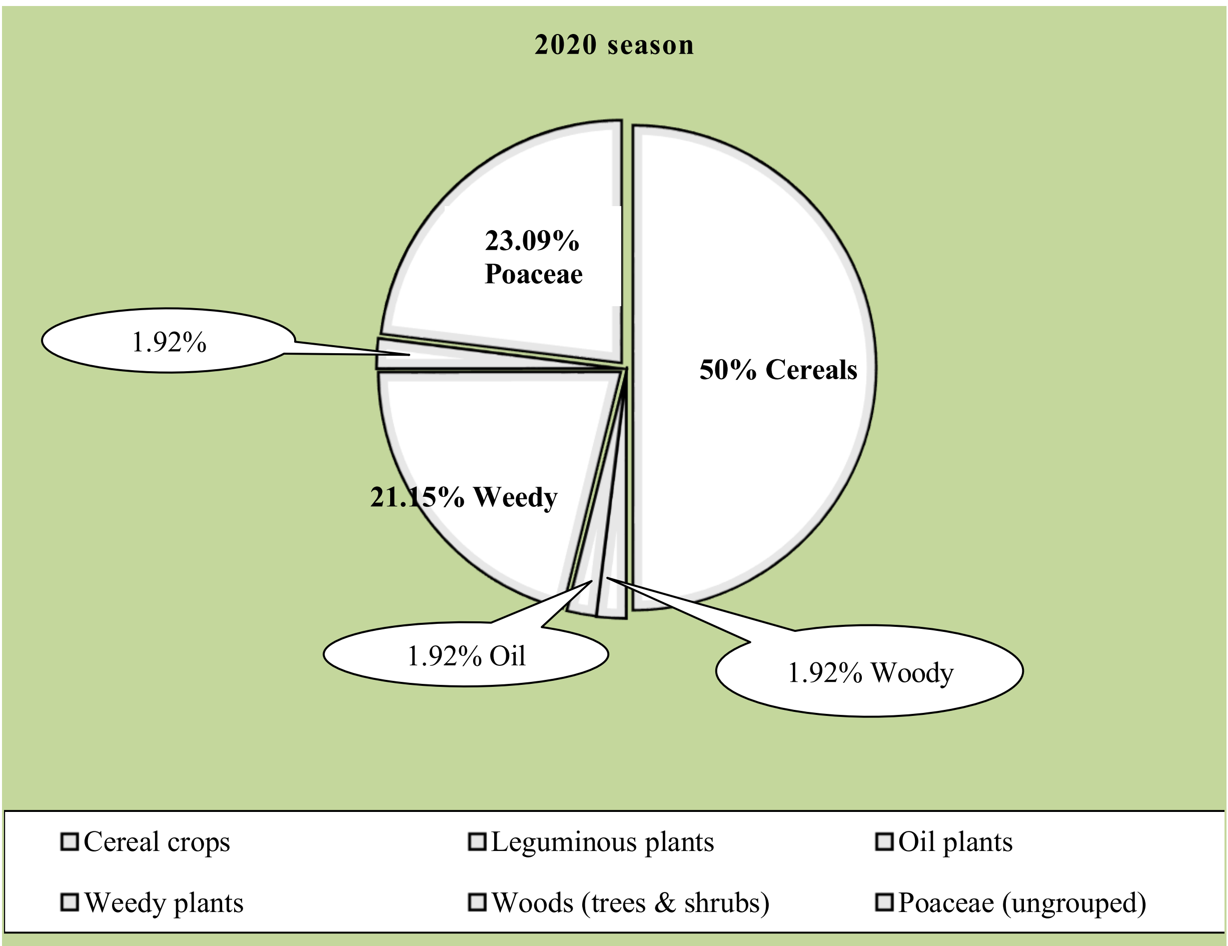


Chart.5 The percentage ratios of the identified remains per plant type from the 2020 season.

CHAPTER FOUR

5. FINDINGS, DISCUSSIONS AND CONCLUSIONS

5.1. Classifications and Quantifications of Findings

The identified remains from the 2016-2020 field seasons at Harlaa (Chapter 4) were classified into species, genus, and family taxa levels. Accordingly (Table.12), 542 remains were classified into 17 plant species, 107 remains into 7 genera, 68 remains into 5 family groups, and 1 was unidentifiable and could not be categorized either into a family or genus or species taxon level. In the cereal crops type, the most common are T. *dicoccum* (51) followed by H. *vulgare* (43) and T. *monococcum* (9) in the species level of category. In the genus level, *Lolium* sp. occurs most frequently (55) followed by *Triticum* sp. (22), *Hordeum* sp. (12) and *Sorghum* sp. (4).

Under the weedy plants type, C. *album* (278) constitutes the largest amount of remains in the species level classification followed by C. *hybridum* (34), C. *polyspermum* (33) and O. *stricta* (24). In the genus level, *Chenopodium* sp. (11) was the only identified remain throughout the five seasons. In the leguminous plants type, L. *culinaris* is the most common (6) in the species level. Under the woody plants type, A. *moschatus* is the most frequent (21) followed by A. *nilotica* (19) and C. *Africana* (12) in the species level category. In the oil plants type, one archaeobotanical remain per taxon level were identified (one in the family and one in the genus categories). A total of 59 remains were identified under the *Poaceae* (ungrouped) plant type.

No	Type	Taxa category	Identified remains	No. of Remains Per Year					
				2016	2017	2018	2019	2020	Total
1	Cereals	Species	*H. vulgare*	-	7	24	12	-	43

2			*T.monococcum*	-	6	-	3	-	9
3			*T.dicoccum*	-	2	33	16	-	51
4		Genus	*Hordeum sp.*	-	1	-	3	8	12
5			*Triticum sp.*	-	6	3	8	5	22
6			*Lolium sp.*	-	2	23	21	9	55
7			*Sorghum sp.*	-	-	-	-	4	4
8	Weedy	Species	*C. album*	10	93	7	168	-	278
9	Plants		*C. hybridum*	3	31	-	-	-	34
10			*C. polyspermum*	2	31	-	-	-	33
11			*O. stricta*	-	-	-	24	-	24
12		Genus	*Chenopodium sp.*	-	-	-	-	11	11
13	Legumes	Species	*L. culinaris*	-	4	2	-	-	6
14			*C. arietinum*	-	1	-	-	-	1
15			*P. abyssinicum*	-	1	-	-	-	1
16			*T. foenum*	2	1	-	-	-	3
17		Genus	*Astragalus sp.*	-	1	-	-	1	2
18		Family	*Fabaceae*	-	-	1	5	-	6
29	Oil plant	Species	*L. usitatissimum*	1	-	-	-	-	1
20		Family	*Linaceae*	-	-	-	-	1	1
21			*Asteraceae*	-		1	-	-	1
22	Woody	Species	*A. moschatus*	-	-	-	21	-	21
23	plants		*C. Africana*	-	2	3	7	-	12

			C. macrostachyus	-	-	-	5	-	5
24			*A. nilotica*	-	-	19	-	-	19
25			*A. digitata*	1	-	-	-	-	1
26		Genus	*Ziziphus sp.*	-	-	-	1	-	1
27		Family	*Ulmaceae*	-	-	-	-	1	1
28	*Poaceae*/ ungrouped	Family	*Poaceae*	1	-	17	29	12	59
29	>>		*Unidentifiable*	-	-	1	-	-	1
Total									718

Table 12: the number of each identified remain per taxon level from 2016-2020 seasons

5.2. The Taxonomy and Phytogeography of Identified Remains

The taxonomical discussion includes the classification, naming and descriptions of identified botanical remains to decipher information regarding their distinctive biological characters. This helps us to understand and organize the floral diversity in the study area, thus allowing us to distinguish the endemic species, and their possible significances for the inhabitants. The classification alone helps us to ascertain the number of identified plants.

The phytogeographical discussion includes the origin, geographic dispersal, ecological preference and evolution of identified plants. It helps us to increases our insights and knowledge on past biodiversity and distributional patterns of plants in species, genus and family levels. Understanding the phytogeography also helps us to observe changes in abundance of the plant species under discussion. Together with the ethnoarchaeological survey made in the study area and its environs, the phytogeographical analysis elucidates the role of climate change in changing the distribution of species, vegetation belts, and its potential impact on communities and the ranges and patterns of population responses to environmental change. Furthermore, it provides palaeoecological and palaeophytogeographical insights to understand the past, present-day, and possible future reactions, to environmental change.

Botanical (scientific) names, and common names (English) are used to foster a common understanding, because plants have different vernacular names in different countries, regions, cultures, and languages. Below, the identified plants' ecological preferences (the mean annual rainfall, altitudinal and preferred environmental conditions) presented (see Table.13) in order to anticipate the past environmental conditions of the study area, species diversity and phytogeographical distribution of plant species.

Identified plants	Common names (English)	Altitude (m)	Mean annual rainfall (mm)	Preferred environmental conditions
Hordeum	Barley	1500-4000	500-1000	Temperate, tropical and sub-tropical zones (in moderate and low humidity) (FAO, 2014)
Triticum	Wheat	1500-3700	750-900	Temperate, tropical and sub-tropical zones (FAO, 2014)
Lolium	Perennial Ryegrass	600-2000	750-900	humid tropical, sub-tropical areas with high altitude, and humid temperate zone (Ahmet & Özköse, 2014)

Sorghum	Sorghum	900-1500	400-755	Tropical wet & dry, desert or arid, steppe or semi-arid, and subtropical humid environments (FAO, 2014)
Chenopodium	Goosefoot	1250-3600	580-690	Tolerant of a wide range of climates, with cosmopolitan distribution, commonly found in almost all cultivated crops and wasteland, in pastures and strips of uncultivated land, and riverbanks, and including drought prone areas (Friis, 2014)
Oxalis stricta	Yellow sorrel	1300-2900	800-1300	Temperate, tropical and sub-tropical humid and dry environments (Lollar & Marble, 2014)
Lens culinaris	Lentil	500-1700	300-400	Cool temperate and low rainfall sub-tropical zones (Ladizinsky, 1993)
Cicer arietinum	Chickpea	1800-2700	700-1200	Highland and semi-arid regions of tropical climate (Beyene et al., 2015)
Pisum abyssinicum	Ethiopian pea	1800-3000	700-1000	Temperate, sub-tropical and dry environments (Gixhari et al., 2014)
Trigonolla cf. foenum	Fenugreek	<2000	870	Cool temperature of tropical and temperate zones (Dejene et al., 2020)
Astragalus	Milkvetch	3000-4500	2000-2700	Tropical and sub-tropical high-altitude environments (Amiri et al., 2020)

Linus usitatissimum	Flax	1790-3090	550-1000	Cool temperate and tropical climates (Worku et al., 2015)
Abelmoschus moschatus	Okra	550-1100	1000-1400	Tropical and sub-tropical climates, commonly in disturbed and open areas (Institute of Biodiversity Conservation, 2007)
Cordia Africana	Large-leaved Cordia	550-2600	700-2000	Woodland, savannah and bush, in warm and moist climates (Alemayehu et al., 2016)
Croton cf. macrostachyus	Rush foil	200-2500	700-2000	Mountainous, savannah, and bushland regions of the African tropics (Abdisa, 2019)
Acacia nilotica	Babul/ Kikar	600-1700	200-1200	Sub-tropical and semi- arid environments (Seebacher and Reichard., 2009)
Adansonia digitata	Baobab	<1500	250-1000	Hot and dry savannah areas of sub-Saharan Africa (Kehlenbeck et al., 2015)
Ziziphus sp.	Jujube	400-2000	300-2000	Sahara and Sahel in Africa including Eastern Africa and Arabia (Arndt et al., 2001)
Ulmaceae	Elm	<2500	1000-4000	Temperate and tropical environments (Zavada, 2015)

Table 13. Botanical names, mean annual rainfall, altitudinal and environmental preferences of identified plants from Harlaa.

5.2.1. *Hordeum* sp.

Hordeum (barley) belongs to the genera *Hordeum* L. in the *poaceae* family taxon. There is no conventional consensus regarding its origin. Some scientists (e.g. Hanson, 1952; Harlan, 1971; Badr et al., 2000; Mulatu & Grando, 2011), on the one hand, mention China, Tibet and Nepal as the origins of *Hordeum*; while others (e.g. Bekele, 1983; Corinto, 2014), say it originated in Ethiopia.

In the former scenario, the cultivation of *Hordeum vulgare* in the 'Fertile Crescent' is dated back to 10,000 B.C. Passing some 2000 years under cultivation stage, Ceccarelli et al. (1999) noted that this plant was domesticated from its wild relative *Hordeum spontaneum* around 8000 B.C in many places such as Jordan, Palestine, Lebanon, Syria, Southeastern Turkey, Western Iran and Iraq. Since then, this crop was widely diffused to the rest of the world (particularly to areas along the Nile Valley) including Ethiopia. In the later scenario, the northern highlands of Ethiopia are thought to be the centers of origin and species diversity of this crop. However, its wild relative has not yet been identified in Ethiopia. Regardless, barley (*Hordeum vulgare*) is one of the most widely grown and staple crops in Ethiopia, and along with sorghum, maize, rice, and wheat, is also one of the world's five most important cereal crops (Bekele, 1983; Beldados et al., 2015; Mercuri et al., 2018; Beldados, 2019).

Archaeobotanical investigation has revealed large amount of macroremains of *Hordeum vulgare* seeds (55) from the site of Harlaa (see Table.13 and Figure 8). Barley remains were present in most of the excavation units, particularly in kitchen & residence areas, which indicates its vital significance for food, and potential cultivation in the area during the ancient and medieval periods.

According to Badr et al. (2000) and Admassu (2020), the hardy nature of *Hordeum* sp. enables the species to grow in varied topography (such as hills and plains) and can withstand adverse agro-environments (such as drought, and saline and alkaline soils). Altitudinally, this plant best grows within an elevation range of 1800 to 3500m ASL. According to Mulatu & Grando (2011), it can also grow in rainfed and irrigated conditions. There is archaeological evidence for water reservoirs at Harlaa which may have been used for growing food crops.

(a)  (b) 

Figure 3. The archaeological remain of a Hordeum vulgare seed identified from Harlaa: context-HAR19-E-14: Hearth (a), and the modern specimen reference of it. Photo Endris Hussien ((a) 2019, (b) 2021)

5.2.2. *Triticum* sp.

Triticum, commonly known as wheat, is a genus name belonging to the *poaceae* family. It has more than 10 species that grows in many parts of the world. It was first cultivated at about 10,000 years ago in the Near East and was domesticated around 9,000 B.C in Turkey (Heun et al., 1997). It is one of the five most economically important cereal crops in the world.

Archaeobotanical evidence of wheat has been uncovered from many parts of the world, and evidence of Triticum sp. (*T. aestivum, T. monoccocum* and *T. diccocum*) has been archaeologically identified in Ethiopia, particularly in the northern highlands,., and from the pre-Aksumite and Aksumite sites of Mezber and Ona Adi sites in Adigrat (Andrea et al., 2011; Beldados et al., 2015) in northern Ethiopia. This suggests that the plant grows in high elevations.

In the ancient and medieval contexts of Harlaa, likewise, a large amount (82) of Triticum sp. T. *monoccocum* (emmer wheat) and T. *diccocum* (Einkorn wheat (Figure 9) have been identified (see Table.13). It is unusual to find wheat as an archaeological remain from lowlands since this crop often grows in highland areas. Most of the remains were identified from hearth and ash contexts, which suggests that the people of Harlaa grew it for consumption. It also indicates the diffusion of wheat and barley cultivation from the northern highlands of Ethiopia (where wheat and barley dominantly grow – (e.g., Beldados, 2015) towards the eastern lowlands.

(a) 

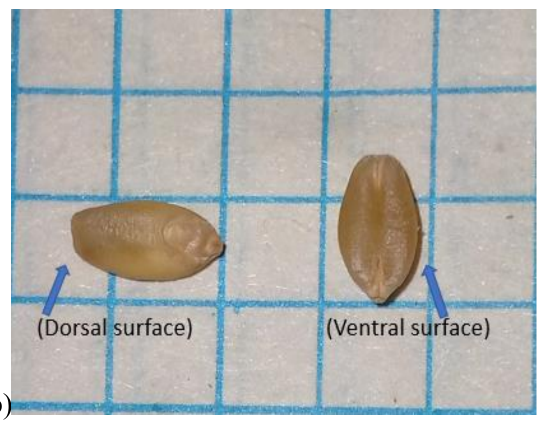
(b) 

Figure 4. The archaeological seeds of Triticum dicoccum (with dorsal surface on the right, and ventral on the left) identified from Harlaa: context- HAR19-E-14: Hearth (a), and the modern specimen reference of it (b). Photo by Endris Hussien ((a) 2019, (b) 2021).

5.2.3. *Lolium* sp.

Archaeological evidence of *Lolium* sp. was identified from the site of Harlaa. This crop, also known as perennial ryegrass, belongs to the genera *Lolium* L. in the *gramineae* family taxon group. It is one of the most commonly grown plants in cultivated areas particularly in places where wheat and barley grow. It causes significant yield reduction in various cereal crops, and is therefore considered as a crop weed. Some researchers (e.g., Ahmet & Özköse, 2014) argue that having nondormant and non-shattering seed stalks allow it to thrive unintentionally when grown along with wheat and barley.

According to Andrea et al. (2011) and Beldados et al. (2015), the archaeological remains of *Lolium* have been identified along with wheat and barley in most of the pre-Aksumite and Aksumite contexts at Mezber and Ona Adi sites in Adigrat, northern Ethiopia. It was also identified at Harlaa (see Figure 10) in large quantities and with high distribution across excavation areas therefore supports the theory that wheat and barley were cultivated in the area.

a)  b) 

Figure 5. The archaeological macroremains of Lolium sp. seeds identified from Harlaa: context-HAR20-G-10: Hearth at Base (a), the modern specimen reference of it. (b) (Photo by Endris, 2021).

5.2.4. *Sorghum* sp.

Sorghum is the genus name of about 25 flowering plant species in the family *poaceae*. Northeast Africa has been recognized as the center of origin for the species *sorghum bicolor*, which represent the various domesticated species, due to the availability of complex wild progenitors (Wet and Huckabay, 1967; Harlan, 1969; Nicoll, 2004). The various wild populations are grouped under the nomenclature of *sorghum certicilliflorum.*

As indicated in Harlan (1969), the earliest evidence for wild *sorghum* utilization prior to the cultivation stage came from the Egyptian-Sudanese border around 7,000 BC. *Sorghum* is believed to be native to Africa (Beldados, 2019). It had been thought that the fully domesticated version of *sorghum bicolor* was diffused out of Africa between 2500 to 1900 BC based on charred macroremains and impressions in ceramics uncovered in India (Boivin and Fuller, 2009).

Sorghum sp. usually grows in areas characterized with hot and dry agro-climatic conditions, like those of the Ethiopian lowlands where it grows. Although the current inhabitants of Harlaa grow and utilize sorghum, there has been no evidence identified in the archaeological record from the site until recently. Luckily, however, it was identified for the first time during the 2020 season (see Figure 11). This is helpful in providing more information regarding environmental change and environmental continuity. Chronologically, the context of this crop (HAR20-G-12) is dated between the early-11th and early-13th centuries AD at Harlaa. Although a number of food crops were identified from different contexts (dated between the mid-6th and 11th centuries AD), there is no evidence for sorghum at this time, suggesting that it was not cultivated as part of the food crops identified from the area during this period. Its chronology tells us that growing sorghum as a food crop was started between the 11th and 13th centuries AD.

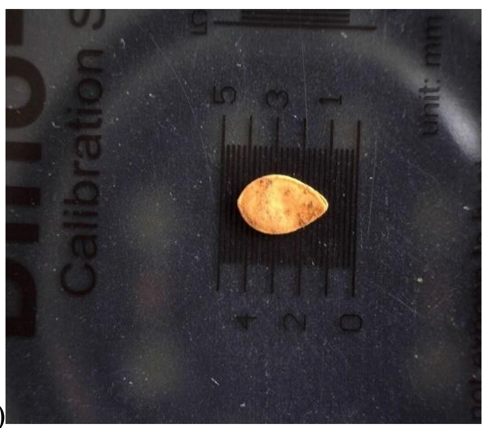
(a)  (b) 

Figure 6. the archaeological remains of Sorghum sp. seeds identified from Harlaa: context-HAR20-G-12 (a), and the modern specimen references of it (b). (Photo by Endris Hussien, 2021).

5.2.5. Linum Usitatissimum

Linum usitatissimum, commonly known as flax, belongs to the family *Linaceae* that comprises over 250 annual and perennial herbaceous flowering plant species. *Linaceae* is sub-divided into two sub-families known as *Linoideae* and *Hugonioideae.* The former includes shrubs and small trees (*Tirpitzia*) usually grown in temperate and tropical environments of Europe, Asia, Australia, America and Africa. *Linum*, the largest genus in the *Linoideae* sub-family, originated in Eurasia about 46-51 million years ago, and from there it diffused to the rest of the world. It constitutes more than 180 species including the cultivated flax, *Linum.* It has also a cosmopolitan distribution all over the world. (Worku et al., 2015).

The oldest domesticated version of *L. usitatissimum* was recorded in Syria, dated to 9000 BC (Worku et al. 2015). It has played a significant role in the social and economic developments of humanity from the Neolithic period onwards when its fibers and seeds have been used for a variety of purposes. Ancient Egyptians, for example, used its oil to embalm the dead body prior to its wrapping in many layers of fine linen strips (Fikere, et.al., 2013). Regardless of its significances, *Linum usitatissimum* has largely been used as a food and cash crop, but it is also used for other purposes, such as component of paints, inks, varnishes, and lubricants since ancient times. Historically, people also used floral resources to treat diseases, and in the present-day, the roasted form and flour of *L. usitatissimum* mixed with boiled water is used as traditional medicine to cure abdominal pain, particularly for gastric issues. In Ethiopia, *L. usitatissimum* is cultivated in diverse agro-climates, including highlands with an altitude of >2500m ASL. Due to this agro-climatic diversity, Ethiopia is considered as one of the centers of diversity for linseed (Fikere et al. 2013). Archaeologically, a large amount of domesticated flax/linseed was uncovered from Adigrat in northern Ethiopia dating between 1005 and 840 uncal. BC. Although not common in arid environments, it has also been identified from the site of Harlaa (see Figure 12). However, only two seeds (one in species and one in family taxa groups) were identified.

(a) 

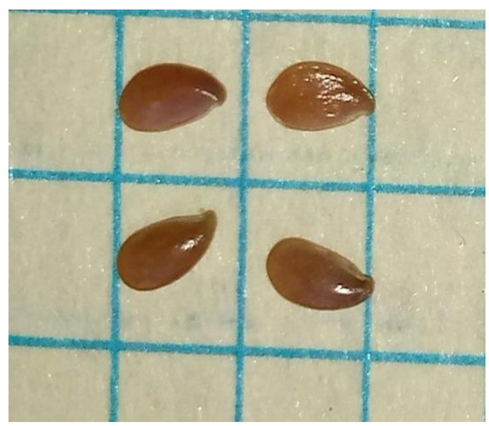
(b) 

Figure 7. Photos showing the archaeological remains of L. usitatissimum identified from Harlaa: context- HAR16-B-4 (a), and modern reference seeds of it (b). Photo by (a) Alemseged Beldados and Endris Hussien (2019), and (b) Endris Hussien (2021).

5.2.6. *Astragalus* sp.

As confirmed by previous research (Miraj & Kiani, 2016; Amiri et al., 2020) *Astragalus* is one of earth's largest genus of flowering plants in the *Fabaceae* family comprising approximately 2900 species. It includes the various herbs and shrubs of annual and perennial plants with a cosmopolitan distribution in Europe, Asia, and America. It commonly grows in tropical and sub-tropical high-altitude environments. Regardless of its significance, the leaves, roots, and stems of Astragalus is used for food, fuel, and medicine to cure teeth, urinary and respiratory related health problems in many countries. It could also be commercially exploited as gum tragacanth for industrial and commercial purposes (e.g., in Iran) among many other values (Amiri et al. 2020). In Ethiopia, it has been chewed for the traditional treatment of tooth pain, and it is possible it had the same significance for the inhabitants of Harlaa as well. At Harlaa, only two macroremains of the genera *Astragalus* were uncovered, one each from the 2017 and 2020 field season samples (Figure 13).

(a) 

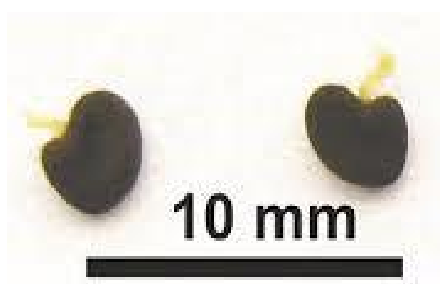
(b) 

Figure 8. Macroremains of astragalus sp. identified from Harlaa: context- HAR20-G-11 (a), and modern reference seeds of it. Photo by Endris Hussien (a) 2021), and (b) from https://www.researchgate.net%2Ffigure%2The-seeds-of-Astragalus-penduliflorus, accessed on 10/04/2021).

5.2.7. Trigonella foenum-graecum

Trigonella Foenum-graecum (commonly known as Fenugreek) is a species in the genus of *Trigonella* under the *Fabaceae* family. It is an annual flowering herb believed to be originated from the eastern shores of the Mediterranean region, and from where it widely diffused worldwide. Archaeological evidence of this plant was first identified from a site named Tell Halal in Iraq that dates back to 4000 BC.

According to Dejene et al. (2020), fenugreek, also known as "*Abish*" in Amharic, is also believed to be native to Ethiopia. It has been widely grown in many parts of the country, including the eastern lowlands where the study area of this research is located. It can grow in almost all soil types and tolerate almost all environmental conditions.

In the medieval context of Harlaa, three macroremains of *Trigonolla foenum graecum* were recovered. This plant has been widely used in Ethiopia for many purposes (Million, 2012). It leaves a substantial amount of residual nitrogen in the soils and adds significant organic matter that help the subsequent crop to better grow. For this reason, farmers use it as a rotational crop to improve soil fertility. Economically, it is important for its nutritional, commercial and medicinal benefits. It is also used as a spice ingredient and herbal remedy, and both the leaves and seeds are used for the treatment of diabetes, heart related disease, cancer, and blood pressure. In terms of leguminous seeds, fenugreek generates income in the international market. Moreover, it can be used as a milk substitute, and is widely used as an infant feed due to its high lactose content. Eating Fenugreek is also believed to increase appetite and blessings. Historically, it was taken as a multi-use plant by the ancient Greeks, Romans, and Egyptians, who used it to cure infections and burns, and to induce childbirth (www.myspicer.com, accessed on 10/04/2020).

5.2.8. Cicer Arietinum

The species *Cicer arietinum,* commonly known as chickpea, belongs to the *Fabaceae* family. Charred chickpea was also identified from Lalibela cave, east of Lake Tana in northern Ethiopia, dating to 1005-840 uncal. BC. Botanically, it is a self-pollinated pulse crop, and is considered one of the oldest crops which appeared during the Neolithic agricultural revolution. The earliest archaeological evidence of the cultivated version of *Cicer arietinum* was uncovered from the Near East dating back to 8500 cal. BC (Beyene, et.al, 2015). Initially, it was a temperate region pulse crop, however, it later began to be grown in the tropical and sub-tropical regions of the world, including Africa. According to Beyene et al. (2015), *Cicer arietinum* can also grow in arid and semi-arid environments in rainfed conditions because it has a deep tap root system which helps the plant to withstand drought by extracting water from the deep soil.

In Ethiopia, *Cicer arietinum* was and still is used largely as a source of protein, as well as bean and soyabean. Besides its dietary components for food, chickpea has also long been used as a rotation crop to increase soil fertility. Because of the diverse agro-climatic conditions of Ethiopia, its wide distribution in almost all regions made the country the largest producer in Africa. The country is also considered as one of the centers of diversity for this pulse crop (Beyene et al. 2015). It was one of the macrobotanical remains recovered from the archaeological excavations at Harlaa (see Figure 14).

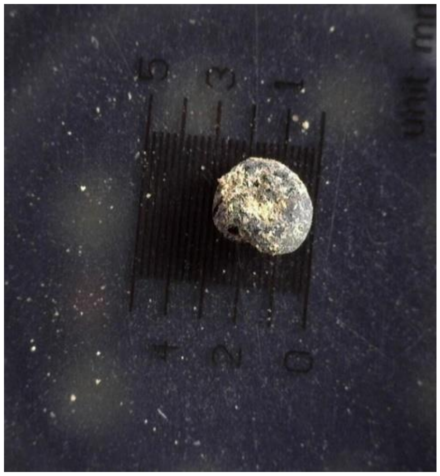
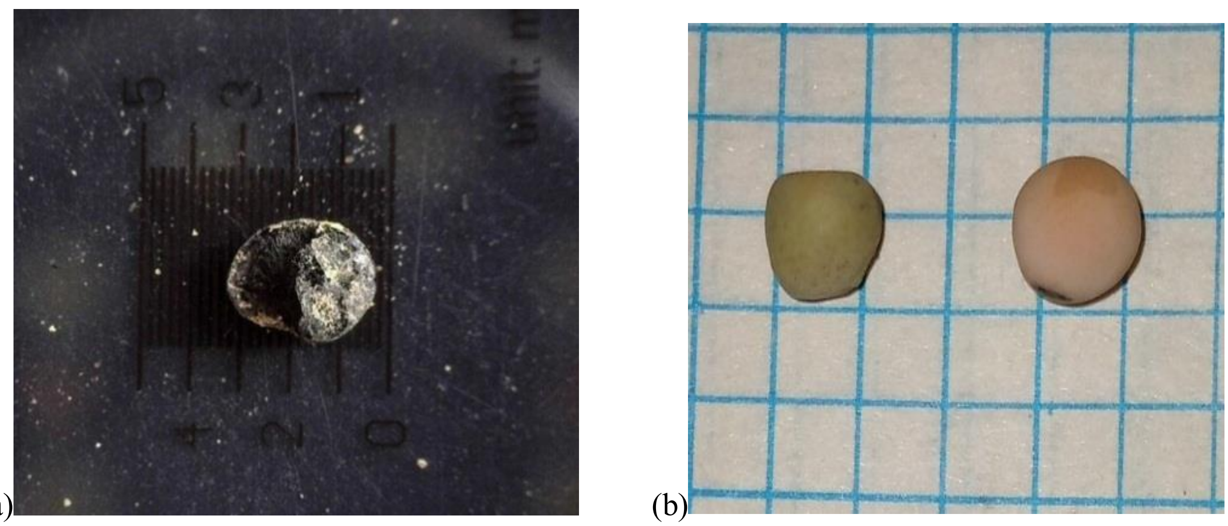
(a)  (b) 

Figure 9. Photos showing the archaeological remains of Cicer cf. arietinum recovered from Harlaa: context-HVS 1-70 cm (a), and the modern reference seed of it (b). Photo by Endris Hussien ((a) 2019, (b) 2021).

5.2.9. Pisum Abyssinicum

Pisum abyssinicum, commonly known as pea, is one of the oldest domesticated legume crops belonging to the *Fabaceae* family. Chronologically, its domestication dates to 10,000 BC in the Near East and Central Asia. Although many names have been attached to *Pisum, Pisum fulvum Sibth. & Sm.* and *P. sativum* L. are the two commonly recognized names. *P. sativum* is divided into two subspecies, *P. sativum* subsp. *sativum* (the domesticated form) and *P. sativum* subsp. *elatius* (the wild form). The former has been widely grown in Syria, Lebanon, Israel, Palestine, and Jordan, whereas the latter is distributed along the Mediterranean basin. The Ethiopian pea (*Pisum abyysinicum*) is not taxonomically grouped under either of those species or sub-species mentioned above, though it shares some characteristic features with subsp. *sativum*. According to Butler (2003), Gixhari et al. (2014) and Trněný et al. (2018), Ethiopian pea may possibly has an independent *pisum* gene-pool from which it has been brought to domestication.

Pea can grow in diverse agro-climatic conditions, such as in temperate, sub-tropical and dry environments. It has been used as dry grain, fodder, and as green immature fresh seed (known as "*Eshet"* in Amharic). Archaeologically, carbonized seeds of leguminous plants, such as cowpea *(Vigna unguiculata)* and *Pisum cf. sativum,* were recovered from Porc Epic, an archaeological site near Dire Dawa in eastern Ethiopia that dates to 5700±110 uncal. BP (Clark et al., 1984). Macroremains of *Pisum abyssinicum* seed was amongst the other legume crops recovered from the archaeological site of Harlaa (see Figure 15). These findings add to the archaeological remains of *Cicer cf. arietinum* uncovered from Harlaa and possibly indicates that the region has long been one of the areas where leguminous plants were brought to cultivation and use.



(a) (b)

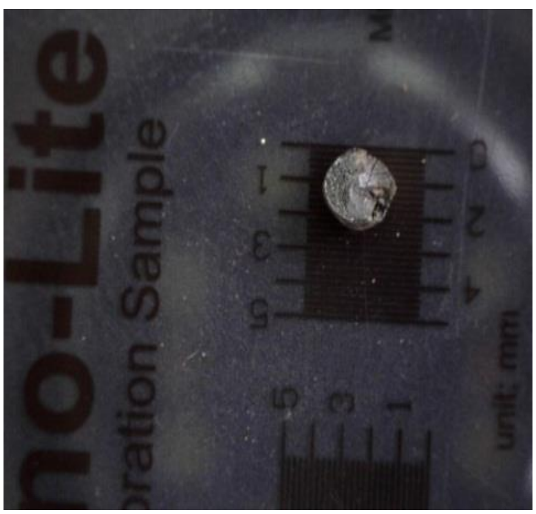
Figure 10. Photos showing a fragmented macroremain of Pisum cf. abyssinicum identified from Harlaa: context- HAR17-B-23 (a), and the modern specimen reference of it (b). Photo by Endris Hussien ((a) 2019, (b) 2021).

5.2.10. Lens Culinaris

Like other legumes, the first domesticated version of *Lens culinaris*, commonly known as lentil, is originated from its wild progenitor of a short-statured plant known as *L. Culinaris* ssp.

Orientalis in the Middle East during the Neolithic revolution, with evidence it from Turkey, Crimea and Israel (Ladizinsky 1993). According to Beldados (2018), the remains of lentils were also uncovered from an Aksumite context in Adigrat in Tigray dated back to 100-700 AD. It is also one of the pulse crops in the *Fabaceae* family that has been identified from the archaeological deposits of Harlaa as well (see Figure 16).

It grows in the summer season within agro-environments altitudinally ranging from 500-1700 meters ASL. It has been used for food and medicinal purposes, and Ethiopian "Wot or Wet" ('stew' in English) is most commonly prepared from lentils (locally known as "*misir* in Amharic). Traditionally, it is also thought to heal wounds -dry seeds are ground and soaked in water, and the resulting cream is then smeared on the affected body part.

a) 

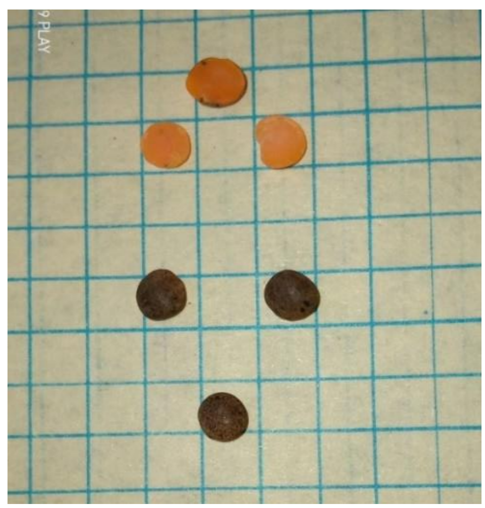
b) 

Figure 11. Photos showing Half part of lens culinaris identified from Harlaa: context- HAR-B-25 (a), and the modern specimen references seeds of it (b). Photo by Endris Hussien ((a) 2019, (b) 2021).

5.2.11. Chenopodium sp.

Botanically, *Chenopodium* is a genus name categorized under the family *Chenopodiaceae* and is commonly known as *Goosefoot*. It includes about 250 species which together share similarity in terms of vegetative morphology and high phenotypic plasticity that makes identifying them into distinct species taxon category difficult (Singh 2010). For to this reason, *Chenopodium* is a complex weedy plant that is not well-understood yet. It is a drought-resistant perennial and annual herbaceous plant that grows in dry and bare lands, which might be the reason that a large number of seeds were identified from Harlaa.

In Ethiopia, this weedy plant usually grows in altitudes ranging from 1250-3600 m, and often in acacia woodlands (Friis, 2011). A total of 355 *Chenopodium* sp. Remains were identified from the archaeological deposits at Harlaa. From these, 278 seeds were C. *album* (Figure 17a), 34 were C. *hybridum* (Figure 17b) and 33 were C. *polyspermum*. This suggests that C. *album* has a high distribution, probably as this species can produce between 200 and 75,000 seeds per plant in one season.

There are many scholarly works conducted regarding the nutritional composition and medicinal significance of *Chenopodium* (Yadav, et al., 2007; Singh, 2010; Shraeder, 2015; Agza et al., 2018). However, the medicinal uses vary across species due to their different chemical compositions. The leaf of *C. album*, for example, contains essential oil mineral matter particularly in potash salts and components of Nitrogen. Its leaf has also a long tradition of medicinal significances related to the treatment of digestive issues, peptic ulcers and hepatic disorder, abdominal pains, eye diseases, throat troubles and diseases of blood (Yadav et al., 2007; Shraeder, 2015). The ancient and medieval Harlaa populations could have been using this plant for the above-mentioned benefits.

a) b)

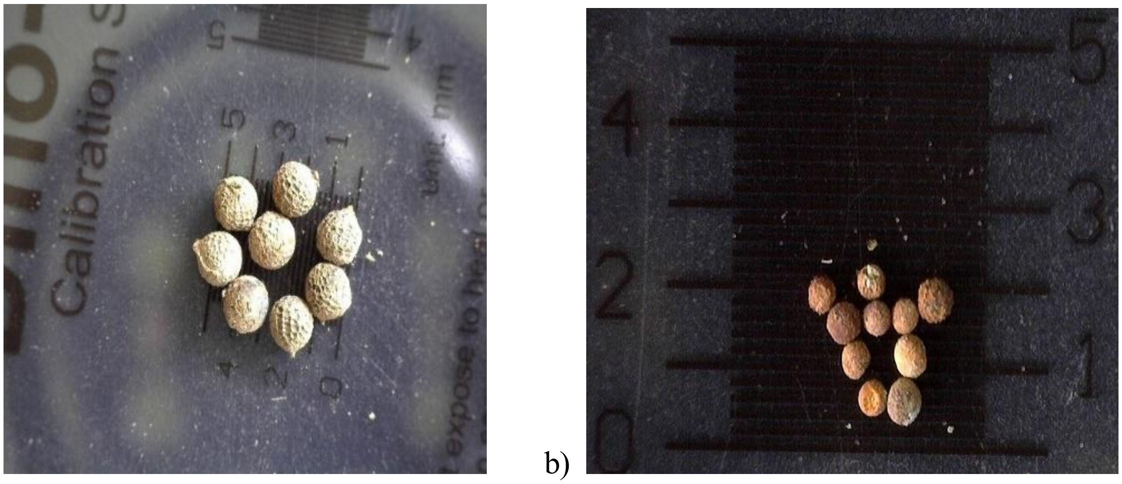


Figure 12. Photos showing the seeds of C. album (a), and C. hybridum (b), both recovered from Harlaa: context- HVS 2-120 cm (Photo by Alemseged Beldados and Endris Hussien, 2019).

5.2.12. Oxalis Stricta

Oxalis stricta, commonly known as yellow wood sorrel, is one of the most common broad-leaved annuals in cool climates and a perennial weed in warm climates respectively. It belongs to the family *Oxalidaceae*, and often grows in woodlands and grasslands. It is also believed to be originated from North America (Lollar and Marble 2014). As shown in Figure 18, its leaves are characterized by heart-shaped leaflet pairs in (usually) sets of three (Figure 18a), and tear-drop shaped seeds (Figure 18b). It can spread by both rhizomes and seeds that makes this plant difficult to control. Traditionally, this weed is believed to cure diseases, such as cancer, urinary tract infections and fever. Macroremains of *oxalis stricta*, commonly known as *oxalis*, were recovered from the archaeological site of Harlaa.

a) b)

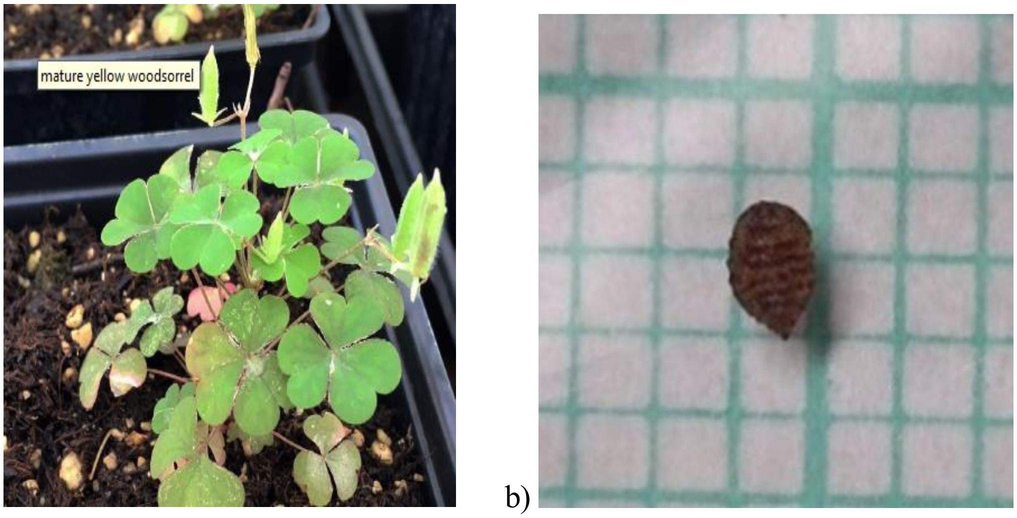
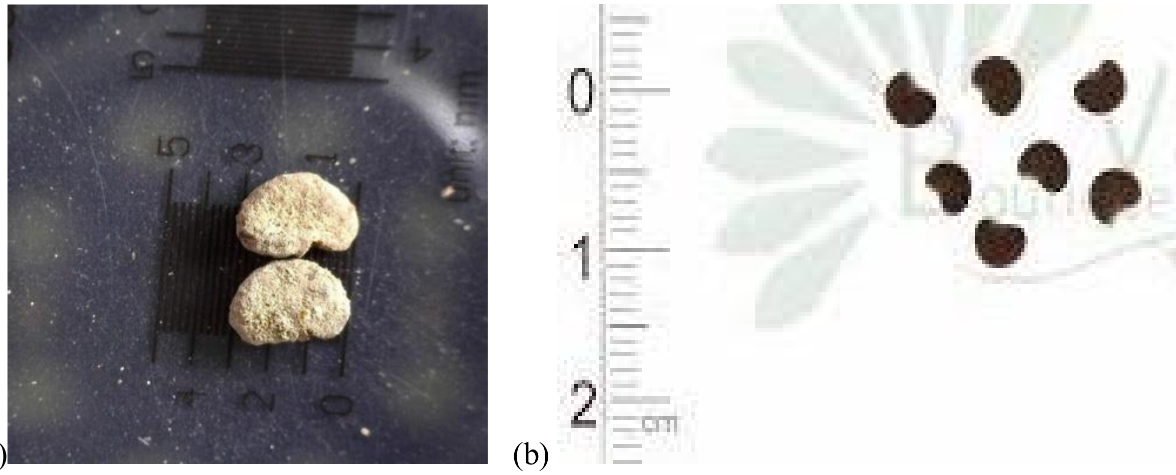


Figure 13. Photos showing O. stricta plant (a) (from Jeffrey 2020), and archaeological seed remain of it identified from Harlaa: context- HAR19-E-12 (b) (photo by Alemseged, 2019).

5.2.13. Abelmoschus Moschatus

Abelmoschus is a genus name derived from the Arabic word "*abu-I-mosk,"* meaning "father of musk" because its seeds smell of musk. It belongs to the family *Malvaceae* and is believed to be native to India. It is a perennial shrub plant that can grow up-to 2 meters height. In Ethiopia, *Abelmoschus* spp, also known as okra, is widely grown. A total of 21 archaeological seeds of this plant were identified from the historic site of Harlaa (Figure 19).

Its vegetables are also used for food in the southern-western parts of Ethiopia (Institute of Biodiversity Conservation, 2007), and it has a range of medicinal significances. Traditionally, it is thought to cure intestinal complaints, stomatitis, diabetes, and diseases of the heart, and it allays thirst and stops vomiting.



(a) (b)

Figure 14. Macroremains of Abelmoschus moschatus identified from Harlaa: context- HAR19-F-West of 11 (a), and modern reference seeds of it (b). Photo by (a) Alemseged Beldados and Endris (2019), and (b) (from (https://www.boutique vegetale.com%2Fp%Fabelmoschus-moschatus, accessed on 11/ 06/ 2020).

5.2.14. Adansonia Digitata

Adansonia digitata, also known as *baobab*, belongs to the family *Malvaceae*. It is a very long-lived deciduous tree native to Africa. West Africa is believed to be the origin of this multi-purpose tree (Kehlenbeck et al. 2015). Its distribution in sub-Saharan countries is high, particularly in semi-arid, sub-humid and savanna environments. This remarkable tree can grow as high as 25m and has a very thick trunk, and wide-spreading branches (often 10-15m in diameter) (Kehlenbeck et al. 2015).

It is considered as very significant in many African cultures and histories, and has been widely used by many African peoples for its numerous economic, medicinal and commercial benefits (DeCaluwé et al., 2021). No part of it is insignificant, and the fruits and leaves are useful for food and traditional medicine. According to (DeCaluwé et al., 2021), the fruit can be eaten fresh or processed into porridge, ice cream, sweets, juice, and jam. It has high sugar, vitamin C and mineral contents, and is also important for industrial uses such as the manufacture of oil and cosmetic products.

Abundant carbonized and desiccated remains of A. *digitata* seeds were recovered from the archaeological sites of Kassala in Sudan and northern Ethiopia (Beldados 2018). The remains from Sudan were dated to the 5^{th} -4^{th} millennia BP. Most of the seeds recovered were complete. The seed has two layers: the outer and inner layers. The inner part that covers the seeds inside is the hardest (see Figure 20b-d). Despite the large-scale distribution of A. *digitata* in almost all parts of Africa, including the eastern parts, only one fragmented remain from a seed was identified from the archaeological site of Harlaa from the 2016-2020 field seasons. This indicates trade contact than natural availability and growth of the plant in the area.

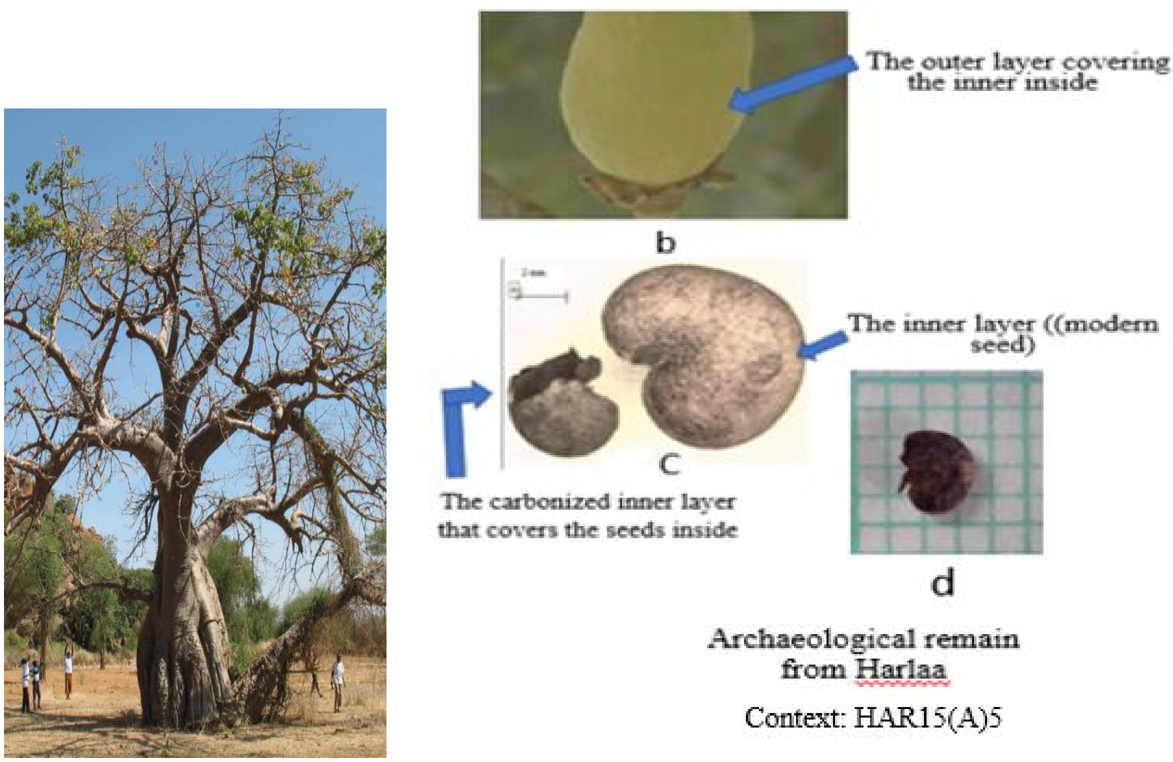
a) 

Figure 15. Photos showing the tree of Adansonia digitata (a) (from Kehlenbeck et al., 2015), fresh fruit (b) (from Orwa, et.al., 2009) and carbonized identified from Kassala [on the left] & modern seeds [on the right] (c) from (Beldados 2018).

5.2.15. *Ziziphus* sp.

The genus *ziziphus* commonly known as 'jujube', constituting approximately 100 species, consists of trees, shrubs and herbs distributed in arid and semi-arid environments due to their potential adaptation of drought stress. This genus name belongs to different plants (ranging from the drought-resistant perennial trees with maximum growth of 9m height to small annual herbs) grouped into six families: *Rhamnaceae, Leguminaceae, Mollugnaceae* (which favors silt and clay soil), *Chenopodiaceae*, *Cruciferae* (commonly available in aquatic environments) and *Cucurbitaceae*, which unless otherwise, are available in low-lying cultivated lands as weeds (Orwa, et.al., 2009; Beldados, 2015).

The diverse species of *ziziphus* have also been amongst the floral resources selected by peoples for a variety of purposes. The leaves, roots, stem, fruits, and seeds were used especially for nutritional and medicinal benefits. Traditionally, the medicine prepared from *ziziphus* was thought cure insomnia, skin related diseases, inflammatory conditions, and fever. Apart from these uses, the stem has been also exploited in many countries including Ethiopia, as timber for construction and household implements making, the leaves for livestock fodder, and the branches as firewood and charcoal. *Ziziphus spina christi* is also believed to be used by some people in times of drought when there is a shortage of edible plants as a source of vitamins (Arndt & Popp, 2001; Beldados, 2015 and 2018).

According to (Beldados, 2015 and 2018), carbonized remains of *ziziphus spina christi* fruits were recovered from Khartoum between c. 6000 and 9000 BP and Kassala site in Northeastern Sudan dated to the 5th Millenia BP. One fragmented remain of *ziziphus* sp. (that remained difficult to identify into species level) was also identified from Harlaa. Its presence in the settlement indicates that the historic inhabitants were exploiting it, possibly for some of the reasons mentioned above.

5.2.16. Acacia Nilotica

Acacia nilotica, indigenously known as *Babul* or *Kikar,* is a genus of moderate-sized trees and shrubs dominantly grown in the tropical and sub-tropical environments. It belongs to the sub-family *Mimosaceae* under the *Fabaceae* family. It is also known as *Cheba* in Amharic, and has nine sub-species, of which three of them are native to India and six are indigenous to the African tropics (Seebacher and Reichard, 2009 & Raj et al., 2015).

Acacia nilotica is also commonly found in many parts of Ethiopia. This perennial shrub or tree usually grows between 600-1700 ASL in agroclimatic zones receiving below 1200 mm. It can grow between 2.5-15m height depending on the ecological setup and climatic conditions of the area. It can also be easily distinguished by its feathery leaves and yellow flowers in round nodes (Figure 21a). The deep root system of this plant enables it to extract and preserve water from far below the ground. Farmers have a long tradition of *Acacia nilotica* cultivation, and it was exploited for various reasons. First, they preferred this plant for its capacity to preserve soil and increase soil fertility. They also grew it for its medicinal significances among its many other uses (Atif, 2012; Raj, et al. 2015). Its stem bark, leaves, roots, and seeds are traditionally important to treat cancer, tumor, tuberculosis, wound infections, diarrhea, inflammatory diseases, leprosy, smallpox, skin disease and seminal weakness. The hard thick wood is also used to make household implements, such as grinders (Atif, 2012).

Desiccated macroremains of *acacia nilotica* seeds have been identified from the site of Harlaa. A total of 19 seeds were recovered from context HAR18-B-24. This plant is also currently available in the study area as it was observed during the survey. Its current presence and its presence in the archaeological record indicates that the plant has been grown and used in the Harlaa area since at least the mid-6th century AD, and is therfore suited to the ecology of the area.

a)  b) 

Figure 16. Photos showing Acacia nilotica tree (a), and the archaeological seed of it recovered from Harlaa: context- HAR18-B-24 (b). Photo by (a) (Endris Hussien, 2020) and (b) Alemseged Beldados and Endris Hussien (2019).

5.2.17. Cordia Africana

Cordia Africana, also known as '*Wanza'* in Amharic, is an evergreen moderate size tree or shrub belonging to the family *Boraginaceae*. It is a deciduous tree with spreading branches that can grow between 550-2600m ASL and with an annual rainfall 700-2000 mm. It is commonly scattered at medium to low altitudes, in woodland, savannah and bush environments, and in warm and moist areas, often along the riverbanks of East, South and West African countries. Guinea is believed to be the origin of this plant. This plant can attain an average growth of 14-21 m in height (Alemayehu et al., 2016).

Cordia Africana has a wide range of uses in Ethiopia. It is the most used wood for the furniture industry, and to make household & ecclesiastical tools and instruments, such as drums. It can be also used as firewood, and its leaves as livestock fodder. It is also used as traditional medicine to treat headache, nose bleeds, dizziness and vomiting during pregnancy, wounds and worms (Alemayehu et al. 2016). The fresh or cooked fruits of this plant are also eaten in most parts of Ethiopia.

Twelve remains of *Cordia Africana* seeds were amongst the archaeobotanical findings identified in the 2016 to 2020 field seasons at Harlaa (see Ttable.13 and Figure 22). Most of the remains were fragments. The archaeobotanical representation suggests that this plant has been grown in the area from about the 8th century AD onwards and was used by the inhabitants for either of the benefits aforementioned.

a)  b) 

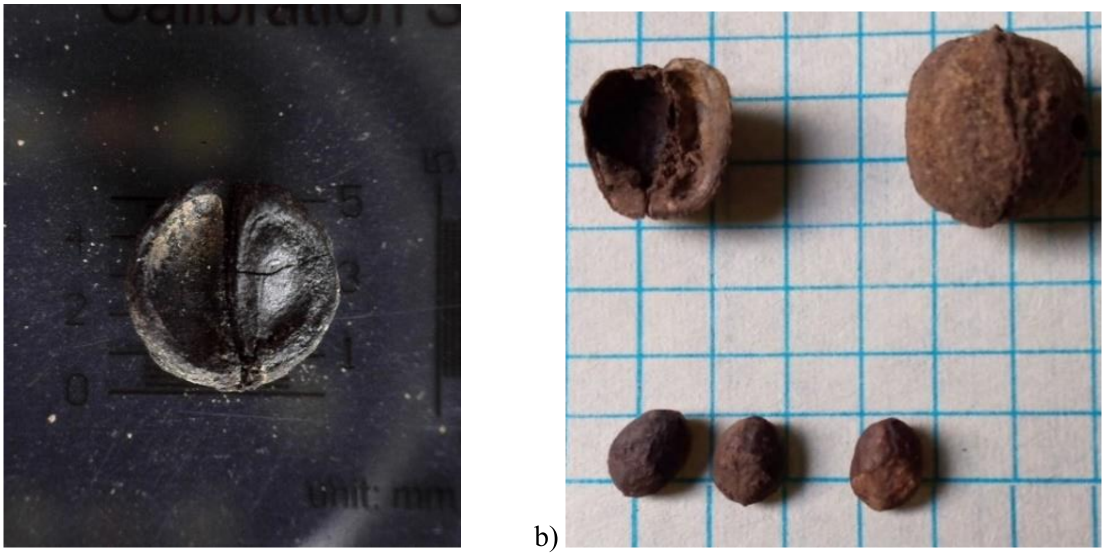
Figure 17. Photos showing the archaeological remains of Cordia Africana seed identified from Harlaa: context- HAR19-E-7 (a), and the modern seed reference seed of it (b). Photo by (a) Alemseged Beldados and Endris Hussien (2019), and (b) Endris Hussien (2021).

5.2.18. Croton Macrostachyus

The species *Croton macrostachyus*, also known as Rush foil, belongs to the family *Euphorbiaceae.* Locally, it is known by different names, such as '*Bisana*' in Amharic and '*Bakkaniisa*' in Afan Oromo. This plant is a moderate sized deciduous tree that occurs in mountainous, savannah, and bushland regions of the African tropics. It grows between 200-2500m altitudinal range, and in areas receiving 700-2000 mm annual rainfall. This drought tolerant tree is widely spread throughout most of East Africa, and is native to Ethiopia, Eritrea, Kenya, Tanzania, Uganda and Nigeria. It is a fast growing tree with heart-shaped leaves and can grow up to 30m height (Abdisa 2019).

Croton macrostachyus is a multi-purpose tree in many countries. In Ethiopia, it has numerous medicinal uses in the primary healthcare system of communities. Its leaves, bark, seeds, and roots carry diverse medicinal contents for peoples and their herds. They used it to treat blood clotting, diarrhea, skin infections, stomach pain, typhoid, wounds, pneumonia, malaria, epilepsy, and bleeding (Ayza et al. 2020). Recently, *C. macrostachyus* was featured in the ethnomedicinal plant study made by Belayneh & Bussa (2014), who reported that the current occupants of Harlaa area are using it to cure liver disease. Moreover, *C. macrostachyus* is also used to keep the beauty of a bride during the honeymoon period (particularly in the Wollo area) – by the smoke released during firing the non-dry immature branches. Furthermore, this plant is used for livestock nutrition, and as timber, for household implement making, and as charcoal and fire-wood.

The remains of the fruits of *C. macrostachyus* were identified from Harlaa. The fruit has three lobes and is an almost globular-shaped capsule 8-12m in diameter with three seeds inside. It has only one outer cover seedcoat with three partitions inside for each seed (see Figure 23a-b).



a) b)

Figure 18. Photos showing the archaeological fruit remain of Croton cf. macrostachyus recovered from Harlaa: context- HAR19-E-12 (a), and the modern fruits (top-right), seedcoat (top-left) and seeds (bottom) (b). Photo by Endris Hussien ((a) 2021, (b) 2021).

5.2.19. Ulmaceae

Ulmaceae, commonly known as Elm, is an angiosperm basically categorized under two sub-groups: *Ulmoideae* and *Celtidoideae*. There are 15 genera which altogether constitute about 200 species of Elm trees and shrubs. It is a handful of tree and shrub widely grown in temperate regions of North America, Europe, and Asia. It is also distributed in tropical Africa and South-East Asia (Zavada 2015). Archaeobotanically, desiccated seeds of *Celtis integrifolia* (one of the species of *Ulmaceae)* were identified in large quantity (in Holocene contexts) at Kassala, Northeastern Sudan (Beldados 2018). Only one fragment of a seed resembling the family *Ulmaceae* was recovered from the archaeological deposits at Harlaa (Figure 24a). Identifying the remains into either in genus or species levels was difficult due to the very fragmented morphology of the seed.

According to Simpson (2010), Elm trees and shrubs have been traditionally used for nutritional and medicinal benefits. Economically, they serve as fiber, fodder, and timber. In the sphere of primary medication, people use it to cure childhood nutritional impairment, parasitic infections, abdominal pain, and chronic diarrhea.

a)  b) 

Figure 19. Photos showing a fragment Ulmaceae seed (sbsp. Celtidaceae) recovered from Harlaa: context- HAR20-G-11 (a), and modern specimen reference of it (b). Photo by (a) Endris Hussien (2021), and (b) (from https://www.celtidaceae+seeds, accessed on 12/01/2021).

5.3. Circumstantial Archaeobotanical Evidence from Harlaa

5.3.1. Plants Imprints

Remains of plants can be found in the form of imprints on clay materials, such as pottery, and plaster. Archaeobotanical data, such as this, can be treated as circumstantial (indirect) evidence for reconstructing ancient subsistence and for the palaeoenvironment. Studying the imprints of botanical remains provides information related to many aspects of plant life and use, just as the study of actual remains does, including domestication, cultivation, storage, processing, use, availability of plants and even trade networks. It also adds knowledge with regard to environmental conditions and people-plant relationships (Tchekhanovets & Frumin 2016).

Botanical imprints can happen when parts of a plant (e.g., a leaf or seed) get stuck on fresh plaster or wet, unfired pottery, and is burnt away when exposed to fire, which leaves the negative imprint visible (Beldados et al., 2015). Imprints can be identified by making a positive copy of them using a fine-grained mud, such as silicone as used in making of the positive copies of leaves, and seeds on a plaster and pot. In addition, the size of imprinted plant remains, and the grain pattern of the mud used determine the quality of the positive imprints and the probability of successful identification of the remains. The archaeological site of Harlaa was not only enriched with archaeobotanical remains of seeds but also in imprints, with one plaster fragment having imprints of two leaves and a seed, and one pottery sherd with an imprint of a seed.

5.3.1.1. Imprints on Plaster

The plaster, of which two imprints of plant leaves and one seed imprint were found, was uncovered from a stone-built building (HAR20-G) during the 2020 excavation season. The plaster was used to cement the dressed stones during the construction of the house. On the plaster, (see Figure 25a and c), imprints of veins and midribs similar to the leaf of *Cordia Africana* were found.

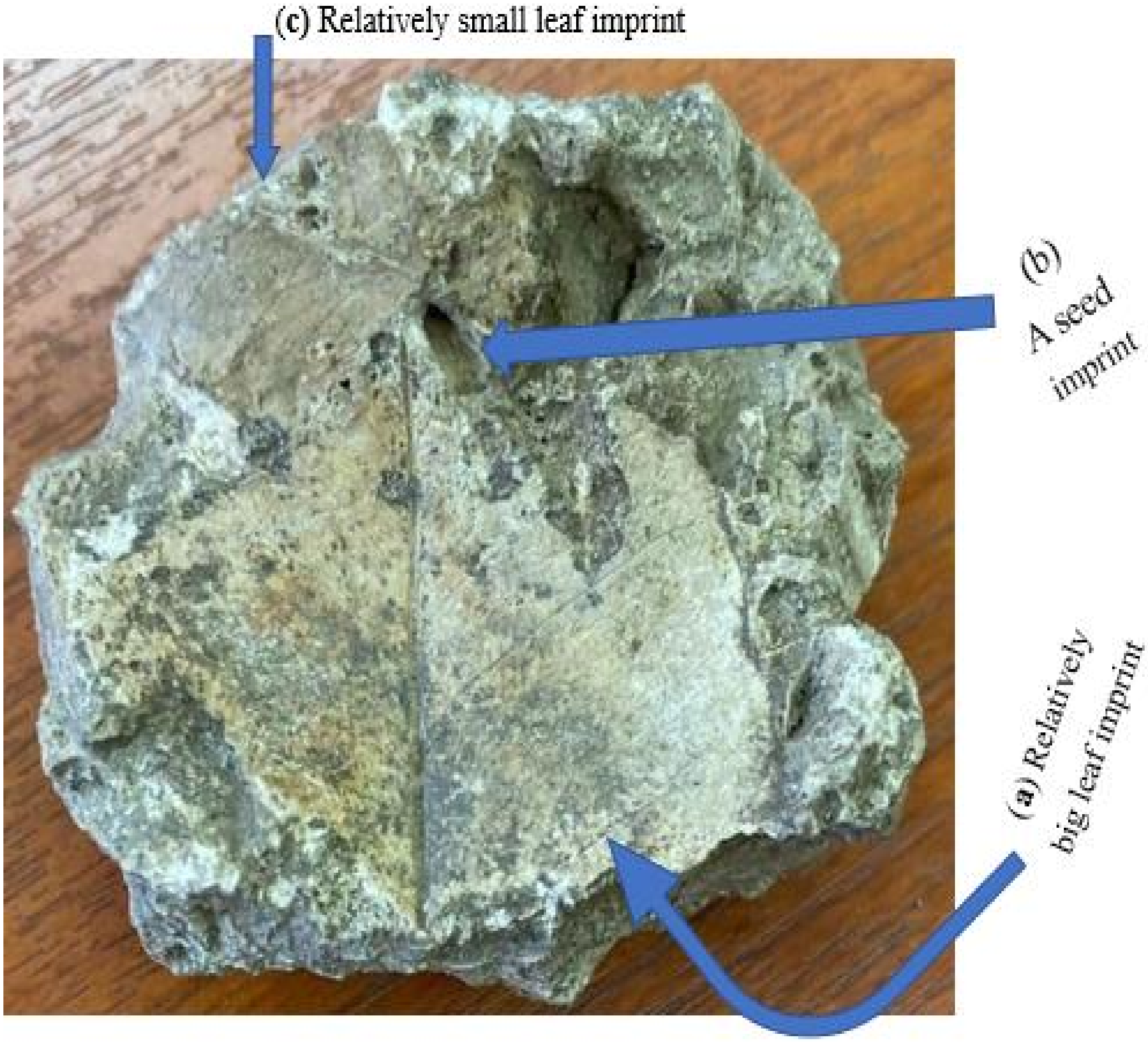


Figure 20. Plant imprints relatively big leaf imprint (a), a seed imprint (b), and relatively small leaf imprint (c) (all of them are the negatives left on a plaster) (Photo by Endris Hussien, 2020).

The leaf of *C. africana* is a fairly-large oval-shaped leaf 20 x 15 cm, with a rounded base and veins prominent on its underside. Although the negative of leaf (c) has a similar pattern with negative imprint (a), producing a positive cast for leaf (c) was difficult.

(a) The positive imprint (cast)

(b) The actual/ modern leaf (dorsal surface)

(c) a drawn reconstruction of the imprint

Figure 21. The positive imprint/ cast, its drawn reconstruction and the modern leaf (photo & drawing by Endris, 2021)

As shown on both plaster and cast (Figure 25a & 26a), neither the negative nor the positive imprint is fully visible. The peripheral parts of the leaf (including margins, apex, leaf lamina, some of the veins and some base parts) were not fully imprinted on the plaster and did not leave a negative impression. However, the midrib and most of the veins are clearly visible, and hence quite identical with those on the dorsal surface of the modern leaf (see Figure 26a-b). Regarding the seed imprint on the plaster, a photo with high resolution was taken (Figure 27a), and a positive cast was also produced (see Figure 27 b).

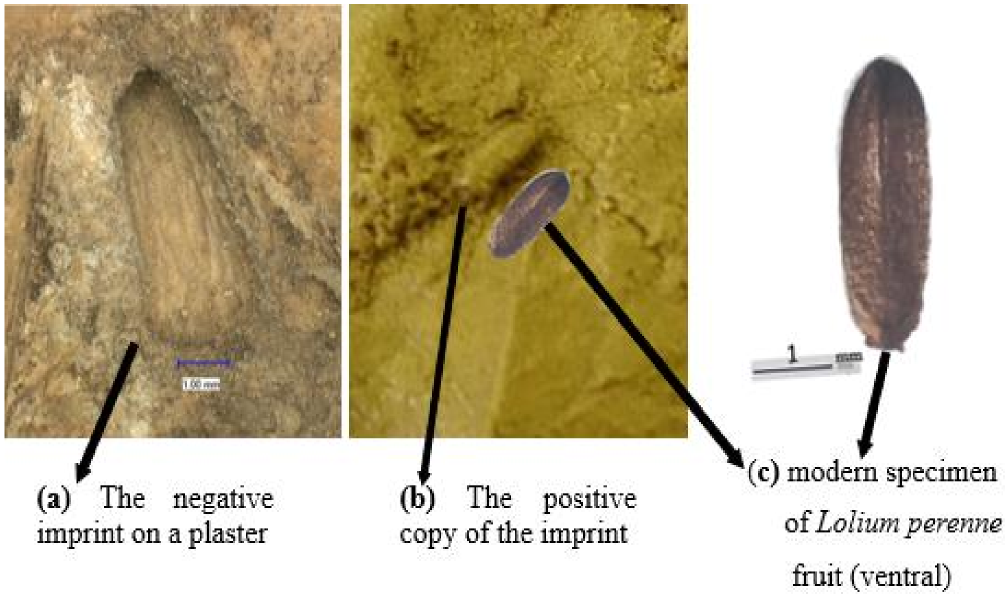


Figure 22. Photos showing the negative imprint on a plaster (a), the positive copy/ cast of the imprint (b), and modern reference of Lolium perenne (c). Photo by (a &, b) Endris Hussien (2021), and (c) from Cappers, Bekker, and Jans, 2006:72, photo no. 308-C).

The imprints (both the negatives and the positives casts) and the modern reference used are shown in their ventral surfaces. More than the cast, morphological similarity is visible between the negative imprint on the plaster (Figure 27a) and the modern reference (c). This *Lolium perenne* is selected among many of the species' diversity presented on the guide handbook known as *Digital Seeds Atlas of the Netherlands* (Cappers, et.al., 2006). All the impressions on the plaster seemed to be unintentionally imprinted as the plaster was used to cement the stones-built complex.

5.3.1.2. Imprint on Pottery

A seed imprint was also identified on a pot fragment. Potters intentionally decorate their pots using many agents, including plant leaves. Also, sometimes, seeds may be mixed with the clay as temper and thus become part of the pot in the manufacturing process, leaving their negatives behind when the pot is fired. Identified imprints can help archaeobotanists see the available crops and other plants in the area where the imprints uncovered.

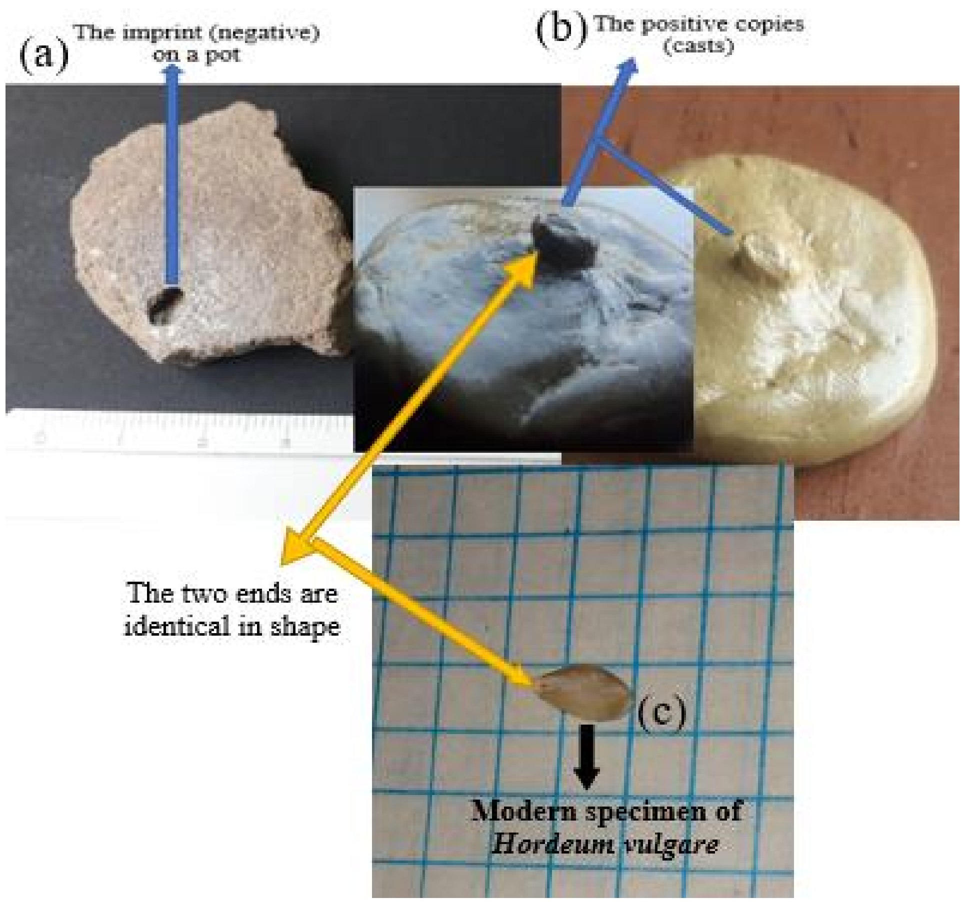


Figure 23. Photos showing a negative imprint of seed on the pot fragment collected from Harlaa: context-HAR20-G (a), the positive copy/ cast of the imprint (b), and (c) a modern seed specimen of Hordeum vulgare used as a comparative of the positive copy of the imprint (photo by Endris, 2021).

As clearly shown above in Figure 28, the positive copy of the imprint has an identical shape with the seed of Hordeum vulgare. Morphologically, the seed has an oblong shape (7-8 mm in length) and papery texture with two distinct blunt tips.

5.4. Subsistence Reconstruction and Environmental History

The data that has been presented proves that the historic Harlaa peoples had developed an advanced form of farming, and were producing various food crops. To compare the ratios of identified plants, a percentage measure is used. This helps to develop phytogeographical interpretation regardless of species diversity and distribution patterns. In addition, it is also important to better understand the function of an archaeological site. Accordingly, a total of 218 food crop remains (cereals, legumes and oil plants), which constitute 30.5% of the total amount of recovered remains, were identified in the 2016-2020 field seasons

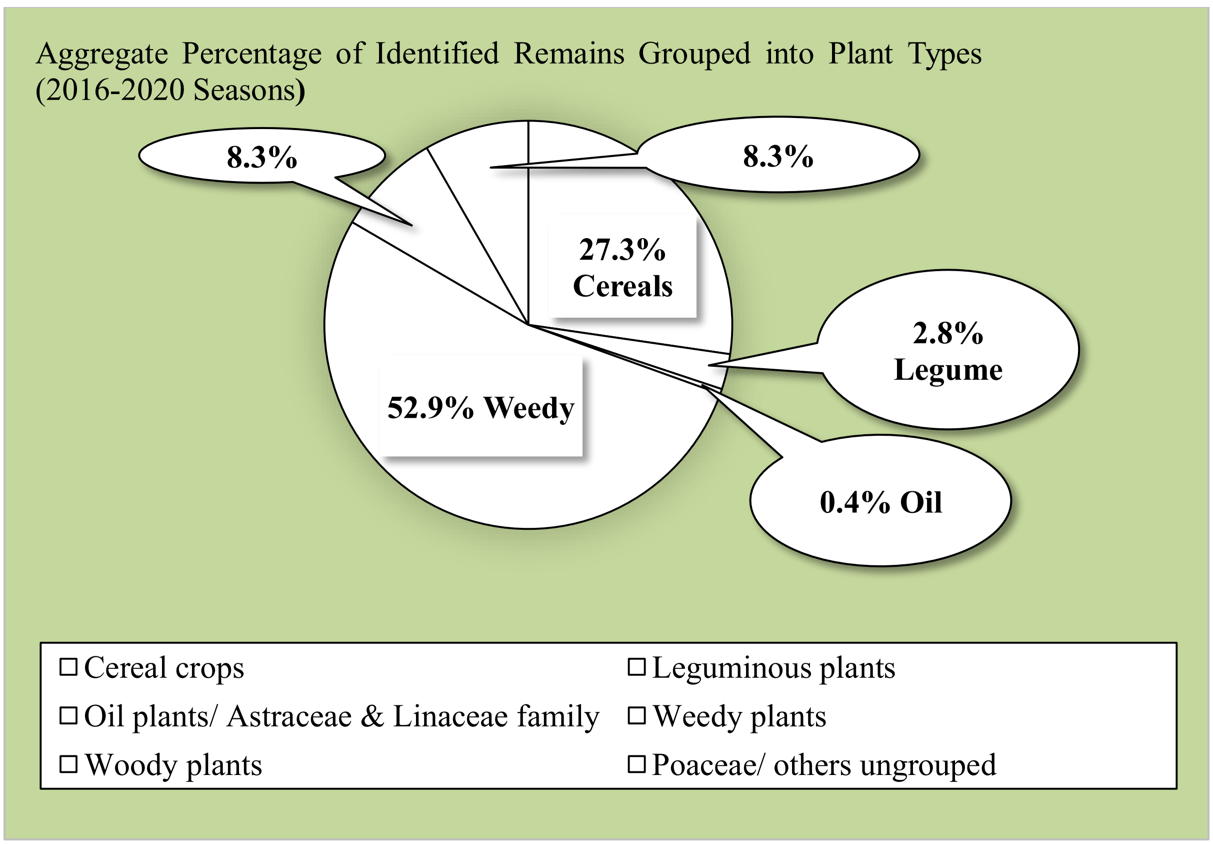


Chart.6. Chart that shows the total percentages of identified remains of all seasons grouped into plant types.

As also presented in Chart.6 above, identified remains are grouped into six plant types as cereal crops, leguminous plants, oil plants, weedy plants, woody plants and others/ungrouped (*Poaceae*). Specifically, the cereals, as the main food crops, constitute 27.3%, the second largest amount next to the weedy plants, were found in most of the seasons and excavation areas. This is suggestive of the inhabitant's food economy as they were mainly dependent on cereal crops, such as *Triticum* sp. (wheat) and *Hordeum* sp. (barley). The abundantly identified remains of *Lolium* sp. (perennial ryegrass) (55 seeds) is also another indicator of the uses and cultivation of wheat and barley because it usually grows along with them. The archaeological presence of these food crops from Harlaa also probably indicates contacts maintained with peoples of other areas (e.g., Northern Ethiopia) where those crops had first grown and used.

Regarding leguminous plants, *Cicer arietinum* (chickpea), *Lens culinaris* (lentil), *Pisum Abyssinicum* (pea), *Trigonolla foenum graecum* (fenugreek) and others were identified although only in small amounts accounting to 2.8% of the total finds. According to Amiri et al. (2020), the legume family is one of the most abundantly represented among the crops and is grown as an accompaniment to cereals for its crucial use of increasing the fertility of the farmlands. It is also grown and consumed as an important source of (generally high) protein for humans since the Neolithic agricultural revolution. Their presence in the form of archaeological evidence could support the hypothesis that the historic Harlaa community cultivated and used food crops.

As presented in Chart.6, the least identified remains from Harlaa are oil plants. Only three seeds (two from *Linaceae* (flax) and one from *Astraceae* (compositeae/ sunflower) families) were identified, accounting for 0.4% of the total. Although small in number they could be taken as potential indicators of the practice of food crop farming subsistence. Food crops are essential both for humans and their animals, and the seeds of cereals, legumes and oil plants can provide vital proteins, carbohydrates and vitamins for humans, and the residual meal and stalks are also very important animal fodders.

Weedy plants are the largest of all recovered remains from Harlaa which constitute 52.9%, more than half of the total amount. Very importantly, *Chenopodium* sp (goosefoot). and *Oxalis stricta* (yellow sorrel) are the only two abundantly identified weeds. A total of 356 seeds in the former and 24 seeds in the latter plant-type species were recovered. *Chenopodium* sp., was identified from almost all soil samples of 2016-2020 seasons indicating its high distribution and species diversity. It is an unwanted seasonal and perennial flowering plant that can grow everywhere. *Oxalis stricta* is also an environmentally opportunistic weed which grows in different habitats. Both weedy plants can grow in fast abundance due to their ability to utilize large amounts of soluble nutrients from the soil, more than crops. They also evolve naturally over time, so that they become more climatically opportunistic than crops. *Chenopodium* is tolerant of a wide range of environments and can grow in almost all cultivated lands. This is because seeds of weeds can easily germinate and attain rapid growth in places where people discard waste materials and unwanted dirt and garbage. The presence of both weedy plants in the form of archaeological evidence, combined with the evidence for the food crops mentioned earlier, indicates that the historic Harlaa peoples had developed food-grain farming subsistence, and were using them as staple food-crops.

The presence of botanical remains in the form of archaeological evidence, are crucial to understand past environmental conditions including the level of their distribution, diversity, and quantitative ratio. Regarding the food crops (particularly the cereals), as discussed earlier, they were identified in large amounts from the contexts dating between the mid-6th and mid-13th

centuries AD. The contexts in which s*orghum* sp. was recovered from are dated between the 11th and 13th centuries AD, suggesting the later cultivation and use of the species in the area from the 11th century onwards. Furthermore, almost none of them (except one L. *usitatissimum* and two T. cf. *foenum graecum* remains) were recovered from the soil samples dating between late-13th and 15th centuries AD. This suggests that there was a major subsistence shift probably due to environmental change that may have resulted with the failure of food crops probably from the 13th century AD onwards. Based on the data obtained through ethnoarchaeological survey and interviews, none of the food crops (except *sorghum*, sometimes) are still grown in the present-day Harlaa area.

Moreover, the current occupants dominantly grow *khat* (*Chata Edulis*) in their farmlands, in which terracing and irrigational canals are common. This suggests that there have been factors (e.g., environmental change) that forced the subsequent occupants of Harlaa (the Oromos) to adopt a new forms of subsistence strategy, i.e., cash crop farming. According to some historical accounts (e.g., Harari People Regional State Culture, Heritage and Tourism Bureau 2015, and Mekuria, 2018), *khat* and coffee were amongst the widely cultivated cash crops by the Harari peoples from around the 15th and 16th centuries AD century although this is not confirmed through archaeological investigation. Other crops, such as coffee, *sorghum*, cotton, tobacco and sunflower are also mentioned. This could possibly suggest that *khat* farming was introduced in Harar and the surrounding vicinity (including Harlaa) as a new form of subsistence produce after the archaeologically identified food crops ceased to be grown.

As far as the archaeologically identified woody plants (trees and shrubs) are concerned, a total of 60 seed remains were identified which constitute 8.3% of the total amount of finds. A. *nilotica*, C. *african a*, A. *moschatus*, C. *macrostachyus*, A. *digitata*, *Ziziphus* sp., and *Ulmaceae* were among remains identified. From these, A. *moschatus* constitutes the largest amount (21) followed by A. *nilotica* (19) and C. *africana* (12). Except C. *africana* (identified in almost all contexts), none of them were identified again (see Table.12). Furthermore, most of these plants are not currently grown in the area except A. *nilotica* (common) and C. *africana* (uncommon), while short shrubs are growing abundantly in the area and its environs. Therefore, the small availability of broad-leaf trees in the area currently, and the diversity of short shrubs on the contrary, could also strengthen the environmental change scenario towards desertification and aridity.

With the aim of testing whether environmental change occurred or not in the study area and the possible impact on the lives of the inhabitants' historical accounts, such as Pankhurst (1972), Zewude (1976) and Wood (1977), were consulted. Accordingly, there were large-scale environmental oscillations termed, according to Beldados (2017:15), as the "*little Ice Age*" between the 13th and 19th centuries in many areas of Ethiopia, including the eastern regions. Famines, droughts, locust invasions and epidemics were among the catastrophes which resulted with repeated crop failures and mass death events of peoples and animals. A series of these occasions are known to have happened and many of these are known by specific names in Amharic. Occasions include, in 1252 (known as *asah*), 1258-59 ('fassas' means 'spreading' in Amharic), 1261-62, 1272-73 (*hglah), 1540*, 1543, 1560-62, 1597, 1611 (*manintita*), 1616, 1618-19, and locust invasions are known during reign of Emperor Iyassu II (1730-55), and in 1826-27, 1835, and 1865, 1888-91 (*Qifu ken*). The terminology given for each episode of calamities could also tell us the extent of the impacts as well. For example, the event of 1611 was known as "*manintita*", which is an Amharic term meaning "no one remained untouched". In this context, we can understand that peoples were the victims of the catastrophes. Those calamities and their wide-ranging impacts also add weight to the story that "divine punishments [were] sent to the Harlaa people for their inordinate pride and extravagant use of resources" noted by Bogale (2020:2), as well as the famine and war discussed by the Harari People Regional State Culture, Heritage and Tourism Bureau (2015) as indicated in Chapter 2.

5.5. Conclusion

Overall, the results in this study show that the historic Harlaa peoples practiced food crop-based farming activities. Almost all of the findings identified from the archaeological deposits were food crops (dominantly cereals). In this regard, *Hordeum* sp. and *Triticum* sp. as food crops, and *Lolium* sp. as a cereal crop weed (commonly grown along with *Triticum* and *Hordeum*) were the abundantly identified remains.

Moreover, the results also suggest that there was a significant subsistence shift and environmental change based on the following three reasons: (1), the food-crops (*Hordeum*, *Triticum*, *Lolium*, *Lens culinaris*, *Pisum abyssinicum* and others) were not identified from the archaeological contexts dating from the 13th centuries onwards; (2), Sorghum sp. was identified in much later dating contexts, circa early-11th-early-13th centuries AD, than the other cereals, which were identified in mid-6th to early-13th centuries AD contexts; and (3) although devoid of archaeological evidence, cash crops (such as *khat* and coffee) were introduced into farming in Harar and the surrounding vicinity around the 15th or 16th century, and after Harlaa had been abandoned because of environmental change, as one reason (though it needs further investigation). This indicates that there was a subsistence shift from the cultivation of annual food-crops to perennial cash-crops.

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List Of Informants

No	Full Name	Sex	Age	Occupation	Place of Living	Date of Interview
1	Abdi Muktar	M	35	Farmer and carpenter	Harlaa	10/02/2020
2	Abraham Yaregal	M	38	Higher Officer at Dire Dawa Culture and Tourism Offoice	Dire-Dawa	06/02/2020
3	Ahmed Jibril	M	45	Farmer and carpenter	Harlaa	06/02/2020
4	Ahmed Muktar	M	28	High school teacher	Harlaa	10/02/2020
5	Ali Mussa	M	60	Farmer	Harlaa	05/02/2020
6	Fuad Yusuf	M	26	Economic intelligence	Harlaa	05/02/2020
7	Hamza SheikOmar	M	25	High school student	Harlaa	08/02/2020
8	Mustofa Hamis	M	30	Elementary school teacher	Harlaa	06/02/2020
9	Rauf Ahmed	M	28	Farmer	Harlaa	08/02/2020
10	Taju Baker	M	26	High school student	Harlaa	10/02/2020

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APPENDIXES

Appendix-I. The Chronology of Contexts from Harlaa (2016-2020 Seasons) provided by Professor Timothy Insoll, 2021

The 2016 season soil sample contexts

Context	Date/ Chronology
HAR (A) 2 This should be corrected to HAR16-B-2	Late 13th to early 15th centuries AD
HAR (A) 3 (HAR16-B-3)	Late 13th to early 15th centuries AD
HAR (A) 4 (HAR16-B-4)	Late 13th to early 15th centuries AD
HAR (A) 6 (HAR16-B-6)	Late 13th to early 15th centuries AD
HAR (A) 9 (HAR16-B-9)	Late 12th to late 13th centuries AD

The 2017 season soil sample contexts

Context	Date/ Chronology
HVS 1-10 cm C14 date	Early 11th to mid-12th centuries AD
HVS 1-30 cm	Estimated as early 11th to mid-12th centuries AD
HVS 1-50 cm	Estimated as early 11th to mid-12th centuries AD
HVS 1-70 cm	Estimated as late 8th to late 10th centuries AD
HVS 1-90 cm	Estimated as late 8th to late 10th centuries AD
HVS 1-110 cm C14 date	Late 8th to late 10th centuries AD
HVS 2-20 cm C14 date	Mid-12th to mid-13th centuries AD
HVS 2-40 cm	Estimated as mid-12th to mid-13th centuries AD

HVS 2-60 cm	Estimated as 11th to early 12th centuries AD
HVS 2-80 cm	Estimated as 11th to early 12th centuries AD
HVS 2-90 cm C14 date	Late 8th to late 10th centuries AD
HVS 2-100cm	Estimated as late 8th to late 10th centuries AD
HVS 2-120 cm	Estimated as late 8th to late 10th centuries AD
HAR17-B-23	

The 2018 season soil sample contexts

Context	Date/ Chronology
HAR 18 (B)10	11th to mid-13th centuries AD
HAR18 (B)13	11th to mid-13th centuries AD
HAR18 (B)18	11th to mid-13th centuries AD
HAR18 (B)19	11th to mid-13th centuries AD
HAR 18 (B) 22	11th to mid-13th centuries AD
HAR (B) 23	Mid-6th to 10th centuries AD
HAR (B) 24	Mid-6th to 10th centuries AD
HAR (B) 25	Mid-6th to 10th centuries AD

The 2019 season soil sample contexts

Context	Date/ Chronology
HAR 19 (E) 7	Mid-11th to early 13th centuries
HAR 19 (E)10: Hearth	Mid-11th to early 13th centuries
HAR 19 (F) West of 11	Mid-11th to early 13th centuries

HAR 19 (E) 12	Mid-11^{th} to early 13^{th} centuries
HAR 19 (E) 13: Posthole	Mid-11^{th} to early 13^{th} centuries
HAR 19 (E) 14: Hearth	Mid-11^{th} to early 13^{th} centuries
HAR 19 (E) 30 C14 Date	Mid-11^{th} to late 12^{th} centuries AD

The 2020 season soil sample contexts

Context	Date/ Chronology
HAR-20 (G) 10/hearth at base	Early 11^{th} to early 13^{th} centuries AD
HAR-20 (G) 11	Early 11^{th} to early 13^{th} centuries AD
HAR-20 (G) 12	Early 11^{th} to early 13^{th} centuries AD
HAR-20 (G) 12/Posthole	Early 11^{th} to early 13^{th} centuries AD
HAR-20 (G) 12)/Charcoal	Early 11^{th} to early 13^{th} centuries AD
HAR-20 /Hamadi Ibro	Obtained through survey (modern)

Appendix-II. Photo of an in-situ pot filled with soil

Context: HAR-20 (Hamadi Ibro)

Appendix-III. Main Questions for Interview

Name____________________

Age______________________

Place of Living_____________

Occupation________________

Question 1. Are there any food crops that the current residents of Harlaa are growing in their farmland? If ‘Yes’, Mention them? If ‘No’, what food crops they are using for consumption?

Question 2. Frow where they bring the food crops? Is there any nearby market to buy grains for food?

Question 3. What are the dominant plants grown in Harlaa and its surroundings naturally?