Gossi: The Ancient Nubian Mud Built Grain Silo

Article in Nyame Akuma · June 2015

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Introduction

A silo (from the Greek siros, “pit for holding grain”) is a structure for storing bulk materials. Modern silos are commonly used for bulk storage of grain and other materials. Three types of silos are in widespread use today: tower silos, bunker silos, and bag silos. In the past archaeological ruins and ancient texts showed that silos were used in ancient Greece as far back as the late 8th century BC. The Egyptians built grain silos in walled enclosures that were carefully plaster-coated on the inside and whitewashed on the outside.

Nubia, which encompasses parts of southern Egypt and northern Sudan, is one of the very important parts of the world that historically has its own grain storage techniques. This paper tries to focus on the most important ancient silo for grain storage called gossi in the Nubian language. Unfortunately, the technique is going to fade out with modernization. In fact the construction of gossis stopped in the 1990s and very few families store grain in gossis today.

Historical Background of Grain Storage in Nubia

Evidence of food storage in Sudan is known since prehistoric times beginning with the first human settlement in the Mesolithic (6000-10000 BC). At that time, it seems that there was surplus food production. The first evidence comes from the El Baraga Mesolithic site near Kerma where storage pits were discovered (Honegger 2004: 27). Other food storage pits from the Neolithic (6000-4000 BC) were discovered in the Tkulainos site in eastern Sudan. During the Neolithic period, human settlement was established, food production based on farming was adopted, and social organization became more elaborated (Sadr 1991: 33).

During Pre-Kerma times (3500-2500 BC) the society was more organized and food production increased as is evident from the large numbers of (300) storage pits that were discovered in Kerma’s eastern cemetery (Honegger 2003). In addition, an additional 140 circular pits that date back to Pre-
Kerma times were identified in the city of Kerma (Bonnet 1991:12-13). Also Bonnet (1992:14) recovered pits 30-40cm in depth and a big pottery storage jar. In Sai Island, Gues (1998: 66) found ceramic pots inside pits that were dated to 2700 BC. Some of these pits are deep and contained wheat and barley grains. Near the pits, Gues (1998) found wooden planks that may have been used to cover the pits.

Adams (1966) mentioned that C-Group (2200-1200 BC) archaeological sites reflect an increased reliance upon agriculture and animal husbandry and Adams added (1977: 154) that in lower Nubia grain storage pits were discovered belonging to this group. Inside C-Group houses in lower Nubia, tethering posts for animals were found as well as silos for storing grain (Emery and Kirwan 1935: 91). During Kerma times (2500-1500 BC) more stable and organized communities appeared and grain storage became well known. For example, large numbers of pits were discovered on the bank of the Wadi Khewi in Gism Arba’a village (Gratien 2006: 25). On Sai Island, near Kerma cemetery, a number of grain storage pits were discovered that have brick supporting walls. In the same vicinity grinding stones were distributed (Osman 2014: 97). In Amara West village inside a New Egyptian Kingdom settlement (1650-1000 BC) Spencer (1997: 132) found large pottery jars used for storage. A set of storage pits were found inside a room in the settlement that date to the same period (Spencer et al. 2014: 34).

During Kushite periods (650 BC-AD 350) grain storage appeared on a large scale at Napatan and Meroitic sites. For example, huge silos or large jars were discovered in a building of El Kowa town (Welsby 2008: 26), and large storage mud-jars (700cm in diameter) were found in Gala Abu Ahmed in northwest Sudan (Jesse 2010: 548). Approximately 136 large storage jars were recovered in Napatan rooms in Sanam Abu Dom (Vincentelli 2014). Nowotnick (2014) found a big storage jar in El Hamadab, a Meroitic settlement, and storage pots were recorded in the ground in Meroitic rooms in Wad Banaga (Onderka et al. 2013).

In the area of the El Haraz (Fourth Cataract region) Abdul Majeed (2012: 29) reported huge jars that were used for grain storage and dated back to the Post-Meroitic period.

Grain storage media continued through the medieval Christian and Islamic periods. During excavations of Christian Soba city, grain storerooms were discovered in a building (Shinnie 1955: 23), and other mud-built construction was found in one room (Welsby and Daniels 1991: 111). A number of storage pits were discovered in Kulubnarti’s Christian complex (Adams 2011: 64-65), and a deep hole (with a millstone inside it) was used to save grain inside a Christian building in New Amri (Fourth Cataract region) (Abdul Majeed 2012: 44).

Osman and Edwards (2012: 318) found a storeroom inside a house in Habrab village in the Third Cataract region. It is a big hole in the ground in Simit Island village (Osman and Edwards 2012: 415). About five holes supported with burned walls with cross inscription were found on Sai Island (Osman 2014: 68).

In the Third Cataract region Osman and Edwards (2012: 260) found different sizes of mud-built containers, known locally as gossi, that were used in grain storage dated to the early Islamic period. Recently a gossi was found in the excavation of El Fasher market site in El Khandag town (Dongola) (Sygharoun 2014), and another gossi was found in El Hamra Christian complex kitchen in El Ga’ab depression (Dongola) (Tahir 2015) (Figure 1).

It is clear that grain storage is an old technology in the Nubian region and can be simply classified into three categories: rooms, holes and jars. Underground holes may be small pits or a large hole with walls that are sometimes supported by bricks, stones or are solidified by burring the walls of the hole. Jars, ceramic or mud-made, range from smaller to larger sizes, and are mostly used as underground storage.
Gossi

Gossi is a mud-built silo for crop storage in Nubia (Figure 2). It was adopted, as it seems, during the Christian period (AD 500-1500) coinciding with the introduction of the sagia (wooden water wheel) to the area.

Gossi parts

Gossi have three main parts: body, upper cover and pospos blocker. The body is a cylindrical barrel with thin mud walls that sometimes becomes narrower toward the upper cylinder. The base is circular with a relatively thick wall. The upper part is open. Near to the base, there is a small round pore called pospos with a thick protruding wall. It is used to take out the grains. The cover is circular and similar to the base but has a thinner wall and a smaller diameter than the base. The pospos blocker is a piece of mud of the same material as the gossi or a piece of sandstone. It has a flat circular base and tapers at the tip.

Gossi sizes

The sizes vary from very large commercial containers to household medium and small sized gossis. One gossi measured at Kerma, has a height of 3.75m and a 0.45m diameter creating a volume of 6.97m³. A large size gossi is 2-4m in height with a diameter of 0.4-0.5m. These gossis are usually used for commercial purposes. A medium size gossi is 1.5-2m in height with a diameter of 30-35cm and it can store up to four jowals (sacks). A small size gossi has >1.5-0.5m in height with a diameter of 25-20cm that can store up to one half jowal.

Other related Containers

- **Galo silo**
  - Galo silo are large pottery ware used for storage. They are put in the shade, especially when dates are stored for home consumption. It has a cover similar to that of the gossi, but it is without a pospos.

- **Camar**
  - Camar is a gossi of a maximum 50-
70cm height with the same cover as that of the gossi, but without a pospos. It is built for keeping chickens from cats, dogs and jackals attacks during the night.

Types of crops

Before filling the gossi with grain, a fire-lit palm leaf is usually inserted into the cylinder to kill all pests and to evacuate the moisture inside. Ash is also sprayed as pesticide. If it is very large gossi, then a boy is put inside the pot to clean it before firing. Sometimes the ash is sprayed on the grain. The cover and the pospos are sealed with mud. The stored crops are wheat, sorghum, maize, Lablab (Dolichos lablab), cow pea (Vigna unguiculata), lupin (Lupinus sp.), broad bean and dates. Wheat, sorghum, maize and dates are stored in large and medium sized gossis. Other crops are stored in small size gossis because they are produced in small quantities.

Materials, Preparations and Building Technique

Women build gossi from the clay or mud that is taken from the Nile riverbank and it is mixed with donkey and/or cattle dung. This mixture is fermented for 7 to 21 days depending on the air temperature. If the clay is very sticky, modifiers are used. These are sand and crushed wheat stems.

Before building, the fermented mud, which will be used on that day, should be kneaded strongly using hands or legs. Firstly, the base is constructed on the sandy ground and then everyday a slab layer is built up. The new slab is built after the drying of the old
slab depending on the atmosphere. The height of the slab varies, but mostly it is 15 to 20cm. After finishing the wall, the internal surface should be smoothed using sticky mud mixed with lime to decrease the permeability of the wall. Sometimes women use local white lime as paint for impermeability and/or for ornamental purposes. Moreover, women sometimes use crushed wheat or broad bean stem mixed with mud on the wall surface to decrease the risk of erosion by rain. At the beginning of gossi construction, women practice some rituals such as cooking beans and offering them to the children to eat. Then they chant some religious words such as prayers to the Prophet Mohammad (peace be upon him).

**Location of Gossi**

Gossis are placed in a sunny yard beside the compound wall (Figure 3). In rare cases, some types of small gossis or galos are put in the shade. Gossis are often put above the ground on three or four stones to keep the stored grain away from moisture, mice and other animals.

**Temperature Modulation Test**

The factors affecting grain storage are moisture contained in the grains, storage temperature, infection from insects and fungi, and feeding of birds and rodents. Nubians expose the grains to sunlight for one or more days to reduce their internal moisture and to kill pests, if present, before storing. The duration of exposure to sunlight depends on the food type. For example, dates may take a longer time to dry while wheat, sorghum and beans take less time to be ready for storage.

Gossi physically block the entrance for insects, fungi, birds and rodents. It is raised from the ground on 3 to 5 stones (opertae), which are made from the same material as the gossi or sometimes sand stone pieces are used. It is known that Nubia has extreme air temperatures that may exceed 48 even 50°C in the summer and falls to 3°C in winter. To test the gossi’s ability to modulate the internal

![Figure 3: Gossis in a sunny yard beside a wall.](image)
temperature, a thermometer was used to measure the air inside a loaded gossi. The thermometer was put inside through a small pore. The measurements were taken at different times in the day: early morning, afternoon and night to testify to the affect of air temperature fluctuation. The crop stored was wheat (Table 1).

It is clear from Table 1 and Figure 4 that the gossi has the capacity to maintain a difference of 2 to 4°C lower or higher than the air temperature and to fix the grain temperature at 34°C, in the range of 28 to 38°C (Figure 4). The induction of heat via the mud wall was very slow so that there were no extreme changes to the temperature during the day and night. This may not be the case with extreme temperatures in Nubia.

Generally, many fungi propagate at lower temperatures between 20 and 25°C. The grain may reach these temperatures in winter nights and early mornings but during the day the temperature becomes higher. During the summer, when air temperature reaches 48-50°C, the grain temperature may become higher than 34°C. This will eliminate fungi and insect propagation and growth but the seed embryo still will remain viable.

**Discussion**

The introduction of the sagia was a real revolution in Nubia in terms of crop production. Subsequently the excess crop was in need of storage. Eventually Nubians built safe protective containers for grain storage. During the Christian period, the gossi was adopted as above ground storage, and more recently gossis were kept outside of houses. This

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<tr>
<th>Early morning</th>
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<td>32</td>
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**Table 1:** Temperature records inside and outside the gossi.

**Figure 4:** Curves for temperature records: inside and outside the gossi.
may be attributed to the aridity of the climate and the social context of peace and security, which was common in the kingdom of Nubatia and Makuria. Nubians used local materials to build silos that can even protect seed embryo viability despite the silos being situated under the sun’s direct rays.

Practicing crop storage was challenged by pests, which attack all types of stored crops and cause considerable losses. This was found to be the principal threat for stored crops. This problem made the Nubians to develop a method of storing that could overcome pests. They managed to build the *gossi*, an efficient device for storing, as is demonstrated in this study. Gossis can keep the internal temperature at a relatively constant level when the outer air temperature fluctuates. This explains how the traditional silo was able to store crops without any changes in their physical and chemical qualities while preventing pest attacks. In the future, other crops can be tested to determine if the grain type and space affect the *gossi*’s internal temperature. The experiment should be conducted in all ranges of external air temperatures in order to evaluate the extreme fluctuations in the internal temperature of the *gossi*. Different sizes of *gossis*, and also different thicknesses of walls, should be measured to evaluate their role in heat conduction through the silo walls.

**Acknowledgments**

Our thanks to Samier Bokab for his assistance in this work and to Amani Zein El A’abdein Mahjoub for drawing the *gossi*.

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