

## TRADITIONAL HERMETIC METHODS OF GRAIN STORAGE USED IN CYPRUS

ELENI PAPADEMETRIOU<sup>1</sup> AND A. VARNAVA<sup>2</sup>

<sup>1</sup>*Ministry of Education and Culture, Cultural Service, Nicosia, Cyprus*

<sup>2</sup>*Cyprus Grain Commission, 26 Stasandrou Str., Nicosia, Cyprus*

### ABSTRACT

Four structures, traditionally used since medieval times for storing grain in Cyprus, are described. Storage in those structures was primarily based on the concept of hermetic storage. The first structure, *goufa* (plural: *goufes*) or *voufa* (cavity, hole, well), was an underground space built in the open. Walls were covered with mud, and a fire was lit inside before storing grain in it. When temperature had been reduced and the floor cleaned, grain was poured in. The opening was then sealed with a lid and mud. The second structure, *fournos* (oven, kiln), was built with stones and mud in a hemispherical shape and located outside in the courtyard. Its capacity was about 500–1,000 L. Before storing grain, a fire was lit in it. Grain was placed inside the *fournos* after its temperature had fallen sufficiently. The third structure, *pilini* (*pilos* in Greek, mud or clay), was a 50–500-L clay pot. After the pot was filled with grain, its opening was closed with a wooden or stone lid. In some cases larger pots, with an opening on top for pouring in grain and another one at bottom for emptying, were built inside the houses. Finally, a fourth method was the storage of grain in thickly woven woollen or cotton bags placed in the middle of a heap of straw in a store-room.

In the first two structures, *goufa* and *fournos*, fire disinfested the space and reduced air humidity. The thick walls of these structures and the mud sealant provided the systems with a certain degree of airtightness. In them, oxygen concentration was reduced and carbon dioxide increased gradually as a result of grain and insect respiration.

### INTRODUCTION

Throughout the ages, people have tried to protect their agricultural products from attack by pests and deterioration due to pests and diseases. In this paper, four methods of storage which were used in rural regions of Cyprus until at least the first part of this century are described. One of these structures was underground, the other three above-ground. In all cases, storage in these structures was based primarily on the concept of hermetic storage.

## DESCRIPTION

### *Goufa*

The first grain storage structure is called a *goufa* (plural *goufes*) (Yennadios, 1972). The name is derived from the medieval Italic “gueffa”, meaning “underground prison”. In Cyprus it has the connotation “hole” or “well” (and at least until recently this word was used to describe a room with a pit). This structure was an underground store-pit, shaped like a flask, with an opening narrower than the periphery. The villagers co-operatively constructed *goufes* near the fields or threshing places, preferably on a slope. They chose soil which was dry, hard, heavy and free of sand. In some cases *goufes* were hollowed into limestone rocks (Figs. 1 and 2).

Before storing grain in one of these structures, the walls were covered with mud and a fire lit inside. When the temperature returned to normal, grain was poured into the *goufa* and the opening was well closed with a flat stone lid and mud. These structures had a capacity of 50–150 kg, and grain was stored in this way for up to one year.

This type of grain storage was in use until at least 1930 in the isolated region of Karpassia and in Akanthou village. In some cases, groups of up to fifty pits were built in one place.

Similar storage structures hollowed out of solid limestone rock can be seen in Malta (Hyde and Daubney, 1960).



Fig. 1. A group of underground storage structures (*goufes*) outside the village of Akanthou, Karpassia (front right), 1971.



Fig. 2. A group of underground *goufes* outside the village of Akanthou, 1971.

### ***Fournos***

The second structure is called *fournos*, meaning “oven” or “kiln”. This is an above-ground store constructed outdoors in courtyards or gardens or even close to the field. It was constructed (on a raised base) of stones, brick and mud with straw. It was conical, with walls 25–30 cm thick (Figs. 3 and 4).

At the top there was an opening for pouring the grain into the *fournos* and at the bottom a second opening for emptying.

The *fournos*, like the *goufa*, was fired with burning tree branches before being used for storing grain. Both openings were sealed by mud after the grain was introduced. Grain was kept in these structures for up to one year.

Similar storage structures can be seen on an ancient Egypt papyrus (Attia, 1948).

### ***Pilini***

The third structure used for grain storage (Fig. 5) is called *pilini*, from Greek *pilos*, meaning mud (Kythreotes, 1972). This was a large cylindrical pot, 1–1.5 m high, usually standing on a base with three small feet. It was made of mud mixed with fine pieces of straw. First the base was made, and after it dried, the sides were built up. The walls were about 10 cm thick.



Fig. 3. *Fornos*, an aboveground store, Moni Sina, Eleousa, Karpassia, 1910 (Richter, 1913).



Fig. 4. *Fornos*, Karpassia, 1972.



Fig. 5: *Pilini*, a mud-pot for storing grain, Messaoria, 1970.

After pouring the grain or flour inside, the pot opening was closed with a wooden or stone lid. An opening in the side close to the base was used for emptying the contents. Before being stored, the grain was washed and dried.

*Pilini* were in use for storage up to 1974 in the Karpassia and Messaoria regions (Papademetriou, 1992; Xistouris, 1972).

### **Bags**

The last method of storage is placing the grain in thickly-woven woollen or cotton bags placed at the center of a heap of straw in a store-room. The bags were woven from strips of woolly or hairy material. As the store-room was being filled, the straw was compressed by children. Farmers used to store seed-grain in this way for up to one year. This method of storage was used primarily in Messaoria (in Lisi and other villages) and Pafos (Panaretos, 1974).

## DISCUSSION

The concept of hermetic storage (Vayssiere, 1948), on which these storage methods were based, is described in Tables 1, 2, 3 and 4.

TABLE 1  
Hermetic concept of storage in *goufes*

Parameter	Influence on the airtightness of the structure
Location	Underground Limited supply and penetration of oxygen into the structure
Walls	Covering the walls with a mud layer reduced gas exchange between the interior and the surrounding soil
Sealing of openings	There was only one opening on the top, well sealed by mud, preventing or reducing gas exchange between the interior and the atmosphere
Duration of storage and frequency of opening during storage	Storage lasted up to one year (enough time for the production of carbon dioxide and the reduction of oxygen). The structure was opened only at the end of storage, so the airtightness was not destroyed during the storage
Preparation of structure and grain before starting storage	Lighting a fire inside the structure before filling it with grain reduced both the relative humidity of the air and the amount of oxygen inside the structure as well as disinfestating the space
Degree of airtightness	Medium

TABLE 2  
Hermetic concept of storage in *fournos*

Parameter	Influence on the airtightness of the structure
Location	Aboveground. Surrounding air rich in oxygen
Walls	20–30 cm thick walls (made of stones, brick and mud) and an outer covering of mud reduced gas exchange between the interior and the surrounding atmosphere
Sealing of openings	There were two openings, well sealed by mud which prevented or reduced gas exchange between the interior and the surrounding atmosphere
Duration of storage and frequency of opening during storage	Storage lasted up to one year (ample time for the production of carbon dioxide and the reduction of oxygen). The structure was opened only at the end of storage, so the airtightness was not destroyed during the storage period
Preparation of structure and grain before starting storage	Lighting a fire inside the structure before filling it with grain reduced both the relative humidity of the air and the amount of oxygen inside the structure
Degree of airtightness	Medium

TABLE 3  
Hermetic concept of storage in *pilini*

Parameter	Influence on the airtightness of the structure
Location	Aboveground. Surrounding air rich in oxygen
Walls	10 cm thick walls made of mud are not expected to seriously affect gas exchange between the interior and the surrounding atmosphere
Sealing of openings	There were two openings which were not sealed hermetically
Duration of storage and frequency of opening during storage	Storage lasted up to one year, but the structure was frequently opened during storage
Preparation of structure and grain before starting storage	There was no preparation of the structure The grain was washed and dried before storage
Degree of airtightness	None

TABLE 4  
Hermetic concept of storage in bags hidden inside a straw heap

Parameter	Influence on the airtightness of the structure
Location	The bags of grain were placed in the middle of a heap of straw in a store-room The surrounding air was poor in air and oxygen and enriched in carbon dioxide because of both the compression of the straw layers during filling and the respiration of insects on the top of the straw heap
Sealing of the flat store	The opening on the roof was well sealed by stone and mud The second opening (door) provided very poor airtightness
Duration of storage and frequency of opening during storage	Storage lasted up to one year, but the structure was frequently opened to obtain straw
Preparation of the structure and grain before starting storage	None
Access by insects and rats to the grain in bags	Difficult
Degree of airtightness	Poor Modification of air composition due to insect respiration

Some additional factors affected the success of grain storage in such structures as the *goufes* and *fournos*. These are the very low moisture content of grain (7–12%) during harvest and Cyprus's dry climatic conditions.

There are modern modifications of the traditional hermetic methods of grain storage in Cyprus described above. There are eight Cyprus "Ctesiphon" semi-underground pits, 1,200 t wheat capacity each, which were built in 1955 (Hall *et al.*, 1956). In Nicosia, two

platforms were constructed on a concrete base. With polyethylene covering the floor and a PVC liner covering the top of the grain, a good airtight seal is provided during storage. Their capacity is 2,500 and 4,000 t, respectively. In use since 1987, these platforms provide 1–3 years of storage for grain (Navarro *et al.*, 1992; Varnava *et al.*, 1995). Lastly, three airtight concrete bins of 2,500 t capacity each were erected in 1996 in the new silo at Limassol port.

#### ACKNOWLEDGEMENTS

The authors wish to thank Mr Ioannis Leandrou of the Cyprus Grain Commission for his assistance in presenting visually the old storage structures.

#### REFERENCES

- Attia, R. (1948) Typical methods of handling and storing grain in Egypt. In: *Preservation of Grains in Storage*. UNFAO. *J. Agric. Stud.* **2**, 105–109.
- Hall, D.W., Haswell, G.A. and Oxley, T.A. (1956) Underground storage of grain. *Colon. Res. Stud.* **21**, 27 pp.
- Hyde, M.B. and Daubney, C.G. (1960) A study of grain storage in fossae in Malta. *J. Trop. Sci.* **2**, 115–129.
- Kythreotes, I. (1972) “Pilinia” and “Voufes” (in houses and fields). *J. Laografiki Kypros* **4–5**, 22–23 (in Greek).
- Navarro, S., Varnava, A. and Donahaye, E. (1992) Preservation of grain in hermetically sealed plastic liners with particular reference to storage of barley in Cyprus. In: *Proc. Int. Conf. on Controlled Atmospheres and Fumigation in Grain Storages* (Edited by Navarro, S. and Donahaye, E.), Winnipeg, Canada, 11–13 June 1992, Caspit Press Ltd., Jerusalem, 223–234.
- Papademetriou, E. (1992) *Ethnografika Karpasias*. Nicosia, Cyprus. 13 pp. (in Greek).
- Panaretos, A. (1974) The rural house in Lisi, Mesaoria and in Kissonerga, Pafos. *J. Laografiki Kypros* **10**, 1–7 (in Greek).
- Richter, O.M. (1913) *Griechische Sitten und Gebrauche aus Zypern*. Berlin.
- Varnava, A., Navarro, S. and Donahaye, E. (1995) Long-term hermetic storage of barley in PVC-covered concrete platforms under Mediterranean conditions. *J. Postharvest Biol. Technol.* **6**, 177–186.
- Vayssiere, P. (1948) Hermetic storage, the process of the future for the conservation of foodstuffs. UNFAO. *J. Agric. Stud.* **2**, 115–122.
- Xistouris, S. (1972) The “Pilinia”. *J. Laografiki Kypros* **4–5**, 140–141 (in Greek).
- Yennadios, P. (1972) *Phytologikon Lexikon*. Athina, Vol. 2, 527–528 (in Greek).