UNDERGROUND STORAGE IN SOME ARAB COUNTRIES

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ABSTRACT

The traditional methods of grain storage on the farm level in the Peoples Democratic Republic of Yemen, the Arab Republic of Yemen, the Democratic Republic of Somalia, the Democratic Republic of Sudan and the Arab Republic of Egypt, were surveyed with special details about underground storage.

The different underground pits, their merits, drawbacks, description and methods of their up-grading were included.

INTRODUCTION

During a trip in some of the Arab Countries to study the traditional methods existing and used for grain storage in the Arab Peninsula, Somalia and Sudan, underground storage was found to be one of the most common. A review of the types, environmental conditions affecting such storage, and its efficiency, as well as other similar traditional methods are presented in detail for each of the countries visited.

The Peoples Democratic Republic of Yemen

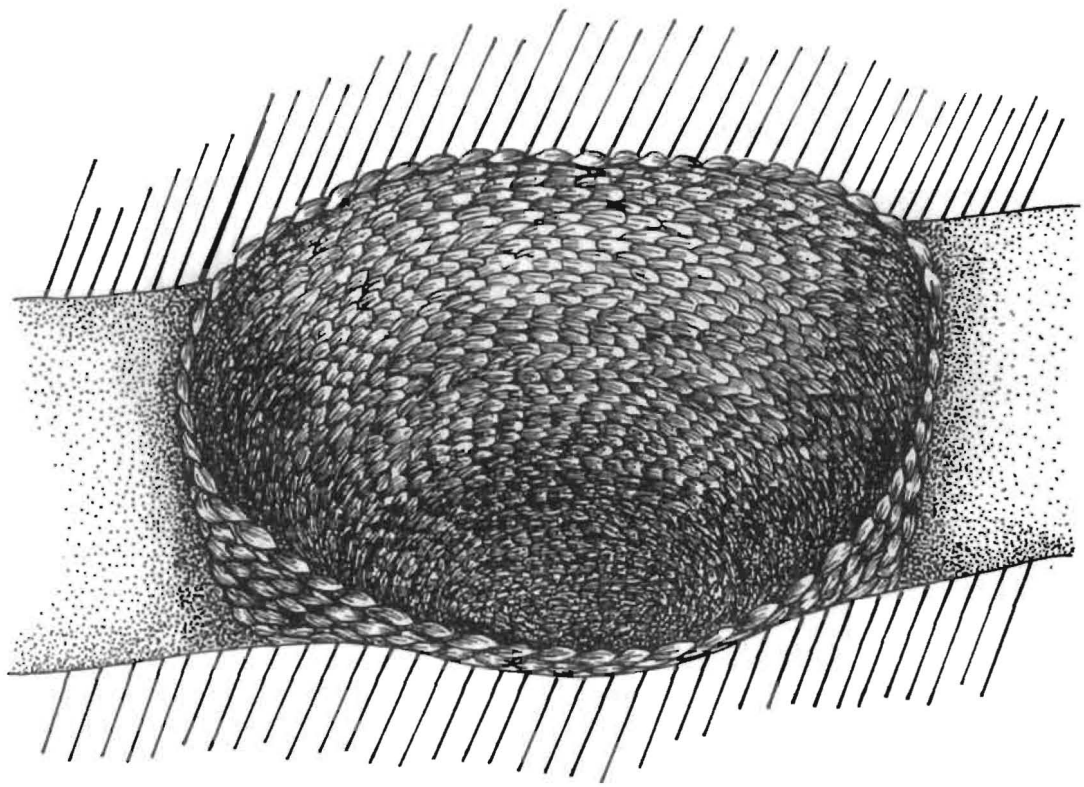
In the Peoples Democratic Republic of Yemen, and on the farm level, some farmers store their grains in baskets made of date-palm leaves completely compact with a capacity not exceeding 150 kg. Such baskets are kept in underground pits and covered with soil. Grains stored by this method last for a long time in a good condition provided that their moisture content is low and the soil is dry.

Arab Republic of Yemen

On the farm level, farmers store corn, which is one of the most important cereal crops produced, in pits under ground. Pits excavated in the ground for this purpose are locally called "madfans". The total capacity of madfans existing now in the YAR reaches about 200,000 tons. A madfan is dug either in heavy clay soil or in rocks. It has a funnel shape, 4 meters deep and ranging between 4 and 8 meters top diameter. The bottom is flat, of ½ meter diameter. The depth and diameter depend on the quantity of grains supposed to be kept in the madfan. The inner surface has a very gentle slope to prevent the structure from collapsing. The soil must be compact and hard to avoid, as far as possible, the infiltration of water. Before the madfans are filled with grains, their inner surfaces are lined with a thick layer of corn stalks or any other dry plants or herbs. After filling to the top, the grains are covered with a thick layer of dried plants as mentioned before and then with a thick layer of soil having a dome shape. Grains are kept in such madfans relatively safely for as long as 4 years. When the madfans are opened and the grains have to be sold, their prices are 10% lower than the fresh crop. The percentage in the reduction in prices corresponds positively with the storage period in madfans.

The efficiency of madfans as a grain storage method in the YAR is correlated mostly with the quantity of rainfall in the area. In Hodeida, in the South West of the YAR where the rainfall is at its lowest level, the loss in stored grains in madfans is very limited, compared with grains stored in madfans in other governorates having high rainfall. High rainfall results in caking, especially near the walls, and the level of damage might reach in some rare cases about 30%, besides tainting of the grains and loss of their bright colour. In such severe cases, the grains are most probably unfit for either human or animal consumption. Spoiled grains which are seemingly good, when consumed result in symptoms of stomach aches and intestinal troubles.

On the other hand, when the soil is dry, the grain is dry and there is no rainfall, the madfans keep grains in a very good condition for as long as 10 years.



Basket of date palm leaves buried under ground existing in P. D. Yemen R.

The total loss of grains kept in madfans is, in some rare cases, considerable, but when there is no water seepage or infiltration and there is no infection or infestation at all the loss is negligible. This may lead us to state that "madfans" as a method of storage are fit for the purpose and their success depends on:

a. the locality where the madfans are dug
b. the type of soil
c. the period of storage
d. the moisture of grains should not exceed 12%
e. the walls should be dry; otherwise, burning dry plants inside before storing the grains will help in drying up the inner surfaces.

The madfans are used permanently for grain storage in the arid zones with very limited protection. Protection involves getting rid of the inner surface of the madfan which may carry various spores from the old crop and which may badly affect the new crop.

This type of storage is considered airtight storage and depends mainly on the CO_2 build-up to the level which is lethal to all organisms. Therefore, if implemented properly, insect infestation does not increase and mould damage could be kept at its minimum level.

To avoid spoilage of grains due to soil water infiltration it is suggested that cracks in the walls should be plastered and walls should be lined with thick polyethylene welded sheets. This suggestion as well as others should be tested on some madfans mainly located in the rainy regions.

It is also advisable that storage in madfans should be shortened to the least possible number of years.

On the other hand, the farmers' houses generally consist of three flats, the basement is used for grain storage either in sacks or in buld. Most of the farmers dig some underground pits of limited size to store grains for their own consumption.

Underground pits in the YAR are in some cases conical and very limited in size, especially when dug in the rocks or inside houses.

To overcome the problem of storage in madfans by small producers, the use of barrels for grain storage is now being used on a limited scale. The number of barrels used now for this purpose reaches about 50,000. The barrel has a 40 gallon capacity and has a screw cover. To make these barrels always available in the market, a special plant of the barrel industry is to be constructed.

Democratic Republic of Somalia

A - Underground Pits

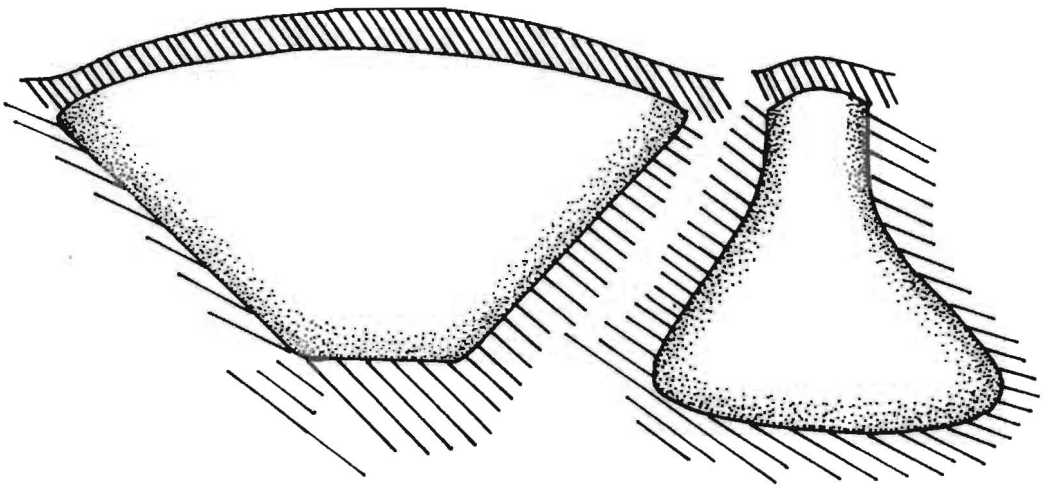
About 50% of the total production of grains in Somalia is kept on the farm. In the South, most of the quantity is stored in underground pits excavated directly in the soil. The size of the pit varies from as low as 5 tons (mainly pits owned by the farmers) to 250 tons (pits owned by merchants). Due to shortage of threshing machines, farmers in some cases store their own corn on cobs in pits. Storing maize on cobs in underground pits does not meet the requirements of hermetic storage due to the sufficient amount of air still present and consequently insect infestation might show and build up considerably.

The shape of the underground pits in Somalia is variable; they are either rectangular or boat-like, or conical with a small upper hole.

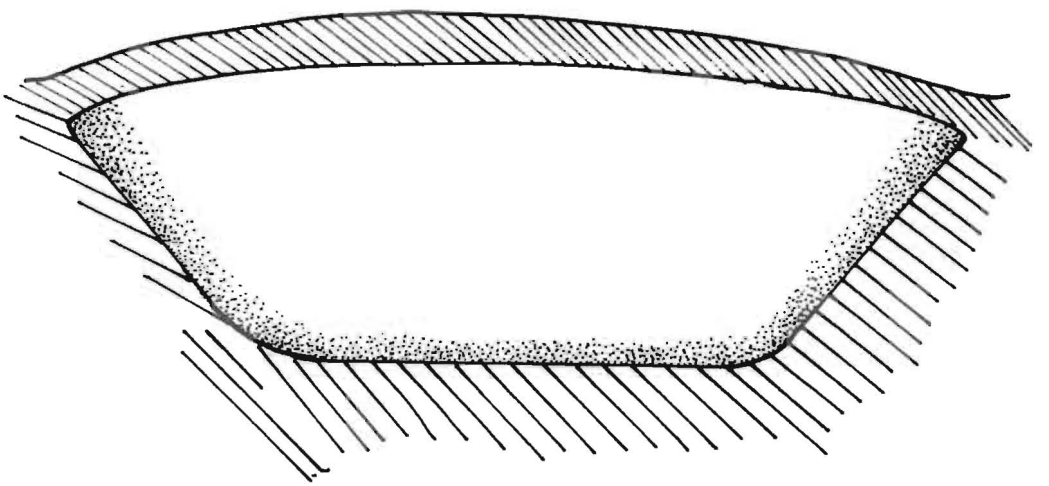
In all cases, before the pits are filled, they are lined carefully with dry stalks of corn or sorghum plants, dry plants or seaweeds and then covered with the same lining and then with a thick layer of soil.

Grains are kept in such pits for several years, reaching in some cases 10 years.

The main problem of pit storage in Somalia is the high moisture content of grains when placed in the pits. In many cases a thick layer of caked grains shows up near the walls and on the top, as well as tainting and discolouration of kernels. The other draw-



Under ground pits existing in A.R.Yemen & Somalia



Boat like shape under ground pit

existing in Somalia

back is the infiltration of soil water into the pit, especially after heavy rainfall reaching the aforementioned bad conditions.

Lining the inside of the pits with a thick layer of overlapping polyethylene sheets could be considered a remedy in the case of water infiltration, but in general this type of storage in Somalia needs a research program based on studying the soil profiles in the different areas and their compatibility with this type of storage.

B - Underground Bins

In Somalia, underground bins occur widely and these bins are owned by the Agricultural Development Corporation (ADC).

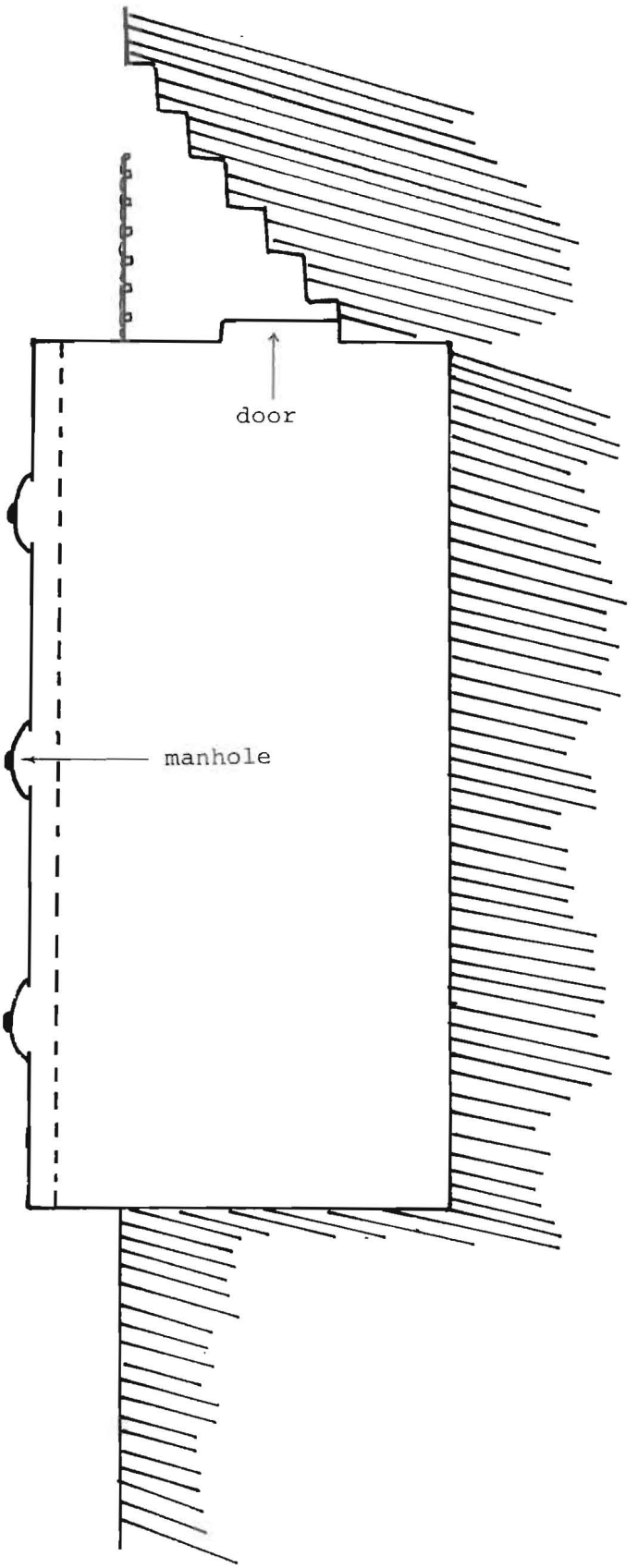
The bins are constructed underground. The dimensions and capacities are variable and in many cases reach more than a thousand tons. They are rectangular in shape, the height is about 5 meters, 4 of which are below ground level. They are built either from concrete or local stones, the roof being of concrete. Each bin has several manholes at the top and one side door with stairs going down for unloading. The manhole covers are either conical or flat. When filling, a space of less than one foot is left free from grains over the top surface of the grains.

This type of storage could be considered the best existing in Somalia. However, to up-grade this method the following points should be applied:

1. Grains should be at a maximum of 12.5% m.c., otherwise high moisture content might result in moulding and deterioration.

2. To overcome the problem of translocation of moisture in the bin it is suggested that each bin be supplied with a certain amount of slick lime (raw calcium oxide) to be put in shallow containers on the surface of the grain underneath every manhole. This slick lime should be replaced periodically, as soon as it changes to the powder form which indicates its inability to react with more water (calcium hydroxide).

3. Repairing and cleaning and disinfecting the inner surfaces before the entry of the new crop.



Under ground bin existing in Somalia

4. Periodical inspection is very essential in order to refumigate as soon as any number of live insects shows up.

The Democratic Republic of the Sudan

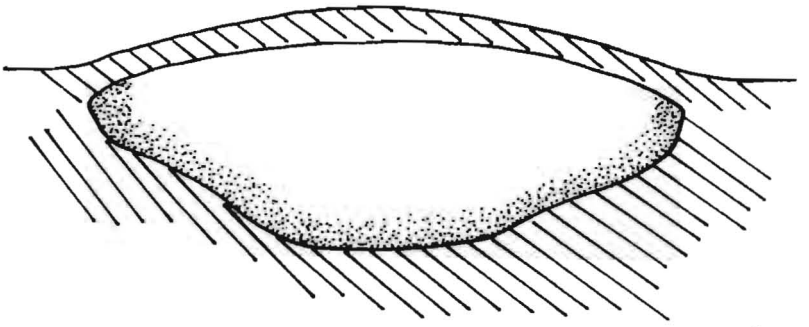
The underground pits in the Sudan, locally called "matmura" are a traditional storage method and are mainly concentrated in Central Sudan where local cultivators depend on this method of storage entirely to keep their produce.

Matmuras belonging to small producers are dug under ground in dry land and vary in size and capacity, very rarely exceeding 25 tons. They are cylindrical in shape, having a depth equal to that of the diameter. Before being filled, they are plastered on the inside surface with cow dung mixed with clay and then a fire is lit inside the pit until the walls become dry. Dura (Sorghum) is kept in such pits very successfully for at least three years and probably up to ten years. It was also noted that the success of matmuras for grain storage depends positively on their sizes. In small matmuras, loss in germination of seeds is expected.

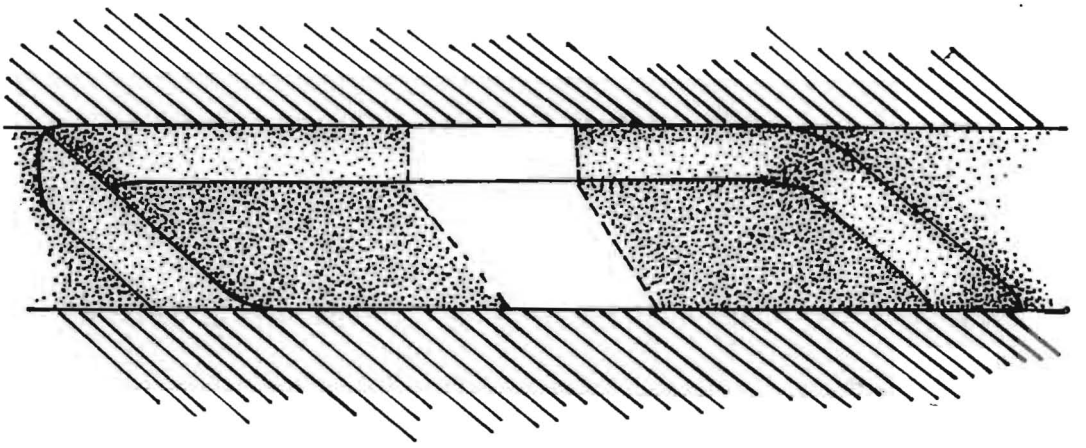
A matmura belonging to traders or as a governmental storage is large enough to hold up to 700 tons of grains. Places where such matmuras are dug have to be chosen carefully, taking into consideration that the area must be high enough and very far from water infiltration. The soil must be heavy clay so as to be compact. Such matmuras are dug in a shallow funnel shape with a flat bottom, boat-like shape or as a trench ranging between 50 and 150 meters in length, 11 meters wide and 2.5 meters deep. Grains if kept dry in these matmuras (9% m.c.) and stored during the dry season may last very safely up to 18 months inspite of rainfall.

When pits get old, after several years of continuous use, the internal surfaces become so hard that they become susceptible to cracking and consequently infiltration water may seep in and severe deterioration may occur. In such conditions, the locality of the pits has to be changed.

Losses due to storage in matmuras do not exceed 2% within 18 months, and are due to caking of the periphery within 3 cm.



Shallow funnel-shape



Shallow-rectangular

(50-150) x 11 x 2.5 m

Under ground pits existing in D.R.of Sudan

Egypt

Underground storage has been used in Egypt since ancient days (3000 - 4000 years ago). At that time grains were stored underground in deep ditches, either between two layers of straw or in baskets made of stems of bamboo (Arundo donax). The size of each ditch depended on the quantity of grains stored, but in general never exceeded two or three tons.

Nowadays, this method exists in rainless regions far from infiltration water and regions free from termites as well as in the desert areas and in the oases. It is very essential that grains, before being stored, be dry. Covering with sand keeps the grains in a very good condition and free from insect infestation. In its simplest form, the underground store, in such places, is nothing but a deep ditch sufficient to keep a quantity of grains used for the owners' own consumption.

South of the Nile Delta, in lower Egypt, Barheem village (Mounoufia Governorate) is the only village in which faba beans (Vicia fabae) are stored on a commercial basis in underground pits. This method of storage started in this village during the First World War in 1919.

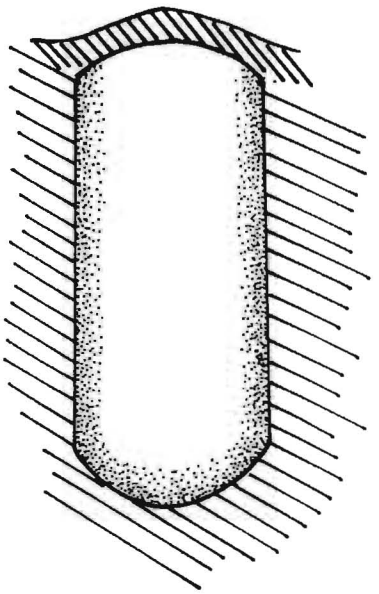
This village has a storage capacity of about 45,000 tons in 5000 pits scattered over an area of about 30 feddans (a feddan equals 4200 m^2).

When first excavated, the pit is of about three meters bottom diameter and two meters deep with a flat bottom and an entrance hole of one meter diameter and two meters deep. With these dimensions, it holds about 6 tons of beans. After being dug, the walls are well pressed and smoothed. Before the second and third storage seasons, the pit is enlarged yearly and gradually until it reaches its full capacity of about 11 tons (3.25 m diameter and 3 m deep).

1.Under ground ditch existing in Egypt.

2.Under ground pit (Matmura) existing in Sudan.

3.Rectangular under-ground pit existing in Somalia.



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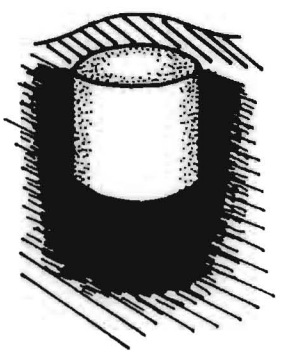

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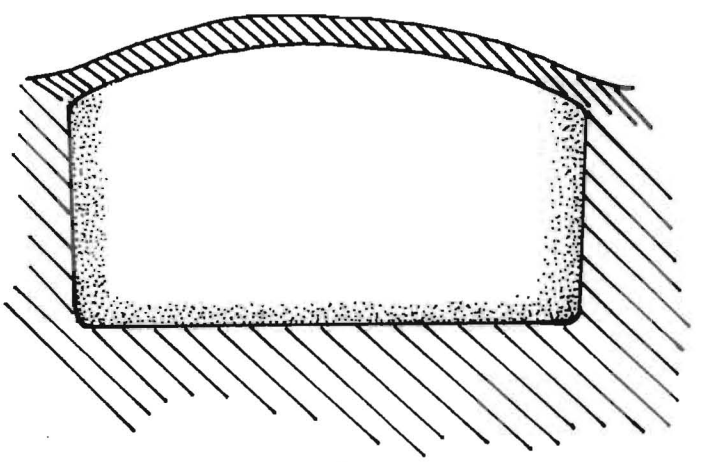

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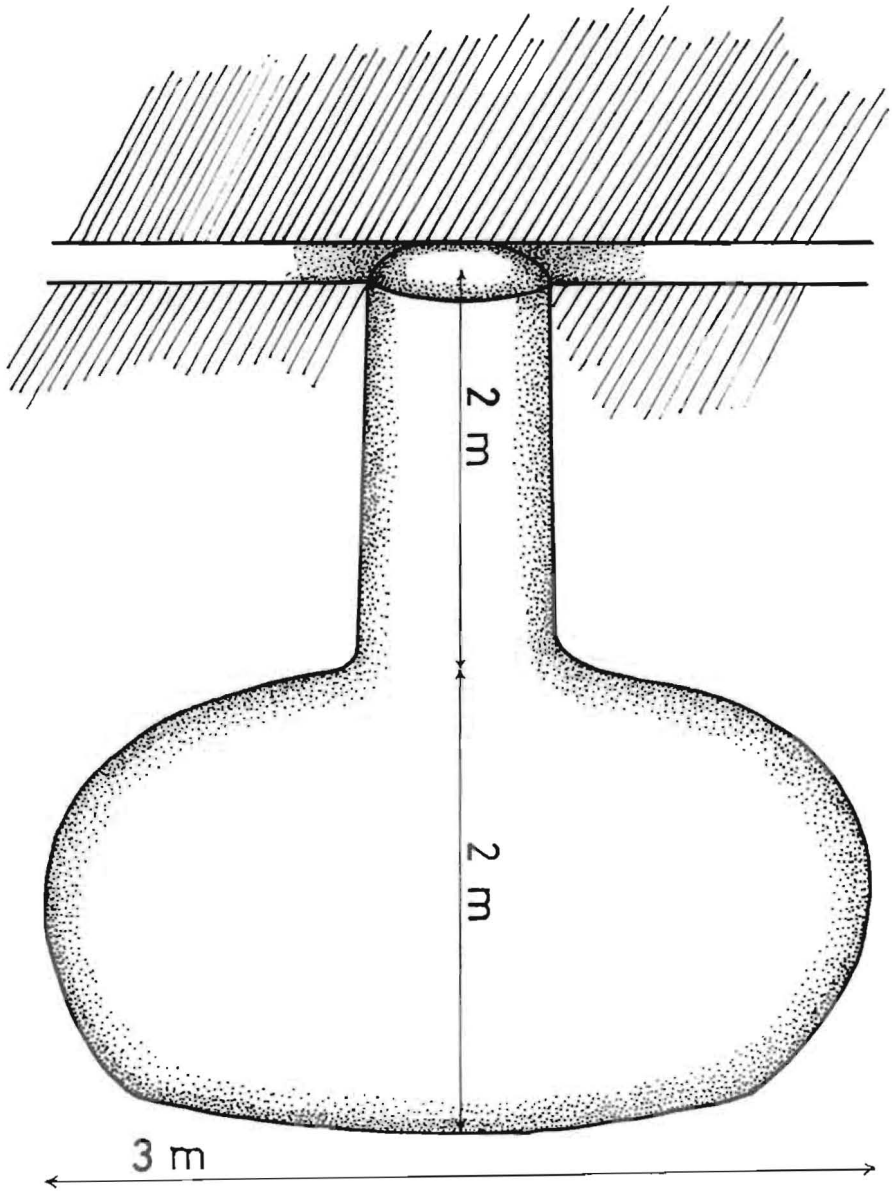

Pitcher like under ground pit

existing in Egypt

Through the only hole at the top, grain can be either introduced or removed. As the pits are filled, the bottom and walls are lined with faba bean straw or helba (Trigonella foenum-graecum) straw and finally covered and sealed with mud.

Beans are either introduced or removed from the pit by labourers. Because carbon dioxide is produced by the beans and thus accumulates in the pit, it is carefully aerated for safety before anyone can get in. Safety for labourers to get inside is detected by a candle flame. If it continues to burn, entrance for labourers is allowed and safe.

The percentage of infestation in stored beans never increases, and the testa remains white instead of turning brown as in the case of beans stored in the open air, where they are exposed to the different weather and light conditions. This method of bean storage also results in better cooking properties for beans. Consequently beans stored in such a way are sold for prices 25% above those of beans stored by other means.

The storage season starts early in May, directly after harvest of the beans, and might last for two months to one year, according to the market demand. Losses under such conditions never exceed 1%, these being due to direct contact of some beans with the walls.