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# GRAIN STORAGE AT FARM AND WAREHOUSES LEVEL

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***Abstract:*** *Grain storage is very important because the quality of flour obtained from grain will be found in the finished products' quality. Grains must be stored in well established conditions regarding temperature, humidity, airflow, trying to avoid the risk of being attacked by rodents and insects. If these conditions are not complied with, some qualitative deficits of the grains - such as mould at pH, infestation, fermentation etc. - may appear. The storage methods are those responsible for maintaining a good quality of the grains.*

***Key words:*** *grain quality, storage methods, storage baskets, timber platforms.*

## 1. Introduction

It is often stressed that traditional storage methods are the product of decades, if not centuries of development, perhaps by trial and error, but certainly as a result of experience of the users and their ancestors. This saying must, in general, be upheld as true and would-be 'developers' should employ utmost respect for traditional practices when endeavouring to introduce 'improvements'. Traditional storage methods at producer level are usually well-adjusted to both the types of grain for which they are intended, and the environment in which they are employed. Consequently, storage losses are often already minimal and it is difficult to justify interference with the established system.

However, for a number of reasons, this is not always the case. In the first instance, it is well known that rural communities are very conservative in their attitude towards change. Thus, if such a community is uprooted, perhaps as a result of conflict, and is forced to move into an environment which is very different both climatically and geographically from that to which they are accustomed, it may take them a long time to adapt or change their grain storage practices accordingly. This is almost certainly the case in central and eastern parts of Zambia, where the 'traditional' basket type of store is not the best form of grain container for local climatic conditions).

Secondly, a growing shortage of the materials traditionally used for the construction of grain stores (usually caused by extended use of such materials) may force rural people to seek alternative means of storing grain. This is the case in the Anatolia region of Turkey and in Lesotho where ancient grain storage practices have virtually disappeared,

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because of the depletion of supplies of suitable timber and grass.

Thirdly, but by no means unimportant, the introduction of high-yielding varieties of grain (which are usually more susceptible to infestation by insects than traditional varieties) and the spread of exotic insect pests of grain through trade or aid have disrupted erstwhile effective storage practices, to the extent that they have had to be abandoned or at least considerably modified with outside assistance.

Traditional grain traders throughout the world have tended to depend upon fairly rapid turnover of stocks as a means of minimizing losses due to pests and other factors. Consequently, their storage facilities vary in quality and condition. With the advent of Government intervention and the establishment of quasi-government grain marketing organizations in many countries, especially during and immediately after the Second World War, the importance of good grain storage facilities and management became apparent. Most of the 'improvements' in warehouse design are associated with such enterprises. The recent tendency to revert to private grain marketing and storage has high-lighted the need for improving the standards of storing and managing grain stocks at this level.

## 2. Traditional Farm Storage Methods

### 2.1. Temporary Storage Methods

Such methods are quite often associated with the drying of the crop, and are primarily intended to serve this purpose. They assume the function of storage only if the grain is kept in place beyond the drying period.

**a. Aerial Storage**

Maize cobs, sorghum or millet panicles are sometimes tied in bundles which are then suspended from tree branches, posts, or tight lines, or inside the house. This precarious method of storage is not suitable for either very small or very large quantities and does not provide protection against the weather (if stored outdoors), insects, rodents, or thieves.

**b. Storage on the ground, or on drying floors**

This method can only be provisional since the grain is exposed to all pests, including domestic animals, and the weather. Usually it is resorted to only if the producer is compelled to attend to some other task, or lacks means for transporting the grain to the homestead.

**c. Open Timber Platforms**

A platform consists essentially of a number of relatively straight poles laid horizontally on a series of upright posts. If the platform is constructed inside a building, it may be raised just 35-40 cm above ground level to facilitate cleaning and inspection. Platforms in the open may be raised at least 1 meter above ground level. They are usually rectangular in shape, but circular or polygonal platforms are common in some countries.

Grain is stored on platforms in heaps, in woven baskets or in bags. In humid countries fires may be lit under elevated platforms, to dry the produce and deter insects or other pests. Instead of being horizontal and flat, the platform may be conical in shape, the point at the bottom. Up to 3 meters in diameter, such platforms facilitate drying because of their funnel shape: at the top they consist of a frame of horizontal poles which is square, circular or polygonal in shape, against which the timbers which form the cone rest; these timbers meet at the bottom on a wide central supporting post.

Platforms with roofs (but no walls), of whatever shape or form, may be regarded as transitional types between temporary and long-term stores. In southern Benin, Togo and Ghana, for example, maize cobs in their sheaths are laid in layers on circular platforms with their tips pointing inwards. The platforms are usually between 2 and 3 meters in diameter, but some may be more than 6 meters wide, with a maximum height of 2.5 meters at the centre and 1.5 meters at the periphery. In Ghana such a granary is called an "ewe" barn.

### 2.2. Long-term Storage Methods

**a. Storage baskets (cribs) made exclusively of plant materials**

In humid countries, where grain cannot be dried adequately prior to storage and needs to be kept well ventilated during the storage period, traditional granaries (cribs) are usually constructed entirely out of locally available plant materials: timber, reeds, bamboo etc. Under prevailing climatic conditions most plant material rots fairly quickly, and most cribs have to be replaced every two or three years - although bamboo structures may last up to 15 years, with careful maintenance. Access to the interior of a crib is gained usually over the wall. This may involve raising the roof, but some cribs have a gap between the top of the wall and the roof to facilitate entry. Relatively few cribs have sealable gaps in the wall or floor for the removal of grain.

**b. Calabashes, gourds, earthenware pots**

These small capacity containers are most commonly used for storing seed and pulse grains, such as cowpeas. Having a small opening, they can be made hermetic by sealing the walls inside and out with liquid clay and closing the mouth with stiff clay, cow dung, or a wooden (cork?) bung reinforced with cloth. If the grain is dry (less than 12% moisture content) there is usually no problem with this type of storage.

**c. Jars**

These are large clay containers whose shape and capacity vary from place to place. The upper part is narrow and is closed with a flat stone or a clay lid which is sealed in position with clay or an other suitable material. Generally kept in dwellings, they serve equally for storing seeds and legumes. So that they may remain in good serviceable condition, they should not be exposed to the sun heat, and should not be either porous or cracked.

**d. Solid wall bins**

Such grain stores are usually associated with dry climatic conditions, under which it is possible to reduce the moisture content of the harvested grain to a satisfactory level simply by sun-drying it. Solid wall bins are therefore traditional in the Sahel region of Africa and in southern African countries bordering on the Kalahari Desert. The base of a solid wall bin may be made of timber (an increasingly scarce resource), earth or stone. Mud or clay silos are usually round or cylindrical in shape, depending on the materials used. Rectangular-shaped bins of this type are less common, because the uneven pressure of the grain inside causes cracking - especially at the corners. The roof is usually made of thatched grass, with a generous overhang to protect the mud wall(s) from erosion. Where a side door or a detachable 'cap' is not provided, the roof has to be lifted for access to the bin. Such silos can serve for 30 or even 50 years.

**e. Underground Storage**

Practiced in India, Turkey, Saharian countries and southern Africa, this method of storage is used in dry regions where the water table does not endanger the contents. Conceived for long term storage, pits vary in capacity (from a few hundred kilograms to 200 tones). Their traditional form varies

from region to region: they are usually cylindrical, spherical or amphora shape, but other types are known as well (Gilman and Boxall, 1974). The entrance to the pit may be closed either by heaping earth or sand onto a timber cover, or by a stone sealed with mud.

## 3. 'Improved' farm storage methods

### 3.1 Temporary Storage Methods

It is recognized that, although temporary storage methods are the least desirable, there are circumstances in which they are unavoidable. The following suggestions and recommendations for improving such storage methods are offered, on the understanding that more permanent solutions to problems should be sought wherever possible. Little can be done to improve aerial storage except, perhaps, to suggest that the bundles of cereals may be safer if suspended in a well ventilated part of the house; or above a fireplace where insects may be deterred and the moisture content of the grain may be reduced.

As far as storage on the ground or on floors is concerned, the grain is less exposed to risk if it is placed on wattle mats or the like laid on the ground or floor. Drying floors could be improved by making them of concrete; or by stabilizing the earth chemically or with natural material such as néré juice. Larger animals are less likely to spoil the grain if such floors are constructed near the house, where they can be better guarded.

If the grain is stored on the floor in a part of the house, it is best to ensure that the floor is clean and stabilized. To prevent the translocation of moisture through the floor to the grain, a plastic sheet should be placed upon it first (or better, embedded in the floor during its construction). The room should be rodent-proofed as far as possible (including wire mesh screens fitted to windows), and the grain should be treated with insecticide. Before each new harvest the room should be cleaned, to remove any residual insect infestation.

Open timber platforms may be improved by fitted rodent barriers around the supporting posts. Furthermore, the posts should be driven at least 60 cm into the ground, to withstand pressures caused by wind, uneven loads, or even animals leaning against them (some animals will rub against trees to relieve itches!). To protect them against termites, posts should be coated with bitumen or used engine oil, or superficially charred after having the bark removed. Alternatively, since termites do not attack fresh, healthy wood, green wood which will sprout and grow may be used as poles.

The central post of a conical-shaped platform should be at least 80 cm high to prevent rodent attack and, like the poles supporting the upper frame, should be fitted with a rodent barrier. The poles or large bamboos comprising the cone, while being sufficiently strong, must not fit so tight together as to impede the passage of air and retard drying. One solution is to cover the timbers with enough loosely woven wattle (sorghum stems for example), to prevent cobs from falling between the timbers, to pass the weight of the grain to the wood and allow air to pass at the same time.

### 3.2 Long-Term Storage Methods

The upright poles which support the platforms of **traditional storage baskets** (cribs) should be at least 80 cm high, and protected against termites as described above. They should also be fitted with rodent barriers in similar fashion. The poles should be as thick as possible, in order to reduce the number needed and therefore the amount of metal sheet which

has to be purchased for making the rodent barriers.

Where it is customary to raise the roof (or part of it) when removing grain from the crib, then the possibility of incorporating a small framed door near the bottom of the wall should be considered. This will prevent damaging the roof and help maintaining its waterproofness. When the platform is conically shaped, an opening in the side of the cone could be practical. If the walls are woven, a trapdoor could be fitted into the platform for access from underneath the crib.

In a dramatic break-away from traditional crib design, while retaining the important principle of using locally available materials as much as possible, the African Rural Storage Centre (ARSC) based at IITA in Ibadan, Nigeria, has developed a crib which optimizes both the drying and storage of maize under humid tropical conditions (FAO, 1987).

Such a crib consists basically of two parallel frames between which the grain, mainly cob maize, is stored. The supporting posts are driven 50 to 60 cm into the ground one meter apart and protected from termites with sump oil, tar or scorching. They are then fitted with rodent barriers.

The walls of the ARSC crib may be constructed of wire netting or local material, such as raffia, bamboo or wooden lattice, and should be 1.5 to 2 meters high. The floor, which should be fixed at least 80 cm above ground level, is made of straight poles; if possible removable to facilitate emptying. The roof may be covered with corrugated metal sheet or thatch, which should overhang a long way to protect the cobs from rain: an overhang of 0.6 to 1 meter is recommended. The various components of the crib are nailed together, or can be bound together with lianas or bark string.

In very humid areas where maize is harvested at 30-35 % moisture content, the recommended width for the crib is 60 cm. In drier zones with a single rainy season, maize is harvested at about 25% moisture content and the width may be increased to 1 meter. In very dry places the crib could be 1.5 meters wide. The length of the crib is a function of the quantity to be stored. Given that 500 kg of maize cobs with their sheaths removed, and a moisture content of 30%, (equivalent to 300 kg of shelled maize at 14% mc) occupy approximately one cubic meter: if a crib is 60 cm wide and 1.7 meters high, it will need to be 5 meters long to contain the cob equivalent of 1,500 kg of shelled maize at the quoted moisture contents. Where possible, the crib should be erected across the direction of the prevailing wind and, if this is strong enough, the supporting posts should be reinforced to resist it. The crib should be located in a ventilated area and not constructed along a wall or next to a windbreak of trees.

Calabashes, gourds, and earthenware pots can be rendered virtually airtight by treating the exterior surfaces with varnish or with dry oil such as linseed oil (McFarlane, 1970). The mouth may be carefully sealed with wax; or covered with a doubled plastic sheet tied firmly in position. If an absolutely air-tight seal cannot be guaranteed, the grain should be treated with insecticide.

Jars should be treated like small containers (see above) to make them airtight. Very large and immobile jars could be provided with outlets in their bases, for the easy removal of grain. Such outlets could, for example, be metal tubes fitted with lockable caps for greater security. If the cap is well designed it would ensure both security and air tightness.

## 4. Standard Warehouse Design

All warehouses consist of a floor, walls, a roof, and one or more entrances. However, they can vary considerably in the detailed composition and construction of these basic components; and may include others, such as ventilators, windows, artificial lighting etc. The various combinations of features possible have to be considered very carefully, together with other factors relating to location, intended use etc. when planning the construction of a warehouse.

Paramount importance should be attached to ensuring that the quality of the commodity to be stored will not be affected by physical factors such as moisture and heat. Wherever possible and practical, the design of the warehouse should incorporate features which will protect its contents from attack by rodents and birds, and facilitate the use of insecticides.

The warehouse should also be easy to clean and maintain (there is no point in using components which are not readily replaceable or repairable); and it should provide good working conditions.

## 5. Conclusions

On grain storage, paramount importance should be attached to ensuring that the quality of the commodity to be stored will not be affected by physical factors such as moisture and heat. Wherever possible and practical, the design of the grain stores should incorporate features which will protect its contents from attack by rodents and birds, and facilitate the use of insecticides. These should also be easy to clean and maintain (there is no point in using components which are not readily replaceable or repairable); and it should provide good working conditions.

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