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Problems of Traditional Underground Grain Storage Pits In Agropastoral Villages in Gabiley Region, Somaliland

Mustafe Abdulkadir Abdurahman*

College of Agriculture and Veterinary Medicine, University of Hargeisa, Somaliland

Abstract

The aim of this study was to identify the problems and challenges associated with traditional underground pits in Gabiley region and to propose or identify ways to mitigating those problems. Focus Group discussion, and farmer interviews in eleven villages under Gabiley region, along with site visits (observations) were used to collect relevant information on traditional underground pits. All Focus Groups in the surveyed villages stressed that they continue to use traditional underground pits because of necessity and lack of affordable alternative storage tools. Sorghum grain loss estimates with an overall mean of 15% grain loss over the eleven surveyed villages. Survey indicated that sorghum grain could be stored in traditional underground pits for 18 months on average, if the pit was kept undisturbed. The frequent openings of pit caused reduction of storage period of the crop. The study found out that traditional underground pits are not suitable for proper and safe grain storage. It is recommended that farmers be supported with acquisition of metal silos with one to two-ton capacities, as a better alternative to traditional underground pits. Farmers should be trained on proper management and handling of grain to reduce losses and enhance food security and household income.

Keywords: Traditional underground pit; Metal Silos; Grain quality; Focus group discussion

Introduction

Small-scale farmers in many developing countries including those in eastern Africa use underground pits to store food grains. Underground pits offer the small-scale farmer an inexpensive method of storing grain for extended time periods. However, various reports indicate that substantial losses occur when grain is stored in underground pits [**1**]. These losses can be either qualitative physico-chemical loss encompassing reductions in the nutritional qualities of the grains, or grain weight loss, or both. These losses in stored grain results in increased food insecurity and reduced household income. Losses of grain stored in underground pits can be caused by multiple factors including the pit environment (humidity, temperature) or biotic infestations (insects, rodents, and molds). The physical environment of the underground pit can play a significant role in the grain storage life and condition.

According to [**2**], Underground pit storage is recognized and utilized in lowland areas where geological formation doesn't endanger the storage. Losses of 25% to 50% in traditional farm storages and occasional 100% losses in underground pit storages. The losses include qualitative and quantitative of grain at every postharvest stage involves harvesting, threshing, transportation, and storing. Losses that happen during storage are caused by different factors including abiotic (granary architecture, humidity, temperature, soil type) and biotic (micro-organisms, insect, rodents) factors was indicated by [**3**]. The most explanation for storage loss particularly in pits is insect infestation, although damage is partially attributed to molding and soil contamination.

[**4**] described that minimizing grain storage losses becomes crucial not only from the perspective of improving food security but also from the need to preserve harvested grain on which farmers have invested their knowledge, finance, labor and time. Seen from this point of view, any intervention that is aimed at improving agricultural productivity per unit of land will not achieve its purpose unless backed by a parallel system that also minimizes post-harvest losses. Otherwise, more harvests equate to more losses. Storing the grain in underground pit is known in drylands of Ethiopia where there is shortage of wood and other materials for construction of above ground storage bins.

Farmers in Gabiley region use underground pits to store food grains. These pits are usually dug in sites close to the farm homestead for facilitating supervision and ease of access. Grain storage allows the farmer to keep the grain in good condition and sell any surplus at a later time when grain prices are more favorable than at harvesting period. However, little information is available about the conditions and problems farmers face in underground pits as a grain storage system. Identifying these problems can help to identify methods and techniques for further improvements in the pit technology as well as explore better alternative grain storage methods.

Materials and Methods

Study area

The study area is eleven villages located in Gabiley region, Somaliland. Geographic coordinates, altitude, and number of households for each surveyed village are shown in (**Table 1**). Taysa has the largest number of households and therefore the highest human population, whereas Yelda with only 55 households has the smallest population size. The total number of households in the eleven villages is approximately 5900. Geedabeera, the easternmost site in the study area, is the lowest point in the landscape, whereas Boodhley at 1585m above sea level is the highest point among the surveyed villages. Data in

***Corresponding author:** Mustafe Abdulkadir Abdurahman, College of Agriculture and Veterinary Medicine, University of Hargeisa, Somaliland, E- mail: mustafe441@gmail.com

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(**Table 1)** show that, in general, the elevation in the study area increases in a southwesterly direction as Boodhley and Gorey have similar elevations and are located in the southwest edge of the surveyed villages.

Data collection and analysis

Data collection included both qualitative and quantitative methods. For primary data collection the following methods were used:

Focus group discussions: Focus group discussions were held in selected villages in Upper Biji Watershed, Gabiley region, to collect available information from the resident communities on the use of underground pits for grain storage. The eleven villages surveyed are shown in **Table 1**. A semi-structured guide questionnaire was employed during the focus group discussions. Focus group discussion members included village committee members, members of farmers groups or cooperatives. The selected groups were farmers who currently use or previously used underground pits for grain storage. The purpose was to interview those farmers with some level of experience with underground pits as a grain storage method.

Key-informant interviews: Key-informants, who are individuals with specific information on underground pits, were interviewed to capture additional information on this traditional storage technique. Key-informants were Ministry of Agriculture officers.

Field observations: Farms with underground pits were visited. However, only empty underground pits were observed, as farmers refused to open their pits for inspection. The farmers said that the pits were filled with grain sorghum only about two months ago and opening them would accelerate grain deterioration. In addition, the farmers stated that little or no insect infestations could be found in grain stored in pits for such a short period.

Secondary data were collected from relevant documents and reports. These included reports related to underground pits in eastern Africa.

Data were entered Excel Worksheets, analyzed and summarized in Tables.

Results and Discussions

Description and use of underground pits

Before excavating, farmers look for a site suitable for establishing an underground pit. The Focus Groups indicated that farmers base their selection criteria for pit excavation on topography, and proximity to homestead. Farmers prefer high ground, and hilly sites for making an underground pit, since such sites are stable and not exposed to floodwater. Although underground pits are inexpensive structures for preserving food grains for the smallholder farmer, their manual excavation is a laborious task. An average pit is 1.6m deep, with 2.2m base diameter, and 0.4m mouth diameter (**Table 2**). More than 90% of households in the surveyed villages, except Yelda village, use underground pits for grain storage. Most farmers in the latter village have abandoned underground pits and are using other storage tools such as bags, metallic vessels, and jerrycans. Yelda Focus Groups and farmers reported that a major reason for abandoning underground pits in their community was that grain production per household was less than its level in the past, because of increasing number of households, who must share a constant land area and therefore must cultivate smaller farm parcels. Sorghum and maize, and also barley in the case of Gorey village, are the only grains stored in underground pits.

All Focus Groups in the surveyed villages pointed to their experiences with higher susceptibility of maize to maize weevil in underground pits compared to sorghum. They were convinced that sorghum is more a hardy crop that tolerates adverse environmental and biotic conditions compared to maize, not only in the field but also in storage. [**2**] Reported that in Ethiopia farmers predominantly store sorghum grain in underground pits and rarely store maize grain in pits.

The Focus Groups and farmers stressed that, in general, a farmer opens his underground pit only once to remove the stored grain. According to the interviewed farmers and Focus Groups, frequent opening of the pit increases insect infestations and accelerates grain quality deterioration. To minimize the frequency of pit opening, households in the same settlement share grain obtained from one of their member's underground pit. After consuming grain from that pit, another household opens its pit and the grain is again shared among households. Whenever a household opens its pit, that household repays all the grain that it had received through this sharing system.

Grain losses in underground pits are variable and depend on the conditions existing in the pit environment, the moisture content of the grain at the time of storing, and the storage duration. Sorghum grain losses after one-year storage in underground pits as estimated by the Focus Groups are reported in **Table 3**. Sorghum grain loss estimates ranged from 25% provided by the Taysa Focus Group and 7% provided by the Yelda Focus Group, with an overall mean of 15% grain loss over the eleven surveyed villages. These estimates are based on the extensive experience of farmers with the use of underground pits as grain storage facilities. In eastern Hararghe region of Ethiopia, sorghum grain losses, after seven months storage in underground pits, ranged from 2% to

Table 1: GPS data and number of households in surveyed eleven villages under Gabiley region.

S/No.	Village name	Latitude (North)	Longitude (East)	Altitude (masl)	Households
1.	Hidhinta	9.54598167	43.73199500	1489	600
2.	Taysa	9.56746000	43.67288500	1540	1500
3.	Korje	9.26947667	43.68457667	1486	320
4.	Boodhley	9.60059333	43.54284000	1585	650
5.	Boqor	9.63719667	43.57262000	1567	700
6.	Geesdheere	9.62203500	43.72848333	1452	180
7.	Yelda	9.65626167	43.59790667	1513	55
8.	Ijara	9.58397667	43.62882000	1564	680
9.	Gorey	9.62331833	43.50343667	1577	720
10.	Lafta-tiinka	9.63101167	43.62623833	1544	250
11.	Geedabeera	9.58800000	43.76070000	1435	240
Total			5895		
Masl: meters above sea level					

Table 2: Percentage of households using pits, average pit dimensions, labor required for pit construction and capacity of average pits (Source: FGD).

Village name	Percentage using pits	Average pit dimension (m)			Labor required (man-days)	Capacity (50 kg bags)
		Depth	Base diam.	Mouth diam.		
Hidhinta	99%	1.0	2.0	0.4	16	30
Taysa	95%	1.5	3.0	0.4	20	25
Korje	90%	1.5	2.0	0.4	14	25
Boodhley	99%	2.0	2.5	0.4	10	50
Boqor	99%	1.8	2.5	0.4	10	30
Geesdheere	100%	1.7	2.3	0.4	14	50
Yelda	5%	1.5	2.5	0.4	8	50
Ijara	90%	1.5	2.0	0.4	10	25
Gorey	90%	1.5	2.0	0.4	20	15
Lafta-tiinka	100%	1.5	2.0	0.4	16	25
Geedabeera	100%	1.7	1.7	0.4	10	20
Averages	88%	1.6	2.2	0.4	13	31

Diam: Diameter

Table 3: Percentage grain loss, storability period, and pit opening frequency (Source: FGD).

Village name	Percentage grain loss after one year	Storability period (Months)	Pit opening frequency
Hidhinta	20%	12	Usually only once a year
Taysa	25%	24	Max 2 times per year
Korje	10%	12	Max 2 times a year
Boodhley	12%	12	Usually only once
Boqor	20%	24	According to need
Geesdheere	16%	10	Usually once
Yelda	7%	36	According to need
Ijara	10%	24	Only once
Gorey	20%	4	Only once
Lafta-tiinka	10%	24	According to need
Geedabeera	10%	12	Usually only once
Averages	15%	18	

FGD: Focus Group Discussions

Table 4: Major problems associated with traditional underground storage pits as ranked by FGD. Higher rank numbers imply decreasing importance of the problems.

Village name	Rank one	Rank two	Rank three	Rank four
Hidhinta	Water infilatration	Insects	Moisture	Poor seed viability
Taysa	User illness	Moisture	Water infiltration	Mold
Korje	Water infiltration	Insects	Moisture	Poor seed viability
Boodhley	Water infiltration	Insects	Change in taste	User illness
Boqor	User illness	Moisture	Insects	Mold
Geesdhere	insects	Insects	User illness	Deterioration of taste
Yelda	Water infiltration	Insects	Moisture	Mold
Ijara	Insects	Moisture	Moisture	Poor seed viability
Gorey	Water infiltration	Insects	User illness	Grain impurity
Lafta-tiinka	Water infiltration	Water infiltration	Moisture	Pit collapsing
Geedabeera	Water infiltration	User illness	Insects	Pit collapsing

13% **[5]**. Various factors contribute to grain loss in underground pits including insects and molds as discussed in the next section of this report.

The Focus Groups were asked to estimate how long sorghum grain could be kept in underground pits without incurring significant deterioration in quality. The estimates they provided varied from 4 months to 36 months with an average of 18 months **(Table 3)**. However, they added that these estimates apply only to underground pits that are kept sealed and opened only once to remove the grain. As mentioned earlier, farmers prefer to open their pits only once. Focus Groups in six of the surveyed villages indicated that they open their underground pits to remove stored grain only once per year, while three villages reported that they open their pits according to need, and the remaining two villages said they open pits a maximum of two times in a year **(Table 3).** Farmers reported that a filled pit, if kept sealed, preserves grain better than partially filled pit.

Problems associated with traditional underground pits

Based on Focus Group Discussions and information provided by interviewed farmers, the major problems associated with underground grain storage pits are described below in sequence according to their decreasing importance.

Water infiltration: Farmers and Focus Group Discussions identified water infiltration into the pit as the most serious drawback of using underground pits for grain storage. Seven of the eleven villages surveyed considered water infiltration as the most serious problem occurring in underground pits **(Table 4)**. Water infiltration into the pit occurs in three main ways: (a) through surface runoff water draining into the pit, (b) through cracks in the pit walls, and (c) through tunnel erosion with subsoil water seepage.

Insects: Three of the eleven surveyed villages ranked insect infestations as the most serious factor affecting grain stored in underground pits, while six villages considered insects as the second most important problem associated with underground pits **(Table 4)**. Two stored grain insects, the maize weevil (Sitophilus zeamais), and the Angoumois grain moth (Sitotroga cerealella) are most common in the villages surveyed. We observed both insects in sorghum grain stored in bags and metallic containers in Hidhinta and Taysa villages, while we also found the Angomouis moth in sorghum grain stored in metallic silos in Ijara and Yelda villages. However, the farmers did not accept to open their underground pits for inspection.

Moisture: Five of the eleven surveyed villages rated moisture as the third important problem associated with use of underground pits as grain storage structures, while the remaining villages thought some other factors such as insects, water infiltration, user illness, mold, and change in grain taste were third in importance **(Table 4)**.

Other Problems

Focus Groups in the surveyed villages mentioned different factors as the fourth problem affecting grain stored in traditional underground pits. These factors with equivalent weights include:

Poor seed viability: Farmers indicated that seed stored in underground pits loses germination capacity within a short period. In eastern Hararghe region of Ethiopia, sorghum grain germination declined from 83% at beginning of the storage period in underground pits to 27% after seven months of storage [**5**].

User illness: Farmers stated that they get ill after opening an underground pit to remove stored grain. They said such illness is characterized by difficulty in breathing, cough, and high fever which last for weeks or even months.

Mold: Development of mold on the grain stored in underground pits was listed by the farmers as one of the significant problems associated with underground pits [**5**]. Observed an increase over time of Aspergillus and Pencillium on sorghum grain stored in underground pits in Hararghe region of Ethiopia. Mold contaminated grain poses health hazards to humans through the production of mycotoxins in the food grains such as aflatoxins.

Grain impurity from soil contamination: Food grains stored in unlined underground pits are inevitably contaminated with soil, gravel, stones, and other debris in the soil profile. Such grain requires extra cleaning effort and is a burden to women, who exclusively carry out this cleaning operation for the household.

Pit collapse: During the Focus Group Discussions in the surveyed villages, some farmers complained about their experiences with their pits collapsing from heavy rainfall pressure or from flash floods. Although farmers usually select high land for establishing an underground pit, this cannot be always ensured in farming communities located in lower land areas. Pit collapse results in heavy grain loss or loss of the entire grain stock in the pit since cleaning such grain from soil is almost impossible [**6**]. This situation is further worsened if water infiltration into the pit accompanies pit collapse. Some farmers who reside in and cultivate low level land informed the survey team that they excavate a new pit every year to avoid pit collapse.

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Conclusion

Postharvest grain losses in smallholder farms in Somaliland increase food insecurity and decrease household income. As confirmed by the farmers and Focus Groups, grain losses in underground pits can reach unacceptable levels within a year of storage period. Severe reductions in grain nutritional qualities can occur from insect and fungal infestations encouraged by high temperatures and increasing moisture in the grain and pit environment. Excavation of underground pits is laborious and time consuming. Underground pit use in the study area is not gender balanced, as pits are managed, and their grain contents accessed only by men. Many farmers experienced total grain loss when flash floods, runoff water, or subsurface seepage filled their underground pits with water. Development of fungi and production of mycotoxins on grain stored in underground pits pose serious health risks to consumers. Deterioration of grain quality results in rejection at the grain markets and loss of household income. Therefore, it concluded the study that traditional underground pits were not suitable for safe grain storage. It recommended that:

Support farmers to acquire metal silos and hermetic bags with different capacities according to cultivated land area per household. CIMMYT working in Kenya has reported that metal silos can store grain in good condition for up to three years. Metal silos with one to two-ton capacities may be appropriate for the communities in eleven villages of Gabiley region.

Train farmers on effective methods of grain storage including proper management of grain before and after storing. The farmers must learn the importance of adequately drying the grain before taking it into the storage facility, as well as the benefits of adopting good hygiene and sanitation procedures in grain handling.

Plastering the traditional underground pit with plastic lining can reduce moisture movement from the pit walls into the grain and reduce the rate of mold and insect infestations. A farmer in Yelda village who used large plastic sheets in the pit for grain storage found improved grain storability. This method can be tried on a limited base.

Metallic barrels of 200-liter capacity function in a manner similar to those of metallic silos and sustain grain quality for longer periods than underground pits. These metallic barrels, which are less expensive than metal silos, may be suitable for households that cultivate small areas.

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