Testing Out-Door Storage Structures on Maize

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Abstract

An experiment was conducted to compare the quality of maize stored in three different types of storage structures (locally made in-door storage Gotta, out-door raised bed and mud silo storages)of approximately similar dimension.

Important parameters like surrounding temperature, relative humidity, moisture content, thousands grain weight, grain temperature and total observation data were collected and recorded through out the storage period. Based on the collected data the condition of stored maize was evaluated.

It was found that, in all storages minimum fluctuation of moisture content (minimum on the month of April 8.4% in raised bed and maximum on the month of September 11.1% in mud silo storage) and grain temperature difference were recorded. In all Gottas and mud silo storages

after four months, it was seen more maize grain breakage due to rats and crawling of pests also was began to be seen.
Seed count and thousand grain weight data measurement show that the mean difference is significant at the 0 .05 level among storages. Maize stored in raised bed storage structure was found to be better in terms of grain loss in comparison with those at mud silo and Gotta. Average percentages of grain loss during eight months of storing period were 4.17, 6.15 and 7.66 % for raised bed storage, mud silo and gotta, respectively.

Introduction

The purpose of all grain storage structures is to furnish protection against deterioration due to rain and soil moisture, provide a barrier against insects and vertebrate predators, maintain stable temperatures inside the storage, reduce the grain surface exposed to ambient air, and reduce the uptake of moisture by the grain after rain or during the night (Boxall R.A *et.al*).Grain storage is carried out by different social groups to satisfy their interest at various levels for a number of purposes, i.e for market, and food for the household and future use.

Between 60% and 70% of grain production in Africa is stored at farm level, generally for family consumption but also for sale and for seed. Storage methods which have evolved over many generations are often well adapted to local conditions (Agboola, 1994).

In Amhara region the main cereal grains cultivated are *teff*, maize, sorghum, barley, wheat and finger millet. Recent investigations have shown that due to use of improper facilities and storage techniques, serious quantitative and qualitative losses occur on some of these crops. A study under taken by FAO has estimated the post harvest quantitative loss in grain to be around 25% of annual production. One of the methods for minimizing these post-harvest losses is introducing of improved storage stractures. This method would not only lead to a substantial increase in the income of the farmer but also gross national product of these essential commodities.

The need for storage of grain in the region occurs mainly because of the seasonal nature of production. Grains have to be stored for periods ranging from 3-8 months. At harvest, farmers sell 50 to 60% of their produce, which is referred to as the marketable surplus, and they keep the rest for their own consumption, for seed purpose and for future sale. (Yonas metafiria and melaku Jirata, 2003)

Farmers use a variety of traditional storage structures to keep their harvested grain. Based on their locations they are categorized as indoor, out door and underground storages. Among these varieties of storages most farmers used to keep their harvested grain by traditional indoors storage structures like clay pots, woven basket, small mud-straw bins (Gotta), sacks and different containers. However, this traditional storage structure invites insects and rodents into the house and also complicates the household hygiene. In addition, structures and containers reduce the room available in residential houses. Even though, traditional storage structures are not expensive and are easy to manufacture by farmers themselves, it lacks to create suitable environment to store grain and to prevent grain damage by loss causing agents.

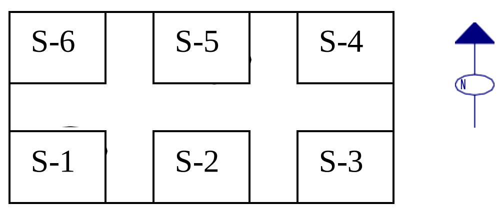
That is why in the past years there have been several attempts to introduce improved out door storage structures to various farming communities in the Region by governmental and non governmental organizations. However, most of the efforts were directed towards introducing of storages that lack the necessary technical information

Therefore, the objective of this study was to present experimental studies on the performance of different types of storages structures and based on the results to select and recommend the best ones to the farming community

Materials and Methods

For site selection, specific criteria were developed, i.e, maize production potential, occurrence of storage pests, and awareness about the improved storage structures among farmers, availability of local construction materials, road accessibility, and closeness for monitoring purpose. Site selection was made through discussion with relevant institutions such as wereda council, development agents at site, farmers service co-operatives, and so on. Based on the criteria's and discussions made, the trial site for testing of storage strictures for maize had been selected at Alafa in west Gojjam zone

The location of each raised bed and mud silo out-door storage structures were selected randomly using lottery system, the first pick on the first number was erected (Fgure 1). The structures of out door storage structures are presented on Figures 2 and 3. Gotta as in-door storage structure was placed inside farmers' house near the kitchen which is not far from main storage trial site (Figure 4).



S.1 – Raised bed S.2 – Mud silo S.3 - Mud silo S.4 - Raised bed S.5 - Raised bed S.6 - Mud silo

Figure 1: Construction lay-out for out door storage structures

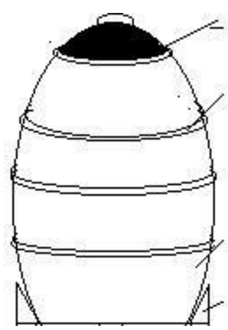


Figure 2: Mud silo Figure 3: Raised bed storage Figure 4: Traditional in door storage storage

Gotta)

Two different types of cylindrical out door storage statures, i.e. raised bed and mud silo storages made of wood, grass and straw were constructed according to the lay out on the area of 100 square meters. (Figure 1) The construction materials and dimensions of the two storage structures more or less were identical. The difference is being rested on the ground with concrete floor for mud silo and suspended above the ground with four posts for raised bed storage structure (Figures 2&3)

The traditional one which is constricted out side the trail site, because of its functional condition, was also build using animal dung, chopped straw and clay soil not far from the trail site area by experienced local farmer. This storage has the same shape and holding capacity as that of the out door storages.
After the arrangement of storages on their respective location, all of them were filled with 400kg of maize variety BH660 which was harvested from the same area. To eliminate field pests, all stored maize was fumigated.
To monitor the surrounding temperature and relative humidity, thermo-hydrograph was installed inside experimental site and data was recorded through out the storage period. Grain temperature at the depth of 20cm was taken by digital thermometer at five locations in each of the storage structures as shown in Figure 5. The moistures content of the grain where also determined using quick grain moisture tester. Every month data was recorded through out the test period. (May 2001 to December 2002)

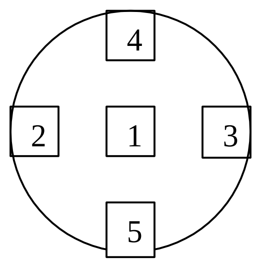


Figure 5: Horizontal section of an Experimental cylindrical storage bin with the position of data taken for grain sample and temperatures (1-center, 2-East, 3-Weast, 4-south, and 5-North).

Two-grain samplers and sample holding boxes were manufactured at Bahir Dar Agricultural Mechanization research center and were used to collect and hold grain. Grain samples were collected from nine equal intervals and at five position of each storage bin (Figure 5) in an interval of 30 days. A representative samples was obtained from the depth penetrated by the sampler. Using count and weight methods samples were analyzed for the moisture content and weight losses (damage) of grain, respectively. This method provides an estimate of loss where a base line cannot be obtained at the beginning of the storage season (Anon, 1996). Three samples, each of about five hundred grains, were extracted and the grains in each sample were then sorted into the damaged and undamaged grain and then counting and weighting each fraction. (Peace Crop, 978,) The data then was substituted into the following equation and calculated for percentage of weight losses.

$(UxNd) – (DxNu) / U(Nd+Nu) x 100 = \%$ weight loss

Where U = weight of undamaged grain
D = weight of damaged grain
Nu = Number of undamaged grain
Nd = Number of damaged grain

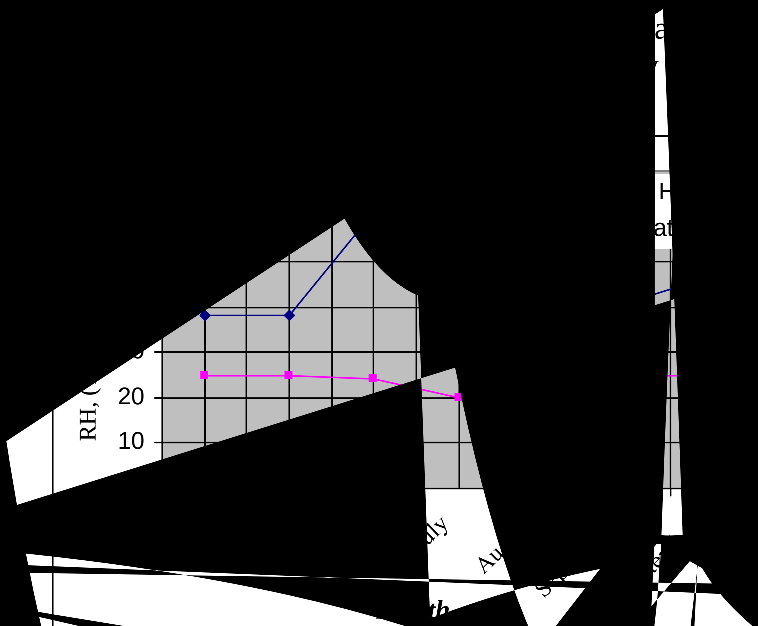


Fig... 5: Ambient ... ela... midit... age... maize

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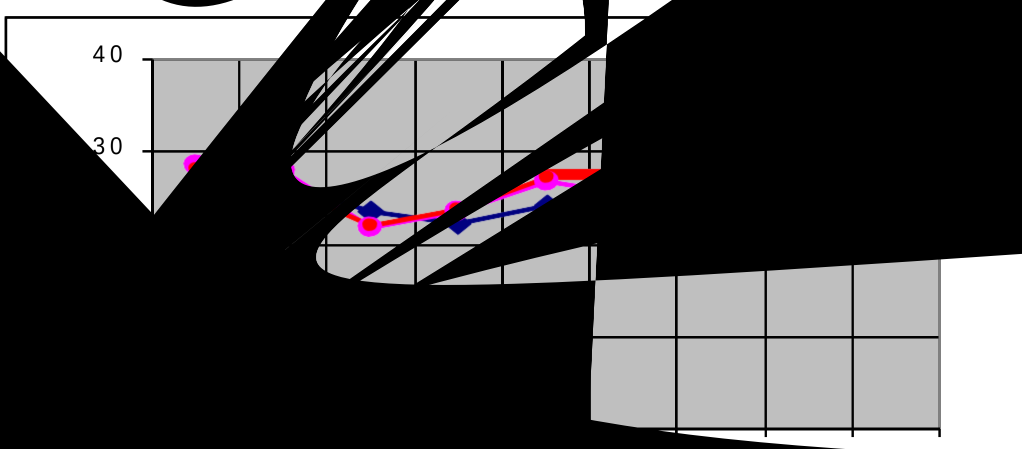


Figure 6: *Grain temperature change during storage of maize in three different storage structures*

Studies indicate that temperature between 21 ^{0}C– 43 ^{0}C speeds up the life processes of all organisms (Yonas Metaferia and Melaku Jirata 2003). Therefore, the ambient grain temperature were within the optimum range for insect infestation However, for the first four months, the rate of infestation was very low and also significant number of insects was not observed in all storages. After the month of August, the grain temperature started to increases because of an increase in ambient temperature and respiration of grain. The highest grain temperature was 31.8 0C in the mud silo storage (Figure 9).

Statistical analysis of grain weight losses using count & weight method of sampling in different storages by multiple comparisons (ANOVA) show that, the mean difference was significant at the 0.05 level between raised bed and Gotta, whereas, there was not significant difference among mud silo storages (Table 1and 2)

In the case of thousand grain mass sampling method, the statistical analysis indicate that the raised bed storage mean difference was significant at the 0.05 level from both storages (Table 2).

Average percentages of grain loss during eight month storing period were 4.17, 6.15 and 7.66 %, for RS, MS and GS, respectively. Even though, in all storages grain losses were seen, the greatest average percentage of grain loses was found in traditional indoor storage (*Gotta*).

Table 1: Statistical analysis of grain weight losses using count & weight method in different Storage by multiple comparisons

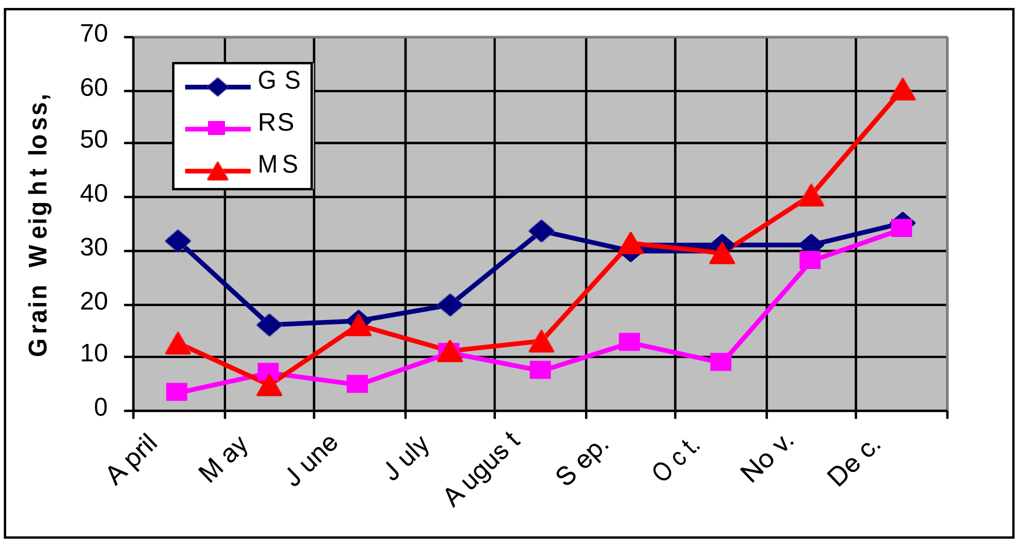
	(I) Grain Storages	(J) Grain Storage	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	GS	MS	.9133	1.1710	.465	-1.9520	3.7787
		RS	2.9600*	1.1710	.045	9.462E-0	5.8254
	MS	GS	-.9133	[illegible]	.465	-3.7787	1.9520
		RS	2.0467	1.1710	.131	-.8187	4.9120
	RS	GS	-2.960*0	1.1710	.045	-5.8254	-9.4624E-02
		MS	-2.0467	1.1710	.131	-4.9120	.8187

*. The mean difference is significant at the .05 level.

The reason was that, there were high insect and rat infestations. *Gotta* is often used in the house, therefore, due to poorer sanitation, and other family activities, there will be appropriate condition for emerging of rodents. In the other hand, burning of woods for house-hold purpose increases room temperature thereby will be an increase in grain temperature that favors pest breeding process.

Table 2: **S**tatistical analysis of grain weight losses using thousand grain mass methods in different storage by multiple comparisons

Temperature and moisture are the major factors determining factors in accelerating or delaying of the complex phenomena of the biochemical transformation (especially the "breathing" of the grain). Furthermore, they have a direct influence on the speed and development of insects and microorganisms.



Month

Figure **7:** Percentage of grain weight losses during storage of maize in different storages (TGM)

It was observed that after two months, the grain moisture content increased from 9.2%, 10.7% and 10.9%, in the Gotta, RS and MS storages, respectively. At the end of six months, the grain moisture content has dropped to 9.2 %, 9.3% and 9.5% (Figure 8). Since the safe moisture content of maize for storing is up to 13.5%, this variation of moisture content did not affect the maize condition (Yonas Metaferia and Melaku Jirata, 2003)

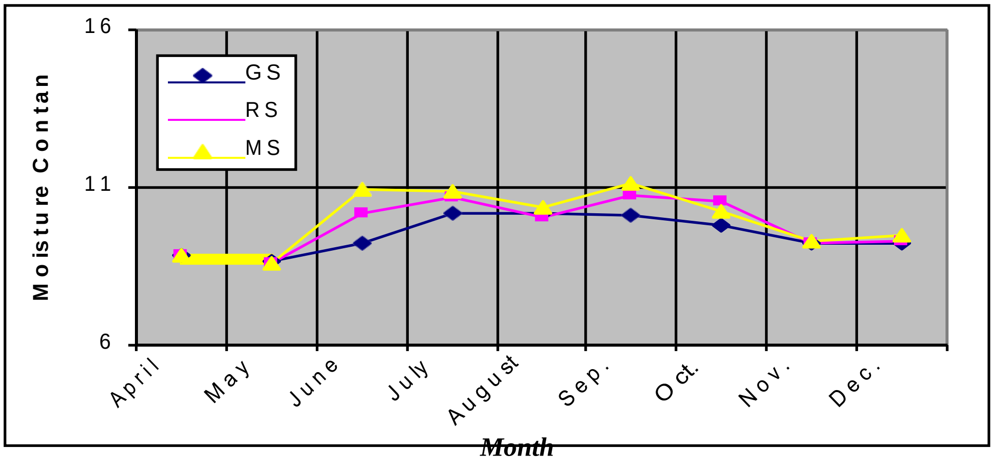


Figure 8: moisture content changes during storage of maize in three types of storage structures

Insects can live and reproduce at temperatures between +15°C and +35ºC. But temperature depends not only on climatic conditions but also on the biochemical changes that are produced inside a grain mass, provoking undesirable natural heating of the stored products (Yonas Metaferia and Melaku Jirata, 2003). For that reason, climatic conditions did not favor significantly the emergency of common pests during the first three months of storage (May to July).

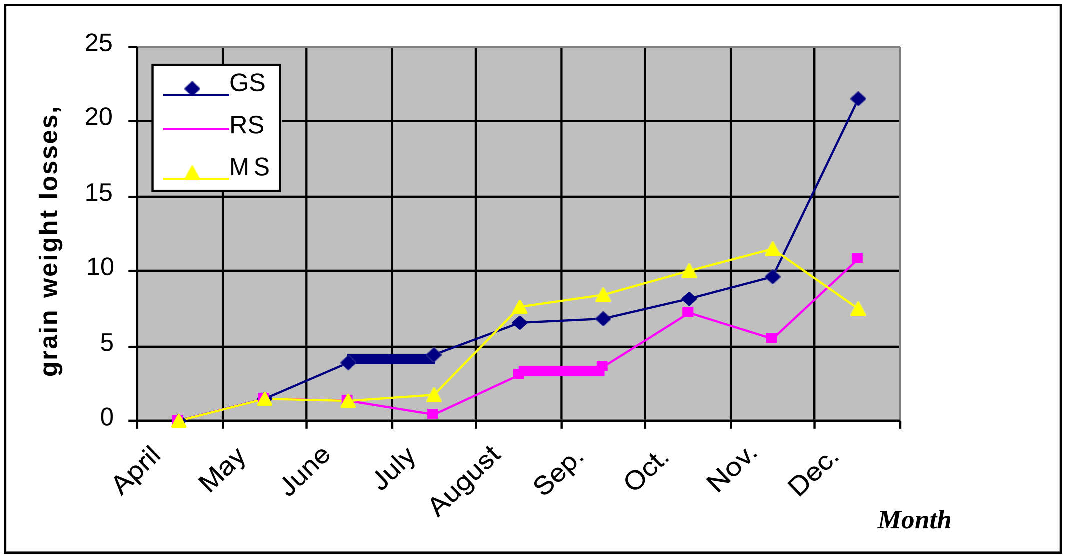


Figure 9: Grin weight losses during storage of maize in three types of storage structures (C&W)

Even though, high temperature (21^0C- 43^0C) speeds up the life processes of all organisms, (Melaku Jirata, May2003) during this time the percentage of grain loss was very low (Figure 9). But starting from August, grain losses increased, because of the accumulated insects feed on the stored maize and their metabolic processes produced heat and carbon dioxide. The added heat made the grain temperature to rise and accelerated development of large amount of insects (Figure 8 and 9). Up to the 3rd month in all types the storages existence of rice weevil, red flour Beetle and grain moth pests had been seen very few, but during the last three months of storage (October-December), the amount of observed crawling pests was extremely very high in GS and MS than RS. From observation, the wastage caused by the rice moth is negligible since it was limited to the upper stored grain. In the other hand, after the 3rd month of storage in all traditional storages (*Gotta*) and mud silo, the presence of mice was almost permanent. They enter in to *Gotta* and mud silo through the roof and/or by making holes at the base and causes serious damage and wastage of the stored produce both by their consumption and faucal contamination. This condition increased damage of grain in both indicated storages, where as for raised bed, because of its rat preventing mechanism attached on all its four legs, it was not a problem.

Conclusion and Recommendation

Even though all tested storages are capable of storing grain, the raised bed out door storage structure was found to be the best. Using of this storage structure in warm or cold area is suitable with its additional advantage of rat preventing mechanism and raised platform condition that reduces condensation and increases ventilation action.The result of the study also indicated that long period storing of maize with out inspection may cause serous losses of grain. Therefore, the selected storage will be more effective if it is assisted by proper storage technique and managements which enhance the quality of stored produce. Some of them are:

- Activities in preparation for storage (cleaning the storage, destruction of infected residues, and selection of healthy ears at harvest) permit a substantial reduction of insect attack. Moreover, to ensure effective control, the use of chemical products can not be overemphasized.
- Inspection methods permit the detection of levels of infestation corresponding to application of a treatment in order to avoid serious grain losses and wasteful superfluous insecticide treatments. But to prevent insect infestation and damage the treatment should be applied to the grain immediately after harvest and at intervals of three to six months depending on the recommendation and type of the chemical.

References

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