



Photo: GOAL-Ethiopia

Adaptation and adoption of improved household grain and seed storage in southern and eastern Ethiopia

Introduction

Maize is the most important cereal in Ethiopia, gradually replacing sorghum as the preferred crop, with 4.2 million metric tons (MT) produced by eight million smallholder farmers. It is the least expensive cereal to produce on a unit basis and, hence, a lower cost source of cereal calories compared to teff, wheat, or sorghum. Most maize is produced by smallholder farmers with less than 2 hectares of land. Among these farmers only 5% use certified maize seed and fertilizer, and 80% of production is consumed on farm. Sales take place soon after the harvest due to financial pressure and the risk of loss through storage, which can range from 15–40% (IFPRI 2010).

This case study takes place in two distinct geographical areas: Boricha in Sidama Zone of the Southern Nations Nationalities and Peoples' Region and Daro Lebu in Chiro Zone of the Oromia Region. Farmers in the two areas have different storage practices. Cereal is traditionally stored in underground pits in Daro Lebu while, in Boricha, above-ground storage is universal. Daro Lebu has almost half the population density of Boricha (259/km² versus 402/km²) with significantly lower rainfall (800–1200 mm versus 1700–2200 mm per year). Maize, sorghum, teff, and beans are common in both areas, however, potato, sweet potato, and vegetables are more common in Boricha, with its higher altitude and rainfall. Coffee and chat are important

cash crops in Daro Lebu and cattle and small ruminants contribute significantly to livelihoods in both areas. Erratic rainfall is common to both areas and so post-harvest storage is an important means to promote food security and resilience (Seyoum and Jonfa 2012).

Reduced quality of grain from insect infestation and moisture can have significant implications to both food availability and income. This results from direct loss and poor quality influencing market prices. Similarly, reduced quality of seed due to moisture results in lower germination, plant vigor and yield. Cereal prices fluctuate greatly between harvests which can make effective storage profitable. For example, maize sells at 160 birr/quintal (US\$0.84/kg) after harvest in February to March and can fetch 300 birr/quintal (US\$1.58/kg) in the period of August to October (IFPRI 2010).

As a reflection of this, improved storage has been promoted in Ethiopia for at least two decades. In 1995, Sasakawa Global 2000 introduced improved maize cribs which the Ethiopian Ministry of Agriculture and Rural Development continues to promote as of 2013. Adoption rates of new storage technologies have been low due to expense and the extent to which new technologies vary from traditional practices. In addition, farmers have been reluctant to advertise new stores for risk of being a target for theft (IFPRI 2010; Seyoum and Jonfa 2012).

An improved above-ground grain storage with 1200 - 1500 kg capacity, constructed at household level, West Hararghe Zone, Oromiya Region, Ethiopia, 2012.

The store has a similar design to a traditional store but is sturdier and equipped with metal rat guards on the poles to prevent rodents climbing them.

Materials & Methods

The project targeted 800 households with a goal to reduce loss of seed and grain through the adoption of improved storage methods. The first objective was to conduct on-farm trials and research of improved post-harvest handling and storage. The second objective was to promote the adoption of improved post-harvest handling and storage practices to reduce loss of grain and seed by 15%. The third objective was to document and disseminate research of new technologies and the extent of their adoption (Seyoum and Jonfa 2012).

A participatory action research approach was used to increase farmer awareness of storage losses and new practices. The first step was to identify the magnitude and causes of maize losses under traditional storage. The main cause of post-harvest loss is insects (weevils and, to a much lesser extent, termites) followed by rodents and moisture. The project baseline, using farmer recall, estimated losses of maize stored in sacks to be 30%, maize stored in bins above ground to be 22%, and losses of maize stored in underground pits to be 26%. The survey also suggested that sorghum storage losses were similar to that of maize.

Training targeting extension agents and a sub-set of farmers was carried out on post-harvest handling, management, and storage at village level (kebele) development centers. Participants of the training were expected to share knowledge gained with other farmers. Training and sensitization along with improved storage demonstrations were expected to improve farmer practices on post-harvest handling and raise demand for improved storage.

Storage design and cost: In collaboration with Haramaya and Hawassa universities, a series of workshops were organized with farmers, referred to as “farmer research groups,” to discuss existing storage practices, rates of loss, and best options to reduce loss. These resulted in the development of four improved storage designs: two above-ground bin designs and two underground pit designs. The above-ground stores have a similar design to traditional stores but are sturdier and equipped with rat guards. The below-ground stores have improved ventilation and drainage.

The two modified above-ground designs were raised off the ground with metal rat guards on the poles to prevent rodents climbing them. The initial modified design involved 5 wooden poles 50-75 cm raised above the ground forming a foundation on which the store was constructed. The second modified design had four wooden poles extending to the roof of the granary which provided extra support and longevity, reducing the likelihood of the granary to tilt and eventually collapse. The modified underground pits were designed to reduce moisture using two different structural designs. The estimated material cost, labor excluded, for the improved above-ground store ranged from US\$100 (1,900 birr) to US\$121 (2,300 birr). The project provided a 50% subsidy on construction materials (Seyoum and Jonfa 2012).

Results & Discussion

The project achieved its training target as 756 of a targeted 800 farmers were trained in improved maize storage through a step down approach which reached 172 village (Kebele) training center members from eight villages in the two project areas. The three-day training of trainers covered crop harvest, causes of storage loss, behavior of storage pests, and controlling storage pests to reduce loss. Among those trained, 723 farmers were male and 23 were female. An additional 3,179 farmers were identified in project documents as having been sensitized on improved post-harvest handling and storage practices. It is not clear from the project documents to what extent farmers changed practices as a result of training, but the final evaluation reports suggest that participating farmers had a “noticeable attitudinal change in terms of promoting improved post-harvest handling and storage practice.”

Against a target of 800, a total of 423 improved stores were constructed of which 421 were above-ground stores. A total of 320 farmers in Boricha and 101 farmers in Daro Lebu constructed improved stores. Only six women decided to invest in storage construction. A key reason cited for the low adoption rate was cost. The actual construction cost of the above-ground store was 67% higher than the estimate;

costing on average US\$105 (2,000 birr) according to farmer interviews during the final evaluation. An average store can hold from 1500 to 2000 kg so the cost of storage ranges from US\$0.05 to US\$0.07/kg of maize. In addition, the value of maize can increase by over US\$0.50/kg between harvests in February and planting the following August (Seyoum and Jonfa 2012; Tesfaye 2012).

Despite the project's aim to promote research linkages between universities, extension staff and project staff, the only key research outputs were the improved storage designs. More regular feedback might have resulted in adaptation in terms of project approach, technology design, technology promotion and ultimately a higher adoption of improved storage technologies. In addition, a more regular financial modeling and cost-benefit analysis would have been a useful complement to assess farmer returns to storage investment.

The reduction in storage losses from improved storage was not measured, but a proxy for the value of improved stores can be estimated by comparing weevil infestation in a traditional structure to an improved structure. The project documents suggest that the number of weevils after nine months was 37/100 grams in traditional storage compared to 3/100 grams in improved storage, representing a 90% reduction. After nine months of storage in the traditional structure, the number of damaged grains increased significantly and maize seed germination dropped precipitously. Over the same period in improved above-ground stores, seed germination decreased very little and damaged grains increased slightly (Figure 1). While this is a measurement of only one improved store, it does show the potential impacts of improved storage on both reducing pests and improving germination.

Effect of nine months storage on maize damage & seed germination

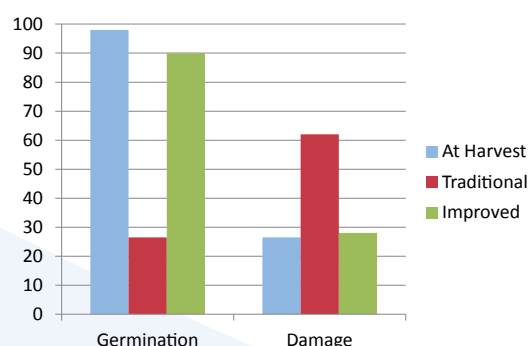


Figure 1: Maize germination rates comparing a traditional and an improved storage unit

Improved on-farm storage can significantly reduce maize loss and benefit poor farm households.

There is a range of promising hermetic storage technologies ranging from the metal silo, the Purdue Improved Crop Storage (PICS) sack and GrainPro SuperBag to 20 liter plastic containers for seed. These products, when used correctly, control maize insect pests in storage without insecticides.

The economic analysis using maize price data from 2012 and 2013 is outlined in Figure 2. The data indicate positive average returns for both the traditional bin and the improved storage structure when the opportunity cost of capital (OCC) is not considered, with a 2.5% and 29.1% return, respectively. At a 25% annual OCC, the traditional bin no longer has positive economic returns (-16.2%). The improved structure maintains positive economic returns under 25% OCC (10.4%), but does not stay positive for producers facing a 50% OCC (-8.4%). This indicates that while the improved structure dominates the traditional bins, the investment may not be profitable enough for farmers with high OCCs, given average grain price increases of only 36% over the storage period. Additionally, the improved structure has an upfront cost which is about three times that of the traditional bins (estimated at US\$33), making it difficult for farmers to produce this cash without credit mechanisms. These dual factors may help explain the reluctance of many farmers to adopt this technology. Results for sorghum lead to the same conclusions as with maize, given similar loss rates and price movement.¹

¹ See seed storage brief #3: *Economics and promotion*

Returns to maize storage with traditional vs. improved technologies

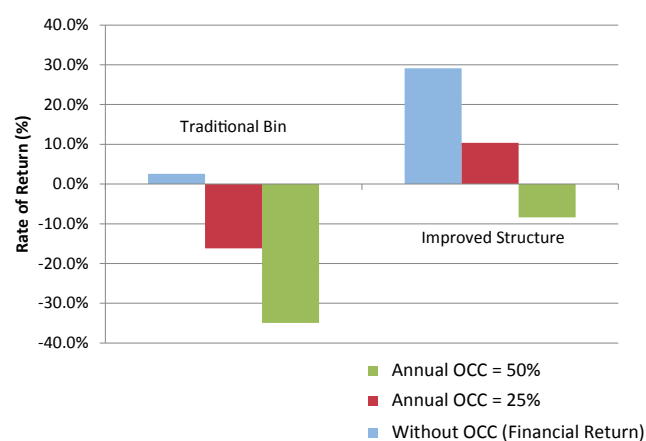


Figure 2: Economic returns to maize storage with traditional vs. improved technologies

Conclusions & Recommendations

There is a clear need to improve maize storage in order to reduce losses, enable farmers to delay sales to obtain better prices, and increase the availability of food. The improved above-ground stores are preferred to the improved below-ground stores. However, costing over US\$100 to construct, above-ground stores may be unaffordable for smallholder and women farmers.

The improved maize stores are designed for grain and not for seed. Though certified hybrid maize seed is available, only 5% of smallholder maize farmers purchase and plant certified seed according to IFPRI (2010). This means that 95% of the smallholder farmers' maize seed is their own saved, acquired from neighbors or purchased from the local grain market. Therefore, the need to explore technologies to improve on-farm maize seed storage remains.

It appears that hermetic seed and grain storage are promising technologies for future development. For grain, this includes the 100 kg PICS sacks and the GrainPro SuperBags, both available for testing in Ethiopia. In addition, metal silos have been shown to be effective in Kenya without insecticides and should be evaluated for storing larger volumes (De Groote et al. 2013). For seed, used 20-25 liter vegoil containers might be more appropriate for farmers planting less than one hectare of maize.

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Contact information

Meseret Mengistu
Livelihoods Programme Coordinator
GOAL-Ethiopia
Email: meseretm@et.goal.ie

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