OVERVIEW

# The Improved Seed Storage Project

## Overview of Briefs and Case Studies

*Seed is the foundation for the production of cereals and grain legumes that underpins farm family food security and income across Africa and Asia. Throughout Africa, in particular, farmers themselves produce an estimated 80–100% of the seed of both local and improved varieties. A recognition of the centrality of farmer-managed seed suggests that research and development practitioners need to support this important system and seed source. Farmers typically produce seed and grain in the same field, although there can be wide variation between crops and cropping systems. Methods for seed selection also vary, as seed might be selected in the field or after harvest, or from stored grain only at the time of planting.*

### The importance of storing seed in a smallholder context

There are many advantages for farmers in being able to store their own seed. Using seed from their own stores means that: a) farmers can sow varieties whose quality and management requirements they know well; b) they can access seed without having to lay out cash (in contrast to spending for seed purchased from agro-dealers and local markets); and c) their stored seed is always available on time and just nearby. Unfortunately, farmers often struggle to prevent losses in stored seed that may impede their ability to maintain quality seeds for upcoming plantings. Among other constraints, stored seed may be attacked by insects and pests; or it may lose its ability to germinate, perhaps due to high temperature or too much moisture.

Investing in good seed storage, that is, investing in efforts to help farmers save their seed "at the front end" (preventatively), should be seen as a strategic investment. Particularly with vulnerable farmers and in high stress regions, better seed storage options may mean less need for emergency assistance when times get tough "at the back end," when drought or flood or other stresses mean that multiple sowings, or more seed overall, might be needed to ensure that farmers can adequately sow their fields.

### On-Farm Seed Storage Project overview

Recognizing the need for more critical thinking on seed storage options for smallholder farmers, the United States Office of Foreign Disaster Assistance (OFDA), supported a series of grants from 2009–2013 examining diverse seed storage methods across six countries and diverse crops (Table 1). All country case studies are available separately (see reference section). A learning workshop was also held in April 2013 in Bujumbura, Burundi to document and socialize lessons learned across the varied initiatives (CRS 2013).

In terms of general findings, field programs indicated some advances in reduction of seed storage loss, improved seed quality (viability and vigor) and ultimately yield. As examples, in Mozambique, farmers' combined use of 1.5 liter bottles, ash, and cooler box technology allowed for stabilized temperature

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance
MercyCorps
GOAL an international humanitarian organisation
CRS CATHOLIC RELIEF SERVICES

and resulted in reported germination rate increases of 50–90% for maize (as fluctuations negatively impact germination). In Afghanistan, ventilation of traditional pit storage, rigorously combined with improved plant selection in the field and better seed handling practices (separating seed from tubers destined for consumption), cut potato storage losses down from 30% to 5% and resulted in marked yield increases, from 12 to 16 metric tons per hectare.

**Table 1.** Summary of seed storage interventions tested in OFDA-funded On-Farm Seed Storage Project: 2009–2013

| Country | Crop | Technology tested | Implementing partner |
|---|---|---|---|
| Afghanistan | Potatoes | Ventilate underground pits; improved seed handling practices (separating tubers destined for seed and consumption) | Catholic Relief Services |
| Burundi | Beans (with farmers also extending to maize) | Various hermetic storage products containers PICS*, GrainPro bags, Food oil cans, clay pots | Catholic Relief Services |
| Burkina Faso | Cowpea and rice | Various hermetic products, the main one being PICS sacks (multi-layer, made of 2 polyethylene bags), also plastic bottles and painted clay pots | Catholic Relief Services |
| Ethiopia | Maize, sorghum and groundnuts | Below- ground storage pits | Mercy Corps |
| Ethiopia | Maize | Modification of above-ground granaries and below-ground storage pits | Goal |
| Mozambique | Maize | Storage in 1.5 liter bottles, with ash and cooler box of clay/bamboo | Aga Khan Foundation |
| Timor-Leste | Maize | Metal drums | Mercy Corps |

** Purdue Improved Crop Storage*

## Seed storage briefs

These storage briefs aim to synthesize some of the technical lessons from field experience in testing and encouraging adoption of seed storage technology. Brief no. 1 focuses on seed quality and the principles of seed storage technology. Brief no. 2 takes a closer look specifically at hermetic seed storage. Brief no. 3 provides an overview analysis of the economics and promotion of improved seed storage options.

These briefs are intended to be practical guides for field managers and implementers who have to make concrete decisions around seed storage programs. They should help practitioners design better on-farm seed storage proposals in consultation with famers, implement activities which better meet farmers' needs, and monitor and evaluate their activities more effectively. Each brief concludes with a reference section for further reading to encourage an ongoing learning process.

## References

Catholic Relief Services, 2013. Documenting and Socializing Lessons Learned from 7 OFDA Grants on Household Seed Storage. Workshop held: April 15–19th 2013. Bujumbura, Burundi.

Purdue Improved Crop Storage, (n.d.): http://www.entm.purdue.edu/PICS2/

## Case study documents

Quality Potato Seed through Improved Production and Storage in Ghor Province, Afghanistan. CATHOLIC RELIEF SERVICES (CRS), Afghanistan. 2013.

Quality seed through storage in Burkina Faso. CATHOLIC RELIEF SERVICES (CRS), Burkina Faso. 2013.

Strengthening Farmer-saved Bean Seed through Hermetic Storage in Burundi. CATHOLIC RELIEF SERVICES (CRS), Burundi. 2013.

Adaptation and Adoption of Improved Household Grain and Seed Storage in Southern and Eastern Ethiopia. GOAL, Ethiopia. 2013.

Enhancing Post-harvest Systems in Ethiopia. MERCY CORPS–Ethiopia. 2013.

MERCY CORPS, Timor Leste. 2013. Effective seed storage in Timor-Leste.

(not available- AGA KHAN FOUNDATION: Mozambique case study).

Catholic Relief Services is the official international humanitarian agency of the Catholic community in the United States. We ease suffering and provide assistance to people in need in 91 countries, without regard to race, religion or nationality.

This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.



**Suggested citation**

Catholic Relief Services (2014). Introduction – Improved Seed Storage Briefs. Nairobi: Catholic Relief Services.

The views expressed in this document are those of the authors and cannot be taken to reflect the official opinions of CRS.

Project funded by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Brief edited by:

CRS CATHOLIC RELIEF SERVICES


# Quality potato seed in Ghor Province, Afghanistan, through improved production and storage

## Introduction

Ghor Province, in the central highlands of Afghanistan, typifies many highland areas in Central and South Asia. The terrain is semi-arid and mountainous with limited irrigated land. Forty percent of the rural population is unable to meet its annual household consumption needs. Potato is the principle staple along with wheat, grown by 80% of households as an important winter food and the main income-generating crop. Most farmers produce 10–15 metric tons (MT) of potato annually, based on average yields of 8–12 MT per hectare and average land allocations of 1–1.5 hectares. More than 15% of total irrigated land in Ghor Province, 43,696 hectares, is devoted to potato. Few inputs are used in production due to cost and availability.

The average household size in the central highlands of Afghanistan is seven, and most family members are involved in key household enterprises like crop production, livestock rearing, and firewood collection. However, a division of labor exists which reflects both inter-household economics and social norms. With potato, men prepare the land, assist with planting, lift the potatoes at harvest, transport potatoes to stores, and sell them in the market. Women are responsible for selecting seed tubers at planting, planting the seed, and sorting and grading the potatoes at harvest. Potatoes have a high return per unit of land and are a promising crop for both home consumption and income generation.

Farmers store their potatoes during winter months in pits, 1.5–2.0 meters deep and 1.5 meters in length and width, usually near the field from which they were harvested, and directly covered with 30 centimeters (cm) of soil. Seed and ware (eating) potatoes are generally stored together throughout the winter, when temperatures can be as low as -30°C. Farmers typically store 2–3 tons per pit, based on the volume of the store. Farmer stores often suffer from ventilation issues due to poorly designed or malfunctioning vents and over packed stores. Losses by the following spring generally exceed 30% and can amount to total loss. Storage affects tuber quality, which is often poor due to fungal and bacterial rot as well as excessive sprouting. Seed is selected from the surviving tubers but the following crop shows reduced vigor and growth as a result.


Opening the communal potato storage pit in Lal after six months storage. The interest of the community was palpable!

## Materials & Methods

This project targeted a total of 1,680 households in Chaghcharan and Lal Wa Sarjangal (Lal) districts of Ghor Province with training on potato selection, handling, and on-farm storage through introducing minimal-cost ventilation systems to traditional pits. Poor sorting of potatoes prior to storage and poor ventilation of potato pits were identified as major contributors to high storage losses. Households were encouraged to carefully select and gently handle their potatoes to minimize tuber damage. The main modifications to traditional storage included ensuring air space of 30 cm above the potato stack, promoting the use of two aluminum vents to promote air circulation and a wooden rack on the floor to ensure air flow under the potato stack.

At the time of this project, there were also on-going community storage programs taking place in a neighboring province. These involved community stores capable of storing 20 tons, sufficient for up to 20 farmers, and costing on average US$8,000. The community stores were not well received. Their scale and cost made them beyond the reach of communities without significant external assistance. Similarly, previous efforts to introduce formal and informal potato seed schemes have failed due to lack of trust between producers and buyers and because households did not have the assets to regularly purchase seed potatoes.

**Storage structure:** Pits are an ideal cost-effective means of storing potatoes during the cold Afghan winter when temperatures can fall to -30oC. Simple ventilation ducts alone were not considered sufficient to draw air through the potato stack. It was hypothesized that if a pocket of warm air could be captured above the stack, the forces generated upon the release of this air to the atmosphere would be sufficient to draw in cool ambient air. The mid-day air temperature in winter, 4–6°C, is ideal for potato storage, and so an appropriate ventilation mechanism was designed to disperse cool ambient air through the potato stack. To develop the concept in association with the targeted communities, communal pits (Figure 1) were constructed by a group of 35 households in six villages of the two target districts.

**Training on seed handling and storage:** Concurrent with the promotion of the store, good seed selection and handling practices were promoted through a series of training courses held at the appropriate time of the cropping season. These courses were aimed at men and women from the same household to not only ensure that the person most likely to carry out a task was knowledgeable, but also that household members could discuss the practices confidently and plan their work together. Training was kept to five key topics and limited to 30 minutes to accommodate for participant time. Topic areas were (a) timely cessation of irrigation and dehaulming (cutting back the stem) pre-harvest, (b) rigorous sorting at harvest, (c) gentle handling, loading the pit and curing, (d) ventilation management, and (e) opening the pit and seed preparation. Intensive follow-up visits were carried out as farmers were in the field carrying-out the practices in question.

**Storage management:** Each participating household brought their selected seed potatoes to the communal pit for loading. Potatoes were loaded into labeled open-weave net bags. Weights were recorded, and the bags were then placed in the pit and covered with surplus sorted potatoes. Following curing, which involves closing the pit for 10 days to allow the gentle build-up of heat and moisture to hasten the suberization process (healing of wounds on the potato skin), the pits were regularly vented by opening the inlet and exit vents. The vents allowed warm exiting air to draw in cool ambient air. Ventilation was controlled by condensation, aided by the surface of a cool shiny metallic object placed at the exhaust vent to condense warm, humid, exiting air. When condensation ceased, air movement stopped and the vents closed automatically. Upon opening the pit in spring, the tubers from each bag were sorted so the healthy and rotten tubers could be weighed separately. Healthy tubers were then planted. During the cropping season all participants were trained to select healthy plants from which to select seed for the following season using the seed plot technique.

**Monitoring activities:** Participating farmers planted the tubers from the communal pit alongside those stored in the traditional manner. All cultural practices were the same for both parcels. Days to 50% crop emergence, emergence percentage, plant vigor using a scale of 1 to 3 (1 = poor vigor, 2 = moderate vigor, 3 = vigorous) and sample harvest yields from two randomly selected plots (10 square meters in size) within each parcel were recorded. Issues and suggestions on seed selection, handling, and the modified pit storage technology were openly discussed with farmers and changes were incorporated in the second season. In addition, another 12 groups were formed in different villages and they completed one cycle using practices refined during the course of the project. In May 2013, a sub-set of participating households were surveyed to understand the impact of improved seed selection handling, principle uses of the increased production and income, key take-home messages from the project, and factors affecting their decision to adopt the stores.

## Results & Discussion

In total, 840 households and 1,680 individuals (a male and a female member from each household) took part in the project. Across both sites there was a marked reduction in storage losses, an increase in plant vigor, and an increase in reported yields. Feedback from the final project assessment consistently mentioned that training was not time-consuming and that follow-up was field based and personal. The "doing is believing" approach helped participants better understand and adopt improved selection, handling, and storage practices. Participants also noted that the simplicity of the storage modification and the low cost (US$10 in materials) made adoption easy.

**Storage design:** The stores proved practical, easy to operate and overall significantly reduced losses. In the exceptionally cold winter of 2011–2012, however, condensation formed on the roof of many pits and dripped on the potato stack below. There was no apparent spoilage, but it was recommended to improve the insulation by increasing soil cover from 30 cm to 50 cm. Excessive condensation was a reoccurring issue in pits that were not completely filled, thus in Season 2 all pits were filled to within 40 cm of the top to generate enough heat to drive the system. It was further recommended to ventilate twice per week in order to expel excessive humid air and reduce the condensation effect. Most heat and moisture is generated in the first few weeks after curing. In Season 2, many farmers left their pits open until the first frosts, from which time regular biweekly ventilation was implemented. Some pits had damp walls at the time of filling and hence experienced higher levels of condensation. In Season 2,

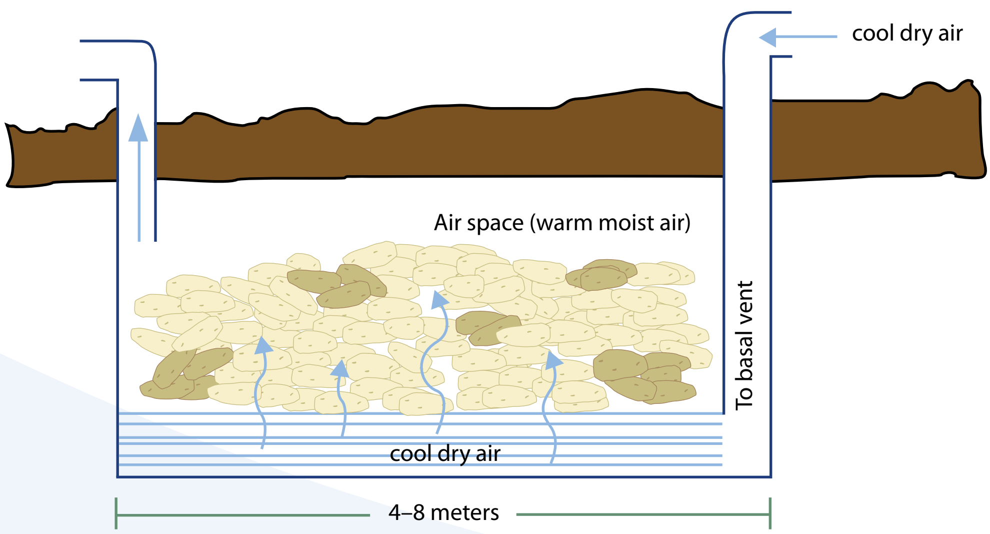


**Figure 1:** Prototype village communal store

all pits were constructed well in advance to allow pit walls to thoroughly dry and to be able to absorb considerable moisture during the winter. It was also noted that a few communities lined their pit roof with plastic, which prevented the soil in the roof from absorbing moisture and greatly increased condensation. In Season 2, plastic was not used. The Season 2 modifications resulted in significant reductions in losses, as reflected in Table 1.

**Storage losses:** Average losses in the community pits, where the improved storage technology was demonstrated, are shown for each district and participating village in Table 1. Across two seasons, the reported losses with improved storage technology was under 5% in both districts, an over 80% reduction compared to losses in farmers' own pits. Based on assessing five farmer stores near each target village, approximately 30 per district, the average reported farmer losses were 35% in Chaghcharan district and 21% in Lal district.

Losses reported in Table 1 are equally attributable to loss in tuber weight and loss due to disease, notably Fusarium spp. There were also marked differences in losses due to rot which were attributed to differences in selection practices. At the time of loading, some seed was not well selected and the resultant losses served as a good demonstration of the importance of selection. Losses during the second storage season were uniformly less than in the first season, presumably due to lessons learned and improvements to store design and operation. Second season losses were minimal and almost entirely attributable to loss in weight from respiration rather than rotten tubers.

**Crop development and yields:** Surprisingly, there was no significant difference in days to 50% emergence between farmer traditional practices and the improved storage technology, both averaging 28 days. However, there were large differences between farmers within a village using the same improved storage technology. This is attributed to the depth of planting which varied from 10 cm to >25 cm; the timing of the first irrigation which ranged from pre-planting to one month post-planting; and tuber sprouting as most tubers had no sprouts at planting and thus took longer to emerge. There were marked differences in plant vigor between farmer traditional practices and the improved storage technology. Using a scale of 1 to 3; farmers in both districts reported an increase of 25% to 45% in plant vigor. Chaghcharan farmers rated plant vigor from improved store seed at 2.48 as compared to 1.70 for the farmers' own seed (45%), while in in Lal the figures were 2.78 to 2.15 (25%). Table 2 compares yields across both districts for a single season and shows that crop yields were higher and damaged tubers lower when planting seed potato from improved stores.

**Table 1:** Summary of % storage losses by weight

| District | Number of households storing | Village* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean |
| **Season 1** | | | | | | | | | | |
| Chaghcharan | 166 | 13 | 3 | 8 | 7 | 5 | 10 | – | – | 6 |
| Lal | 312 | 6 | 1 | 3 | 5 | 5 | 2 | – | – | 3 |
| **Season 2** | | | | | | | | | | |
| Chaghcharan | 183 | 4 | 4 | 6 | 3 | 1 | – | – | – | 3 |
| Lal | 273 | 0 | 0 | 0 | 2 | 0 | 3 | 1 | 3 | 1 |

** NB: Villages not the same in each year in each district*

**Table 2:** Harvest yields (kg/10m$^2$) and % rotten/damaged tubers – Season 1

| District | Store type | Number of samples | Total harvest (kg) | Weight healthy tubers (kg) | % Rotten/damaged tubers |
|---|---|---|---|---|---|
| Chaghcharan | CRS | 7 | 44.3 | 37.0 | 16% |
| Chaghcharan | Farmer | 19 | 28.2 | 19.7 | 30% |
| **% increase** | | | 57% | 47% | |
| Lal | CRS | 23 | 95.1 | 84.6 | 11% |
| Lal | Farmer | 23 | 83.8 | 73.4 | 12% |
| **% increase** | | | 13% | 15% | |


Training in good seed selection practices targeted men and women from the same household to not only ensure that the person most likely to carry out a task was knowledgeable, but also that household members could discuss the practices confidently and plan their work together.

No data was available for Season 2 due to extreme drought conditions and the failure of irrigation supplies. In Chaghcharan, there were also significantly more rotten tubers in the farmer plots (30%) than those from the improved stores (16%) and the total harvest was 57% more when fields were planted with seed originating from improved stores. In Lal, differences in yield and tuber loss from seed originating from improved storage technology were small because the overall yields were very good due to favorable growing conditions.

**Storage unit production costs:** Labor and material costs for each unit are an estimated US$22. It is estimated that each storage unit requires at least 3 days of labor and the daily labor rate is approximately US$4 (US$80 per month). Ventilation pipes cost approximately US$5 and timber for roofing is also estimated to cost US$5. Digging the storage hole requires two laborers for 1/2 day, while constructing the storage roof and installing the ventilation (pile or chimney) also requires two laborers for 1/2 day. An additional day of labor is required for acquiring materials, which includes accessing piping or building chimneys for ventilation and recycling beams or cutting fresh beams from trees for the storage roof.

**Livelihood impact:** The fact that seed and ware (consumption) potatoes are stored together rendered it impossible to look at seed in isolation. Households quickly appreciated the value of improved storage technology, reflected in Table 3, summarizing how farmers in each district used the extra income derived from the combination of reduced storage losses and improved yields. Seven major uses for the increased production were identified by respondents with marked differences between men and women.

**Table 3:** Use of increased production and income (% respondents identifying each category)

| Reported use | Women | | Men | |
|---|---|---|---|---|
| | Chaghcharan | Lal | Chaghcharan | Lal |
| Home consumption | 80 | 98 | 100 | 100 |
| Sold for food (rice, oil, tea) | 80 | 43 | 95 | 4 |
| Sold for wheat | 53 | 47 | 71 | 19 |
| Purchased clothes | 73 | 73 | 43 | 35 |
| Purchased production inputs | 13 | 16 | 86 | 12 |
| Repaid debt at harvest | 40 | 19 | 29 | 7 |
| Pay school fees | 27 | 23 | 24 | 23 |

In both districts, nearly all male and female respondents thought that safe storage would permit increased consumption within the household. More than 50% of male and female respondents in Chaghcharan reported that they would sell potatoes to buy rice, oil, tea, or wheat. Respondents were more likely to report using the increased income to repay debt at harvest in Chaghcharan. Roughly one quarter of respondents reported that the increased income would be used to pay for school fees. In both districts, women were more likely than men to purchase clothing. In the more commercially-oriented Chaghcharan district, 86% of men but only 13% of women envisaged using the increased income to purchase inputs for the following season, reflecting their respective roles in the production cycle.

Communities need to be encouraged to use the extra yields as an opportunity to diversify their cropping system and improve resilience. The increased potential and reliability of the potato crop could encourage farmers to expand production and disrupt the established rotation of wheat, potato and a nitrogen-fixing fodder crop (alfalfa or clover) leading to pest and disease consequences. Pressure for food crops is already seeing a reduction in fodder crops and soil fertility. An expansion of potato production could exacerbate this.

**Factors influencing technology adoption:** Provincial agricultural extension services in Afghanistan are limited due to lack of staff, low levels of training, and a lack of mobility. For new technology to be quickly shared over a wide area, innovative approaches will be needed as well as a thorough understanding of household motives for adoption. Eleven key factors influencing farmer adoption of improved storage and handling practices were identified through discussion with farmers in both districts, listed in Table 4 below. Farmers in both districts reported the flexibility in selling and consuming potatoes to be a paramount factor influencing the adoption of improved storage and handling technologies. Nearly all male and female respondents in Chaghcharan noted that reduced need to purchase seed was a key influencing factor. Over both districts, nearly all households surveyed said that they will use the improved practices for the following season and virtually all farmers indicated that they prefer individual stores to using community stores.

Effective extension campaigns identify practices which have been successfully transferred and those which may need further attention. Table 5 presents the principal take home messages as noted by male and female participants in both districts.

Among the nine principal take-home messages, planting depth and fertilizer placement were not included in training but were frequently discussed at meetings. The importance of ceasing irrigation early, sorting and store management were well noted but surprisingly ventilation of the store did receive universal mention. This may be because the stores were communal and often managed by one person, thus many participants had not actually carried-out the practice. There were key differences between the sexes concerning emphasis on activities often not related to their role in the production cycle. For example, men in Chaghcharan emphasized the importance of female activities like sorting and planting while women emphasized the importance of male activities like irrigation, dehaulming, and ventilating the store.

**Table 4:** Factors influencing adoption of improved storage and handling practices (number (N) of respondents identifying each category)

| Reported influencing factor | Women | | Men | |
|---|---|---|---|---|
| | Chaghcharan | Lal | Chaghcharan | Lal |
| | N=81 | N=2 | N=90 | N=94 |
| Flexibility in selling and consuming potatoes | 63 | 0 | 90 | 94 |
| No need to purchase seed at planting | 81 | 0 | 77 | 0 |
| Improved stores are simple to operate | 44 | 1 | 77 | 27 |
| Reduced seed storage losses | 81 | 1 | 50 | 56 |
| Increased yields from the stored seed | 19 | 1 | 67 | 52 |
| More food available in the spring | 38 | 0 | 47 | 9 |
| Reduced ware storage losses | 19 | 2 | 53 | 6 |
| All improvements (selection, handling, storage) are based on current practices | 56 | 0 | 40 | 0 |
| Provides income for other essentials | 13 | 1 | 47 | 24 |
| Improved seed quality | 44 | 0 | 23 | 36 |
| No new structure needed with the improved seed storage technology | 38 | 0 | 23 | 18 |

**Table 5:** Principal take-home message for improved seed selection, handling, and storage (% of respondents identifying each category)

| Principal take-home message | Women | | Men | |
|---|---|---|---|---|
| | Chaghcharan | Lal | Chaghcharan | Lal |
| Store must be ventilated | 50 | 64 | 42 | 67 |
| Must sort at harvest | 61 | 2 | 95 | 7 |
| Cease irrigation early | 78 | 17 | 74 | 7 |
| Dehaulm early | 44 | 0 | 16 | 0 |
| Sort before planting | 39 | 19 | 79 | 37 |
| Less deep planting | 22 | 0 | 37 | 0 |
| Use fertilizer | 39 | 0 | 26 | 0 |
| Storage management | 67 | 41 | 74 | 33 |
| Seed selection in field | 44 | 98 | 68 | 100 |

## Conclusions & Recommendations

Low-cost improved ventilation of traditional potato storage pits is a practical and highly effective intervention to reduce high storage losses while improving crop yields, food security, and marketing options. Throughout the project, losses have been consistently reduced under a range of adverse conditions.

Project interventions should focus on a few key related topics rather than all aspects of storage. Adaptations should be simple, built upon existing practices and economically feasible. Training should be short and focused to respect participants' other responsibilities; timely, focused follow-up is essential.

In targeting beneficiaries it is essential to include male and female members from each household in all activities. This is because men and women not only play different roles in the production cycle, but also receive and prioritize messages differently. Ensuring that both male and female family members are trained facilitates inter-household discussion and increases the likelihood that practices are carried-out in an appropriate and timely manner.

It is recommended that extension material for store construction, management, and crop handling are included in a technical manual. Such a manual is being prepared in collaboration with the University of California, Davis. The manual will be translated into Dari and published on a website. Subsequent outside funding has permitted the production of a video on potato storage which is intended for extension workers in Afghanistan.

In terms of adoption and impact, more than 300 non-participating households are known to have constructed storage pits for the 2013 harvest and farmers are now storing onions and garlic in sacks above their potatoes. A pilot conducted by CRS has shown that apples can be stored above the potatoes, and a small demonstration is currently being conducted in Herat province with onions, a crop for which lack of in-country storage is the major constraint to famer income. With the Office of U.S. Foreign Disaster Assistance (OFDA) funding, studies are beginning in Malawi and Ghana to adapt the ventilation concept to storing sweet potato under hot conditions. Further studies are required to evaluate in more depth the applicability of the concept over a wider range of crops.

Photo: CRS Afghanistan

Traditional storage pits (above) are not ventilated resulting in frequent losses of 30–100%.

## References

Asian Development Bank (2011). Rural Business Support Project (RBSP) Afghanistan. Final Report. http://rootsofpeace.org/wp-content/uploads/2011/11/ADB-RBSP_Final-Report_Nov-4-2011_web.pdf

Booth, R. H. and R. L. Shaw (1981). Principles of Potato Storage, International Potato Center (CIP), http://cipotato.org/resources/publications/manual/principles-of-potato-storage

Bryan J. E. (1983). On-farm seed improvement by the seed plot technique, pp 13. Technical Information Bulletin No. 7, CIP, Lima, Peru.

CRS-Afghanistan (2013). Improving potato seed storage, increasing production and ensuring improved food security for rural families in the Central Highland of Afghanistan. Video.

Schweiger, J., Potts, M. J., Keith, D., Santibanez, M-P., Neukirchen, M., Yari, F. and M. Bell (2013). Increasing Potato Yields through Improved Potato Storage Pits. http://afghanag.ucdavis.edu/.

This case study analyzes the findings of the "Quality potato seed through improved production and storage" project in Afghanistan. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success. The editor would also like to thank the author Farid Yari who contributed significant time and effort collecting valuable background information.

Catholic Relief Services is the official international humanitarian agency of the Catholic community in the United States. We ease suffering and provide assistance to people in need in 91 countries, without regard to race, religion or nationality.

**Contact information**
Farid Yari
CRS-Afghanistan
Email: farid.yari@crs.org



**Suggested citation**
Yari, F. *Quality Potato Seed in Ghor Province, Afghanistan, through Improved Production and Storage*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.



Project supported by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Case study edited by:

CRS CATHOLIC RELIEF SERVICES


Photo: CRS-Burkina Faso

# Quality seed through storage in Burkina Faso

## Introduction

Landlocked in the heart of the Sahel, Burkina Faso is ranked second-to-last on the UNDP's 2007 Human Development Index. Almost 75% of Burkina Faso's 14 million people live on less than US$2 a day. Especially vulnerable are rural households, constituting 80% of the population, who rely on agriculture for their livelihood. Major staple crops include millet, sorghum, maize, cowpea, rice, and groundnut. The agricultural sector faces multiple challenges that affect crop productivity and food availability. Seed selection, handling, and storage can contribute to farm level productivity through improved yields and reduced post-harvest loss (CRS 2011).

Cowpea is an important crop in the Burkina cropping system where it is usually intercropped with pearl millet. Burkina Faso exported over 200,000 metric tons (MT) of cowpea in 2010. Storage losses due to bruchids in cowpea reach 80 to 100% after six months storage if the grain is not properly stored. The challenges in controlling cowpea storage pests are demonstrated by the variety of storage methods used, the estimated 40% of farmers that employ insecticides, and the fact that most farmers are forced to sell cowpea immediately after harvest when prices are lowest and must buy more seed for the next planting season. Seed from the local grain market is frequently of poor quality and not of the preferred variety, yet farmers continue to cultivate traditional varieties sourced from their own stocks, neighbors, or local markets (CRS 2011; Traore and Kone 2013).

Research institutes have developed improved techniques for cowpea storage such as hermetic triple lined sacs and solar heater techniques, but these are not yet widely available. Burkina Faso's national Environment and Agricultural Research Institute, INERA, has developed and released a wide range of new cowpea varieties that are shorter duration, have partial insect resistance, striga resistance and higher grain and fodder yields. The government of Burkina Faso, with donor support, invests in seed production, certification and distribution of the improved cowpea varieties (along with new varieties of other staple crops) to farmers. In spite of this, farmers appear to have low access to the new cowpea varieties and continue to cultivate traditional varieties. Farmers continue to struggle with cowpea grain and seed storage. This case study focuses on the results of project activities with cowpea aimed at addressing these issues.

## Materials & Methods

Severe flooding in Burkina Faso in 2007 resulted in significantly lower crop yields and dramatic increases in food prices in 2008. This lowered the availability of smallholder farmers' own saved seed and raised the price for off-farm purchase. CRS responded quickly to this seed security shock by conducting a rapid seed assessment and by organizing a series of Seed Voucher and Fair events with funding from USAID/OFDA. Farmers in Burkina Faso have also been exposed to hermetic storage through the Purdue Improved Cowpea Storage (PICS) project. The PICS technology involves a double layer of plastic – one bag inside another bag to guarantee an oxygen free environment – and an outer bag for protection. Based on this earlier experience, CRS collaborated with two local NGO partners, agro-dealers, and INERA to strengthen both on-farm seed management of cowpea and farmer access to new varieties of cowpea. The project had three core activities: promotion of new varieties in small packs through vouchers; training on seed management (selection, handling, storage); and the promotion of different storage containers based on the principle of hermetic storage technology.

In 2009 and 2010, 19,226 farmers received seed of six new cowpea varieties and 10,991 received hermetic containers for seed storage from local agro-dealers through vouchers provided by the project. Farmers were provided with information both on the new varieties and on the principles of hermetic storage without insecticide. The project implemented varietal demonstration plots to highlight the performance of new cowpea versus traditional varieties. The performance of the new varieties was monitored over two seasons for yield and seed multiplication rate. The percentage of seed stored and planted the following year was recorded. A sample of seed from three consecutive generations was analyzed for germination and varietal purity by INERA (Remington and Barbier 2012).

## Results & Discussion

During the two seasons of project implementation, 19,226 direct beneficiary farmers obtained 19,226 seed vouchers and 10,991 storage containers in the northern part of the Namentenga; this represents 107% achievement of the targeted 18,000 farmers. Each farmer received a 1 kg packet of certified seeds for production, multiplication and management.

Program staff distributed the various cowpea storage containers to farmers in the interest of testing hermetic storage techniques. The following containers were distributed: 179 PICS sacs, 22 plastic containers (25L), 446 plastic containers (20L), 11,031 plastic containers (5L) and 1,484 plastic containers (1.5L). FASO Plast, a private company located in Ouagadougou, provided the PICS sacs and some of the new 5L plastic containers; all other storage containers were purchased from local traders. The key project achievements are presented in Table 1.

The project promoted three new cow pea varieties, as reflected in Table 2. During the 2010 campaign, seed samples were collected from 391 cowpea farmers (223 men and 168 women). The average cowpea yields of new varieties in small plots were 746 kg/ha (with a range from 393 kg to 1,088 kg/ha) in 2010 and an average of 527 kg/ha (ranging from 486 kg to 612 kg/ha) for 2nd generation cowpea seed, compared to 321 kg/ha for local varieties.

A significant majority of male (86%) and female farmers (85%) stated that yields from new varieties exceeded the yields of their current variety. Their preferred variety depended on meteorological conditions, market conditions and the use of grains. For example, women and men who owned livestock preferred KVX745-11P for fodder production.

Germination rates ranged from 32% to 100% after two generations, indicating that farmers are capable of maintaining seed quality. As expected, the varietal purity of farmer-saved seed varied from 78 to 100% but the average increased slightly from 91 to 94% from the first to the second harvest, indicating that varietal purity can be maintained by farmers.

As indicated in Table 1, over the two years a total of 19,226 farmers accessed cowpea seed as a result of this project. However, the use of vouchers to connect farmers with seed enterprises and agro-dealers was not successful as virtually all certified seed is purchased by the government for distribution to farmers.

This project promoted the use of a variety of hermetic storage technologies: PICS sacks, vegetable oil containers of different volumes, 1.5 liter water bottles, and traditional clay pots. Table 3 presents a comparison of the most popular hermetic storage technologies employed. In general, the larger the unit volume of a hermetic storage container, the lower the unit cost. With a storage capacity of 100 kg per unit, PICS come in at roughly US$.02 per kg compared to US$.12 per kg for vegetable oil containers handling 26 kg. However, while the re-cycled vegetable oil containers are readily available in the market and can be used for many seasons, PICS sacks have to be replaced every 2–3 years.

**Table 1:** Project participants per key activity

| Year/season | Seed coupons of cowpea improved varieties (N) | Improved cowpea storage containers (N) | Beneficiaries (N) | |
|---|---|---|---|---|
| | | | Direct | Indirect |
| 2009 | 10,719 | 2,484 | 10,719 | 64,314 |
| 2010 | 8,507 | 8,507 | 8,507 | 51,042 |
| Total | 19,226 | 10,991 | 19,226 | 115,356 |

- As indicated in Table 1, a total of 10,991 cowpea storage units were made accessible to farmers. Multiple hermetic storage containers, all appropriate for seed, were purchased by farmers using vouchers. These hermetic storage containers included 20–25 liter vegetable oil containers, 1.5 liter plastic water bottles, and 5 liter plastic containers.. For storing seed, most farmers suggested that the 5 liter plastic containers were the most appropriate. Hermetic storage techniques for the conservation of cowpea grains produced in 2010 were used by 77% of men and 67% of women; and by 93% of men and 88% of women for the conservation of the cowpea seeds 2nd generation produced in 2010. These results are well above the target of 50%. In general, the containers used by farmers depended on the quantities of the grains/seeds stored. For grain storage, 61.5% of the farmers used 25 liter or 20 liter plastic containers and 28.3% used PICS sacs. On average, farmers stored 23–24 kg of cowpea grains, which correspond to 22–29% of total production. Farmers either consumed or sold the remaining grain. On average, farmers stored 6 kg of improved variety seed and 5 kg of local variety seed. When surveyed, farmers agreed that all containers promoted by the program could provide nearly 100% protection against insects; however the 5 liter plastic containers were more readily used than PICS sacs. Our analysis identified the following reasons:
    - Used plastic containers are widely available in local markets for only US$1.50 to US$3 per unit.
    - Plastic containers can be reused for multiple years.
    - Plastic containers are appropriate for storing small quantities of seed/grain.

  As the cowpea value-chain continues to develop and production continues to increase, we anticipate that adoption rates for PICS sacs will rise as they are more appropriate for storing quantities of 50 kg or more.

The supply chain for PICS sacks and new 5 liter containers was not established during the project but CRS and its partners worked with small agro-dealers to order containers from the factory (FASOPLAST) in conjunction with voucher activities.

- In terms of loss reduction due to hermetic storage, the beneficiaries reported that no losses have been noted during the storage period. In addition, the percentage of farmers that use chemicals for conserving cowpea grain has decreased from the baseline of 40% to 22% for grain and 6% for seed – both of which have surpassed targets. The majority of 2nd generation cowpea seeds produced by farmers meets FAO Quality Declared Seed Standards.[1] An analysis of seed samples revealed the following results:
    - The germination rate of R2 seed ranged from a low of 32% to a high of 100% with an average of 72%; those of R1 certified seeds ranged from 64% to 96% with an average of 79%.
    - The germination rate of KVX396-4-5-2D increased from 72% (R1) to 77% (R2). Farmers were able to maintain a high germination percentage of their own saved seed – often surpassing the R1 germination rate for all varieties tested.
    - The varietal purity of the 2nd generation seeds ranged from 78% to 100% with an average of 91% but improved to 94% in the R3 seeds generation, demonstrating that farmers were able to improve and maintain the purity of their cowpea seed.

[1] FAO Quality Declared Seed Standards stipulate that seed must meet the following key parameters: 98% genetic and analytic purity, 75% germination rate, 13% humidity.

**Table 2:** Characteristics of the cow pea varieties promoted

| Variety | Cycle | Yield | Observations |
|---|---|---|---|
| IT98K-205-8 | 65 days | 926 kg/ha | Extra early called 'Hunger Stopper' |
| KVX396-4-4 | 70 days | 1012 kg/ha | Drought resistant |
| KVX745-11P | 70 days | 637 kg/ha | Dual purpose grain and fodder; Semi-runner |
| Local | – | 321 kg/ha | |

**Table 3:** Comparison of hermetic storage technologies (Remington and Barbier 2012)

| Type | Number | Weight | Price | Price/kg | Cowpea price US$/kg | Cowpea price US$/kg | Price difference US$/kg stored | Gain by container US$/kg stored |
|---|---|---|---|---|---|---|---|---|
| | | | | | Harvest time | After storage | | |
| PICS | 179 | 100 | 1.70 | 0.02 | 0.60 | 2 | 1.40 | 1.38 |
| VegOil | 22 | 25 | 3.00 | 0.12 | 0.60 | 2 | 1.40 | 1.28 |
| VegOil | 446 | 20 | 2.50 | 0.13 | 0.60 | 2 | 1.40 | 1.27 |
| Vegoil | 2,115 | 5 | 1.24 | 0.25 | 0.60 | 2 | 1.40 | 1.15 |
| Mineral water | 1,484 | 1.5 | 0.25 | 0.17 | 0.60 | 2 | 1.40 | 1.23 |

## Conclusions & Recommendations

Over 25 MT of certified seed of new cowpea varieties were injected into the cowpea system via small packet exchange for vouchers. This proved more effective and efficient than the government program for distributing cowpea seed to meet 100% of farmers' sowing requirements. This is because the cost of 1 kg of certified cowpea seed costs only US$1.00 to US$2.00. At an estimated cost of US$37,500, farmers produced over 2,500 MT of good quality first generation, post certified seed. Through the small packet approach, nearly 20,000 farmers increased their awareness of and access to the new cowpea varieties and within one season produced adequate seed to meet the entirety of their cowpea seed requirement.

On-farm hermetic cowpea seed storage proved effective in controlling insects without insecticide. All sizes of hermetic containers from the 1.5 liter mineral water bottle to the 20 liter vegetable oil container to the 100 kg PICS sacks were found to be effective. The use of insecticide in seed storage dropped from 40% to only 6%. An unanticipated impact was that the use of insecticide on grain also dropped from 40% to 22%.

Hermetic storage, with accompanying training on seed management, provided an incentive to farmers to maintain varietal purity. This has resulted in a stronger and more integrated seed system that potentially enables farmers to capture a better sale price for a product that meets market and customer requirements.

## References


CRS Burkina Faso. 2011. Quality Seed through Storage. Final Report, August 2009 to May 2011. CRS Burkina Faso.

Remington, T. and Barbier M. 2012. Improving Cowpea Seed Quality through Hermetic Seed Storage. Presentation at the Purdue Improved Cowpea Storage Workshop. April 10–12, 2012. Accra, Ghana.

Traore, A. and Kone H. 2013. CRS Burkina Faso Household Seed Storage Learning Paper: Quality Seed through Storage. Documenting and Socializing Lessons Learned from Seven OFDA Learning Grants on Household Seed Storage. April 15-19, 2013. Bujumbura, Burundi


## Further reading


Tinsley, R. L. 2012. The Crop Genetic Pump: A Possible Task for NGOs. ECHO Asia Notes Issue 14, July 2012. Available at: http://agrilinks.org/sites/default/files/resource/files/The_Crop_Genetic_Pump.pdf



This case study summarizes the findings of the CRS Quality Seed through Storage Project in Burkina Faso. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success. The editor would also like to thank Tom Remington, Jean Joseph Coulibaly and Amidou Traore who contributed significant time and effort collecting valuable background information for this study. Special thanks to Anselme Yormalan Hervé Kone, Program Coordinator/OCADES Kaya who was an implementing partner for the activities described in the case study.





This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.



**Contact information**
Amidou Traore
Agricultural Program Manager
CRS Burkina Faso
Email: Amidou.Traore@crs.org





**Suggested citation**
Remington, T., A. Traore, J. J. Coulibaly and H. Kone. *Quality Seed through Storage in Burkina Faso*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.




Project supported by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Project executed by:

CRS CATHOLIC RELIEF SERVICES

CATHOLIC RELIEF SERVICES


Photo: CRS-Burundi

# Strengthening farmer-saved bean seed through hermetic storage in Burundi

## Introduction

Bean (*Phaseolus vulgaris*) is the most important crop in Burundi, cultivated on over 400,000 hectares of land. Eighty percent of beans are produced by farmers holding parcels of less than two acres and beans are grown in association with maize, bananas, cassava and sweet potato. Beans provide as much as 50–60% of dietary protein in Burundi and the annual per capita consumption is about 60 kg, the highest in Africa. Beans also supply B-vitamins, calcium, iron, phosphorous, potassium and zinc, which are essential for human growth, health and cognitive development. Bean residues are used as mulch in coffee and banana production, and are also used as animal feed during the dry season (Grisley and Mwesigwa 1991; Birachi et al. 2011).

In Kirundo Province, 96% of farmers ranked bean as one of their three most important crops followed by banana at 45%. In spite of its importance, Burundi's bean production has declined almost 20% from 250,000 metric tons (MT) in 2003 to 203,000 MT in 2009, and supply is not meeting domestic demand. Farmers prefer the semi-climbing varieties to both climbing and bush varieties in northern Burundi. Most farmers, especially the less well-off, occasionally purchase seed from the open market (David and Sperling 1999). The quality of the seed from the market is variable, where seed from local sources tends to be better than seed from distant markets (CRS 2011).

Until recently, farmers have had little access to improved varieties of bean and then only to bush types. Farmers cultivate beans three times a year: in the first and second rainy season in the uplands, and in the dry season in the lowlands. With support from CIAT (International Center for Tropical Agriculture), ECABREN (East and Central African Bean Research Network) and PABRA (Pan African Bean Research Alliance), ISABU (Institut de Sciences Agronomiques du Burundi) has initiated an ambitious program to identify and develop a range of new varieties, increase seed of these varieties and ensure that farmers have access to them in a timely manner. It is important that this identification of new varieties by farmers be combined with support to ensure that they can sustain access to preferred varieties, either through purchase or by managing their own seed. Seed management – particularly selection, drying, conditioning, and storage – is critical for seed viability and ultimately yield (CRS 2011).


A collection of hermetically sealed seed storage containers from the project including plastic seed containers and modified small Batwa clay pots.

## Materials & Methods

The set of activities discussed in this case study were designed and executed under an OFDA grant aimed specifically at promoting on-farm hermetic storage technology. This project was complemented by a USAID/Food for Peace project that assisted farmers to evaluate 22 new bean varieties (eight climbing, six semi-climbing and eight bush) in the same geographic zone where CRS in collaboration with ISABU designed a "mother and baby" trial with 63 mother locations and 915 participating farmers (average of 15 farmers per "mother" location).

Also in collaboration with ISABU, CRS implemented the OFDA-funded On-Farm Bean Seed Storage project from November 2011 to March 2013 in four provinces of Burundi (Kirundu, Kayanza, Ngozi and Muyinga). The focus of this program was training on bean seed production, conditioning and storage while promoting farmer access to hermetic seed containers.

These storage containers included PICS sacks, GrainPro Superbags (both 100 kg capacity), 20 liter vegetable oil containers, 1.5 liter mineral water bottles and modified small Batwa clay pots. PICS sacks involve a polyethylene bag and seal which is then surrounded by another identical bag and sealed. The double-bagged crop is then held within a third, woven polypropylene bag. The GrainPro Superbag is made of multilayer polyethylene (PE), sealed by a two-track zipper using a zipper slider, and is 73 grams per square meter. Plastic bottles and oil containers were available locally but had competition for their use. Bottles and oil containers have multiple other – and in many cases more valuable – uses than seed storage. Traditional clay plots were widely available but don't seal well or keep out moisture.

Hermetic storage using a wide range of plastic containers and sacks is effective in bean seed storage without insecticide.

Supporting farmers with hermetic seed storage is a catalyst for strengthening farmer seed management.

Hermetic storage is a great link to farmer participatory varietal evaluation and small packet promotion.

## Results & Discussion

Through these efforts a total of 515 kg of seed of 22 new bean varieties were supplied to farmers in small packets (0.5 kg/packet). A total of 20,660 farmers (18,880 women) were trained in seed production, conditioning and storage and were provided with different hermetic seed storage containers.

There was widespread acceptance and adoption of the range of hermetic storage containers at the close of the project apart from Batwa clay pots which farmers found difficult to hermetically seal. A follow up visit revealed that farmers have started to use hermetic storage (primarily the recycled plastic containers) for other crop seed, including pea and maize.

Data from the project baseline and the project evaluation suggests that project participants were able to significantly increase the percentage of seed from their own saved seed sources, from 55% to 80%.

There was also a reduction in seed loss from 20% to 8% (comparing the baseline to the final evaluation) and a reduction in the use of insecticides in storage from 49% to 4%.

The 43 farmers who sold seed as part of the project increased the quantity of seed sold significantly and the selling price slightly (Figure 1). The increase in the quantity of seed sold is attributed to better selection, conditioning and storage, all of which resulted in less loss of seed (more to sell) and better quality seed (CRS and ISABU 2011).

Farmers storing seed for their own use found that the 100 kg PICS sacks and GrainPro Superbags were too large. However, these larger sacks are appropriate for storage of seed for sale as well as for grain. Seed sale prices increased from $0.40/kg to $0.54/kg for Season A and from $0.40/kg to $0.45/kg for Season B. It is thought that these increases were due to consumer interest in and demand for new varieties.

With only a short and variable dry season between Season A and Season B (c. June to October), seed drying can be a problem. The importance of drying seed before hermetic storage was stressed during training sessions. However, in spite of possessing two seed moisture meters, the project failed to monitor seed moisture across the three seasons at container closure and opening. Change in varietal purity under farmer seed management was also not monitored, so it is not known whether farmers are maintaining varietal purity and if not, why not (accidental or purposeful mixing) (CRS and ISABU 2011; Ntahontuye 2011).

## Conclusions & Recommendations

The Hermetic Bean Storage pilot demonstrated the benefit of improved storage on the quantity of seed stored for a farmer's own use and for sale. Adoption of hermetic storage was 100% with evidence of spread to other crops. The supply chain for vegetable oil containers and mineral water bottles already exists and the price is affordable. However, both the PICS sacks and GrainPro Superbags were imported by the project and are therefore not currently available commercially. In collaboration with Purdue University and GrainPro, effort is required to establish this supply chain to meet the demand of seed producers/sellers and also for on-farm bean grain storage.

As hermetic storage is applied to other crops, increased attention needs to be paid to adequate seed drying before storage while promoting new varieties. This can be achieved by working to strengthen the commercial seed retail supply chain and supporting small packet sales for farmer variety evaluation. If funds are available, partial value coupons can be a powerful marketing tool and incentive. This should be carried out in conjunction with promoting hermetic storage and better information on new varieties, where labeling storage containers with variety names can facilitate the monitoring and spread of new varieties.

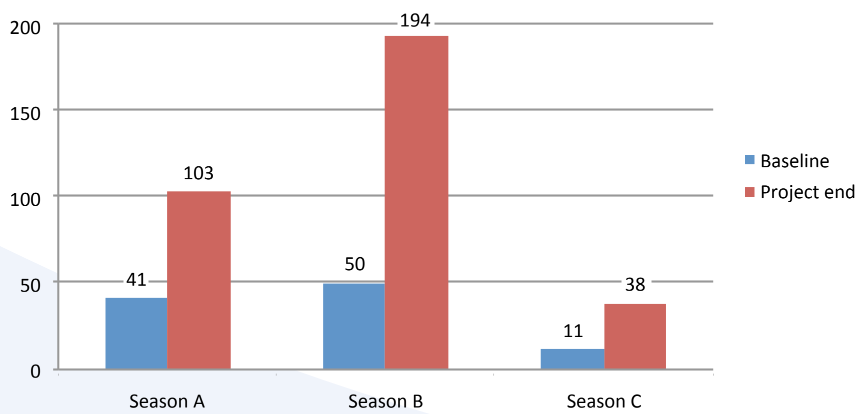


**Figure 1:** Kg of seed sold by farmers participating in project 2010–2011

## References

Birachi et al. (2011). Factors influencing smallholder farmers' bean production and supply to market in Burundi. African Crop Science Journal. Vol. 19 No. 4 335-342.

CRS (2011). From relief to resilience – linking Burundian farmers and researchers in evaluating improved bean varieties. CRS.

CRS and ISABU (2011). Rapport des essais sur les haricots saisons 2011 A, B et C.

David, S. and Sperling, L. (1999). Improving technology delivery mechanisms: Lessons from bean seed systems research in eastern and central Africa. Agriculture and Human Values 16: 381–388. http://vegetables.wsu.edu/Hort-503/Seed-Syst-paper.pdf

Ntahontuye, N. (2011). Rapport de l'evaluation finale du projet 'Bean Storage' sur le conditionnement et stockage des semences du haricot. Catholic Relief Services, Bujumbura, Burundi.

Ouma, E. and Birachi, E. (2011) CIALCA Baseline Survey. CIALCA Technical Report 17. http://www.cialca.org/files/files/cialca%20baseline%20survey%20report_print.pdf

Grisley and D. Mwesigwa (1991): Characteristics of bean production and marketing in sub-Saharan Africa with emphasis on Uganda and a summary of world trade statistics on dry beans". Paper presented at Seminar on export of dry beans. July 3, 1991, Kampala. CIAT, Africa Regional Bean Program, Kawanda Research Station, Uganda.

This case study analyzes the findings of the Strengthening farmer-saved bean seed through hermetic storage CRS project in Burundi. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success. The editor would also like to thank Tom Remington, Godwin Bashi and Anne Turner who contributed significant time and effort collecting valuable background information. Special thanks to Elie Bunuma for project execution and for organizing the Burundi meeting which brought together case study protagonists from all of the seven countries involved in the OFDA project to document and socialize lessons learned from 7 OFDA grants on household seed storage.

Catholic Relief Services is the official international humanitarian agency of the Catholic community in the United States. We ease suffering and provide assistance to people in need in 91 countries, without regard to race, religion or nationality.

This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

**Contact information**
Salvator Kurinziza
CRS Burundi
Email: salvator.nkurunziza@crs.org



**Suggested citation**
Turner, A. *Strengthening Farmer-Saved Bean Seed through Hermetic Storage in Burundi*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.



Project supported by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Case study edited by:

CRS CATHOLIC RELIEF SERVICES

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/km$^2$ versus 402/km$^2$) 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 advertize 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 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.

**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*

Effect of nine months storage on maize damage & seed germination

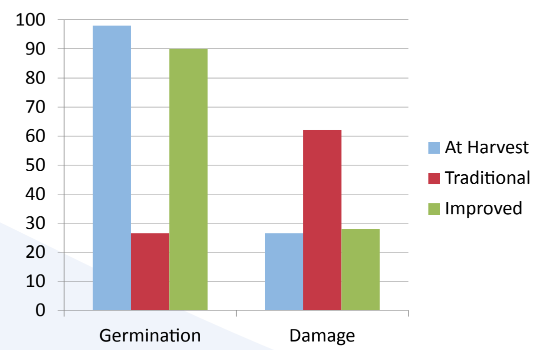


**Figure 1:** Maize germination rates comparing a traditional and an improved storage unit

Returns to maize storage with traditional vs. improved technologies

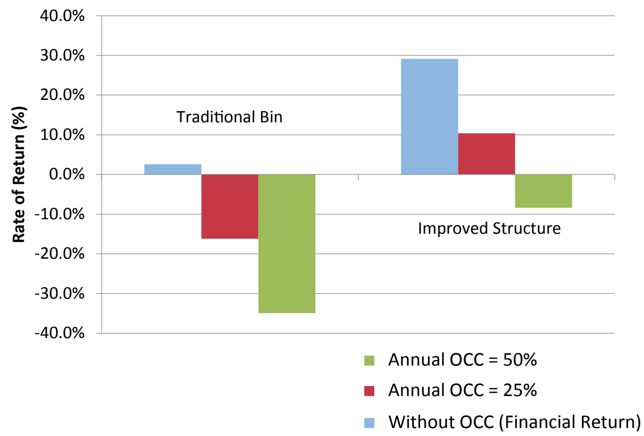


**Figure 2:** Economic returns to maize storage with traditional vs. improved technologies

## 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.

## References

De Groote, H., Kimenju, SC., Likhayo, P., Kanampiu, F., Tefera, T., Hellin, J. 2013. Effectiveness of hermetic systems in controlling maize storage pests in Kenya. *Journal of Stored Products Research*. Elsevier 53 (27-36). Available at: http://dx.doi.org/10.1016/j.jspr.2013.01.001

IFPRI. 2010. *Maize value chain potential in Ethiopia. Constraints and opportunities for enhancing the system*. Washington DC: International Food Policy Research Institute. Available at: http://www.ifpri.org/sites/default/files/publications/ethiopianagsectorwp_maize.pdf (accessed 11/02/2014)

Seyoum, L. & Jonfa, E. 2012. Adaptation and adoption of improved household seed and grain storage project in southern and eastern Ethiopia: Final Evaluation Report to GOAL Ethiopia. Unpublished manuscript.

Tesfaye, B. 2012. Adaptation and adoption of improved on-farm grain storage in southern and eastern Ethiopia: Final consultancy report to GOAL-Ethiopia. Unpublished manuscript.

This case study by CRS analyzes the findings of the improved Household Grain and Seed Storage Project implemented by GOAL in southern and eastern Ethiopia. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success. The editor would also like to thank the authors Meseret Mengistu and Jonathan Garrard for contributing significant time and effort collecting valuable background information as well as Michael Jones for contributing to the economic analysis associated with this case study.



This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

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



**Suggested citation**
Mengistu, M., and J. Garrard. *Adaptation and Adoption of Improved Household Grain and Seed Storage in Southern and Eastern Ethiopia*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.



Project funded by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Case study edited by:

CRS CATHOLIC RELIEF SERVICES


# Enhancing post-harvest seed systems in Ethiopia

## Introduction

Sorghum is the 3rd most important crop in Ethiopia, cultivated on one million hectares, and is the most important crop in drier, drought prone areas. Sorghum occupies 48% of cultivated land in East Hararghe and 42% in West Hararghe. Farmers in 'kola' or the lowland dry zone of East Hararghe grow mainly long cycle maize and sorghum intercropped with groundnuts in the first cropping season, followed by short cycle varieties of maize and sorghum in the second season. Only 3% of the sorghum area is planted with modern varieties (McGuire 2005). The preference is for long duration varieties seeded in the first rainy season and harvested eight to nine months later at the end of the second season. Climate change appears to be affecting the rains, providing additional incentive to the search for new varieties.

The sorghum seed system is both complex and dynamic. Due to high incidence of crop failure and post-harvest losses, farmers in these areas often try to save twice the amount of seed required for replanting as a buffer. Farmers tend to use a high seed rate of 15 kg/ha with a frequent need for reseeding and, on average, save 30 kg of seed for each hectare sown. In addition to problems of low productivity, inadequate household storage options force farmers to sell immediately upon harvest when market prices are lowest (Dejene 2004). A significant quantity of sorghum grain is threshed and sold immediately to generate income, pay off loans, and avoid the risk of loss due to insects or theft (McGuire 2005).

Sorghum seed is selected at harvest and stored as panicles in the kitchen or in pots or sacks. As a result, there is significant seed loss due to weevils and so farmers often apply insecticides. For long-term sorghum storage in Hararghe, 70% is stored in pits dug in sandy or gravel soils that are well drained (McGuire 2005; Dejene 2004). Pit stores cost less than above-ground storage and there is less damage due to insects and reduced risk of loss due to fire and theft. However, the high humidity and temperatures in the unlined pits reduces seed viability (Dejene 2004). Farmers rarely use sorghum stored in pits as seed. Own saved seed is preferred and is complemented by seed from the social network and increasingly from the local grain market. In East Hararghe, there has been little investment in improving seed quality through improved storage.

A local tailor making the pit storage bag (PSB).

PSBs are made of highly durable, rubberized-canvas and can be sewn using basic manual sewing machines.


## Materials & Methods

The project targeted more than 10,000 farmers in East Hararghe. MercyCorps teamed up with the Fedis Agricultural Research Center and Haramaya University to conduct a baseline assessment which indicated that grain loss in unlined pits averaged 30%. This loss was due to mold caused by moisture migration from unlined walls and higher temperatures. Grain in the pits has a 17% moisture content compared to 13% in above ground grain storage and an average temperature of 30°C compared to 22°C for above-ground stored gain. Above-ground stored grain sorghum seed maintains a 90% germination rate (Dejene, 2004). The project offered a low-cost rubberized canvas bag referred to as Pit Storage Bags (PSBs) to use as a lining material in traditional grain storage pits. The aim was to protect the seed and grain from moisture and pests.

To include an exit strategy from the start, private sector actors who could manufacture, market and disseminate the PSBs were identified. They developed sample PSBs for on-farm demonstration before their wider production and dissemination to interested project beneficiaries. Based on feedback from farmers and government extension experts, the PSBs were modified, produced and disseminated to 1,400 interested households, through producers and 11 farmer field schools. Farmers contributed 20% of the cost of the PSB while the remaining 80% was covered by the project through a voucher system.

**Storage structure and cost:** The PSB looks like a giant sock with a draw-string closure at the top and is made of a highly durable, readily available, rubberized-canvas which can be sewn using basic manual sewing machines employed by village-level tailors. PSBs can be adapted to almost any sized pit, retail at US$32 for a two-ton bag, and have an estimated lifespan of over two years (Belayneh 2011).

**Training and technology promotion:** PSBs were sold at US$29 in exchange for vouchers with farmers paying US$5.80 (110 birr) and the PSB producer receiving a voucher worth US$23.2 (440 birr). Farmer field schools were used to train farmers on post-harvest handling and storage. Each trained farmer was expected to train an additional ten farmers. Storage demonstrations were conducted at farm level with government officials, PSB producers, and farmers (Belayneh 2011).

Pit storage bags combined with traditional pit storage can significantly reduce storage losses.

PSBs control moisture more effectively than traditional pit storage alone.

While the economic returns from using PSBs are high, cash-strapped farmers may have a hard time covering the startup investment cost.

There is a need to explore hermetic seed storage – to complement grain storage and to strengthen farmer storage of sorghum seed.

## Results & Discussion

A total of 1,400 farmers (including 187 women) accessed the PSBs in three woredas (districts) in East Hararghe where sorghum is the most important cereal crop (Table 1). These farmers contributed 20% to the full cost of the technology.

According to a farmer survey based on grain storage, losses in traditional pits were estimated to be approximately 30% (Table 2), where over 80% of respondents estimated grain losses of 20–40%.

Grain loss in modified pit storage using PSBs reduced significantly according to a survey conducted as part of the project assessment report. Based on farmer recall (N=109), more than 946 quintals were stored for an average of 8.68 quintals per farmer and the reported loss in PSBs was zero. While the baseline assessment showed that farmers were reluctant to plant seed from underground pits, 90% of project participants exposed to the PSBs said that grain stored in PSBs can be used for seed (see Table 3).

Economic analysis was conducted to compare the costs and benefits of using PSB technology as an alternative to the use of the traditional unlined pit (see Table 4). The analysis illustrates that the PSB clearly outperforms the less expensive and less effective traditional unlined pit. In this example, the returns to storage are driven by a massive reduction in dry weight loss (30% for the traditional pit against 1% storage loss using the new pit storage bag) and a doubling in grain price over an eight-month period. The benefit of the PSB is calculated as the economic value of seed/grain under PSB conditions over eight months compared to the traditional unlined pit method. The cost of the PSB technology is calculated as the cost of storage for a 12-month period compared to the traditional unlined pit method. The analysis indicates that the use of a PSB as a liner for a traditional pit can provide a farmer with a financial gain of US$396.59 over the option of selling at harvest. This more than doubles the financial gains with traditional pit storage, which are US$175.34. Both the old and new technologies are compared to the base case of not storing and simply selling everything at harvest.

The financial gains of storage for each technology are then discounted by the cost of money, called the Opportunity Cost of Capital (OCC). The cost of capital can be very high in rural communities and hence financial gains may appear deceptively large if the farmer's cost of money is not taken into account. In the analysis presented in table 4, two OCC's - 25% and 50% - are used to discount the financial gains. Using 25% as the opportunity cost of capital, the storage gains from the new PSB technology are US$328.91 which represents an 81% return on storage while for the old technology the storage gains are US$109.97 which represents a 28% return on storage. With 50% OCC, the storage gains and returns on storage are lower for both technologies, significantly better for PSB, and an excellent investment compared to selling at harvest.[1]

[1] See Seed Storage Brief #3. *Economics and Promotion – Insights for Program Design*. Nairobi: Catholic Relief Services.

This analysis illustrates two key points in the Ethiopian sorghum market. First, dramatic increases in prices over the eight-month storage period (114% in this example) makes storage a potentially lucrative investment for farmers. Second, the value of preventing losses greatly exceeds the increased cost of the new PSB technology. When producers face both a 25% and 50% annual opportunity cost of capital, comparable to some formal and informal interest rates on loans, the traditional and PSB technology still exceed both thresholds. However, the economic returns for traditional pit storage rapidly approach zero as the rate of OCC grows above 50%, indicating that, at this threshold, the poorest producers (analogous to those with high OCCs) may indeed be better off selling at harvest than using traditional pit storage.

## Conclusions & Recommendations

Improved sorghum grain pit storage in PSBs had a significant impact on reducing grain loss and maintaining grain quality. The value of preventing losses greatly exceeds the cost of the new PSB technology making it an excellent investment for farmers.

Key challenges for this grant included the difficulty to make PSBs tailored to the shape of existing traditional storage pits, convincing farmers to prepare and dig new pits compatible to the design of the PSB, farmer access to credit services to contribute their 20% (110 birr) to the PSB, and promoting the

**Table 1:** PSBs accessed by male and female farmers by district

| | PSBs Accessed | |
|---|---|---|
| **Woreda (District)** | **Woman** | **Men** |
| Babile | 63 | 411 |
| Gursum | 98 | 301 |
| Midega Tola | 26 | 501 |
| TOTAL | 187 | 1,213 |

**Table 2:** Grain loss and its cause in traditional storage pits (N=109)

| Proportion of grain loss | % of respondents |
|---|---|
| 20% or less | 34% (37) |
| 30-40% | 33% (36) |
| 40% or more | 33% (36) |
| **Primary reported cause of grain storage loss** | |
| Mold | 27% (29) |
| Weevils | 18% (20) |
| Weevils and mold combined | 55% (60) |

**Table 3:** Responses to grain stored in PSBs (N=109)

| | **YES** |
|---|---|
| Can grain stored in pit storage with a plastic bag be used for seed? | 89% (n=98) |
| Have you used grain stored in modified pit storage as seed this past season? | 65% (n =71) |

**Table 4:** Economic analysis of the PSB as alternative to use of a traditional unlined pit

| | Sell at Harvest | Old Pit | Pit with Liner |
|---|---|---|---|
| Harvest (kg) | 2000 | 2000 | 2000 |
| Months Stored | - | 8 | 8 |
| Dry weight losses (%) | - | 30 | 1 |
| Quantity Marketed (kg) | 2000 | 1400 | 1980 |
| Total Price Discount for Grain Damage Present [compared to clean grain] (%) | - | 0 | 0 |
| Commodity Price for clean, undamaged grain after storage period (US$/kg) | - | 0.405 | 0.405 |
| Final Price Received (US$/kg) | 0.189 | 0.405 | 0.405 |
| Commodity Revenue (US$) | 378.00 | 567.56 | 802.69 |
| Total Technology Cost (for total quantity stored for entire storage period) (US$) | - | 14.222 | 28.102 |
| Rate of OCC (ex. 25% or 50%) | - | 50 | 50 |
| Total OCC | - | 130.74 | 135.37 |
| Economic Gain on Storage (US$) | - | 44.60 | 261.22 |
| Economic Return to Storage | - | 11.4 | 64.3 |
| | Importance of OCC: Annual rate | | |
| Financial Gain to Storage (US$) | 0 | 175.34 | 396.59 |
| Financial Return to Storage (%) | 0 | 44.7 | 97.7 |
| Economic Gain on Storage (US$) | 25 | 109.97 | 328.91 |
| Economic Return to Storage (%) | 25 | 28.0 | 81.0 |
| Economic Gain on Storage (US$) | 50 | 44.60 | 261.22 |
| Economic Return to Storage (%) | 50 | 11.4 | 64.3 |

development of an inputs supply chain for a new, not yet proven technology targeting rural customers.

PSB storage maintains seed viability, enabling farmers to use stored grain as seed if needed. However, there is a need to strengthen farmer storage of sorghum seed that is selected at harvest and stored separately from grain. This effort could be combined with support to farmer participatory evaluation of new sorghum varieties.

## References


Belayneh, Z. 2011. Impact of traditional pit storage improvement using plastic bag lining on grain storage loss reduction in East Hararghe Zone. MercyCorps.

Dejene, M. 2004. Grain storage methods and their effects on sorghum grain quality in Hararghe, Ethiopia. Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden. Available at: http://pub.epsilon.slu.se/534/1/Mashillafin00.pdf

McGuire, S. 2005. Getting genes: rethinking seed system analysis and reform for sorghum in Ethiopia. Doctoral Thesis, Wageningen University. The Netherlands. Available at: http://edepot.wur.nl/121643



This case study by CRS analyzes the findings of the "Enhancing post-harvest and seed system project" implemented by MercyCorps in Ethiopia. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success. The editor would also like to thank the author Zelalem Belayneh who contributed significant time and effort collecting valuable background information for this study as well as Michael Jones for his contribution to the economic analysis associated with this case study.

Catholic Relief Services is the official international humanitarian agency of the Catholic community in the United States. We ease suffering and provide assistance to people in need in 91 countries, without regard to race, religion or nationality.

This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.



**Contact information**
Zelalem Belayneh
Postharvest seed and grain storage program coordinator
at Mercy Corps Ethiopia
Email: zbelayneh@et.mercycorps.org



**Suggested citation**
Belayneh, Z. *Enhancing Post-harvest Seed Systems in Ethiopia*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.





Project supported by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Case study edited by:

CRS CATHOLIC RELIEF SERVICES


# Effective seed storage in Timor-Leste

## Introduction

Timor-Leste is a small, impoverished country on the eastern end of the Indonesian archipelago. It ranks 134th out of 187 countries in the UNDP 2012 Human Development Index, where US$0.76 of every US$1 earned is spent on food and 60% of the 1.1 million population live below the official poverty line of US$1 per day. Maize is the most important cereal crop in Timor-Leste with an estimated production area of 120,000 hectares (ha), representing approximately 8% of total land area (14,916 $km^2$), and with yields approximating 1 metric ton (MT) per hectare. Cropping systems in Timor-Leste vary depending on topography, elevation, and long wet and dry seasons which are subject to wide variability and can have a major impact on agricultural productivity. Agricultural productivity in the mountainous target districts of Ainaro and Manufahi is characterized by high rates of erosion, low soil fertility, poor access to water, and low levels of livelihood diversification. Farmers grow maize followed by cassava or mixed cropping of maize with cassava, sweet potato and taro. Rice predominates in the lowlands. Because of the relatively long wet season, cropping systems are usually of longer duration and a more efficient post-harvest storage system for cereals could enhance resilience and food security (Da Silva and San Valentin 2004; UNDP 2013; FAOSTAT 2012).

Post-harvest losses for grain crops are estimated to be 30%. It is common practice for farmers to save and store seed amongst grain in storage for the next planting season, in particular for maize and rice. Limited knowledge and resources for effective seed selection, handling, and post-harvest storage have led to high post-harvest losses and contributed to poor yields. Post-harvest handling and storage programs have tended to focus solely on grain storage systems with much less emphasis on seed selection, handling, and storage. An earlier wave of community seed storage projects met with little success due to lack of ownership and accountability (Da Costa et al. 2013).

This paper is based on the Effective Seed Storage (ESS) pilot phase in two districts of Timor-Leste, from August 2011 to February 2013, working with two local manufacturers. The pilot's goal was to design and develop sustainable and scalable farmer seed storage models in Timor-Leste. MercyCorps, along with CRS and five local NGOs, is expanding the ESS program nationwide, targeting at least 10 (out of 13 districts) in the country and working with 17 local manufacturers.

Metal silos with a capacity of 35 kg and 75 kg were developed and selected as the preferred storage unit as they could be hermetically sealed (control for insects, without the need for pesticides) and protect against rodents.

This technology was already known by Timorese farmers. Drums were introduced by the Portuguese and promoted in earlier projects with the support of UN/FAO.

## Materials & Methods

The project utilized a "design thinking" approach to design the seed storage system. In February 2012, the project commissioned a scoping study by an expert from the University of Illinois to assess existing storage practices as well as farmer attitudes and willingness to pay for storage in the two target districts. The study suggested that farmer seed management "based on long-standing traditions and methods passed along by their ancestors", was highly ineffective and recommended a focus on reducing post-harvest storage losses of farm-saved maize (seed and grain) and raising the quality of farmer saved seed through improved post-harvest handling and storage. The study noted that seed was not always stored in rodent-resistant or fire-resistant containers, that seed and grain were usually not separated, and that it was common for farm families to lose all of their grain and seed in storage (Elliott-Litchfield 2012).

The study recommended a variety of storage options for further market assessment, including: (i) 50-100 liter polymer drums (not to be confused with steel drums, some of which may have been used for oil/gasoline/chemicals), (ii) plastic water bottles or bags (i.e. GrainPro) inside large-opening silos or custom silos specifically for seed (smaller in size, no discharge spout, and airtight), (iii) polymer plastic rectangular totes, available in various sizes and with airtight lids; and (iv) wooden container boxes. The study also identified glass wine bottles, vegetable oil containers, biscuit tins, and other post-consumer containers that might be used as stand-alone containers, but these are only available on a limited basis (most likely at no cost). Following the study, ESS, in partnership with a local blacksmith, developed prototypes of improved quality silos (airtight and smaller, as required for seed storage) and wooden containers for testing. The project found that high quality wooden containers would be prohibitively expensive, and thus decided to drop it from the options for further exploration.

In light of poor economic and physical infrastructure conditions in the target areas, developing supply chains for multiple products would be very challenging, and for that reason the project needed to strategically select and focus efforts on the most in-demand storage solution. To ascertain which would be best, in April 2012 ESS conducted a series of consultation meetings with target communities to select the storage unit that would be the main focus of the project. Consultation meetings included a presentation of various polymer plastic drums, different sizes and models of totes, silos – both with small airtight openings and large openings – jerry cans, plastic bottles, etc. from which farmers were asked to select their preferred product. From a total of 149 participant farmers, 87% selected metal silos with airtight lids, 9% selected metal silos with large openings, while the rest selected other storage units. It is likely that custom manufactured silos were prioritized by farmers because they convey the desired attributes (airtight, rodent and fire resistant) and embrace the "drum culture" of Timorese farmers (identified by the study). Based on this, the project then decided to focus on market development of metal silos (MercyCorps 2012).

**Storage structure and cost:** The developed and promoted storage system was a cylinder-shaped metal silo. Following consultation meetings with farmers and after the second prototyping process, 35 kg and 75 kg metal silos were developed and selected as the preferred storage unit as they could be hermetically sealed (control for insects, notably weevils, without the need for pesticides) and protect against rodents. The metal silos were an improved design based on those earlier introduced by the UN FAO and could be made by trained local blacksmiths (Mejía Lorío and Njie 2012).

During the pilot phase, MercyCorps supported two local manufacturers, one in each district, to develop a market system, including linking with materials, assisting in promotion activities and distributing vouchers to selected farmers to create demand (details are presented in respective sections). Materials used for the silo include: galvanized steel sheets (0.5 mm, 26 gauge); PVC caps; solder (50% lead/50% tin); hydrochloric or muriatic acid (10% concentration); flux such as rosin or sal ammoniac (ammonium chloride); paint; soap powder and rags; and charcoal. Total production costs (excluding labor) range from US$15–25, depending on size. The manufacturers were allowed under contract to sell units for between US$20 and US$35 (for farmers who received vouchers and allowing fluctuations of material costs) but manufacturers then agreed to sell at US$23 for the 35 kg unit and US$26 for the 75 kg unit. Towards the end of the pilot phase the prices remained unchanged.

**Training and technology promotion:** Training was conducted for government extension workers and farmers on good seed selection practices and post-harvest handling. It is important to note that the training was not only to promote the use of metal drum/silos but also to encourage alternative storage systems identified during the scoping study (i.e. the use of used wine/water bottle, jerry can, etc.). Post-training monitoring and support was given to extension workers to improve their outreach. Promotion of the silos was conducted through manufacturers exhibiting them at local markets, and through the production of booklets and leaflets. Training on good seed selection practices and post-harvest handling was obligatory for all beneficiaries receiving a voucher. Comprehensive written instructions were also provided with each unit (including three steps on how to conduct seed selection, drying and storage).

Local manufacturers were trained in basic business management, supported at the start-up, and linked with suppliers for key materials. MercyCorps worked with suppliers to make materials locally available. Selected farmers were subsidized through vouchers, where they were required to pay part of the cost for the silo. Selection criteria for voucher recipients included high levels of vulnerability and/or food insecurity, and a willingness to participate in post-harvest training and project monitoring activities, as well as a willingness to share the information with other farmers. Feedback from early participant farmers was used in the further development of the containers.

## Results & Discussion

During the pilot phase, metal silos were accessed by 3,378 rural farmers across 21 villages in Ainaro and Manufahi Districts. Vouchers enabled 2,337 farmers (34% of whom were women) to access drums from two local manufacturers and 1,041 farmers paid full price for the drums (Table 1). More than 2,200 farmers (31% women) received training on post-harvest techniques and, according to the final evaluation, the adoption of these techniques ranged from 70–100%. The evaluation also concluded that participating farmers increased their food self-sufficiency by nearly two months as a result of this project and storage losses among a group of pilot farmers reduced by 80%.

**Storage design:** Discussions during the final evaluation indicated that a greater range of silo capacity was required. Many poorer households did not store 35 kg of seed, sometimes storing as little as 5 kg (where plastic/glass bottles may have been more appropriate than silos); larger farmers could store more than 70 kg. Difficulty was also noted in separating varieties of seed in cases where farmers grew three of four varieties. For the expansion, the final evaluation encouraged the project to combine the large opening silo design with secondary inner containers holding different seed varieties (i.e., water/glass bottles, jerry can or GrainPro bags). According to the evaluation, 25% of farmers found the cap and opening of the silos to be too small. It was then recommended that the project ensure manufacturers only use large PVC caps. After one season of use, farmer feedback on the silo design was generally favorable as summarized in Figure 1 (Van Duijn 2013).

**Table 1:** Metal drums accessed in Ainaro and Manufahi Districts

| District | # drums accessed | % metal drums accessed by category | | |
|---|---|---|---|---|
| | | Paying full price | Men* | Women* |
| Ainaro | 1,643 | 32% (n=523) | 66% (n=743) | 34% (n=377) |
| Manufahi | 1,735 | 30% (n=518) | 66% (n=806) | 34% (n=411) |
| Total (N) | 3,378 | 1,041 | 1,549 | 788 |

**Based on voucher access only, no gender disaggregated data for full price purchases.*

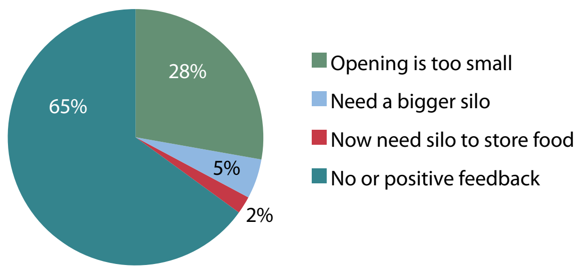


**Figure 1:** Farmer comments on silo design

Program staff carries out quality control at a local manufacturer production center.


An early adopter farmer shows how the new storage system retains seed quality after months of storage.

**Targeting and vouchers:** A voucher-based subsidy was used to promote early adoption of this technology among vulnerable farmers and to partially underwrite the production costs of the two local drum manufacturers. Individual beneficiaries were selected by a team comprised of suco (township) or aldea (village) chiefs, government extension workers, and project and partner staff. The evaluation stated that selection through local leaders may be a potential source of conflict. The original intention had been to distribute 30 silos in each local community to ensure geographic coverage and inclusion of the poorest and most vulnerable. In practice, numbers varied from two to 60 because, in many communities, conflict arose between proposed vulnerable farmers and farming households not selected. Ultimately fewer vulnerable farmers were selected than originally intended. Also, many of the poorest were unable to afford the US$3 contribution and thus vouchers were transferred to others. Beneficiary selection is a crucial step for project success, and to proceed smoothly the beneficiaries' circumstances must be fully understood, the selection criteria explained, and the process accepted by the community as a whole.

Vouchers were valued at US$20 which was US$3 below the retail price of the 35 kg drum and US$6 below the retail price of the 70 kg drum: US$23 for a 35 kg capacity container and US$26 for a 70 kg capacity container. A total of 3,378 silos were accessed by farmers as a result of this project, of which 2,337 were accessed with vouchers which subsidized approximately 80% of the retail price of the drums. Even with the significant subsidy, farmers accessing drums with the vouchers preferred the smaller 35 kg drums both in Ainaro (60%) and in Manufahi (51%). Eighty-five percent of farmers that paid full price for the drum in Manufahi (they received no voucher) purchased the 75 kg drum which reflects their financial status and seed storage needs. The vouchers were effective in creating demand as the project exceeded its target of beneficiaries by 50%. See Figure 2 for a breakdown on drum size accessed with and without vouchers in the two districts.

Based on interviews with drum manufacturers, the unit profitability of drum production ranged between US$2 (10%) and US$7 (25%) per silo according to the manufacturer and silo size. Drum producers made a substantial profit on the smaller units, but it is unclear whether they will continue to achieve enough volume to earn a profit if the subsidies to farmers are removed. Market saturation and fluctuating input prices, principally for metal sheets and labor, make drum production risky. Production diversification could be key for local manufacturers to sustain storage production.

**Training and awareness:** Manuals on improved seed production and storage practices were prepared for the training of government extension workers and 29 extension workers were trained on this, including two women. In Ainaro these materials were also used for training farmers in non-project areas. A sample of the early beneficiaries who had sufficient time to complete a full growing and storage cycle reported adoption of improved practices as shown in Table 2. Although only a small sample was used, the results show a very high rate of adoption, possibly reflecting the simplicity of the practices promoted and also the keen interest of farmers.

**Storage efficacy:** Farmers in Ainaro (N=14) reported an 82% reduction in losses and in Manufahi (N=18) a 79% reduction. A few farmers reported no reduction in losses which may be related to not having used improved seed production techniques since they only obtained the drums and training immediately before harvest. If this is the case, it emphasizes the importance of only storing quality product. A subsequent crop using the improved stored seed has not yet been harvested to note the impact on future production.

While the project focused on seed storage, a number of farmers reported being able to store maize longer, which, if used for grain storage, could result in a significant reduction of the hunger period. Farmer attributions for the improved storability are summarized in Table 3.

**Figure 2:** Drum size and access by district

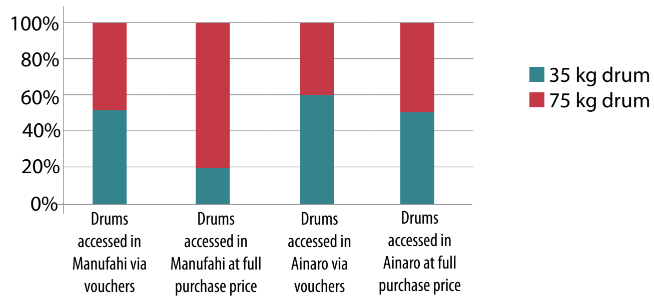


**Table 2:** Respondents attribution for increased duration of storage

| | | % respondents attributing increased duration of storage to | | | | |
|---|---|---|---|---|---|---|
| District | # households interviewed | Improved seed spacing | Improved variety (cv. Sele) | Improved timing of harvest | Improved seed selection | Improved drying practices |
| Ainaro | 10 | 100 | 90 | 70 | 90 | 100 |
| Manufahi | 20 | 75 | 85 | 85 | 85 | 80 |

**Table 3:** Respondents attribution for increased adoption of storage

| | | % respondents reporting adoption | | | | | |
|---|---|---|---|---|---|---|---|
| District | % households reporting longer grain storability | Improved cultivation practices | Improved seed | Favourable growing season | Increased availability of seed | Improved drying practices | Improved grain storage |
| Ainaro | 43 | 90 | 95 | 95 | 70 | 95 | 80 |
| Manufahi | 29 | 93 | 93 | 86 | 86 | 93 | 93 |

**Responsibility for seed production and storage:**
A small survey following project implementation showed a change in perception amongst households concerning who is primarily responsible for seed production and who is responsible for seed storage. Prior to the project it was believed that men were responsible for seed production and women for seed storage. Results in the post-project sample were variable reflecting the differences between households, but there was a general consensus that responsibilities for both activities were now shared more equally. It would be interesting to relate this finding to initial targeting, gender of the trainees, and the design and approach to extension.

## Conclusions & Recommendations

The program goal to design and develop sustainable and scalable farmer seed storage models in Timor-Leste was achieved by developing the market system of a metal-based seed storage solution that is customized, locally manufactured and has facilitated access for farmers to the solution that can be easily replicated/scaled-up nation-wide. Through the design thinking approach, the process has embraced local values (i.e. preference of Timorese farmers towards drums, as introduced by Portugese during the colonial era) for broader adoption. Rapid prototyping and consultative processes which promote regular iteration of program approach and storage design were used to gather and incorporate consumers' insights.

The program used a voucher system to facilitate demand creation rather than simply handing out units. Providing vouchers encouraged direct "transactional interaction" between producers and buyers. Rather than directly distributing the units or providing full-value vouchers, this enhanced the farmers' sense of ownership of the product; making an individual investment causes farmers to value the silo more highly, and further increases their awareness of the importance of high quality seeds. The fact that 1,041 farmers had paid full price for the units at the end of the pilot – with an average cost of US$27 – demonstrates not only the importance of this technology to their livelihood, but also highlights that farmers in rural areas do have cash and will make smart purchasing choices. It is also important to note that smaller units and perhaps other designs – such as plastic bottles – could be effective in helping vulnerable farmers to access inexpensive seed storage solutions.

The timeline for engaging with communities should be longer and there should be more emphasis on cost recovery by reducing the size and cost of the unit so that farmers can plan their cost contribution and subsidy rates can be reduced. Beneficiary selection is a crucial step for project success. The criteria and processes for beneficiary selection, with a strong involvement and support of communities, are more useful than relying on local government and extension workers.

## References

Da Silva, D. and San Valentin, G. 2004. Plant Production in East Timor. East Timor Ministry of Agriculture and Fisheries. Available at: http://gov.east-timor.org/MAFF/English/plant_production.htm

Da Costa, M.D.J., Lopes, M., Ximenes M., do Rosario Ferriera, A., Spyckerelle, L,. Williams, R., Nesbitt, H. and Erskine, W. 2013. Household food insecurity in Timor-Leste. Food Sec. 5:83-94. Available at: http://seedsoflifetimor.org/wp-content/uploads/2011/11/Household-food-insecurity-in-Timor-Leste.pdf

Elliott-Litchfield, J. B. 2012. Review study of farmer seed management and storage practices for MercyCorps East Timor project design. University of Illinois. February 2012.

FAOSTAT. 2012. Available at: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

Mejía Lorío, D. J. and Njie, D. N. 2012. The Household Metal Silo: A Helpful Technology For Food Security. Rome: FAO. Available at: http://www.cirg.ageng2012.org/images/fotosg/tabla_137_C1578.pdf

MercyCorps. 2012. Effective Seed Storage Program, Design and selection process of seed storage unit.

Van Duijn, J. 2013. Effective Seed Storage Program: Final evaluation. MercyCorps, Timor-Leste.

UNDP. 2013. Human Development Report. http://hdr.undp.org/en/media/HDR2013_EN_Summary.pdf

This case study by CRS analyzes the findings of the MercyCorps Effective Seed Storage Project in Timor-Leste. The editor would like to thank MercyCorps Timor-Leste staff for their significant contribution to this case study, notably Wahyu Nugroho for his comments on later drafts and provision of background information and to Marcelino Amaral and Clementino de Jesus Bento for the first draft and identification of lessons learned. Thanks to CRS staff Ana Ferreira for her translation and facilitation with the first draft and to CRS staff Michael Potts for detailed comments and development of a second draft. It would not have been possible to compile this case study without the support and assistance of many people. Catholic Relief Services thanks the members of each community served for their willingness to undertake the projects and to revisit the actions taken to achieve success.

Catholic Relief Services is the official international humanitarian agency of the Catholic community in the United States. We ease suffering and provide assistance to people in need in 91 countries, without regard to race, religion or nationality.

This publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

**Contact information**
Wahyu Nugroho and Joanna Walshe
wnugroho@tl.mercycorps.org
jwalshe@tl.mercycorps.org



**Suggested citation**
Amaral, M., C. Bento and W. Nugroho. *Effective Seed Storage in Timor-Leste*. Edited by Stephen Walsh. Nairobi: Catholic Relief Services, 2014.



Project supported by:

USAID FROM THE AMERICAN PEOPLE | Office of Foreign Disaster Assistance

Case study edited by:

CRS CATHOLIC RELIEF SERVICES