August 2022

Research Summary:

Seed and Grain Storage in Timor-Leste

Background and research rationale

TOMAK (*To'os ba Moris Di'ak,* or Farming for Prosperity) is a ten-year agricultural livelihoods program funded by the Australian Government in Timor-Leste. Since 2016, TOMAK has worked in partnership with Government, non-governmental organisations (NGO) and the private sector to implement integrated interventions that aim to: 1) improve household nutrition by promoting nutrition-sensitive agriculture (NSA) and enhanced dietary practices; and 2) increase rural incomes by improving agricultural productivity and strengthening farmers' market engagement. Gender approaches are embedded in the planning, implementation, and monitoring of activities across the program, in order to promote gender equality and women's economic empowerment. Phase 1 of TOMAK (2016-2021) was implemented in 83 suku in three municipalities (Baucau, Bobonaro and Viqueque). Phase 2 has commenced and will run from 2022-2026 in the same municipalities.

In Timor-Leste, seed system insecurity is one of the underlying factors of food insecurity, with 36% of the country's population currently experiencing chronic food insecurity and 15% experiencing severe chronic food insecurity.[1] More than 80% of the Timor-Leste population depend on the agriculture sector for their livelihoods, engaging primarily in subsistence farming. Maize, rice, and beans are some of the main crops grown by Timorese farmers. Production and yields are severely hampered by a variety of environmental factors and farmers face high post-harvest losses, with the average annual loss of maize estimated to be approximately 30%, owing to poor post-harvest handling and ineffective storage practices.[2] Although it is common practice for farmers to save and store seeds for the next planting season when harvests are sufficient, the use of poor and risky storage systems does not mitigate against pests and moisture, which affect the quality and quantity of seed to be used for the next season and in turn contribute to the continuous cycle of poor yields.

Improved seed storage technologies, such as jerrycans, silos, steel drums, jumbo sacks, and sugar sacks, have the potential to increase food stability by allowing rural households to reduce post-harvest losses and use their agricultural production over a longer period. Along with food availability, access and utilisation, stability is one of the four pillars of food security.

While seed and grain storage was only one component of TOMAK's broader focus in Phase 1, there have been several other projects that have focused on improved seed and grain storage in Timor-Leste. Despite the long history of government and development partner interventions focused on this area, multiple challenges

[1] Integrated Food Security Phase Classification (IPC). "Timor Leste: Chronic Food Insecurity Situation 2018-2023". Available from http://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1151924/. Accessed 1 October 2021.
[2] Gorton, C. 2018. "Food and Nutrition Security in Timor-Leste: Challenges and Prospects". Available from: https://www.futuredirections.org.au/publication/food-and-nutrition-security-in-timor-leste-challenges-and-prospects/. Accessed 1 October 2021.

to sustained practice of improved storage methods remain. To better understand the current situation, TOMAK supported Phase 1 NGO Partner Catholic Relief Services (CRS) to undertake research regarding seed and grain storage practices in Timor-Leste.

Research objective

The overall objective of the research was to gain an in-depth understanding of current seed and grain storage practices in Timor-Leste and the potential for driving adoption of improved practices. Specifically, the assessment intended to:

1. Identify various storage technologies currently available in Timor-Leste, including information on price and the supply chain for storage technologies.
2. Consolidate the various types of technologies used by Timorese households, including their rate of use, and the advantages and disadvantages of these methods.
3. Explore community willingness to pay for improved storage technologies.
4. Explore the sustainability of improved storage technology over time, especially among farmers in areas of previous projects.
5. Consolidate lessons learned around the different models for disseminating seed and grain storage technologies in Timor-Leste.

Methodology

The research included a literature review that preceded field data collection using a mixed methods approach. The collection of qualitative and quantitative data was conducted simultaneously to lessen logistical requirements. The research foremost was one of learning more about the current practices, with a focus on learning from the introduction of new technologies. The selection of target communities for the study was therefore done purposively by selecting target communities where seed storage related interventions had previously been implemented, with the data not intended to be statistically representative for the country.

Quantitative data collection was conducted via a household survey for which respondents were randomly selected from within each suku (see Table 1), while qualitative data was collected via Focus Group Discussions (FGDs) (see Table 2) and Key Informant Interviews (KIIs) (see Figure 1). Field data was collected by trained enumerators from 30 May to 12 June 2022, immediately after or during the rice and maize harvest season in many of the data collection locations. This timing allowed for the observation of actual use of storage technologies as well as inquiries in the purchase of new items. In addition to data collection in the municipalities, CRS staff conducted interviews in Dili, and the external consultant that led the study conducted online interviews with international organisations. TOMAK and CRS carried out multiple consultations with MAF throughout the assessment process from: initial discussions on the rationale (December 2021), presentation of literature review findings (February 2022), review of the methodology and data collection tools (April 2022), observation of data collection (May 2022) and discussion of preliminary findings (June 2022).

TABLE 1: Survey locations and number of respondents

Municipality	Suku	Female	Male	Total
Baucau	4	75	82	157
Lautem	2	30	32	62
Manatuto	3	43	51	94
Ainaro	3	31	58	89
Bobonaro	3	40	51	91
Manufahi	3	39	77	116
Total	**18**	**258**	**351**	**609**

TABLE 2: FGDs topics, locations and number of participants

Topic	Participant type	Municipality	Suku	Female	Male	Total
Different storage types – users of improved technologies	Mixed gender	Baucau, Manatuto, Ainaro, Bobonaro, Manufahi	6	28	36	64
Willingness to Pay– Adopters of technology	Mixed gender	Baucau, Lautem	2	11	13	24
Willingness to Pay - Non-adopters of technology	Mixed gender	Ainaro, Manufahi	2	7	13	20
Gender equality, disability and social inclusion	Female	Baucau, Manatuto, Manufahi	3	30	0	30
	Male	Manatuto, Bobonaro	3	0	33	33
Total		**6**	**16**	**76**	**95**	**171**

FIGURE 1: KII participants

The topics covered in the research included: 1) lessons learned from previous projects, 2) knowledge of storage technologies, 3) access and availability of storage technologies, 4) utilisation of storage technologies, and 5) the gender equality, disability and social inclusion (GEDSI) considerations influencing storage practices and use of technologies.

Limitations

The convergent mixed-methods approach prevents the findings from quantitative data collection from being verified during qualitative data gathering. In future similar studies it is recommended that quantitative data be collected and analysed first so that qualitative methods can be used to verify or explain quantitative findings.

For some data points, FGDs alone were expected to provide sufficient information. However, the FGDs did not always provide the anticipated levels of findings to fully answer the question or data point as the suggested probing questions were not always used.

The following areas were identified where more information would have enriched the assessment: training in grain storage, future trends in storage needs, pre- and post-harvest practices and uptake of improved storage technologies.

Key findings and associated recommendations

1. Lessons learned from previous projects

The research began with a literature review which found that the promotion of secure seed and grain storage commenced through a variety of projects in Timor-Leste more than ten years ago (see Table 3). In general, the focus of the projects was to introduce methods that enabled farmers to store seed and food in an airtight way, especially for maize, and other technologies that would reduce spoilage from pest and disease. Some projects focused solely on the introduction of the storage method, while others were part of larger food security programs. Key lessons learned through the previous projects include:

- **Training, demonstrations, and mentoring** are crucial to the adoption and proper use of storage technologies.
- Farmers value units that: **store multiple crops** (both seed and grain) **or water** throughout the year.
- Trainings should also **consider the cost and benefits of units** for farmers to decide (i.e. give options).
- **Subsidies are effective** since farmers cannot afford to pay.
- Market system approaches can reduce unit prices.

TABLE 3: Seed and grain storage interventions in Timor-Leste*

Organisation	Pre2011	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021
CARE	LIFT												
Drums on Farms													
Food and Agriculture Organisation	2005 - 2010[3]												
International Fund for Agricultural Development		TLMSP (5 municipalities + 2 expansion areas)											
Mercy Corps		ESS – 1											
Mercy Corps/ CRS				ESS – 2		ESS - 3							
								CROPS		(REDI)			
CRS		IYIS											
Oxfam						IMPACT							
World Vision								BFBH					
Ai Com													

* Local Initiatives for Food security Transformation (LIFT); Timor-Leste Maize Storage Program (TLMSP); Effective Seed Storage (ESS) program; Climate-smart Resilience Opportunities through Post-Harvest Storage Program (CROPS); Resilensia Di'ak Program (REDI); Increasing Yields and Improving Storage (IYIS); Better Food Better Health project (BFBH)

[3] Time period specified in FAO, 2018a

2. Knowledge of storage technologies

The study respondents were asked to identify which storage technology types they were familiar with. The technologies were summarised into six groups and the images of the different types were shown to interview and FGD respondents (Figure 2).

FIGURE 2: Improved technologies were summarised into six groups

1. Oil Drum/Corregated iron silo

2. Metal container

3. Plastic drum

4. Jerrycan

5. Jumbo sack

6. Bag

- **81% of farmers recognised one or more of the six improved storage technologies** (Table 4).
- **Farmers are aware of the importance of good seed and grain storage.** The majority of farmers could provide at least one reason why good seed and grain storage is important (96%). However, only 32% of the farmers said they received training in seed storage and even fewer households (21%) received training about the post-harvest handling of crops.
- **Farmers believe traditional methods result in quality products.** Despite the high awareness of the importance of using improved methods, more than half of the farmers (57%) believed that traditional storage gives better seeds. The majority of respondents agreed that they would still store **part** of their food the traditional way, demonstrating that there are dual belief systems about the use of both traditional and modern storage methods. Affordability of storage technologies was still the largest barrier to uptake.
- **Farmers accept high losses.** 21% of the survey respondents said it was acceptable to lose one third of the stored grain.

TABLE 4: Recognition and ownership of improved storage methods

Storage technology	% of HH who recognise the storage type (N=594[4])	% of HHs who own, (out of total 594 HH respondents)
 Oil Drum / Corregated iron silo	31%	24%
 Metal container	28%	22%
 Plastic drums	11%	8%
 Jerrycan	18%	16%
 Jumbo Sack	23%	19%
 Bags	17%	14%

Recommendation:

Explore the cultural drivers that prevent communities from adopting improved technologies, with a particular emphasis on what percentage of food/grain storage would be acceptable to store the traditional way and through improved methods. This would provide MAF and partners with an opportunity to test what would be culturally acceptable. There could also be opportunities where improved traditional storage practices are promoted for small volumes of production (e.g. regular monitoring of moisture content).

[4] 594 represents the total household respondents that grow staples, protein rich crops and/or tubers.

3. Access and availability of storage technologies

- **Farmers rarely know what all available options are.** Their knowledge of and access to storage technologies largely depend on what is promoted by agencies working in their community.
- **Larger items like drums and silos are more commonly obtained through the support of NGOs.** Smaller and cheaper items like jerrycans have been purchased by households from shops.
- Metal storage solutions are the preferred choice because they are durable, protect against rodents, and are airtight. However, drums are difficult to empty due to their small opening and women find them hard to handle.
- **Vendors of raw materials and finished products are expecting price increases due to the war in Ukraine but do not anticipate challenges in obtaining supplies.** Prices will need to be absorbed by buyers.
- **Blacksmiths are open to the diversification of products.** Some blacksmiths also make different products like tool and cash boxes (based on orders by NGOs). The diversification has created income streams that keep personnel employed when there is less demand for storage units.

Recommendation:

Explore the demand for different storage types – Further explore the demand for smaller items like jumbo sacks based on crops that are produced in specific locations. Additional research should include how production per commodity is linked with demand for different storage types.

MAF can play an important role in supporting the supply chain for storage technologies by:

a. mapping out major blacksmiths and maintaining a database to facilitate ongoing relationships between MAF and blacksmiths at various levels including sharing key user preferences from this assessment with these major suppliers;

b. exploring opportunities to provide regular orientations for blacksmiths to the markets and how to market their products to farming communities;

c. carrying out further research on the practice of pre- and post-harvest practices by famers and how they are affecting the quality of storage seed and food grain.

4. Utilisation of storage technologies

Utilisation of storage technologies

- Drums, metal containers, and jumbo sacks were the most commonly owned storage types (Table 4).
- The metal storage options and jerrycans are used for a wide variety of crops, while jumbo sacks are mostly used by rice farmers (Table 5). In general, 60-70% of grain is stored using improved methods.
- The majority of the observed storage items contained maize, except for jumbo sacks, which contained mostly unmilled rice. Bags and metal containers are used for both rice and maize.
- **In general, use of storage technologies for water storage does occur but mainly during times when there is no longer grain or seed to be stored** (Table 6). Household use of storage technologies for water storage is limited to the cropping season (when the seeds are planted and grain has been eaten). This is most common with metal and plastic drums and jerrycans. Out of households that use storage technologies to store water, only a few are storing the water for the whole year (average storage time is 5-7 months). Many units were also empty at the time of the survey even though data was collected just after the April harvest season, which is potentially due to low production volume.

TABLE 5: Percentage of households that are using a particular type of storage for a particular crop[5]

Crop	n - # of growers	Oil drum/ iron silo	Metal container	Plastic drum	Jerrycan	Jumbo sack	Bag	Rice sacks
Maize	**513**	23%	16%	5%	15%	4%	15%	84%
Irrigated rice	**178**	7%	10%	2%	5%	54%	12%	87%
Red/black bean	**93**	5%	8%	3%	33%	1%	5%	71%
Mung bean	**20**	10%	15%	5%	40%	5%	10%	90%
Peanut	**72**	15%	17%	4%	14%	1%	17%	85%
Sweet potato	**116**	3%	2%	2%	0%	2%	7%	68%
Cassava	**233**	3%	4%	0%	0%	0%	7%	57%

TABLE 6: Use of drums/silos over a 12-month period[6]

Month	Mixed seed and food	Seed	Food storage (own production)	Water	Storing other items	Empty
January	30%	35%	6%	11%	2%	23%
February	29%	33%	6%	10%	2%	26%
March	34%	32%	7%	8%	2%	21%
April	45%	36%	9%	7%	0%	11%
May	48%	37%	13%	2%	0%	9%
June	52%	40%	11%	2%	1%	5%
July	50%	40%	11%	2%	0%	9%
August	49%	40%	9%	2%	1%	9%
September	48%	39%	10%	3%	1%	10%
October	47%	36%	8%	3%	2%	15%
November	38%	28%	10%	8%	3%	25%
December	38%	21%	11%	10%	2%	27%

Recommendation:

Integrate training content how to fully dry and clean storage units after they have been used for water storage. The use of storage units for seed or grain storage after its use for water requires an orientation of users of the need for proper drying of the units to prevent rotting of the seed or grain.

Explore other cost-effective options for water storage to promote to communities. While not assessed in this research, it is acknowledged that storage technologies are cheaper than water storage technologies.

As can be seen in Figure 3, the main storage types each have advantages and disadvantages. Therefore, it is not possible to make a conclusion around which specific storage types are the best based on these factors alone. It is important to consider: the volume and the types of commodities produced by the household, preferences on how the commodities will be stored (e.g. single/mixed), and which members of the household will be accessing the storage unit.

[5] The traditional method of rice sacks and utilization for crops is included as a comparison
[6] The months in colour mark the production season of maize and rice in most areas of the country, which also coincides with the rainy season.

FIGURE 3: Improved storage types and their advantages and disadvantages according to FGD participants

Storage type	Volume	Advantages	Disadvantages
Oil drum/ Corregated iron silo 	200L	• Big size • Strong material • The drum is airtight • Big openings allowing easy removal of grain • The food can be stored food for a long time • Content protected against rats and other animals like chickens	• Small lid makes it difficult to remove seed and grain • Heavy to carry • Difficult to find • Used drums need very good cleaning
Metal container 	70L	• Small • Good size to store seeds • Big openings allowing easy removal of grain • Affordable • Easy to refill food supplies • Content protected against rats and other animals	• Needs careful handling not to get dented • If not stored carefully it is damaged quickly
Plastic drum 	180-200Kg	• Big size • Light weight – can be easily carried by men and women when it is empty • Can store both seed and grain • Easy to open • Suitable for cold, humid conditions – will not rust • Content protected against pests and rotting	• Easy to damage by rats/ mice • Easy to damage • When full it is difficult to carry • When it is cold, more susceptible to weevil damage • Susceptible to fire
Jerry can 	10L	• Small size • Good size to store sufficient seeds • Affordable • Easy to replace • Can also be used to fetch water • Easy to move around	• Easy to damage • Can be destroyed by rats • Small
Jumbo sack 	1000kg+	• Big size • Can store a lot of food • Easy to use; easy to fill and take food out • Easy to replace • Protects from pests	• Can be destroyed rats • Heavy to carry
Bag 	30-50kg	• Affordable • Easy to use • Can be used for multiple or many products • Easy to move • Protects from pests	• Easy to damage • Can be destroyed by rats • Easy to damage by fire

Factors Facilitating Uptake

- **Design features of storage technologies are the most important factors influencing uptake by farmers (for survey respondents).** This includes: quality/durability, the size, and easy access to the contents (Table 7).
- **The most common enabling factor to sustained uptake is the cost and availability of improved storage technologies (for FGD participants).** The full cost of technologies is a challenge for farmers when they want additional units or need to replace damaged items. Many farmers learned about new technologies from large storage projects. Blacksmiths maintain no or little stock and make items on order. Travel to other locations to get new items is expensive for farmers (Figure 3).
- **Subsidies or free distribution is important for many farmers.** Without the support, many farmers said that they will be unable to obtain the technology. Respondents often did not know the full cost of units since they received them at a subsidised rate. Evidence from previous storage projects show that farmers are unable to pay full price for the more expensive units (e.g. metal containers).
- **The majority of farmers are interested in purchasing new units but not at full price.** Over half of interested respondents expressed interest in types of units they did not yet own. Most popular are metal and plastic drums and silos (Table 8).
- **The volume of production should match the size of promoted storage items**. Many farmers do not produce sufficient volume to use larger storage items. Therefore, interventions that promote larger units like jumbo sacks and silos (500L to 1 ton) to households might not be appropriate.
- **Farmers need time to invest resources in new technology,** with some only convinced after their neighbours have successfully applied it.

TABLE 7: Key reasons why the households adopted a technology

	Oil drum/ Silo	Metal container	Plastic drums	Jerrycan	Jumbo sack	Bag
Number of owners	144	131	46	97	114	83
The right size	59%	66%	70%	57%	63%	78%
It is good quality	72%	68%	48%	43%	68%	31%
Easy to put in the grain	38%	60%	43%	20%	59%	36%
Easy to take out the grain	17%	39%	30%	13%	38%	24%
Can use for different products throughout the year	15%	15%	2%	3%	18%	5%

FIGURE 3: Barriers to using improved technology

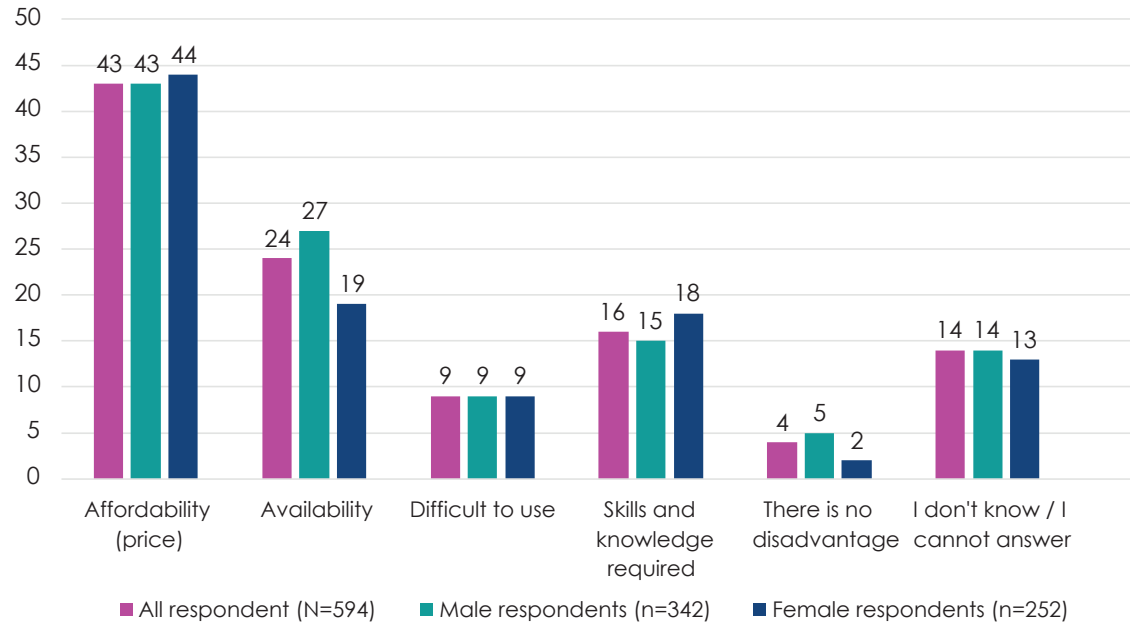

TABLE 8: Willingness to pay

Storage technology	Market price	Seed - Average willingness to pay	Food/Grain Average willingness to pay
Drum	$35-65	$18	$19
Silo	$180	$48	$43
Metal container	$23-35	$13	$12
Plastic drum	$28 - 38	$14	$14
Jerrycan	$2 -20	$3	$14
Jumbo sack	$7.5-15	$8	$8
Plastic bag	<$1	$2	$1
Sugar sack	$0.35-0.65	$2	$2

Recommendation:

Adopt a subsidised model to promote use of improved storage technologies- Since paying for the full cost of most storage technologies is not feasible for most farmers, subsidy models should be used through initial stages (but could be progressively phased out) of storage related interventions. Key selection criteria that include the crop type and production volume per household is essential. Clear communication on the full price of storage technologies should also be discussed with households from the onset of any intervention.

Integrate Social and Behavior Change Communication (SBCC) approaches into storage related interventions. Increased knowledge alone does not motivate or change behaviors. SBCC aims to change behaviours, by positively influencing knowledge, attitudes and social norms.[7] SBCC approaches should focus on behaviour change at the individual, interpersonal, community, and national policy level.[8] For storage interventions at the community level, this should include identification of intended audiences and people who influence them and key promoted practices based on key enablers and barriers to improved storage behaviors (identified through this research).

Support exchange visits – Farmers are observing the use of storage technologies by their peers before adoption. Use of 'champions' that have adopted improved storage practices should be used as one component of a SBCC approach to influence behavior change.

Standardize training and orientations to include demonstration and ongoing mentoring – This is an opportunity for MAF and development partners to develop standard but flexible modules that can be incorporated into the activities AEWs and partners. Important aspects to consider are:

a. the inclusion of and appropriately timed practice session in pre- and post-harvest activities;

b. demonstrations of how to use different storage technologies;
c. allocation of time for follow-up visits and mentoring.

Promote single storage versus mixed storage. Many respondents were using improved storage technologies for both grain and seed. While it is convenient to store both together, every time the unit is opened, risk of pest and disease is introduced to the grain and seed stored inside. Storing seed separately where households will not open the unit until it is needed for the planting season is a much more secure way of storing seed. Mixed storage also increases household risk of running out of seed due to it being consumed. Therefore, programmers should explore the promotion of single storage options for seed in smaller units (which is appropriate for most household production volumes).

5. Gender equality, disability and social inclusion considerations

- **Men and women mostly equally participate in the decision-making and practices of post-harvest management.** Differences may occur depending on the availability of men and women, especially the male household member. Activities that require more physical strength like transport and threshing are more commonly done by men with women doing more harvesting and drying.
- **The promotion of improved storage technology made work easier for women.** The hanging of seeds and grain above the fireplace or under the roof is seen as more work than the improved methods. Women prefer technologies that are easier to move around and have large openings. Men prefer drums due to their

[7] Johns Hopkins Center for Communication Programs.
[8] Bandura, 2006.

durability. People with disabilities face similar challenges with storage technologies, preferring smaller items that are low to the ground with large lids.

- People with disabilities (11 KIIs) did not have experience participating in agriculture or storage related trainings and **recommend they be invited to all meetings.**
- Women did not identify specific obstacles to participate in training, but only 42% of households that received trainings had a female member participate.

Recommendation:

Consultation and involvement of women in all aspects of storage related activities and training should be a key criterion for any intervention. Particular effort should be made to facilitate women's participation in training and explore ways to engage spouses together.

Since **people with disabilities often can only participate when the training is in their suku**, training should be conducted near to the location of people with disabilities and/or transportation should be provided.

Individually assess the appropriate storage types for people with disabilities. This includes engagement of people with disabilities and other members of their household around preferences and specific needs.

6. MAF and storage approaches

- **AEWs integrate the promotion of improved storage technologies within Good Agricultural Practices training for crops.** Through this research, MAF confirmed that most of their storage related training is focused on theory. There is an opportunity to develop specific training content on storage practices across the production cycle that also integrates demonstration and follow-up mentoring.
- With one AEW per suku (though some AEWs cover more than one suku), MAF is limited in human and financial resources to provide ongoing technical assistance beyond farmer groups and select individual farmers.
- **MAF does not currently have a post-harvest policy**[9] or a specific program focused on seed and grain storage.

Recommendation:

Explore the potential to develop a MAF post-harvest policy. The development of a post-harvest policy could:

a. provide overarching guidance to MAF at the national, municipal and suku level on approaches and promoted practices for improved storage technologies;
b. describe how development partners should align their approaches and implementation models to MAF and provide guidance on coordination mechanisms at various levels;
c. outline the system for tracking and reporting storage interventions and uptake of improved methods;
d. include specific guidance on the role of AEWs in promoting improved storage practices within their resource constrained environment.

Conclusion

Improved storage technologies have the potential to increase food stability by allowing rural households to reduce post-harvest losses and prolong use of their agricultural production. This research aimed to explore the availability of various storage types, main barriers and enabling factors to uptake. The results provide useful information for MAF and other development partners on key considerations for storage related programming, including opportunities to:

- Develop a national post-harvest policy that provides guidance on key approaches and promoted practices.
- Engage with the main suppliers and linkages to the private sector.
- Increase focus on training and follow-up mentoring with households.

[9] MAF's food security and national seed policy does not include content or guidance on storage practices or technologies.