Improved Packaging Technology for Humanitarian Assistance

USAID Global Innovation Week
September 2017
Scaling Adoption of Hermetic Post-Harvest Storage Technologies in Uganda
Hermetic storage options

Exchange rate approx: 3000 Sh per USD

POST HARVEST FARMING EQUIPMENT
(WORLD FOOD PROGRAMME ORDER DOCUMENT)

NAME OF FARMER ................................................................. NAME OF FARMER ORGANISER .................................................................

DISTRICT ................................................................. SUB-COUNTY ................................................................. PARISH .................................................................

DATE .................................................................

**SUPER GRAIN BAGS** (80KG / per bag)

**OPTION 1a.**
4 Bags + 1 Plastic Sheet
Total = Sh 65,000
Farmer to pay ⇒ Sh 19,500

**OPTION 1b.**
4 Bags + 2 Plastic Sheets
Total = Sh 102,000
Farmer to pay ⇒ Sh 31,000

**PLASTIC SILO** (250KG / per silo)

**OPTION 2a.**
1 Silo + 1 Plastic Sheet
Total = Sh 147,000
Farmer to pay ⇒ Sh 44,500

**OPTION 2b.**
1 Silo + 2 Plastic Sheets
Total = Sh 185,000
Farmer to pay ⇒ Sh 56,000

**METAL SILO** /medium (530KG / per silo)

**OPTION 3a.**
1 Silo + 1 Plastic Sheet
Total = Sh 393,000
Farmer to pay ⇒ Sh 118,000

**OPTION 3b.**
1 Silo + 2 Plastic Sheets
Total = Sh 430,000
Farmer to pay ⇒ Sh 129,500

**METAL SILO** /large (1300KG / per silo)

**OPTION 4a.**
1 Silo + 1 Plastic Sheet
Total = Sh 550,000
Farmer to pay ⇒ Sh 165,000

**OPTION 4b.**
1 Silo + 2 Plastic Sheets
Total = Sh 587,000
Farmer to pay ⇒ Sh 176,500

Farmers must **only select ONE option**
Farmer willingness to pay

Hermetic Bags (4)

Plastic Silo

Medium Metal Silo

Large Metal Silo

USD (1 USD = 2535 UGX)
# Supply chain costs and profits

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Supplier Cost</th>
<th>Supplier Price</th>
<th>Supplier Gross Profit</th>
<th>Supplier Gross Margin</th>
<th>Channel Gross Profit</th>
<th>Channel Gross Margin</th>
<th>Full Retail Price</th>
<th>Subsidized Retail Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Silo Large</td>
<td>$158.73</td>
<td>$180.00</td>
<td>$21.28</td>
<td>11.8%</td>
<td>$21.84</td>
<td>12.1%</td>
<td>$201.84</td>
<td>$60.55</td>
</tr>
<tr>
<td>Metal Silo Medium</td>
<td>$124.65</td>
<td>$130.00</td>
<td>$5.35</td>
<td>4.1%</td>
<td>$10.04</td>
<td>7.7%</td>
<td>$140.04</td>
<td>$42.01</td>
</tr>
<tr>
<td>Plastic Silo</td>
<td>$47.60</td>
<td>$38.00</td>
<td>$(9.60)</td>
<td>(25.3%)</td>
<td>$5.39</td>
<td>14.2%</td>
<td>$43.39</td>
<td>$13.02</td>
</tr>
<tr>
<td>Bag</td>
<td>n/a</td>
<td>$2.70</td>
<td>n/a</td>
<td>n/a</td>
<td>$(0.07)</td>
<td>(2.6%)</td>
<td>$2.63</td>
<td>$0.79</td>
</tr>
</tbody>
</table>

## Empirical results

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Supplier Cost</th>
<th>Supplier Price</th>
<th>Supplier Gross Profit</th>
<th>Supplier Gross Margin</th>
<th>Channel Gross Profit</th>
<th>Channel Gross Margin</th>
<th>Projected Retail Price</th>
<th>SO1 Full Retail Price</th>
<th>Percent of SO1 Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Silo Large (average)</td>
<td>$158.73</td>
<td>$180.00</td>
<td>$21.28</td>
<td>11.8%</td>
<td>$21.84</td>
<td>12.1%</td>
<td>$196.05</td>
<td>$201.84</td>
<td>97%</td>
</tr>
<tr>
<td>Metal Silo Medium (average)</td>
<td>$124.65</td>
<td>$130.00</td>
<td>$5.35</td>
<td>4.1%</td>
<td>$10.04</td>
<td>7.7%</td>
<td>$153.97</td>
<td>$140.04</td>
<td>110%</td>
</tr>
<tr>
<td>Metal Silo Large (minimum)</td>
<td>$141.29</td>
<td>$153.58</td>
<td>$153.58</td>
<td>12%</td>
<td>$174.52</td>
<td>86%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Silo Medium (minimum)</td>
<td>$79.22</td>
<td>$86.11</td>
<td>$86.11</td>
<td>12%</td>
<td>$97.85</td>
<td>70%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Silo</td>
<td>$47.60</td>
<td>$51.74</td>
<td>$51.74</td>
<td>12%</td>
<td>$58.79</td>
<td>135%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bag</td>
<td>$2.48</td>
<td>$2.70</td>
<td>$2.70</td>
<td>12%</td>
<td>$3.06</td>
<td>116%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bags (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$12.25</td>
<td></td>
</tr>
<tr>
<td>Tarps (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$14.60</td>
<td></td>
</tr>
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</table>

## Projected prices
System dynamics model
Adoption by product

Total over all four technologies reaching 1.05 million households (17.5% of the total) by 2024.
Scaling Adoption of Hermetic Post-Harvest Storage Technologies in Uganda

Background
According to the World Food Programme, nearly one-third of food produced for human consumption is lost or wasted, and over half of that food waste happens during production, post-harvest handling, and storage.

Post-harvest storage technologies like silos and hermetic bags have been successfully developed and piloted with smallholder farmers over the past several decades to mitigate food loss caused by improper storage, but none of these technologies have reached significant scale.

Approach
MIT researchers evaluated post-harvest storage technologies, working closely with the World Food Programme, which had recently established a program to train Ugandan farmers in post-harvest storage and introduce them to post-harvest technologies, while also supporting Uganda’s private sector to develop business models for post-harvest loss reduction.

CITE’s evaluation examined how the post-harvest products used in the program compared in cost, availability, and value to the farmer, and identified opportunities to improve the local supply chains to better deliver these products in the future. To conduct this study, MIT researchers used mixed methods, employing empirical research — surveys, semi-structured interviews, and hypothetical behavioral experiments — to gather data that informed an analytical model.

FULL REPORT: SCALING ADOPTION OF HERMETIC POST-HARVEST STORAGE TECHNOLOGIES IN UGANDA

Massachusetts Institute of Technology, Cambridge, Massachusetts
Universidad del Rosario, Bogotá, Colombia
Gordon College, Wenham, Massachusetts

The Cost and Effectiveness of New Food Assistance Packaging Technologies
Pictured: shipping sized bags in the pilot in a USAID warehouse.

The pilot used standard FIBCs, FIBCs with a PE liner, and FIBCs with a BP.

Shipping-sized bags

Pictured: WPP bag with a PE liner in the pilot. (Liner not visible.)

The pilot used standard WPP bags, WPP bags with a PE liner, and WPP bags with a BP.

Distribution-sized bags

Pictured: An installed PE container liner in the pilot in an American warehouse.

The pilot used PE container liners, which be used with both sizes of bags.

PE container liner
## Procurement experiment

<table>
<thead>
<tr>
<th>Packaging Type</th>
<th>Size (kg)</th>
<th>Treatment</th>
<th>Hypothesized Advantage</th>
<th>Handling cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quality</td>
<td>Size</td>
<td>Avoid fumigation</td>
</tr>
<tr>
<td>WPP or MWP</td>
<td>25/50</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WPP with PE liner</td>
<td>25/50</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>WPP or MWP with BP</td>
<td>25/50</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>FIBC</td>
<td>1000</td>
<td>-</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>FIBC with PE liner</td>
<td>1000</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FIBC with BP</td>
<td>1000</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>WPP with PE container liner</td>
<td>20000</td>
<td>Y</td>
<td>-</td>
<td>Y (partial)</td>
</tr>
<tr>
<td>FIBC with PE container liner</td>
<td>20000</td>
<td>Y</td>
<td>Y</td>
<td>Y (partial)</td>
</tr>
</tbody>
</table>

WPP: Woven Polypropylene  
MWP: Multi-Wall Paper  
PE: Polyethylene  
BP: Bio-Pesticide  
FIBC: Flexible Intermediate Bulk Container
Results:

Cost
Results:

Quality

Picture 3: Punctured WPP bag with PE liner in Djibouti

Table 5: Torn Bags and Value Loss Model

<table>
<thead>
<tr>
<th></th>
<th>Approx. Bags Shipped</th>
<th>Bags Torn</th>
<th>Bags / MT</th>
<th>Value / MT</th>
<th>% Torn</th>
<th>Avg. Value Loss / Bag</th>
<th>Avg. Value Loss / MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPP</td>
<td>4800</td>
<td>6</td>
<td>20</td>
<td>$400.00</td>
<td>0.13%</td>
<td>$0.03</td>
<td>$0.50</td>
</tr>
<tr>
<td>FIBC</td>
<td>320</td>
<td>3</td>
<td>1</td>
<td>$400.00</td>
<td>0.94%</td>
<td>$3.75</td>
<td>$3.75</td>
</tr>
<tr>
<td>WPP</td>
<td>3200</td>
<td>6</td>
<td>20</td>
<td>$800.00</td>
<td>0.19%</td>
<td>$0.08</td>
<td>$1.50</td>
</tr>
<tr>
<td>FIBC</td>
<td>320</td>
<td>3</td>
<td>1</td>
<td>$800.00</td>
<td>0.94%</td>
<td>$7.50</td>
<td>$7.50</td>
</tr>
<tr>
<td>MWP</td>
<td>9600</td>
<td>35</td>
<td>40</td>
<td>$700.00</td>
<td>0.36%</td>
<td>$0.06</td>
<td>$2.55</td>
</tr>
</tbody>
</table>
Summary Report: New Packaging Types as Innovative International Food Assistance Instruments

Massachusetts Institute of Technology
Cambridge, Massachusetts


MIT News
ON CAMPUS AND AROUND THE WORLD

Researchers identify opportunities to improve quality, reduce cost of global food assistance delivery
Research from MIT’s CITE program leverages a procurement process to identify opportunities for improving food aid supply chains.

Lauren McKown | MIT D-Lab
September 13, 2017

Food assistance delivered to the right people at the right time and in the right place can save lives. In 2016 alone, the U.S. Agency for International Development (USAID) delivered over 1.7 million metric tons of food assistance to over 30 million people in 50 countries around the world. However, USAID estimates that over $10 million of that food never made it to the plates of people in need due to spoilage and infestation.

Proper food assistance packaging can be a major contributing factor toward preventing spoilage and infestation. The right kind of packaging can also reduce the need for costly fumigation — which also has the potential to harm human and environmental health if misapplied — and diversify the types of commodities that can be shipped to communities in need, improving recipient satisfaction and nutrition.

MIT researchers have just released a new report detailing an experimental study examining how different packaging approaches and technologies can reduce cost and improve quality of food assistance procured in the United States and shipped abroad.
Acknowledgements

• Post Harvest Storage (Uganda)
  – Research Team: Mark Brennan, Jaime Andrés Castañeda, Jarrod Goentzel, Emily Gooding, Steve Graves, Jonars Speilberg, Mike Veatch
  – Partners: World Food Program, USAID Uganda Feed the Future Program, USAID Global Development Lab

• Food Assistance Packaging (International)
  – Research Team: Mark Brennan, Prithvi Sundar, Jarrod Goentzel, Dan Frey
  – Partners: USAID Office of Food for Peace, US Department of Agriculture, USAID Global Development Lab

This research is 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 Comprehensive Initiative on Technology Evaluation (CITE) and do not necessarily reflect the views of USAID or the United States Government.