EVALUATION

# EVAPORATIVE COOLING TECHNOLOGIES FOR IMPROVED VEGETABLE STORAGE IN MALI

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World Vegetable Center - Mali

Appendix
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D-Lab

World Vegetable Center

MIT | CITE

D-Lab

MIT D-Lab works with people around the world to develop and advance collaborative approaches and practical solutions to global poverty challenges. The program's mission is pursued through interdisciplinary courses, research in collaboration with global partners, technology development, and community initiatives — all of which emphasize experiential learning, community-led development, and scalability. This research was made possible in part through support from Malcom B. Strandberg.

D-Lab led the research design, development of the sensors and the survey instruments, data analysis, and preparation of the report and other outputs.

World Vegetable Center

The World Vegetable Center, an international nonprofit research and development institute, is committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious and health-promoting vegetables. The World Vegetable Center helps farmers increase vegetable harvests, raise incomes in poor rural and urban households, create jobs, and provide healthier, more nutritious diets for families and communities.

The World Vegetable Center led the fieldwork, including the procurement and assembly of the evaporative cooling devices, selection of study participants, and data collection. The World Vegetable Center also contributed to the research design, data analysis, and preparation of the report.

MIT | CITE Comprehensive Initiative on Technology Evaluation

The Comprehensive Initiative on Technology Evaluation (CITE) at MIT is a program dedicated to developing methods for technology evaluation in global development. CITE is led by an interdisciplinary team, and draws upon diverse expertise to evaluate technologies and develop an understanding of what makes them successful in emerging markets. The methodologies developed by CITE were used as a foundation for the research design of this project.

USAID FROM THE AMERICAN PEOPLE

This report was made possible in part through financial support from the United States Agency for International Development. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the United States Agency for International Development or the US Government.

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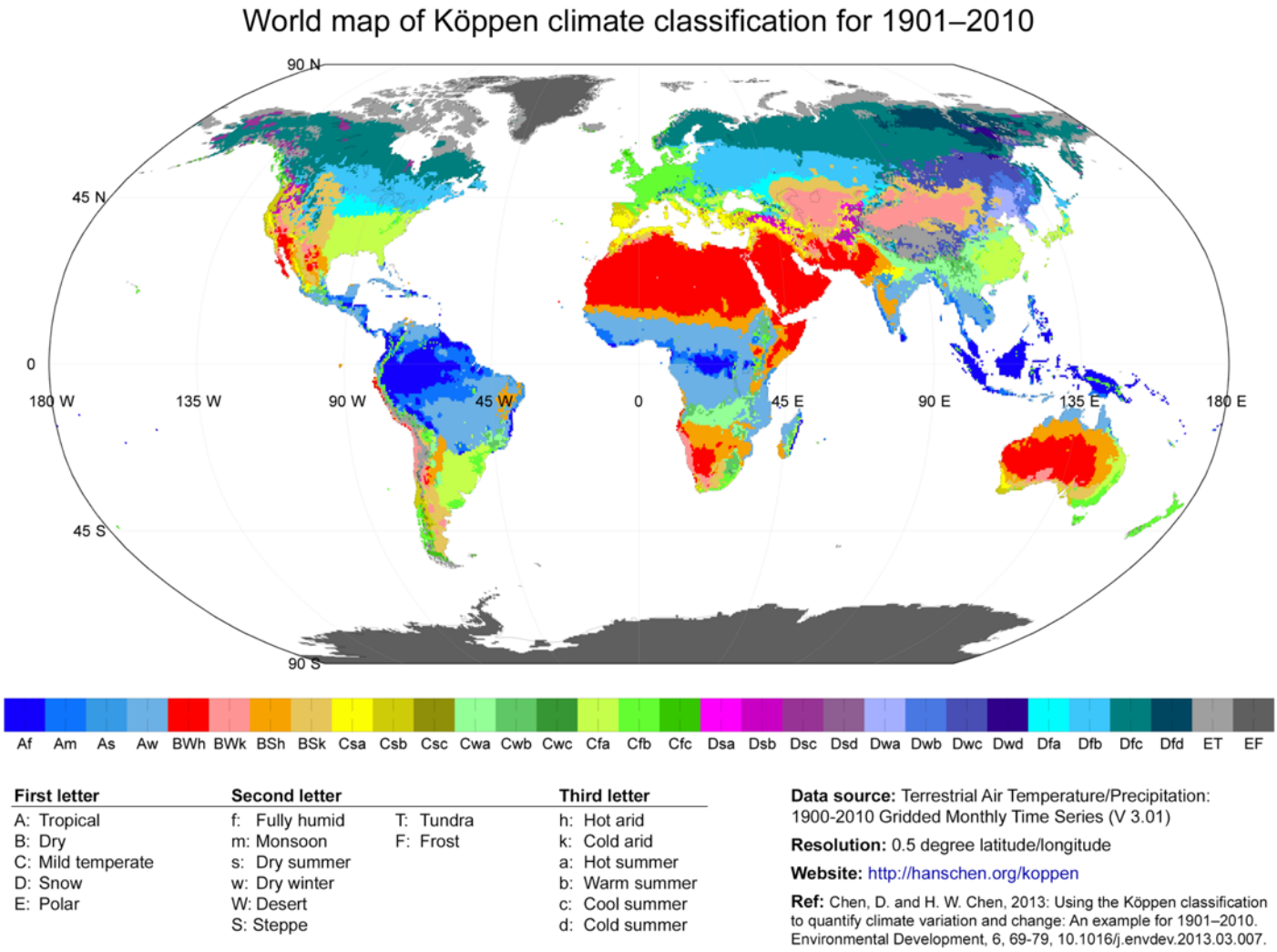
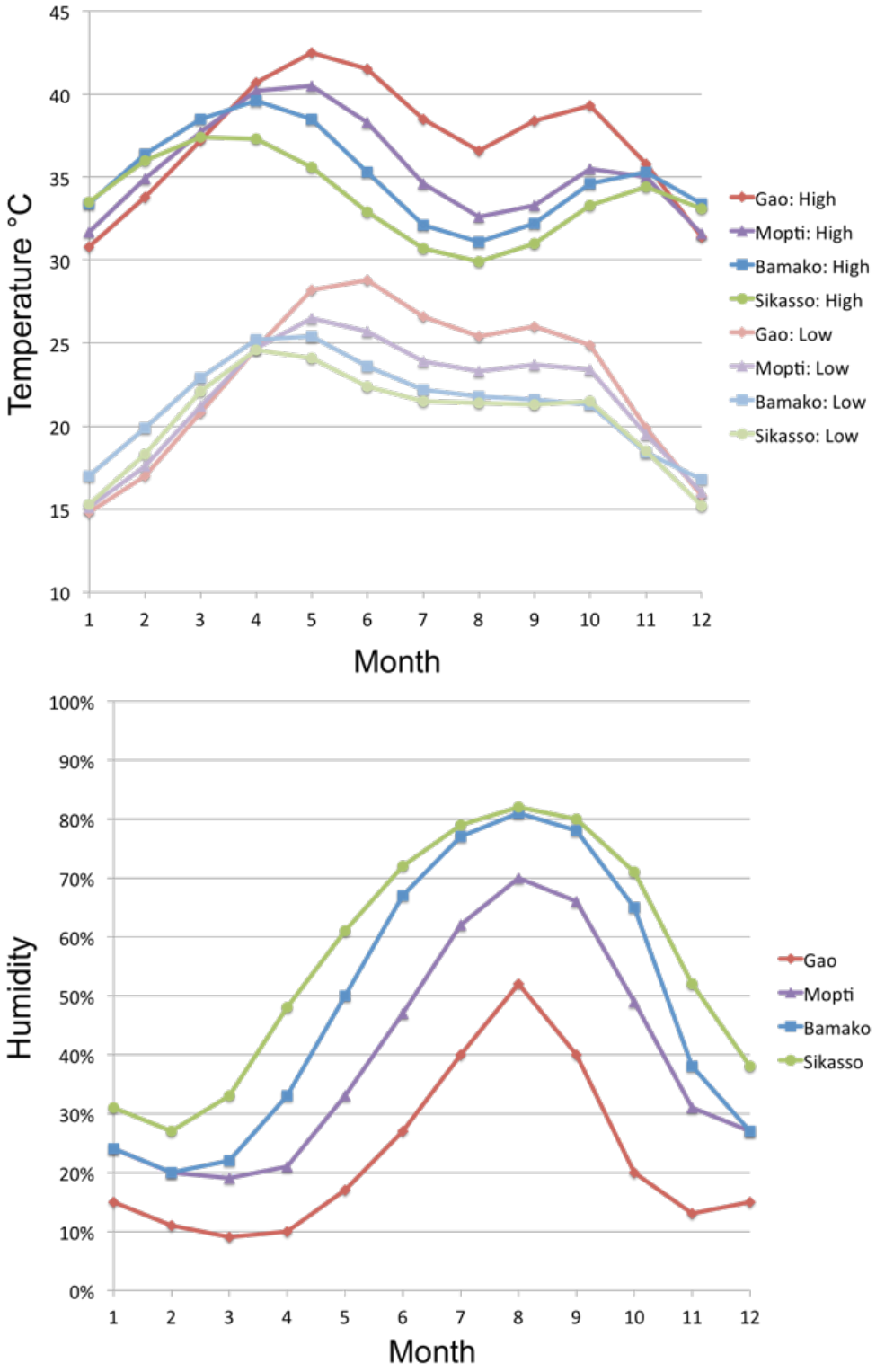
# Appendix 1. Figures

## Figure 1. Koppen climate map




Evaporative cooling would be most effective in the areas classified as:
"Dry-Desert-Hot summer" climates (BWh represented in red) and
"Dry-Steppe-Hot summer" climates (BSh represented in orange).

Figure 2. Seasonal temperature and humidity profiles in Mali



## Figure 3. Photos of evaporative cooling chambers (EEC)

Brick ECC opened

Brick ECC closed

Straw ECC opened

Straw ECC closed

Sack ECC opened

Sack ECC closed

## Figure 4. Photos of clay pot coolers

Pot-in-pot without cover

Pot-in-pot without cover (top view)

Round pot-in-dish without cover

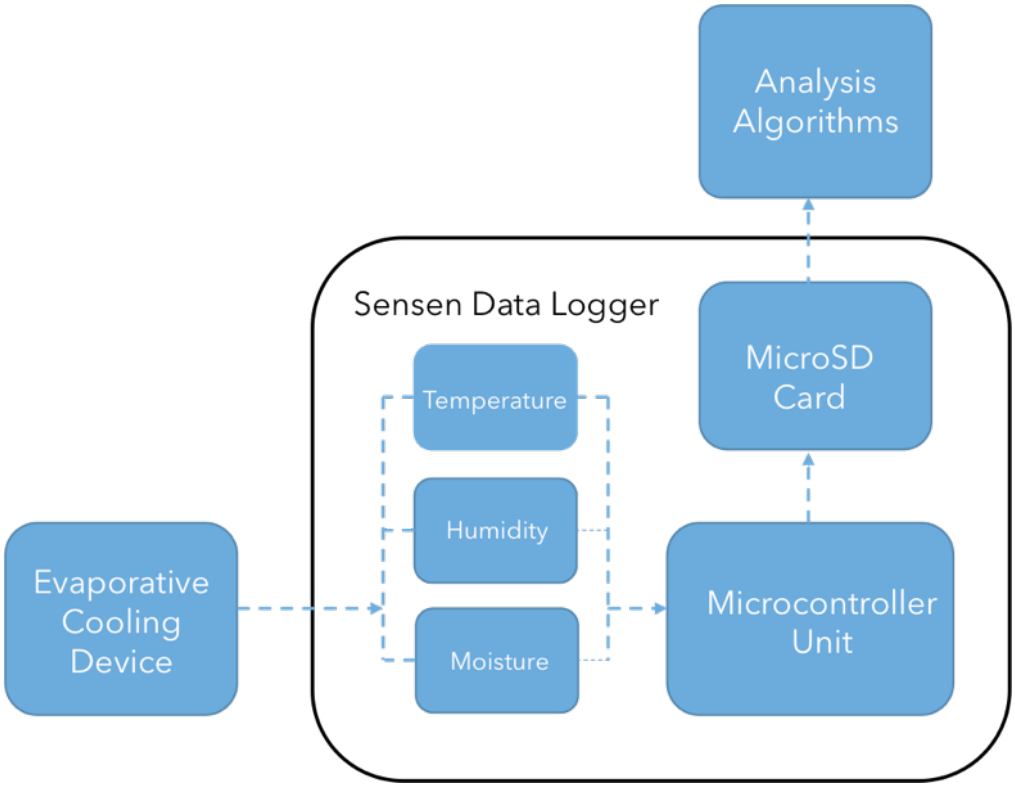
Cylinder pot-in-dish with cover

## Figure 6. Sensor installation training


Above: Training session of World Vegetable Center Technicians on sensor data extraction and battery replacement in Bankass, Mali

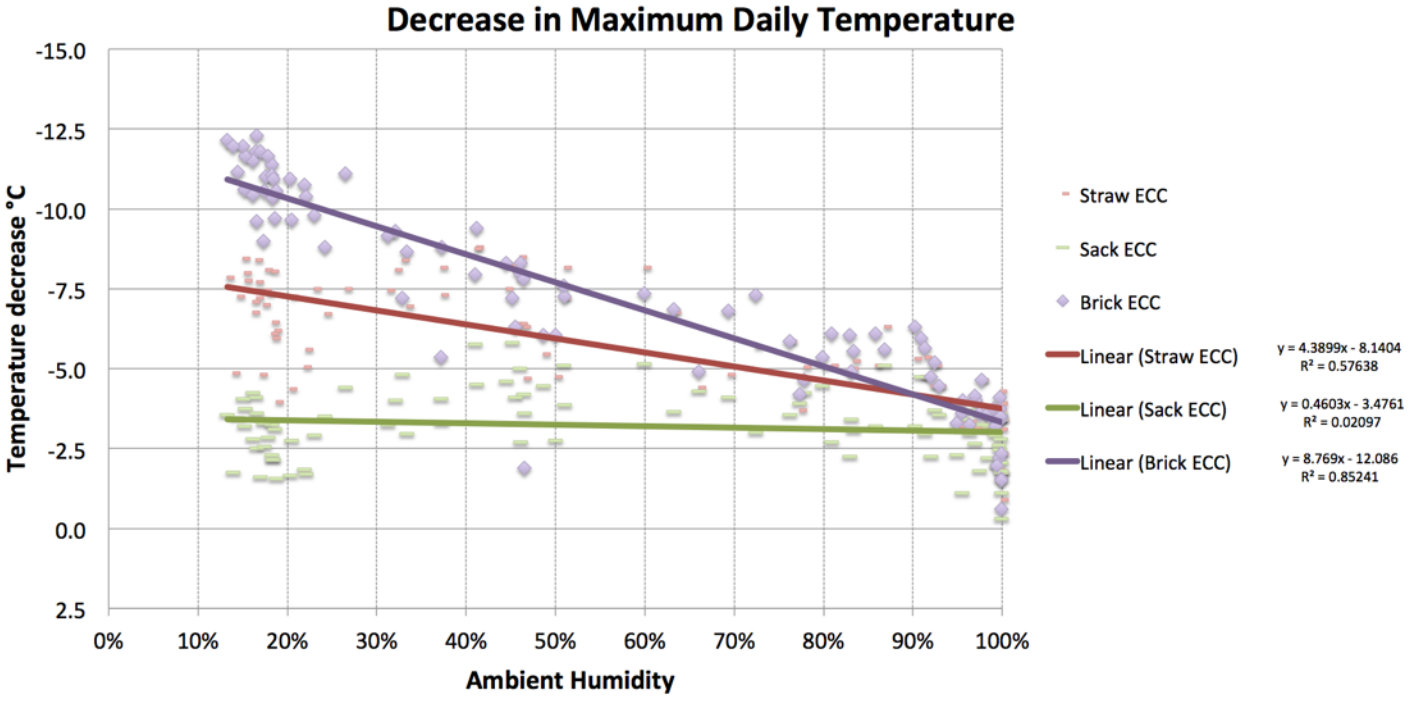
## Figure 7. Sensor data collection equipment

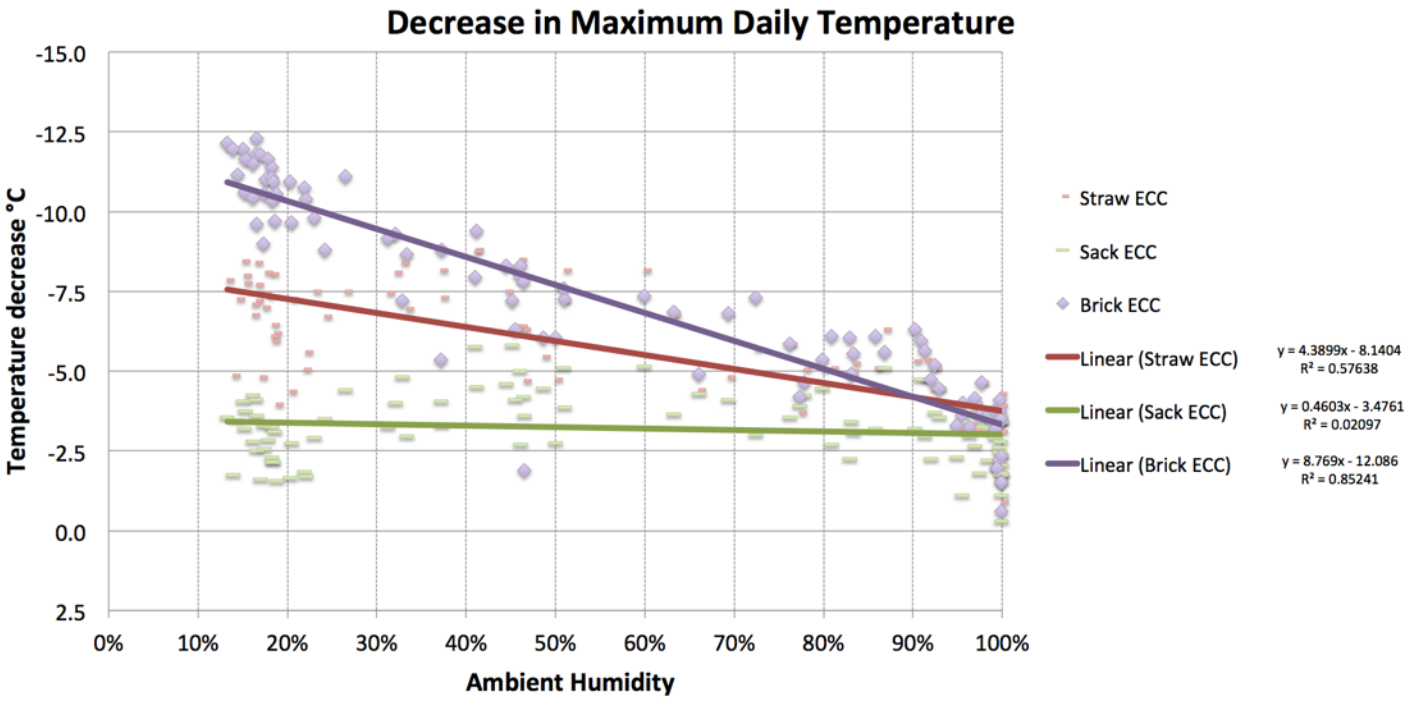
The data-logger design for the study was developed in partnership with Sensen (http://www.sensen.co). Sensen develops low-cost, low-power and long-lasting dataloggers for use in remote settings. The products feature high modularity, designed around a central, adaptable datalogger. For this study, the central datalogger was connected to two DHT11/22 sensors to measure relative humidity and ambient temperature. Additionally, a soil moisture sensor from Sparkfun (SEN-13322) was incorporated in some of the devices to measure the moisture content of the sand. Data was stored locally on a microSD card and collected manually by field staff.



## Figure 8: Individual daily data points for ECCs

Top: Decrease in the average daily temperature as a function of exterior humidity
Bottom: Decrease in the maximum daily temperature as a function of exterior humidity

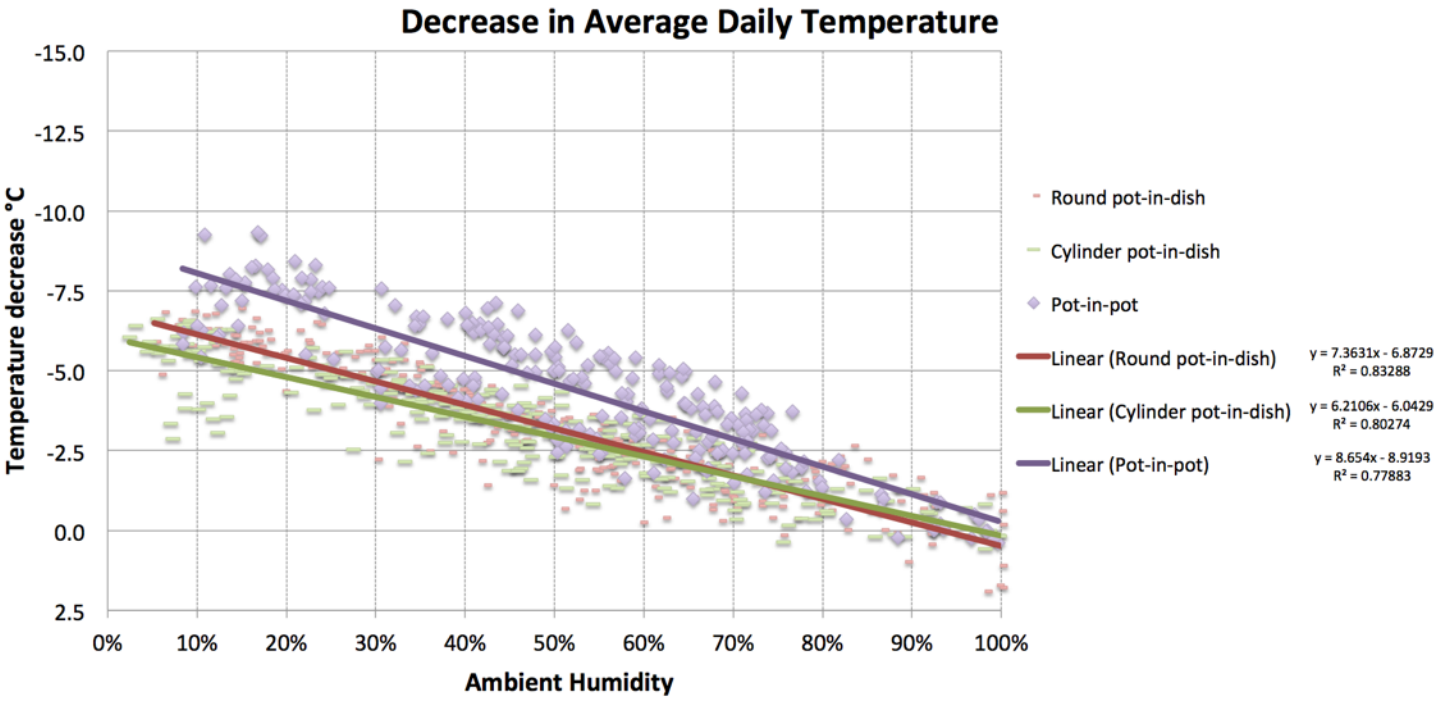


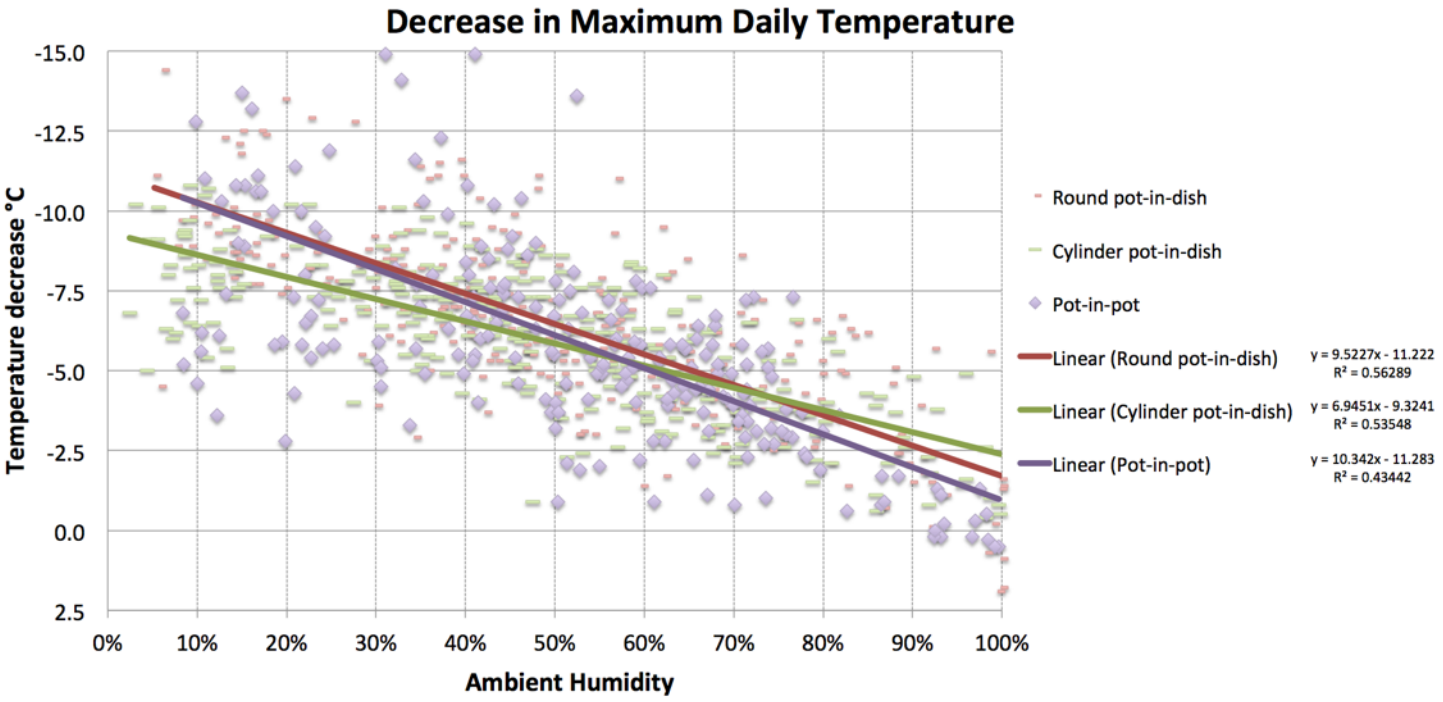




In both plots, each data point represents data collected from one device on one day, between March and July of 2017.

## Figure 9: Individual daily data points for clay pot coolers

Top: Decrease in the average daily temperature as a function of exterior humidity
Bottom: Decrease in the maximum daily temperature as a function of exterior humidity



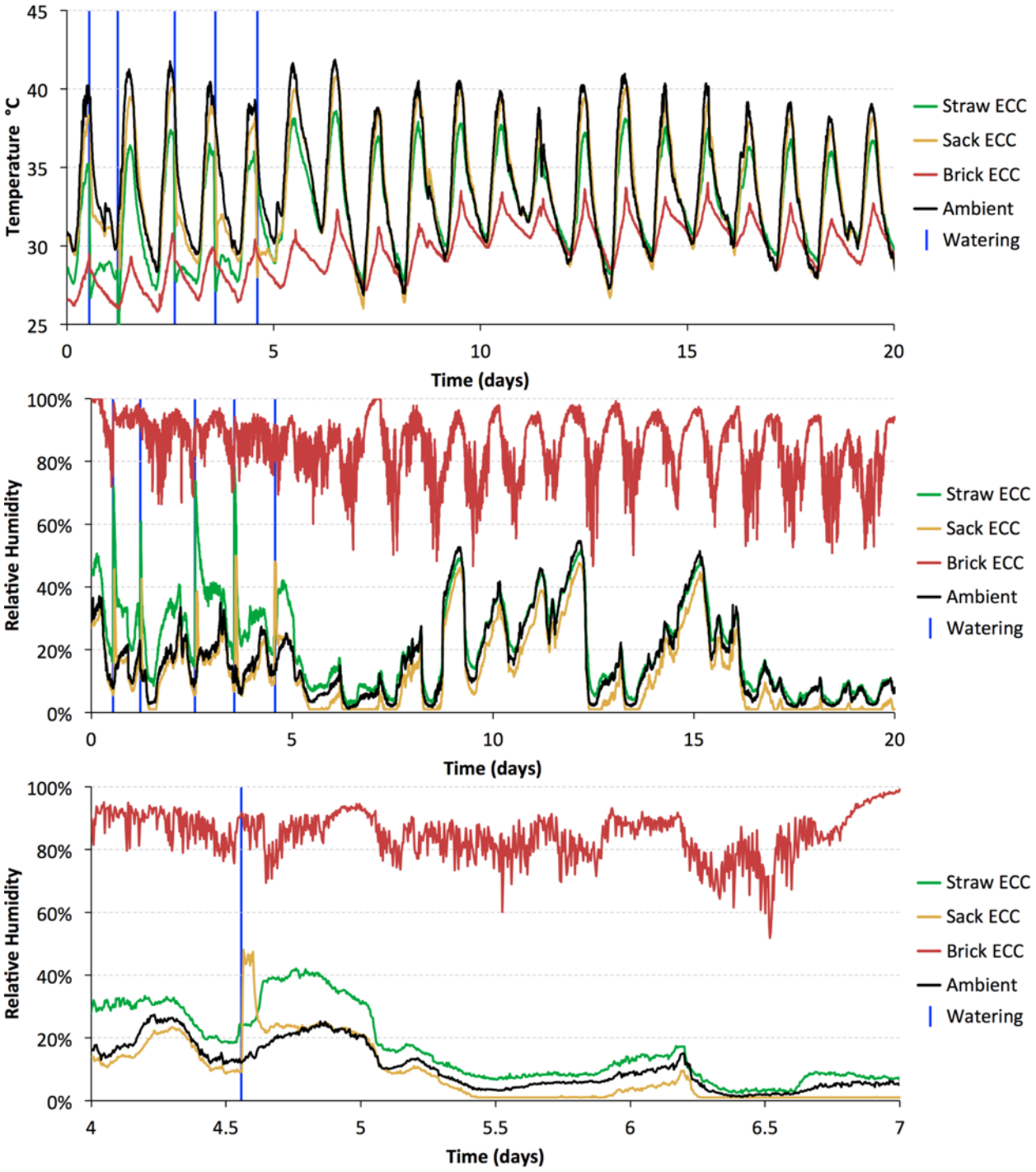




In both plots, each data point represents data collected from one device on one day, between March and July of 2017.

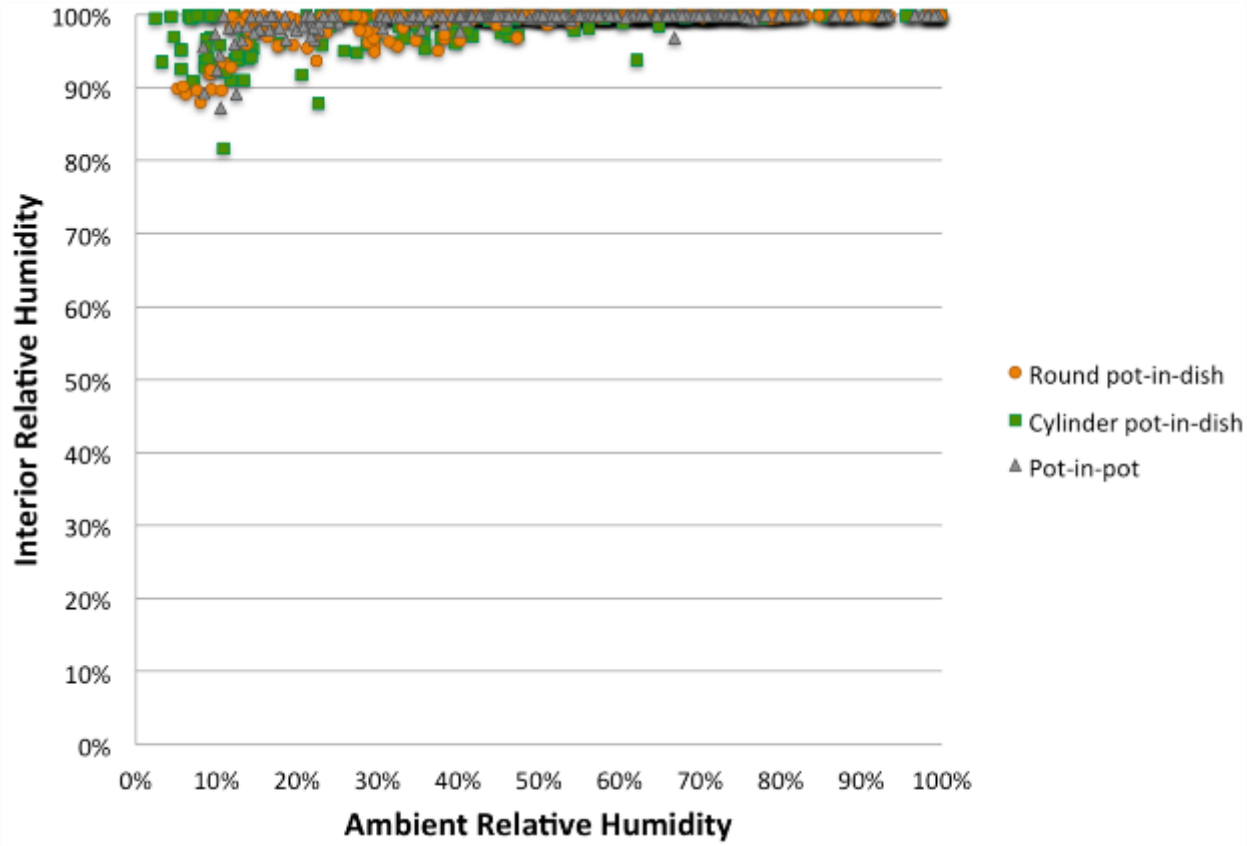
## Figure 10: ECCs with infrequent watering*

Top: Temperature as a function of time after watering** has stopped for each ECC
Middle: Humidity as a function of time after watering** has stopped for each ECC
Bottom: Humidity as a function of time, with a narrower time range than the middle plot

* See Figures 5 and 6 of the full Evaluation Report for this data displayed as daily averages.
** The vertical blue lines indicate when water was added.



## Figure 11: Clay pot cooler interior humidity as a function of exterior humidity



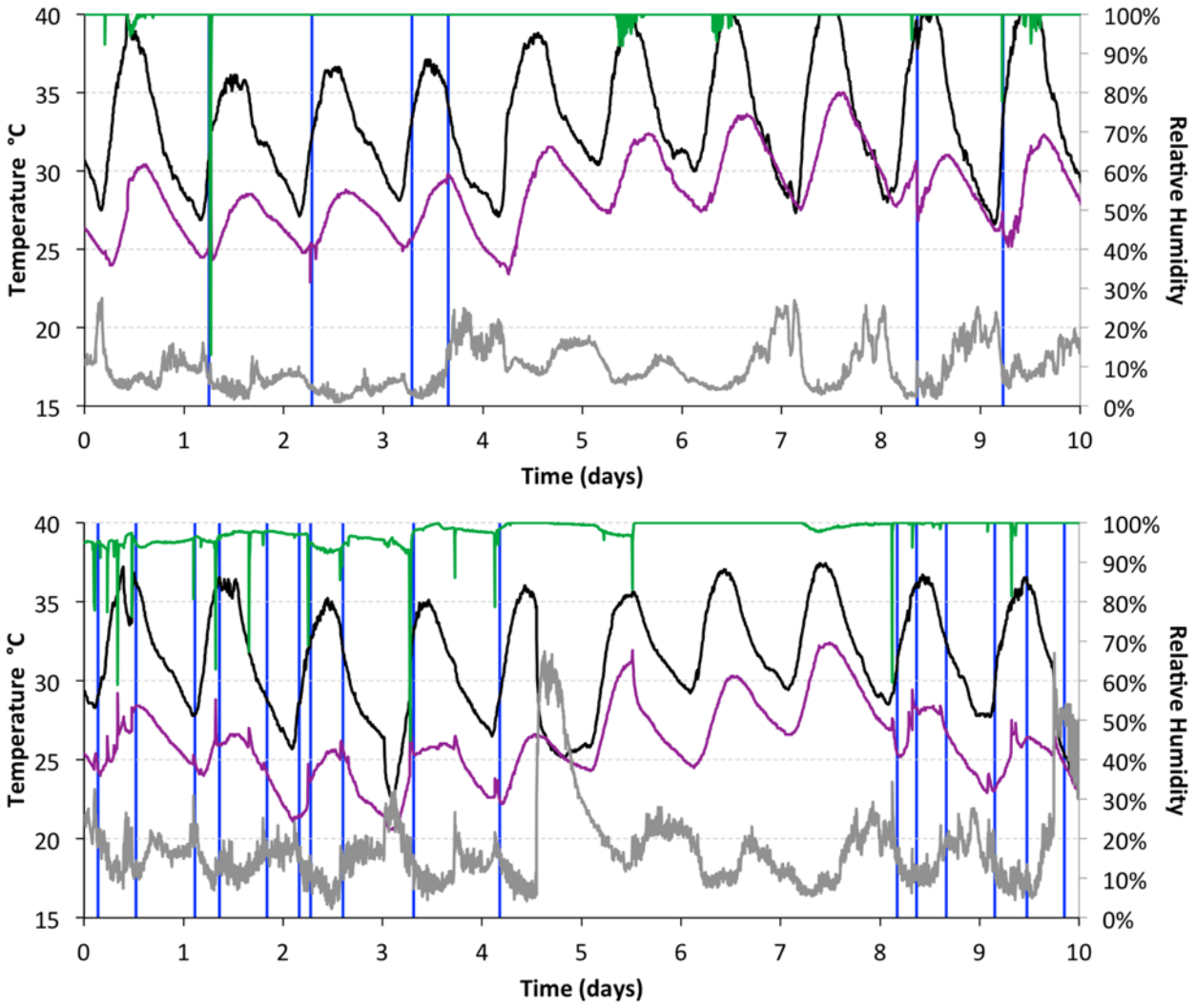

The relative humidity inside each of the clay pot coolers as a function of the ambient relative humidity. Each data point on the plot indicates the average interior and ambient (exterior) humidity one device on one day, between March and July of 2017. Data was only included when the clay pot cooler was watered at least once during previous day, and the day in question.

## Figure 12: Clay pot coolers with infrequent watering

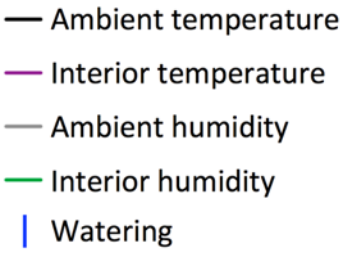
For the figures below: temperature and humidity as a function with and without regular watering. Watering occurred where indicated by the blue lines (related to Figure 8 in the full Evaluation Report)

Top: Clay pot-in-pot

Bottom: Clay pot-in-dish




Legend for both plots:



# Appendix 2. Tables

## Table 1: Villages and participants involved in the group interviews

| Region | BPH or VTIC villages | Focus Group Discussions | | |
|---|---|---|---|---|
| | | Men | Women | Total |
| Sikasso | Sokourani | 6 | 7 | 13 |
| | Molobala | 5 | 8 | 13 |
| | Finkolo | 0 | 13 | 13 |
| | Bledougou | 6 | 7 | 13 |
| | **Sub-total** | **17** | **35** | **52** |
| Mopti | Logo | 3 | 12 | 15 |
| | Yadianga | 6 | 7 | 13 |
| | **Sub-total** | **9** | **19** | **28** |
| Bamako* | Institut d'Economie Rurale, Sotuba | - | - | - |
| | World Vegetable Center, Samanko | - | - | - |
| **Total** | | **26** | **54** | **80** |

*BPH= Best Practices Hub*

*VTIC= Vegetable Technology Immersion Cluster*

** Group interviews were not conducted at the research facilities in Bamako.*

## Table 2: Vegetable shelf life in evaporative cooling chambers (ECCs)

Based on the respondent interviews, the shelf life of eggplants and tomatoes are significantly longer in Sikasso than Mopti for all vegetables. This difference is likely due to the significant variations in climate conditions between the two regions, which impacts the storage conditions experiences by the vegetables in the ECCs. The eggplants and tomatoes in the straw and sack ECCs in Sikasso were stored in conditions that were an average of over 2 °C lower and 20% higher humidity than the vegetables in the straw and sack ECCs in Mopti. Similarly, the average ambient conditions throughout the study period were more favorable for vegetable storage in Sikasso than in Mopti, as Sikasso is situated in the Sudan-Savanna zone while Mopti is part of the hotter and dryer Sahel-Saharan zone in Mali.

Comparison of the shelf life of eggplants and tomatoes in straw and sack ECCs in Mopti and Sikasso[a].

| Region | Vegetable | Reported shelf life (days)[b] | | Ambient conditions[c] | | Interior conditions[c] | |
|---|---|---|---|---|---|---|---|
| | | Straw ECC | Sack ECC | Average Temperature | Average Humidity | Average Temperature | Average Humidity |
| Sikasso | Eggplant | 19 ± 8 | 16 ± 8 | 29.4 °C | 68% | 27.9 °C | 71% |
| | Tomato | 16 ± 5 | 14 ± 5 | | | | |
| Mopti | Eggplant | 8 ± 3 | 9 ± 2 | 32.3 °C | 57% | 30.1 °C | 48% |
| | Tomato | 6 ± 1 | 7 ± 1 | | | | |

[a] There were not enough data points in Sikasso to make this comparison for brick ECCs or with other vegetables.

[b] The first number in the shelf life is the mean, followed by the standard deviation. See Table 3 in the Appendix for additional details, including the maximum, minimum and sample size.

[c] The average temperature and humidity were calculated using the data from the sensors on the straw and sack ECCs at the specified locations for the full duration of the study period.

## Table 3: Reported shelf life (in days) of vegetables

| | | Shelf life of vegetables (days) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | eggplant | | | | | tomato | | | | | hot pepper | | | | | cucumber | | | | | cabbage | | | |
| | | | previous method | | clay pot cooler | | | previous method | | clay pot cooler | | | previous method | | clay pot cooler | | | previous method | | clay pot cooler | | | previous method | | clay pot cooler | |
| Particiapnt # | Type of clay pot cooler | Previous method | dry season | rainy season | dry season | rainy season | Previous method | dry season | rainy season | dry season | rainy season | Previous method | dry season | rainy season | dry season | rainy season | Previous method | dry season | rainy season | dry season | rainy season | Previous method | dry season | rainy season | dry season | rainy season |
| 1 | pot-in-pot | woven basket | 4 | 5 | 8 | 10 | woven basket | 5 | 5 | 5 | 7 | woven basket | 7 | 7 | 10 | 12 | woven basket | 4 | 5 | 4 | 7 | woven basket | 7 | 7 | 5 | 5 |
| 2 | pot-in-pot | woven basket | 4 | 7 | 10 | 15 | woven basket | 4 | 6 | 12 | 15 | woven basket | 8 | 8 | 8 | 7 | woven basket | 4 | 7 | 15 | 20 | woven basket | 4 | 7 | 7 | 8 |
| 3 | pot-in-pot | refrigerator | 2 | 2 | 7 | 7 | refrigerator | 3 | 5 | 6 | 7 | refrigerator | 3 | 3 | 5 | 5 | refrigerator | 1 | 1 | 7 | 7 | | | | | |
| 4 | pot-in-pot | woven basket | 7 | 9 | 14 | 25 | woven basket | 7 | 8 | 14 | 21 | woven basket | 7 | 11 | 14 | 20 | woven basket | 8 | 10 | 15 | 25 | woven basket | 5 | 7 | 7 | 14 |
| 5 | cylinder pot-in-dish | woven basket | 14 | 11 | 30 | 36 | woven basket | 7 | 14 | 30 | 35 | woven basket | 7 | 7 | 30 | 30 | | | | | | woven basket | 8 | 8 | 35 | 35 |
| 6 | round pot-in-dish | woven basket | 5 | 7 | 8 | 14 | woven basket | 5 | 7 | 7 | 14 | woven basket | 7 | 7 | 8 | 14 | woven basket | 3 | 4 | 8 | 14 | woven basket | 2 | 3 | 2 | 3 |
| 7 | pot-in-pot | nearby family water pot | 3 | 5 | 8 | 7 | recipient | 3 | 5 | 7 | 7 | recipient | 5 | 5 | 15 | 14 | | | | | | nearby family water pot | 3 | 2 | 15 | 5 |
| 8 | pot-in-pot | woven basket | 2 | 3 | 10 | 8 | woven basket | 4 | 5 | 10 | 6 | woven basket | 3 | 4 | 8 | 7 | woven basket | 3 | 2 | 8 | 6 | woven basket | 2 | 3 | 10 | 15 |
| 9 | pot-in-pot | woven basket | 6 | 10 | 10 | 12 | woven basket | 4 | 6 | 8 | 15 | woven basket | 5 | 7 | 6 | 9 | woven basket | 7 | 9 | 8 | 10 | woven basket | 7 | 10 | 8 | 12 |
| 10 | pot-in-pot | woven basket | 7 | 10 | 8 | 15 | woven basket | 5 | 7 | 7 | 14 | woven basket | 5 | 7 | 7 | 10 | woven basket | 3 | 5 | 7 | 10 | woven basket | 4 | 7 | 3 | 5 |
| 11 | cylinder pot-in-dish | woven basket | 7 | 7 | 15 | 9 | woven basket | 5 | 5 | 12 | 7 | woven basket | 14 | 14 | 7 | 5 | woven basket | 7 | 7 | 14 | 8 | woven basket | 7 | 7 | 12 | 7 |
| 12 | cylinder pot-in-dish | nearby family water pot | 7 | 7 | 14 | 21 | woven basket | 7 | 7 | 14 | 10 | woven basket | 7 | 7 | 15 | 10 | nearby family water pot | 14 | 14 | 14 | 25 | nearby family water pot | 7 | 7 | 15 | 10 |
| 13 | cylinder pot-in-dish | woven basket | 4 | 7 | 8 | 15 | woven basket | 3 | 5 | 7 | 14 | woven basket | 4 | 7 | 10 | 14 | woven basket | 6 | 10 | 10 | 14 | woven basket | 3 | 5 | 7 | 9 |
| 14 | round pot-in-dish | refrigerator | 5 | 5 | 14 | 7 | refrigerator | 5 | 5 | 10 | 7 | refrigerator | 5 | 5 | 10 | 7 | | | | | | refrigerator | 3 | 3 | 6 | 4 |
| 15 | round pot-in-dish | woven basket | 7 | 8 | 7 | 10 | woven basket | 7 | 7 | 7 | 10 | woven basket | 7 | 7 | 7 | 10 | woven basket | 7 | 8 | 10 | 14 | woven basket | 7 | 14 | 5 | 7 |
| 16 | round pot-in-dish | nearby family water pot | 4 | 6 | 7 | 10 | nearby family water pot | 2 | 3 | 5 | 7 | nearby family water pot | 2 | 3 | 5 | 7 | nearby family water pot | 6 | 7 | 7 | 14 | nearby family water pot | 1 | 2 | 3 | 4 |
| 17 | pot-in-pot | woven basket | 3 | 4 | 7 | 10 | woven basket | 2 | 2 | 5 | 7 | woven basket | 4 | 4 | 7 | 10 | woven basket | 2 | 2 | 10 | 10 | woven basket | 6 | 3 | 20 | 7 |
| 18 | round pot-in-dish | woven basket | 7 | 7 | 2 | 2 | woven basket | 3 | 4 | 2 | 3 | woven basket | 7 | 7 | 2 | 3 | woven basket | 7 | 7 | 2 | 3 | woven basket | 3 | 3 | 2 | 3 |
| 19 | pot-in-pot | woven basket | 7 | 7 | 7 | 14 | woven basket | 7 | 8 | 7 | 10 | woven basket | 4 | 7 | 7 | 14 | woven basket | 3 | 7 | 7 | 14 | woven basket | 2 | 4 | 7 | 7 |
| 20 | pot-in-pot | woven basket | 6 | 8 | 7 | 14 | woven basket | 5 | 7 | 7 | 14 | woven basket | 2 | 4 | 7 | 10 | woven basket | 2 | 3 | 7 | 10 | woven basket | 2 | 4 | 7 | 10 |
| 21 | round pot-in-dish | refrigerator | 7 | 10 | 10 | 14 | refrigerator | 7 | 7 | 7 | 14 | refrigerator | 7 | 8 | 8 | 14 | refrigerator | 7 | ?? | 7 | 14 | refrigerator | 7 | 7 | 7 | 10 |
| 22 | cylinder pot-in-dish | recipient | 7 | 7 | 21 | 25 | recipient | 5 | 7 | 14 | 21 | recipient | 7 | 10 | 14 | 30 | nearby family water pot | 4 | 14 | 14 | 30 | recipient | 7 | 10 | 14 | 21 |
| 23 | pot-in-pot | woven basket | 14 | 7 | 14 | 14 | woven basket | 7 | 3 | 7 | 7 | woven basket | 14 | 14 | 14 | 21 | nearby family water pot | 5 | 5 | 7 | 7 | nearby family water pot | 4 | 4 | 7 | 7 |
| 24 | pot-in-pot | woven basket | 7 | 8 | 8 | 14 | woven basket | 5 | 7 | 7 | 15 | woven basket | 5 | 7 | 10 | 14 | woven basket | 6 | 8 | 8 | 14 | woven basket | 4 | 6 | 7 | 10 |
| 25 | pot-in-pot | food cabin | 7 | 8 | 10 | 14 | food cabin | 7 | 7 | 8 | 10 | food cabin | 5 | 7 | 7 | 15 | food cabin | 7 | 8 | 8 | 14 | food cabin | 3 | 4 | 2 | 5 |
| 26 | pot-in-pot | woven basket | 4 | 2 | 14 | 8 | woven basket | 3 | 1 | 10 | 7 | woven basket | 8 | 8 | 21 | 13 | woven basket | 5 | 6 | 21 | 14 | woven basket | 7 | 7 | 21 | 10 |
| 27 | pot-in-pot | spread on top of a sack | 5 | 7 | 7 | 12 | spread on top of a sack | 3 | 7 | 7 | 10 | spread on top of a sack | 5 | 7 | 7 | 14 | spread on top of a sack | 6 | 8 | 8 | 14 | spread on top of a sack | 3 | 4 | 5 | 8 |
| 28 | cylinder pot-in-dish | spread on top of a sack | 3 | 4 | 7 | 10 | woven basket | 7 | 7 | 4 | 7 | spread on top of a sack | 3 | 5 | 7 | 10 | spread on top of a sack | 4 | 6 | 7 | 14 | spread on top of a sack | 1 | 2 | 2 | 3 |
| 29 | pot-in-pot | woven basket | 5 | 7 | 7 | 10 | woven basket | 4 | 5 | 7 | 8 | woven basket | 6 | 7 | 7 | 9 | woven basket | 7 | 7 | 7 | 11 | woven basket | 5 | 7 | 7 | 8 |
| 30 | pot-in-pot | woven basket | 3 | 4 | 7 | 14 | woven basket | 3 | 5 | 14 | 14 | woven basket | 4 | 7 | 7 | 14 | nearby family water pot | 14 | 20 | 14 | 16 | woven basket | 7 | 14 | 5 | 7 |
| 31 | cylinder pot-in-dish | woven basket | 7 | 10 | 12 | 13 | woven basket | 5 | 7 | 10 | 12 | woven basket | 7 | 10 | 9 | 12 | nearby family water pot | 2 | 5 | 7 | 10 | woven basket | 6 | 7 | 8 | 11 |
| 32 | cylinder pot-in-dish | woven basket | 3 | 7 | 7 | 10 | woven basket | 4 | 7 | 7 | 7 | woven basket | 4 | 5 | 10 | 10 | nearby family water pot | 4 | 7 | 7 | 14 | woven basket | 3 | 4 | 7 | 10 |
| 33 | cylinder pot-in-dish | woven basket | 7 | 14 | 20 | 20 | woven basket | 4 | 7 | 10 | 12 | woven basket | 7 | 7 | 4 | 7 | nearby family water pot | 3 | 2 | 23 | 30 | woven basket | 7 | 7 | 7 | 10 |
| 34 | cylinder pot-in-dish | woven basket | 7 | 9 | 10 | 10 | woven basket | 7 | 8 | 10 | 6 | woven basket | 3 | 7 | 10 | 20 | nearby family water pot | 4 | 7 | 12 | 15 | nearby family water pot | 5 | 7 | 10 | 20 |
| 35 | round pot-in-dish | woven basket | 2 | 6 | 5 | 7 | woven basket | 2 | 2 | 4 | 7 | woven basket | 3 | 4 | 7 | 10 | | | | | | woven basket | 4 | 5 | 7 | 7 |
| 36 | pot-in-pot | nearby family water pot | 2 | 2 | 7 | 3 | woven basket | 3 | 7 | 4 | 10 | woven basket | 3 | 3 | 7 | 5 | nearby family water pot | 2 | 2 | 7 | 4 | nearby family water pot | 4 | 3 | 7 | 6 |
| 37 | cylinder pot-in-dish | woven basket | 3 | 3 | 7 | 8 | woven basket | 3 | 3 | 9 | 7 | woven basket | 3 | 4 | 10 | 8 | | | | | | woven basket | 3 | 2 | 8 | 6 |
| 38 | pot-in-pot | woven basket | 3 | 5 | 8 | 8 | woven basket | 3 | 4 | 9 | 9 | woven basket | 5 | 5 | 9 | 8 | woven basket | 4 | 5 | 9 | 8 | woven basket | 5 | 5 | 7 | 6 |
| 39 | pot-in-pot | nearby family water pot | 5 | 3 | 8 | 5 | recipient | 2 | 3 | 7 | 6 | recipient | 2 | 3 | 7 | 5 | nearby family water pot | 2 | 2 | 5 | 4 | nearby family water pot | 3 | 3 | 5 | 2 |
| 40 | cylinder pot-in-dish | woven basket | 3 | 4 | 10 | 7 | woven basket | 3 | 4 | 7 | 7 | woven basket | 5 | 4 | 15 | 5 | woven basket | 4 | 4 | 7 | 5 | woven basket | 4 | 5 | 10 | 7 |
| 41 | round pot-in-dish | woven basket | 4 | 5 | 7 | 7 | woven basket | 4 | 4 | 6 | 5 | woven basket | 4 | 4 | 7 | 6 | woven basket | 4 | 5 | 7 | 7 | woven basket | 4 | 4 | 7 | 7 |
| 42 | cylinder pot-in-dish | woven basket | 3 | 5 | 10 | 15 | woven basket | 3 | 5 | 10 | 15 | woven basket | 3 | 4 | 5 | 7 | woven basket | 3 | 5 | 10 | 15 | woven basket | 2 | 3 | 5 | 7 |
| 43 | round pot-in-dish | food cabin | 2 | 3 | 15 | 25 | food cabin | 2 | 2 | 7 | 7 | food cabin | 3 | 3 | 7 | 15 | food cabin | 5 | 3 | 15 | 25 | food cabin | 3 | 3 | 7 | 15 |
| 44 | round pot-in-dish | woven basket | 5 | 5 | 7 | 10 | woven basket | 5 | 5 | 7 | 10 | woven basket | 4 | 5 | 6 | 7 | woven basket | 4 | 4 | 10 | 15 | woven basket | 2 | 2 | 7 | 9 |
| 45 | pot-in-pot | woven basket | 2 | 3 | 7 | 15 | woven basket | 3 | 3 | 10 | 15 | woven basket | 2 | 2 | 4 | 7 | nearby family water pot | 2 | 3 | 4 | 10 | woven basket | 2 | 3 | 4 | 10 |
| 46 | cylinder pot-in-dish | woven basket | 5 | 5 | 10 | 7 | woven basket | 7 | 8 | 4 | 5 | woven basket | 7 | 5 | 8 | 4 | woven basket | 3 | 4 | 5 | 5 | woven basket | 5 | 2 | 6 | 5 |
| 47 | cylinder pot-in-dish | nearby family water pot | 4 | 4 | 4 | 6 | spread on top of a sack | 4 | 4 | 4 | 6 | nearby family water pot | 4 | 4 | 4 | 6 | nearby family water pot | 4 | 4 | 4 | 6 | nearby family water pot | 3 | 3 | 4 | 6 |
| 48 | pot-in-pot | woven basket | 4 | 5 | 10 | 7 | woven basket | 4 | 5 | 10 | 7 | woven basket | 7 | 7 | 7 | 5 | woven basket | 4 | 5 | 10 | 7 | woven basket | 7 | 7 | 3 | 3 |
| 49 | pot-in-pot | woven basket | 7 | 9 | 15 | 20 | woven basket | 4 | 5 | 8 | 10 | woven basket | 5 | 5 | 7 | 9 | woven basket | 7 | 9 | 15 | 10 | woven basket | 7 | 8 | 15 | 20 |
| 50 | cylinder pot-in-dish | woven basket | 6 | 10 | 14 | 25 | woven basket | 5 | 7 | 14 | 21 | woven basket | 4 | 6 | 7 | 14 | woven basket | 6 | 10 | 14 | 25 | woven basket | 4 | 5 | 6 | 10 |
| 51 | pot-in-pot | woven basket | 5 | 5 | 17 | 10 | woven basket | 5 | 5 | 15 | 7 | nearby family water pot | 4 | 5 | 7 | 5 | nearby family water pot | 5 | 4 | 13 | 12 | nearby family water pot | 3 | 2 | 7 | 5 |
| 52 | round pot-in-dish | recipient | 4 | 5 | 7 | 10 | recipient | 4 | 4 | 8 | 10 | recipient | 5 | 4 | 7 | 15 | recipient | 5 | 5 | 6 | 8 | recipient | 4 | 6 | 10 | 9 |
| | | **Average shelf life** | **5.1** | **6.3** | **10.1** | **12.4** | **Average shelf life** | **4.4** | **5.5** | **8.6** | **10.5** | **Average shelf life** | **5.2** | **6.1** | **8.7** | **10.8** | **Average shelf life** | **4.9** | **6.2** | **9.4** | **12.6** | **Average shelf life** | **4.3** | **5.2** | **8.0** | **8.8** |
| | | **Standard deviation** | **2.5** | **2.6** | **4.8** | **6.4** | **Standard deviation** | **1.6** | **2.2** | **4.3** | **5.5** | **Standard deviation** | **2.5** | **2.5** | **4.5** | **5.8** | **Standard deviation** | **2.6** | **3.6** | **4.3** | **6.7** | **Standard deviation** | **1.9** | **2.8** | **5.6** | **5.7** |
| | | **Maximum** | **14** | **14** | **30** | **36** | **Maximum** | **7** | **14** | **30** | **35** | **Maximum** | **14** | **14** | **30** | **30** | **Maximum** | **14** | **20** | **23** | **30** | **Maximum** | **8** | **14** | **35** | **35** |
| | | **Minimum** | **2** | **2** | **2** | **2** | **Minimum** | **2** | **1** | **2** | **3** | **Minimum** | **2** | **2** | **2** | **3** | **Minimum** | **1** | **1** | **2** | **3** | **Minimum** | **1** | **2** | **2** | **2** |

*Dry season= April to June; rainy season= July to September*

## Table 4: Evaporative cooling chamber (ECC) rating

The participant's responses to the multiple-choice question "Overall how would you rate the ECC as a cooling and storage product?" are shown in below. The answers to this question corroborate the ratings of the attributes listed in Table 4 of the full Evaluation Report, where the brick ECC is the highest rated, followed by the sack ECC, and the straw ECC being rated the lowest.

Participant's overall impression of each type of ECCs[a]

| Overall impression | Straw ECC | Sack ECC | Brick ECC |
|---|---|---|---|
| Very-good | 3 | 0 | 5 (5) |
| Good | 2 | 15 (6) | 4 (1) |
| Fairly-good | 9 (5) | 4 | 0 |
| Not-good | 1 (1) | 0 | 0 |

[a] This data is responses to a multiple choice question. The first number is from all respondents, and the second number in brackets if for only the respondents from Mopti, all of who had access to all three types of ECCs.

## Table 5: Clay pot cooler rating

Participants were also asked about their overall impression of the clay pot coolers – in response to the multiple-choice question "Overall how would you rate the pot as a cooling and storage product?" Over 95% of the participants rated the clay pot coolers either "Good" or "Very good", with only 2 participants giving the clay pot coolers a rating of "Fairly good", and none giving the rating of "Not good".

Participant's overall impression of each type of clay pot cooler[a]

| Overall impression | Round pot-in-dish | Cylinder pot-in-dish | Pot-in-pot |
|---|---|---|---|
| Very-good | 6% | 15% | 19% |
| Good | 88% | 80% | 81% |
| Fairly-good | 6% | 5% | 0% |
| Not-good | 0% | 0% | 0% |

[a] This data is responses to a multiple choice question. The number of respondents was 20, 16, and 27 for the cylinder pot-in-dish, round pot-in-dish, and pot-in-pot, respectively.

## Table 6: Vegetable shelf life in clay pot coolers

A comparison of the reported shelf life between each of the three clay pot cooler types is shown in below. The differences shelf life between the three types of clay pot coolers could not be determined to be statistically significant, due to the large variance and lack of direct comparison by individual participants.

Shelf life of common vegetables in the three different configurations of clay pot coolers

| | | Reported shelf life (days)[a] | | | |
|---|---|---|---|---|---|
| **Vegetable** | **Season** | **Previous[b]** | **Round pot-in-dish** | **Cylinder pot-in-dish** | **Pot-in-pot** |
| Eggplant | Dry | 5 ± 3 | 6 ± 2 | 11 ± 6 | 8 ± 3 |
| | Rainy | 6 ± 3 | 8 ± 3 | 12 ± 8 | 10 ± 4 |
| Tomato | Dry | 4 ± 2 | 8 ± 4 | 12 ± 7 | 10 ± 3 |
| | Rainy | 6 ± 2 | 11 ± 6 | 15 ± 8 | 12 ± 5 |
| Hot pepper | Dry | 5 ± 2 | 8 ± 4 | 11 ± 5 | 9 ± 4 |
| | Rainy | 6 ± 3 | 13 ± 6 | 16 ± 9 | 11 ± 5 |
| Cucumber | Dry | 5 ± 3 | 6 ± 2 | 10 ± 8 | 8 ± 5 |
| | Rainy | 6 ± 4 | 7 ± 3 | 11 ± 8 | 8 ± 4 |
| Cabbage | Dry | 4 ± 2 | 7 ± 2 | 10 ± 6 | 9 ± 4 |
| | Rainy | 5 ± 3 | 10 ± 4 | 12 ± 8 | 10 ± 4 |

[a] The first number in the shelf life is the mean, followed by the standard deviation. See Table 3 in the Appendix for additional details, including the maximum, minimum and sample size.

[b] The shelf life reported for the previous method of storage used by the participant, including woven baskets, metal and plastic containers, near the family water jar, on top of wet sand or sack.

## Table 7: Evaporative cooling chamber (ECC) construction and cost

List of materials for constructing an evaporative cooling chamber (ECC)

| | Straw ECC | Sack ECC | Brick ECC |
|---|---|---|---|
| **Primary material** | Enough straw to cover all surfaces of the ECC | Enough sack to cover all surfaces of the ECC | Enough for two layers of brick around the sides and bottom of the ECC (typically 400-800 bricks) |
| **Additional material** | Wood and nails or screws to build a frame to hold the straw | Wood and nails or screws to build a frame to hold the sack | Sand to fill the gap between the two brick walls (typically 60-60 kg) |
| | Rope or twine to secure the straw to the frame | Rope or twine to secure the sack to the frame | Wood and straw to make a cover for the top of the ECC |
| **Shade cover** | If the user does not have a shady place where the ECC can be placed, then a cover will need to be made. This typically consists of a wood or metal frame and a combination of straw and plastic. | | |

## Table 8: Clay pot cooler construction and cost

| | Pot-in-dish | Pot-in-pot |
|---|---|---|
| **Primary clay pot** | This pot should be sized to hold the desired amount of vegetables. The interior of this pot can be glazed or covered in cement to prevent water from seeping into the area where vegetables are stored | |
| **Exterior vessel** | A metal or plastic dish large enough to hold the primary clay pot on a bed of sand. This dish should not be too tall such that it blocks the entire side of the primary clay pot. It is ideal for the dish to be ~ 1/3 to 1/2 of the height of the interior clay pot | A clay pot large enough to contain the primary clay pot and allow room for a layer of sand in between the two pots. To allow water to evaporate from the surface, this exterior pot should not be glazed or covered in cement. |
| **Sand** | Enough sand is needed to fill the space between the interior clay pot and the exterior clay pot or dish | |
| **Stand (optional)** | A stand does not provide significant benefits for the pot-in-dish configuration, as water cannot evaporate though a plastic or metal dish | Placing the pot-in-pot on a stand and exposing the bottom surface can increase the evaporation of water and improve the performance |
| **Shade cover** | If the user does not have a shady place where the clay pot cooler can be placed, then a cover will need to be made. This typically consists of a wood frame and a combination of straw and plastic. Due to the relatively small size of the clay pot coolers, most users should be able to find and well ventilated shady area where the clay pot cooler can be stored without significant additional cost | |

# Appendix 3. Data Collection Tools

## Check list for group interview

| Number | Check list for group interviews |
|---|---|
| | **Varieties used and seeds sources** |
| 1. | **Characterization of the focus group discussion participants**<br>a. Number and gender of participants involved<br>b. Do you belong to any organizations or community group? |
| 2. | **a. Identification and characterization primary sources**<br>- What are the primary sources of household livelihood/income?<br>- Can you rank the sources income according to their importance? |
| 3. | **Assessment of food production and purchase**<br>- What are the crops grown in your farming system?<br>- Who is/ are responsible for the production of the crops?<br>- Is the food consumed and /or sold?<br>- Where are they sold?<br>- How are these foods transported until they are sold? |
| 4. | **Training:**<br>- Have you ever received any horticultural/agricultural training or technical assistance?<br>- Where did you receive the training? |
| 5. | **Food and Vegetable storage technologies**<br>- For the food you mentioned, what storage methods do you use for each?<br>- What are the existing food /vegetable storage technologies?<br>- How much food can you store with this method?<br>- What challenges are unaddressed by this storage approach? |
| 6. | **Household and community electricity access**<br>- What are the sources of electricity in your household?<br>- What does your household use these electricity sources?<br>- How much does your household spend on these forms of electricity? |

## Cooperative ECC Interview

| **Cooperative ECC Interview** | **Interview date: _____** |
|---|---|

**A. INTRODUCTION**

1. Good morning/afternoon. My name is _____. I am part of Massachusetts Institute of Technology (MIT) and World Vegetable Center research team, conducting a survey on evaluation of low-cost vegetable cooling and storage technologies in Mali. I am not working for government/municipal institutions. We would like to ask you some questions that should take no more than 45 minutes of your time. We would like to understand vegetable production, consumption and storage in your area. Your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Do you consent to be part of this study?

2. Does the respondent agree to participate in the study? Yes *(tick)* [ ]

3. Name of respondent _____

4. Enter the phone number of the respondent _____

5. Enter the Region _____

6. Enter the Village _____

7. Please record GPS (if possible) _____

8. Do you have a vegetable cooling product with a sensor as a part of this study?

   Yes *(tick)* [ ] No *(tick)* [ ]

   a. Enter the type of vegetable cooling product

   b. Enter the sensor number

**B. GENERAL HOUSEHOLD ASSESSMENT**

I would like to ask some questions about your household / family

1. Gender: Male [ ] Female [ ]
2. How old are you?
3. What is your position in the household?
4. How many people live in your household?
5. How many people are under 18 years old?
6. What is the primary source of livelihood or income in your household?
7. Do you or others in your household have any other jobs or roles in the community?
8. Do you belong to any organizations or community groups? If yes, what type of group?
   *[Example: Farmers' association, cooperative, NGO, savings group]*
   a. [If yes] What type of group?
   b. [If no] Does ANYONE ELSE in your household belong to any organizations or community groups? If yes, what type of group?
      *[Example: Farmers' association, cooperative, NGO, savings group]*
9. Do you or anyone in your household produce or farm any food products? What types of crops are grown?
   a. What is the most important crop you grow?
      [Enter only one]

## C. FOOD PRODUCTION AND PURCHASE

1. Do you or anyone in your household produce or farm any food products? Yes [ ] No [ ]
   *[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | List the type of food produced? | Who is responsible for these farming activities? | Where are they grown? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1. | | | | | | |
| 2. | | | | | | |
| 3. | | | | | | |
| 4. | | | | | | |
| 5. | | | | | | |

2. Have you or anyone in your household ever received any horticulture/agriculture training or technical assistance? Yes [ ] No [ ]

| | What type of training, technical assistance? | Where did you receive the training? | What did you learn from these trainings? | Was this training or technical assistance useful for you? |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |

3. Does your household purchase any foods? Yes [ ] No [ ]
   *[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | What type of food is purchased? | Who is responsible for purchasing these items? | Where are they purchased? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1. | | | | | | |
| 2. | | | | | | |
| 3. | | | | | | |
| 4. | | | | | | |

4. Do you or anyone in your household produce or farm any food products? Yes [ ] No [ ]
*[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | List the type of food produced? | Who is responsible for these farming activities? | Where are they grown? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1) | | | | | | |
| 2) | | | | | | |
| 3) | | | | | | |
| 4) | | | | | | |
| 5) | | | | | | |

5. Have you or anyone in your household ever received any horticulture/agriculture training or technical assistance? Yes [ ] No [ ]

| | What type of training, technical assistance? | Where did you receive the training? | What did you learn from these trainings? | Was this training or technical assistance useful for you? |
|---|---|---|---|---|
| 1) | | | | |
| 2) | | | | |
| 3) | | | | |
| 4) | | | | |

6. Does your household purchase any foods? Yes [ ] No [ ]
*[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | What type of food is purchased? | Who is responsible for purchasing these items? | Where are they purchased? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1) | | | | | | |
| 2) | | | | | | |
| 3) | | | | | | |
| 4) | | | | | | |

## D. ECC VEGETABLE STORAGE

1. What types of food did you store in the ECC storage products?

| | Type of ECC | Fruits vegetables (tomato, eggplant, cabbage, okra, pepper, etc.) | Leafy vegetables (amaranth, sweetpotato, leaves, etc.) | Other foods (milk, juice, water, meat, etc.) |
|---|---|---|---|---|
| 1) | Straw ECC | | | |
| 2) | Sack ECC | | | |
| 3) | Brick ECC | | | |

2. For each type of ECC ask the following individually for specific foods mentioned above

| | Type of food | How long do you typically store this food in the pot you received? | How long can you store this food in the pot before it spoils? | What is the previous storage method you used for this food? | How does this compare to the storage methods you were using previously? |
|---|---|---|---|---|---|
| | ***Example* : *tomato*** | ***5-6 days*** | ***10 days*** | ***A hole in the ground inside my shed*** | ***Better, the old way the tomato spoiled in 2 days*** |
| **Straw ECC** | | | | | |
| 1) | | | | | |
| 2) | | | | | |
| 3) | | | | | |
| **Sack ECC** | | | | | |
| 1) | | | | | |
| 2) | | | | | |
| 3) | | | | | |
| **Brick ECC** | | | | | |
| 1) | | | | | |
| 2) | | | | | |
| 3) | | | | | |

3. For each ECC, how often did you typically add water?
   *Enter in the time frame that the respondent uses. Examples: once a day / three times a day / every three days*

    a. Straw ECC

    b. Sack ECC

    c. Brick ECC

4. How do you perceive each ECC as a cooling and storage product?

    a. Straw ECC

    b. Sack ECC

    c. Brick ECC

5. What are the disadvantages of each ECC as vegetable cooling and storage product?

    a. Straw ECC

    b. Sack ECC

    c. Brick ECC

6. What are advantages of each ECC as vegetable cooling and storage product?

    a. Straw ECC

    b. Sack ECC

    c. Brick ECC

7. How could each ECC be improved?

    a. Straw ECC

    b. Sack ECC

    c. Brick ECC

8. Overall how would you rate the ECC as a cooling and storage product?
   *[Circle one of the options below]*

    a. Straw ECC: Very good / Good / Fairly good / Not good

    b. Sack ECC: Very good / Good / Fairly good / Not good

    c. Brick ECC: Very good / Good / Fairly good / Not good

9. Among the three ECC types, which one is the most challenging in adoption and why?
   *[circle one below of the following and explain why below: Straw / Sack / Brick]*

10. Among the three ECC types, which one is the best for vegetable cooling and storage?
    *[circle one below of the following and explain why below: Straw / Sack / Brick]*

*11.* Which of them is more practical and why?
   *[circle one below of the following and explain why below: Straw ECC / Sack ECC / Brick ECC]*

12. Would you make an ECC for personal use in the near future?
    *[indicate which ECC the respondent would make]*

    a. Please give reasons for your answer:

**CONCLUSION**

1. Do you have any questions for us?

_____
_____
_____
_____

2. Is there anything else we haven't asked that you'd like to tell us?

_____
_____
_____
_____

3. *Field for notes from enumerator on observations and interview context*

_____
_____
_____
_____
_____
_____

***We thank you for accepting to be interviewed and for spending your valuable time with us.***

## Household Interview: clay-pot cooler

| **Household Interview: clay pot cooler** | Interview date: _____ |
|---|---|

**A. INTRODUCTION**

Good morning/afternoon. My name is _____. I am part of Massachusetts Institute of Technology (MIT) and World Vegetable Center research team, conducting a survey on evaluation of low-cost vegetable cooling and storage technologies in Mali. I am not working for government/municipal institutions. We would like to ask you some questions that should take no more than 45 minutes of your time. We would like to understand vegetable production, consumption and storage in your area. Your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Do you consent to be part of this study?

1. Does the respondent agree to participate in the study? Yes *(tick)* [ ]

2. Name of respondent _____

3. Enter the phone number of the respondent _____

4. Enter the Region _____

5. Enter the Village _____

6. Please record GPS (if possible) _____

7. Do you have a vegetable cooling product with a sensor as a part of this study?
   Yes *(tick)* [ ] No *(tick)* [ ]

   a. Enter the type of vegetable cooling product

   b. Enter the sensor number

**B. GENERAL HOUSEHOLD ASSESSMENT**

I would like to ask some questions about your household / family

1. Gender: Male [ ] Female [ ]

2. How old are you?

3. What is your position in the household?

4. How many people live in your household?

5. How many people are under 18 years old?

6. What is the primary source of livelihood or income in your household?

7. Do you or others in your household have any other jobs or roles in the community?

8. Do you belong to any organizations or community groups? If yes, what type of group? *[Example: Farmers' association, cooperative, NGO, savings group]*

    a. [If yes] What type of group?

    b. [If no] Does ANYONE ELSE in your household belong to any organizations or community groups? If yes, what type of group?*[Example: Farmers' association, cooperative, NGO, savings group]*

9. Do you or anyone in your household produce or farm any food products? What types of crops are grown?

    a. What is the most important crop you grow?
    [Enter only one]

## C. FOOD PRODUCTION AND PURCHASE

1. Do you or anyone in your household produce or farm any food products? Yes [ ] No [ ]

*[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | List the type of food produced? | Who is responsible for these farming activities? | Where are they grown? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1) | | | | | | |
| 2) | | | | | | |
| 3) | | | | | | |
| 4) | | | | | | |
| 5) | | | | | | |

2. Have you or anyone in your household ever received any horticulture/agriculture training or technical assistance? Yes [ ] No [ ]

| | What type of training, technical assistance? | Where did you receive the training? | What did you learn from these trainings? | Was this training or technical assistance useful for you? |
|---|---|---|---|---|
| 1) | | | | |
| 2) | | | | |
| 3) | | | | |
| 4) | | | | |

3. Does your household purchase any foods? Yes [ ] No [ ]

*[Prompt with examples if needed: vegetables, fruits, cereal, etc.]*

| | What type of food is purchased? | Who is responsible for purchasing these items? | Where are they purchased? | Is this food consumed and/or sold? | Where are they sold? | How are these foods transported until they are sold? |
|---|---|---|---|---|---|---|
| 1) | | | | | | |
| 2) | | | | | | |
| 3) | | | | | | |
| 4) | | | | | | |

**D. CLAY POT VEGETABLE STORAGE**

1. What types food did you store in the clay pot *(clay pot-in-pot or clay pot-in-dish)* storage product you received?

    a. Fruits vegetables (tomato, eggplant, cabbage, okra, pepper, etc.)

    b. Leafy vegetables (amaranth, sweetpotato, leaves, etc.)

    c. Other foods (milk, juice, water, meat, etc.)

2. *[Ask the following individually for each type of food mentioned above]*

| | Type of food | Using this storage method, how long do you typically store this food? | Using this storage method, how long does it typically last until it spoiled? | What is the previous storage method you used for this food? | How does this compare to the storage methods you were using previously? |
|---|---|---|---|---|---|
| | ***Example : tomato*** | ***5-6 days*** | ***10 days*** | ***A hole in the ground inside my shed*** | ***Better, the old way the tomato spoiled in 2 days*** |
| 1) | | | | | |
| 2) | | | | | |
| 3) | | | | | |

3. I would like to understand a bit more about your indicated ancient storage method

| Type of storage method | Does this storage method use electricity or other forms of energy? | How much food can you store with this method? | Cite some disadvantages of your ancient method | Cite some advantages of your ancient method | How much does it cost you to purchase and/or operate this storage method? |
|---|---|---|---|---|---|
| ***Example : Brick ECC*** | ***No*** | ***50-60 kg*** | ***Extends the shelf life of vegetable*** | ***Regular monitoring*** | ***Nothing*** |
| | | | | | |
| | | | | | |

4. How often did you typically add water to the clay pot-in-pot or clay pot-in-dish?
   *[Enter in the time frame that the respondent uses. Examples: once a day / three times a day / every three days / twice per week]*

5. How do you perceive the pot as a cooling and storage product?

6. What are the disadvantages of your pot as vegetable cooling and storage product?

7. What are advantages of your pot as vegetable cooling and storage product?

8. Overall how would you rate the pot as a cooling and storage product?

   *Circle one of the following options:* Very good Good Fairly good Not good

9. Would you buy a pot for personal use in the near future?

   *Circle one of the following options: Yes Maybe No]*

   a. Please give reasons for your answer:

10. Are there other methods for food /vegetable cooling and storage you prefer? YES [ ] NO [ ]

| What type of storage method would you prefer? | Why would you prefer this storage method? | Why are you not currently using this food storage method? | How much would this storage method cost for you to purchase and/or operate? |
|---|---|---|---|
| ***Example : fridge*** | ***Long shelf life*** | ***Lack of grid electricity/*** | ***Don't know*** |
| | | | |
| | | | |
| | | | |

11. I would like to know more about your ancient equipment of vegetable and food storage method

| Does your ancient equipment operate with electricity? | What is the quantity of food you can store with this method? | Cite some disadvantages of your ancient method | Cite some advantages of your ancient method |
|---|---|---|---|
| ***Example*: No** | ***2-3 kg*** | ***Attacks of predators like mice*** | ***Requires no electricity*** |
| | | | |

12. Do you still use your ancient method/equipment for vegetable and food storage?

Yes [ ] No [ ]

If Yes, why are you using it while having the pot/ECC? Provide your reasons

---

---

---

---

If No, why are you not currently using it?

---

---

---

---

## E. ADDITIONAL QUESTIONS COMPARING THE ANCIENT METHOD OF THE PARTICIPANT TO THE CLAY POT VEGETABLE COOLING AND STORAGE PRODUCT FOR SPECIFIC FOODS

**[***Ask the following questions for each type of foods listed below***]**

| | Do you store this type of food? (yes or no) *if no, skip other questions* | What is your ancient method of storing this food? | Which is better for storing this food, your ancient equipment or the clay pot? | Do you see any differences in how long vegetables can be stored in different seasons? | How long can you store this food in your ancient equipment before it becomes spoiled? (dry season and rainy season) | | How long can you store this food in your clay pot before it becomes spoiled? (dry season and rainy season) | |
|---|---|---|---|---|---|---|---|---|
| | ***<u>Example</u>: Tomato Yes*** | ***Woody basket*** | ***Pot-in-pot*** | ***Woody basket: no differences Pot-in-pot: yes worse in the rainy season*** | ***Dry season: 4-5 days*** | ***Rainy season: 4-5 days*** | ***Dry season: 10 days*** | ***Rainy season: 5-7 days*** |
| 1. | **Tomato** | | | | | | | |
| 2. | **Eggplant** | | | | | | | |
| 3. | **Cucumber** | | | | | | | |
| 4. | **Cabbage** | | | | | | | |
| 5. | **Hot pepper** | | | | | | | |
| 6. | **Sweet potato leaves** | | | | | | | |

## E2. ADDITIONAL QUESTIONS ABOUT THE ANCIENT METHOD OF VEGETABLE STORAGE

1. What were the types of food are stored in your ancient method/equipment?

    a. Fruits vegetables (tomato, eggplant, pepper, sweet pepper, cucumber, melon, okra)

    b. Leafy vegetables (cabbage, lettuce, persil, amaranth, sweetpotato leaves, moringa leaves)

    c. Other food (milk, juice, water, meat, etc)

2. After receiving the clay pot, do you still use your ancient method/equipment for vegetable and food storage?

    Yes [ ] No [ ]

    a. If Yes, why are you using it while having the clay pot? For which foods do you still use it? Provide your reasons

    ---

    ---

    ---

    b. If No, why are you not currently using it?

    ---

    ---

    ---

3. I would like to know more about your ancient equipment of vegetable and food storage method

| Does your ancient equipment operate with electricity? | What is the quantity of food you can store with this method? | Cite some disadvantages of your ancient method | Cite some advantages of your ancient method |
|---|---|---|---|
| ***Example: No*** | ***2-3 kg*** | ***Attacks of predators like mice*** | ***Requires no electricity*** |
| | | | |

4. Do you still use your ancient method/equipment for vegetable and food storage?

Yes [ ] No [ ]

a. If Yes, why are you using it while having the pot/ECC? Provide your reasons

---

---

---

b. If No, why are you not currently using it?

---

---

---

**F. HOUSEHOLD AND COMMUNITY ELECTRICITY ACCESS**

1. What are the sources of electricity in your household?
   *[Examples: electric grid, local mini-grid, generator, solar home system or lantern, disposable batteries]*

2. What does your household use these electricity sources for?
   *[Examples: lighting, phone charging, fan, radio, TV, air ]*

3. How much does your household spend on your primary source of electricity (per month)?
   *[List cost by electricity source if applicable]*
   *[Enter in the units given, for example: per week, month, or initial purchase]*

4. What are the things you like most about your electricity source(s)?
   *[If nothing is liked, enter "none"]*

5. Are there places outside of your home where you have access to electricity?

   Yes [ ] No [ ]

   If yes, where are these places?

   a. _____

   b. _____

   c. _____

## G. ASPIRATIONAL ACTIVITIES

1. Is there anything that you would like to change about your household electricity access?

2. Are there any **activities** that you are not currently doing, but would like to do?

    a. _____

    b. _____

    c. _____

3. [Ask the questions below for only ONE activities mentioned]

    Activity 1: _____

    a. Why would you like to be able to do this activity?

        *Answer*_____

    b. Why are you not able to do this now?

        *Answer*_____

    c. What would be your ideal solution to this situation?

        *Answer*_____

4. In five years, what changes would you like to see in your home?

    a. _____

    b. _____

    c. _____

    d. _____

**H. WRAP-UP**

1. Do you have any questions for us?

_____

_____

_____

_____

2. Is there anything else we haven't asked that you'd like to tell us?

_____

_____

_____

_____

*3. Field for notes from enumerator on observations and interview context*

_____

_____

_____

_____

_____

***We thank you for accepting to be interviewed and for spending your valuable time with us.***

## Consent to Participate in Interview

### CONSENT TO PARTICIPATE IN INTERVIEW

Study: Evaluation of Low-Cost Vegetable Cooling and Storage Technologies in Mali

You have been asked to participate in a research study conducted by the Massachusetts Institute of Technology (M.I.T.) and the World Vegetable Center. The purpose of the study is to determine the performance of vegetable cooling and storage products, and any benefits these products may have for users.

The results of this study will be included in publicly available reports and publications summarizing the findings of this research. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

- Participation in this study is voluntary. You have the right not to end your participation in this study at any time or for any reason. The study will consist of 3-4 interviews, each less than 1 hour, over a period of 6 months.
- You will not be compensated for participation in this study other than the use of the vegetable cooling and storage product that may be provided.
- Unless you give us permission to use your name, title, and / or quote you in any publications that may result from this research, the information you tell us will be confidential.
- We will be using electronic monitoring equipment to measure the performance of the vegetable cooling and storage prodcuts that are the subject of this study. The monitoring equipment will measure the temperature and humidity inside and outside of the vegetable cooling and storage product, the moisture of the sand in the product, and the presence of a coveing on the top of the product. The moniroting device is not capable of recording audio or video.

This project will be completed by no later than August 31, 2018. All interview recordings will be stored in a secure workspace until 2019 after that date. The tapes will then be destroyed.

*Your signature below confirms your agreement with the following statements:*

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

*(Please check all that apply)*
[ ] I agree to participate in this study
[ ] I give permission to share my data Development Experience Clearinghouse in USAID.

I give permission for the following information to be included in publications resulting from this study:

[ ] my name
[ ] photographs of the location where vegetable cooling and storage product are being used
[ ] direct quotes from interviews

Name of Subject _____

Signature of Subject _____ Date _____

Signature of Investigator _____Date _____

Please contact Eric Verploegen (ericv@mit.edu or +1-617-947-9762) with any questions or concerns.

If you feel you have been treated unfairly, or you have questions regarding your rights as a research subject, you may contact the Chairman of the Committee on the Use of Humans as Experimental Subjects, M.I.T., Room E25-143b, 77 Massachusetts Ave, Cambridge, MA 02139, phone +1-617-253-6787.

# Authors & Acknowledgements

## About the Authors

Eric Verploegen, **MIT D-Lab, Massachusetts Institute of Technology**
Dr. Verploegen received a PhD from the Massachusetts Institute of Technology in Polymer Science in Technology. Eric joined D-Lab in 2014 to expand D-Lab's research efforts in the area of off-grid energy. He has over 10 years experience developing technologies for the energy sector, including waste remediation systems for the oil and gas industry and solar cells. He is passionate about helping organizations based in off-grid regions identify technologies, products, and distribution strategies to increase energy access in their communities.

Ousmane Sanogo, **World Vegetable Center**
Dr. Sanogo received a BSc in Agriculture at Polytechnic Rural Institute of Education and Applied Research (IPR/IFRA) of Katibougou, Mali, a MSc in Crop Protection at Gembloux Agro-Biotech, Belgium, and PhD in Plant Breeding at West Africa Centre for Crop Improvement (WACCI), University of Ghana, Ghana. Dr. Sanogo has over 15 years of experience working with national and international agricultural research and development organizations such as International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the World Vegetable Center. He worked in a range of crops including sorghum, rice, cotton, groundnut, *Jatropha* and vegetable crops.

Takemore Chagomoka, **World Vegetable Center**
Dr. Chagomoka holds a PhD from Albert Ludwigs University of Freiburg in Germany. His PhD research focused on food and nutrition insecurity risk mapping in West African cities (Tamale, Ghana and Ouagadougou, Burkina Faso). Dr Chagomoka's previous work assignments have sent him for extended periods to Southern Africa (Zimbabwe and Mozambique), East Africa (Tanzania), Central Africa (Cameroon) and West Africa (Ghana, Burkina Faso and Mali). His research interests include the contribution of agriculture to household food and nutrition security especially in urban and periurban areas, socio-spatial dynamics of food and nutrition security along the urban-rural continuum, Geographic Information Systems (GIS), and post-harvest.

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## Additional Resources

The following additional resources are available at:
http://d-lab.mit.edu/resources/projects/evaporative-cooling

- **Evaluation Report:** The full evaluation report details the findings from this research.
- **Evaporative Cooling Decision Making Tool:** An interactive Microsoft Excel-based decision making tool to help determine if evaporative cooling devices are suitable for a specific context, and to guide the calculation of potential financial savings.
- **Evaporative Cooling Best Practices Guide:** Provides guidance on best practices for determining the suitability of evaporative cooling technologies for a specific context, construction and usage of clay pot coolers and evaporative cooling chambers, and dissemination approaches.