



RESEARCH PROGRAM ON
Roots, Tubers
and Bananas



Manual: *Fresh cassava roots handling for waxing and relative humidity storage*

*Expanding Utilization of Roots, Tubers and Bananas
and Reducing Their Postharvest Losses*

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A broad alliance of
research-for-development
stakeholders & partners



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The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a broad alliance led by the International Potato Center (CIP) jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA), and CIRAD in collaboration with research and development partners. Our shared purpose is to tap the underutilized potential of root, tuber and banana crops for improving nutrition and food security, increasing incomes and fostering greater gender equity, especially among the world's poorest and most vulnerable populations.



Table of Contents

List of Figures	3
List of abbreviations and acronyms	4
1. Introduction.....	5
2. Production	6
2.1. Land preparation.....	6
2.2. Selection of clean planting material.....	6
2.3. Planting.....	6
2.4. Pruning	7
2.5. Harvesting	8
3. Packing and transportation	8
4. Sorting and washing	9
5. Weighing and disinfection.....	9
6. Drying	10
7. Storage.....	10
7.1. High Relative Humidity Storage	10
7.2 Waxing.....	10
8. Marketing	12
9. Conclusion	12



List of Figures

Fig. 1: Ridge making	6
Fig. 2: Disease-free cuttings	6
Fig. 3: Planting in ridges	7
Fig. 4: Pruning of cassava plants	7
Fig. 5: Root harvesting	8
Fig. 6: Packing of roots in crates for transportation	8
Fig. 7: Sorting, trimming and washing	9
Fig. 8: Weighing	9
Fig. 9: Disinfection	10
Fig. 10: Drying	10
Fig. 11: Pack house for application of shelf life extension techniques	12



List of abbreviations and acronyms

CGIAR	Consortium of International Agricultural Research Centers
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Center
CIRAD	French Agricultural Research Centre for International Development
IIRR	International Institute of Rural Reconstruction
IITA	International Institute for Tropical Agriculture
NARO	National Agriculture Research Organization
PPD	Postharvest Physiological Deterioration
RTB	CGIAR Research Program on Roots, Tubers and Bananas
SSA	Sub-Saharan Africa



1. Introduction

Cassava is an important source of food and income in Uganda and in many developing countries in Africa. In sub-Saharan Africa (SSA), cassava is a major staple providing over 20% of calorific requirements and constituting nearly two-thirds of per capita food production.

One of the major challenges facing cassava is its rapid postharvest physiological deterioration (PPD) which normally occurs within two days of harvest. This results into short marketing period, discounted prices, losses in income to growers and traders, and reduced utilization and food security.

This manual is an output of the *Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses* (RTB-ENDURE) and it has been developed to aid building the capacities of actors in producing, handling and marketing fresh cassava roots whose shelf-life is extended by either waxing or high relative humidity storage technologies. The manual presents the basic steps required for the production of suitable cassava roots and for processing them in order to ensure extended shelf-life without detriment of the eating quality during the storage period. In combination with another project output, the manual “Setting up a pack house for waxing and relative humidity storage of fresh cassava roots” this is a valuable resource for entrepreneurs and organization willing to establish and run such a processing plant as well as farmers interested in supplying roots to the pack house.

The process for extending the shelf-life through waxing and high relative humidity storage starts right from field preparation to harvest and postharvest handling. Ideally the two technologies should be promoted concurrently in order to target different fresh cassava market segments and meet diverse consumers’ preferences.



2. Production

Producing fresh cassava roots for waxing and high relative humidity storage requires specific agronomic practices in order to obtain commercially acceptable roots in terms of size, shape and appearance. These practices also help in easing root harvesting and thereby minimizing damages or injuries to the roots. This in turn helps to extend the shelf life since mechanical damages during harvesting accelerate the postharvest deterioration of cassava.

The steps to follow are listed below:

2.1. Land preparation

1. Clear the land of all shrubs and remove unnecessary stumps.
2. Plough the land.
3. Dig ridges in the ploughed area, with care not to facilitate erosion. If land is hilly, ridges should be across the slope. Do not make ridges along the slope (Fig. 1a).
4. Make ridges with the following dimensions: 0.4 meter height by 0.5 meters width. Distance between ridges should be 1 meter (Fig. 1b).

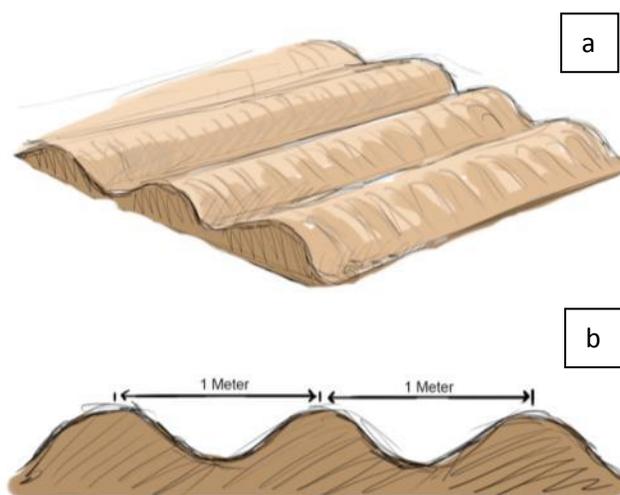


Fig. 1: Ridge making

2.2. Selection of clean planting material

1. Obtain clean cassava cuttings from disease free plants that are 8–12 months old.
2. Identify disease free plants. Check the leaves and stems for any signs of pest attack. Healthy plants have robust stems and branches, lush foliage and minimal stem and leaf damage.
3. Using a sharp machete (*panga*) cut the disease free stakes into 25cm long cuttings for planting (Fig. 2).



Fig. 2: Disease-free cuttings



2.3. Planting

1. Plant at the onset of the rains.
2. Plant the cuttings horizontally on ridges to a depth of 5 cm (Fig. 3a).
3. The recommended plant spacing along the ridge should be 0.6 meters.

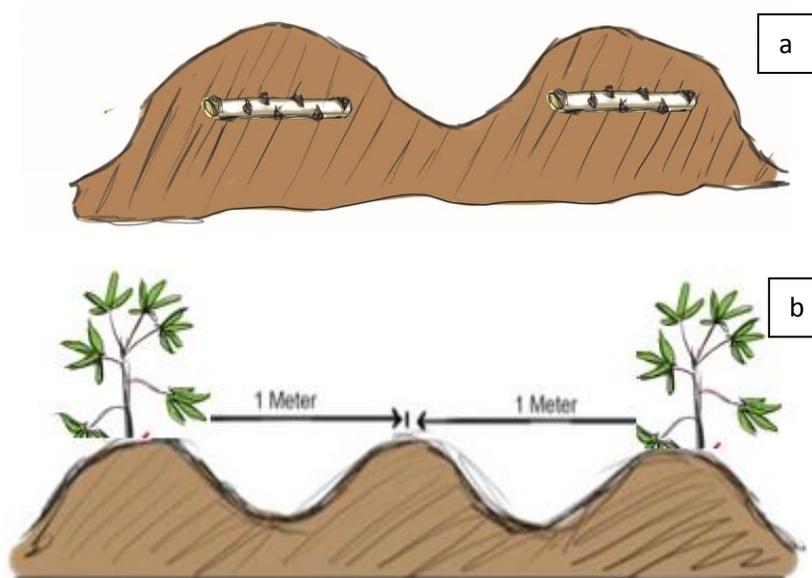


Figure 3: Planting in ridges

2.4. Pruning

1. When the cassava plant is 8 – 12 months old, prune by cutting off the top leaves with a sharp machete (Fig 4a).
2. Leave the pruned plant in the field for 6 days (Fig 4b).

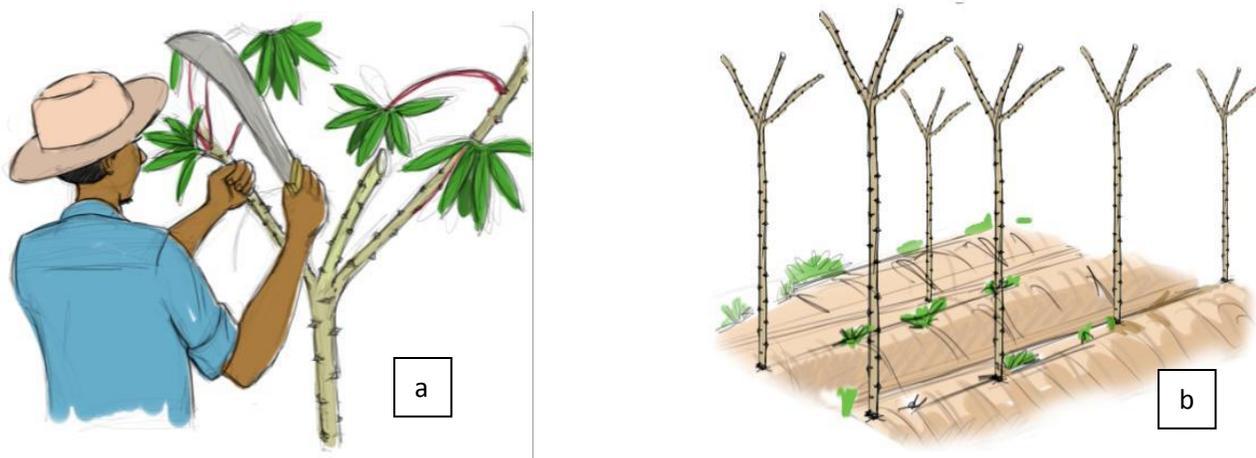


Fig. 4: Pruning of cassava plants



2.5. Harvesting

1. Harvest the pruned plant on day 7 by holding the stem at 0.3 meters above the ground and pulling vertically with care, until all the roots are out of the soil (Fig. 5a).
2. Take care not to bruise or damage the roots during harvesting.
3. Use a machete or secateurs to cut off the roots from the stem, leaving a small piece of peduncle on the roots so that the parenchyma is not exposed to air (Fig. 5b).
4. Select-out damaged and unwanted, oversized or undersized roots.

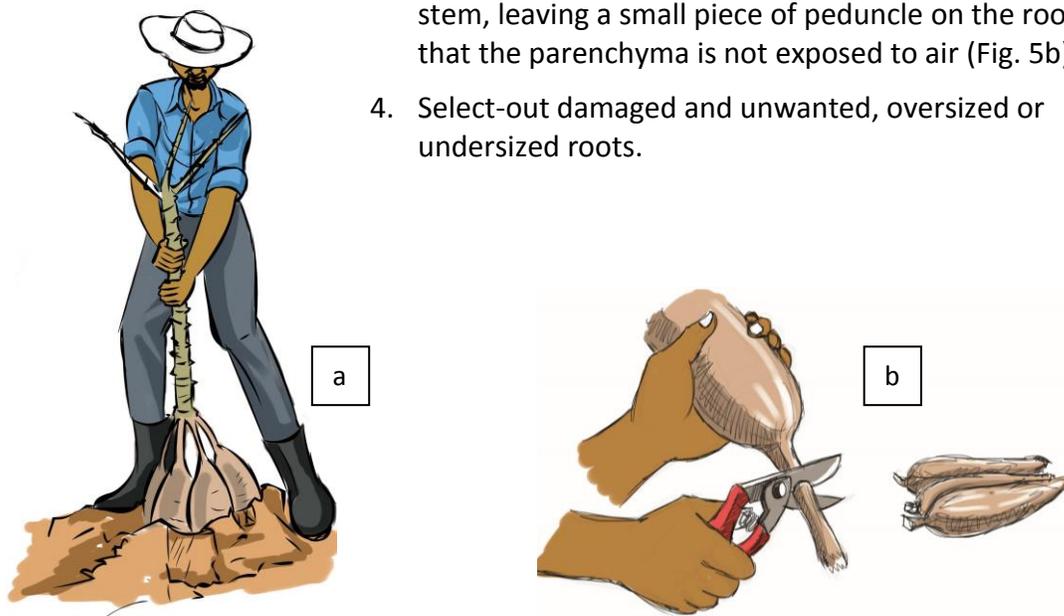


Fig. 5: Root harvesting

3. Packing and transportation

1. Pack the desired roots carefully into plastic crates, ensuring that there is no damage to the roots.
2. Optionally, sort roots of identical sizes or grades into same crates.
3. Do not overfill the crates.
4. Stack the crates carefully on the vehicle
5. Avoid crates resting on the roots by allowing gaps between crates.
6. Transport the roots gently to the processing center.



Fig. 6: Packing and loading



4. Sorting and washing

1. At the pack house repeat the removal of damaged and unwanted, oversized or undersized roots and use them for other purposes.
2. Using a brush with soft plastic bristles, gently scrub the roots in a trough of cold water to remove any soil and foreign matter that might be attached to the roots.
3. Rinse the roots in fresh clean water in another trough, while inspecting the roots for bruises and size. During this process, take care not to bruise the roots.
4. Sort the roots by size or grade.



Fig. 7: Sorting and washing

5. Weighing and disinfection

1. Pack the roots in crates and weigh to make 20kg per crate (Fig. 8).
2. Set the crates on clean level ground or pallets and allow water to drip for about 10-15 minutes.
3. Prepare a solution of fungicide (e.g. Ridomil) and surfactant (e.g. Silwet-Gold) by putting 3 flat tea spoons of fungicide and a bottle top of the surfactant in 100 liters of water (Fig. 9a).
4. Completely immerse the crates with roots into the solution of fungicide and surfactant for 3 minutes, to kill any germs and other contaminants on the roots. (Fig. 9b).

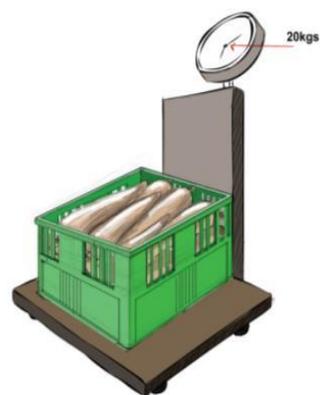


Fig. 8: Weighing

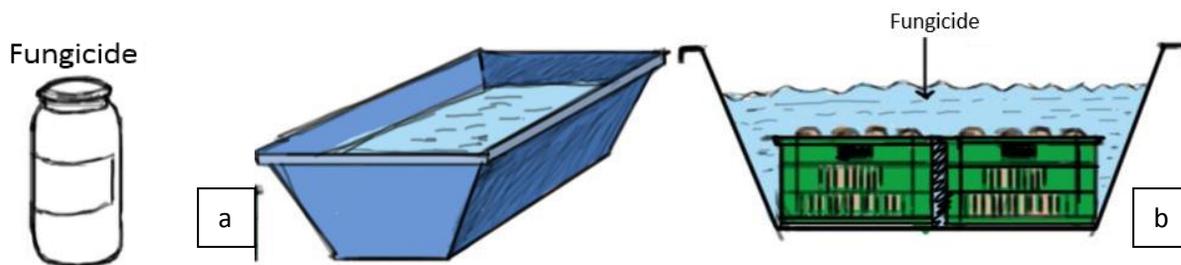


Fig. 9: Disinfection

5. Remove the crates from the solution and allow roots to drip for 10-15 minutes.



6. Drying

1. Spread out the roots to dry for about one hour on a raised platform with wire mesh under shade (Fig. 10).



Fig. 10: Drying

7. Storage

After the disinfection and drying, the fresh roots are ready for either waxing or relative humidity storage treatments to be undertaken in a well-built pack house with the required equipment and tools (Fig. 11).

7.1. High Relative Humidity Storage

1. Weigh about 3 kilograms of disinfected fresh roots.
2. Pack the weighed roots into polythene bags and seal.
3. Label the bags with information about the weight, date of processing and name & contacts of processor. Optionally, the name of the variety, safety and nutritional information, best before date, storage conditions, and suggestions on how to prepare the roots can be added.

7.2 Waxing

1. Heat food grade wax in a rectangular stainless steel tank (600mm x 400mm x 450mm deep) using gas or electric heater to a temperature between 140°C - 160°C. Use of firewood is discouraged due to the difficulty of controlling the temperature.
2. Assemble the dried roots into fabricated metallic baskets.
3. Completely submerge the metallic baskets containing the roots into the melted wax for a maximum of 1-2 seconds.
4. Pack the waxed roots into crates. Each crate should ideally weigh about 20 kilograms but smaller units of packaging can be used depending on consumer and market requirements.
5. Label the crate with information about the weight, date of processing and name & contacts of processor. Optionally, the name of the variety, safety and nutritional information, best before date, storage conditions, and suggestions on how to prepare the roots can be added.

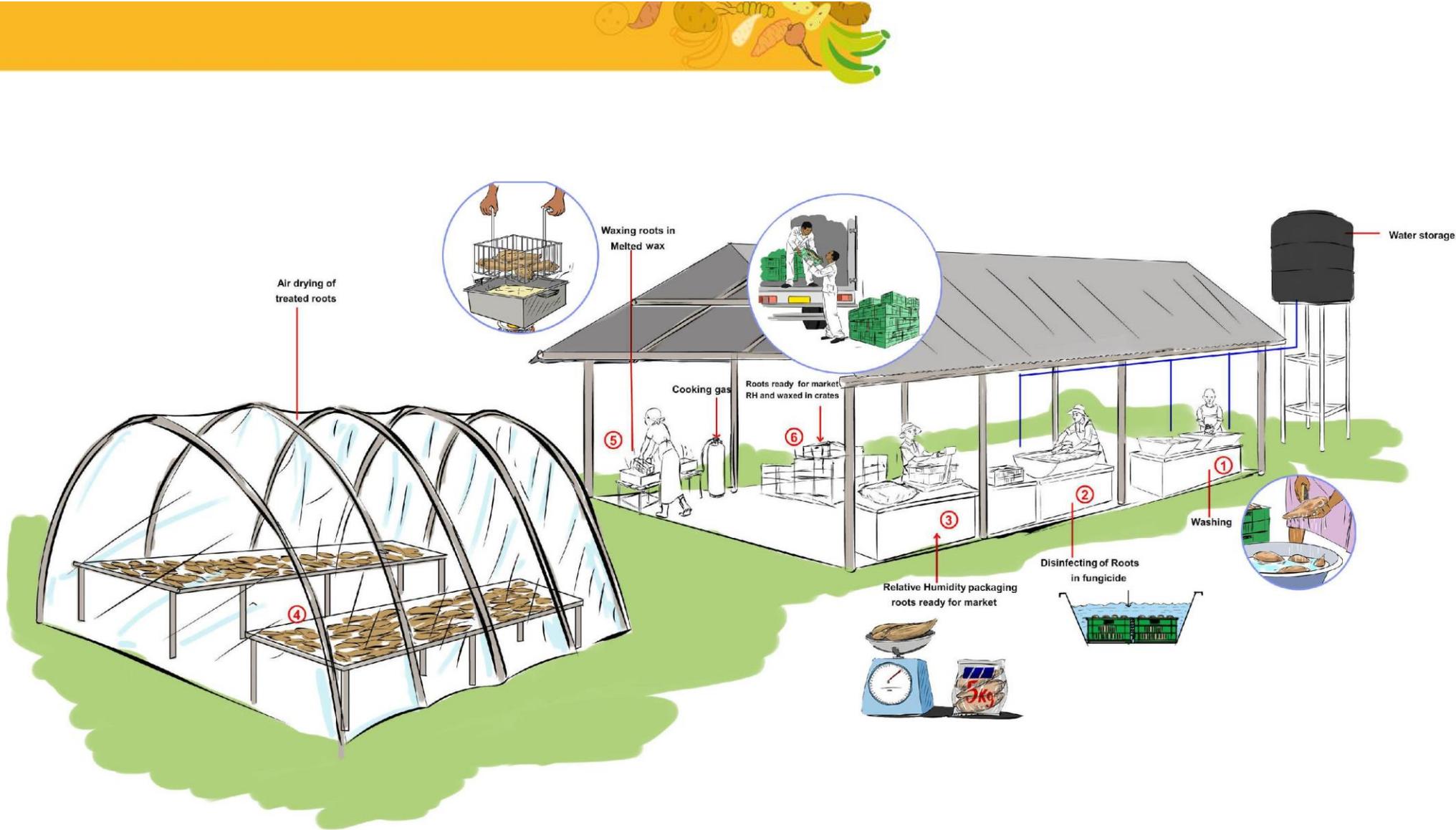


Fig. 11: Pack house for application of shelf-life extension techniques

Precautions: Do not leave roots inside the melted wax more than 2 seconds to avoid cooking. Ensure that the temperature of the molten wax is maintained between 140°C and 160°C using a thermometer. Temperatures below 140°C will lead to a very thick layer of dull wax on the roots. Temperatures above 160°C will cause rapid evaporation of the wax leading to higher costs of operating.



8. Marketing

1. Transport and handle the treated roots (high relative humidity stored or waxed) carefully to avoid any damage to the roots.
2. Do not display the shelf-life extended roots in direct sunshine, but rather under a shade or at room temperature.

9. Conclusion

The application of the shelf-life extension techniques described in this manual is expected to contribute to cassava value addition, reduction of postharvest losses for farmers, transporters and traders, increased marketability over long distances and utilization of fresh roots and, possibly, reduced cost of fresh cassava for consumers in the long-run. The techniques have been described based on exposure visits to CIAT Colombia and minimal pilot testing of the techniques in Uganda. Additional research is being conducted to identify effective pre-harvest practices and best marketing models that will enable increased utilization of fresh cassava roots with extended shelf-life.

