RESEARCH PROGRAM ON Roots, Tubers and Bananas

CGIAR

Manual:
Setting up a Packhouse for Waxing and Relative Humidity Storage of Fresh Cassava Roots

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

RTB ENDURE

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European Commission

IFAD
Enabling poor rural people to overcome poverty

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

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Centro Internacional de la Papa CIP

Bioversity International

CIAT Centro Internacional de Agricultura Tropical International Center for Tropical Agriculture

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

NARO

IITA Research to Nourish Africa

IIRR

Kyambogo University knowlegde and skills for service

IITA Research to Nourish Africa

Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses (RTB-ENDURE) is a 3-year project (2014-2016) implemented by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) with funding by the European Union (EU) and technical support of IFAD. http://www.rtb.cgiar.org/endure

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 of 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.

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ACRONYMS AND ABBREVIATIONS

ASSP	Agriculture Sector Strategic Plan for Uganda
CIAT	International Centre for Tropical Agriculture- there
CIP	International Potato Center - there
CGIAR	Consultative Group on International Agriculture Research – there
GoU	Government of Uganda
IFAD	International Fund for Agricultural Development - there
IIRR	International Institute of Rural Reconstruction
IITA	International Institute for Tropical Agriculture – there
NARO	National Agricultural Research Organization-Uganda
PPD	Postharvest physiological deterioration
RTB	Roots, Tubers, and Bananas
UNDP	United Nations Development Programme

1. BACKGROUND

This manual is an output of the "Extending the Shelf life of Fresh Cassava Roots for Increased Incomes and Postharvest Loss Reduction", a sub-project of the "Expanding Utilization of RTB and Reducing Their Postharvest Losses" (RTB-ENDURE), a 3 year project implemented in Uganda by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) with funding of the European Union and technical support of IFAD. Research to set up and operationalize two cassava pilot packhouses was one of the major outputs of the cassava sub-project. This sub-project was led by IITA with other implementing partners being NARO and IIRR. CIP provided overall management support while CIAT offered capacity building to the Ugandan implementing partners. It was a highly collaborative research project whose partnership extended beyond the original organizations i.e. IITA, IIRR and NARO and eventually included Kyambogo and Makerere universities, Kabarole and Kyenjojo local governments, GoU and Bricks Investment, a private sector actor.

This manual aims at describing how to set up a packhouse for extending the shelf-life of fresh cassava roots by using two technologies, namely waxing and relative humidity storage. In combination with another project output, the user guide "Fresh cassava roots handling for waxing and relative humidity storage" this is a valuable resource for entrepreneurs and organization willing to establish and run such a processing plant.

All opinions expressed in this manual are those of the authors and do not necessarily reflect the views of EU and IFAD.

2. INTRODUCTION

2.1. IMPORTANCE OF CASSAVA

Cassava (*Manihot esculenta*) is an important source of food and income in Uganda, providing about 20% of the calorific requirement. It is one of the ten commodities that have been prioritized by the Ugandan Government in its Agriculture Sector Strategy Plan (ASSP) 2015/16 to 2019/20. Uganda is the sixth largest producer of cassava in Africa with 4.2 million tons produced in 2010 (UNDP, 2012). It is estimated that 60% of the production is destined for household consumption and 40% for marketing (Kimathi, et al., 2007). Nearly 90% of the population consume cassava in different forms at least once daily (MAAIF/FAO, 2011). It is predominantly grown by subsistence farmers as a staple crop on plots of one to three acres (Mugisa, 2010).

The market for fresh cassava is growing driven by population increase, urbanization and changing consumption habits. Fresh cassava is widely consumed both in urban and rural areas as a snack and main meal. Fresh cassava marketing is currently an important source of income (Scoping study, 2014). Uganda has a policy of releasing "sweet varieties", i.e., varieties with low levels of cyanogens. These varieties are popular, with consumer demand increasing especially in urban areas, thereby providing income opportunities to both male and female growers and

traders. Retailing in fresh cassava is dominated by women. Despite its growth in importance, fresh cassava value chain has not realized its full potential in terms of production, utilization and commercialization.

2.2. THE PROBLEM

One of the major constraints facing the large-scale production and commercialization of cassava roots is the rapid postharvest physiological deterioration (PPD) that occurs within 48 hours after harvest. PPD rapidly renders the roots unpalatable and unmarketable. Consequently, cassava roots need to be consumed or processed soon after harvesting. Short shelf-life severely limits the marketing options because it increases the likelihood of losses, marketing costs, and limits access to distant urban markets. The application of technologies that extend the cassava shelf-life, such as waxing and relative humidity storage, can increase marketing opportunities and incomes for smallholders as well as contribute to the reduction of postharvest losses that affect directly mainly retailers and indirectly all value chain actors.

3. APPROACH

While cassava waxing and relative humidity storage are in commercial use in other countries, the investment requirements and commercial viability in the Ugandan context was unknown. Hence, the cassava sub-project has set-up two packhouses in order to test the two storage technologies in commercial setting and to build the capacities of a farmers' cooperative and an entrepreneur hosting the plants. This was preceded by an initial capacity building activity to expose smallholder farmers to the pre-requisites of packhouse construction, materials of construction, equipment and the operations.

The production of this manual is aimed at sharing the experience gained in the process. The manual can guide public and private sector investment in establishing similar cassava packhouses in other cassava producing countries in Africa and beyond. The bill of materials provided are suggestions only and may vary depending on the location and existing unit of measure for sale of construction materials.

4. PACKHOUSE

- A packhouse, in the context of this manual, is a physical structure where fresh cassava roots are consolidated and subjected to shelf-life extension treatment(s) prior to distribution to market outlets. Its location is vital in achieving its goal.
- Packing of fresh cassava roots in high relative humidity containers and waxing of fresh cassava roots for subsequent packing in appropriate containers are the main processing operations from which the name 'packhouse' is derived.

- However, a number of other steps are carried out before and after packing of the treated roots. The specific activities in the packhouse include weighing, sorting and grading, washing, disinfecting, drying, storing under high relative humidity, waxing, packaging in crates and loading into distribution vehicle for marketing. All of the activities constitute packhouse operations.
- A packhouse may be simple or modern, and involving more advanced operations and facilities. This manual focuses on a simple packhouse for smallholder farmers' groups, cooperatives and individual traders. An individual farmer or trader can invest in such a simple packhouse. As business expands and operators gain skills and knowledge, they can improve, expand or upgrade it to a modern packhouse depending on availability of space and financial resources. They may also set up a new modern packhouse.

5. SELECTING A LOCATION FOR CONSTRUCTION OF A PACKHOUSE

In Uganda the fresh cassava value chain is characterized by numerous consolidation or collection centers that are usually managed by rural assemblers. They serve as collection points where fresh cassava is assembled, packed in bags and later on transported on trucks to consumption areas. Until now, there was no packhouse for the treatment of fresh cassava roots for shelf-life extension.

Establishing a packhouse for shelf-life extension of the fresh cassava roots requires a careful analysis of a number of factors that would enable important handling operations to be carried out successfully. Below are some of the factors that require attention.

Source of fresh cassava roots

- PPD occurs immediately after harvest. Therefore, a packhouse should be located within a cassava production zone so as to allow fresh roots arrive quickly for their treatment to commence. Ideally fresh roots should reach the packhouse within four hours after harvest. Another useful consideration is the existence of cassava varieties that are suitable for treatment and acceptable to consumers in terms of the eating quality.

Plate 1: Field varietal identification

- The location must be within easy reach for fresh cassava roots, adequate labour for packhouse operation and, possibly, electricity supply.

- It is critical to conduct an analysis of production level and extent of marketing of the preferred cassava varieties that already exist in the area to ensure that the packhouse will have consistent supply of fresh roots throughout the year at an acceptable price.
- To reduce the cost of construction, the construction site should be relatively flat but with gentle slope to allow run-off of rain water. Swampy or gully erosion-prone areas should be avoided.

Access to road

- A packhouse should have good road infrastructures to allow for easy drop-off and pick-up of fresh cassava in crates.
- A good road network also implies that the packhouse would be easily accessible to a large number of smallholders and traders.

Plate 2: Site location near the road side

Water source

- Many rural areas in developing countries lack sufficient supply of clean water for processing of agricultural produce. Availability of clean water is crucial for packhouse's operations. Careful analysis should be made to determine water availability. Where there is lack of public supply of potable water, water supply can be ensured by a deep or shallow well depending on location and fund availability.

Plate 3: Identification of clean water source

To reduce the cost of drilling a well, it is advised to target areas that would allow for construction of a shallow well. Therefore, before selecting a location for the construction of the packhouse, it is important to assess existing water supply systems in the area. In addition to identification of water sources, it is also crucial to ascertain the amount of water that can be obtained from the well compared to the water requirements of the

packhouse, which also depends on the scale of operation that is planned for the packhouse. Conducting a geo-survey of underground water to identify the best spot for constructing the water well will increase the probability of getting enough water and can save substantial money and time. The cost of digging shallow water well or borehole varies from one location to another. The cost should be ascertained for the selected location. Below (Table 1) is the bill of materials for a water supply system after drilling the shallow water well or borehole.

Table 1: Bill of materials for a water supply system

NO	Description	Unit	QTY
1	Pipes	Number	4
2	Angle line	Number	2
3	Plate	Number	1
4	Whole section	Number	3
5	Water tanks	Litres	1,000
6	Labour	Man-hour	16

In addition to the above considerations, the site and premises should have the following characteristics:

- Minimal risk of air pollution or contamination
- Protection from sun and rain
- Dependable electricity supplies
- Comfort and safety utilities for workers
- Clock-in area and toilet facility.

Plate 4: Cassava waxing and drying facilities

6. PACKHOUSE OPERATIONS FOR WAXING AND RELATIVE HUMIDITY STORAGE

The essential packhouse operations for waxing and relative humidity storage are shown in the flow chart below (Figure 1). The unit operations are used to determine the types and quantities of tools and equipment necessary for constructing and equipping a packhouse.

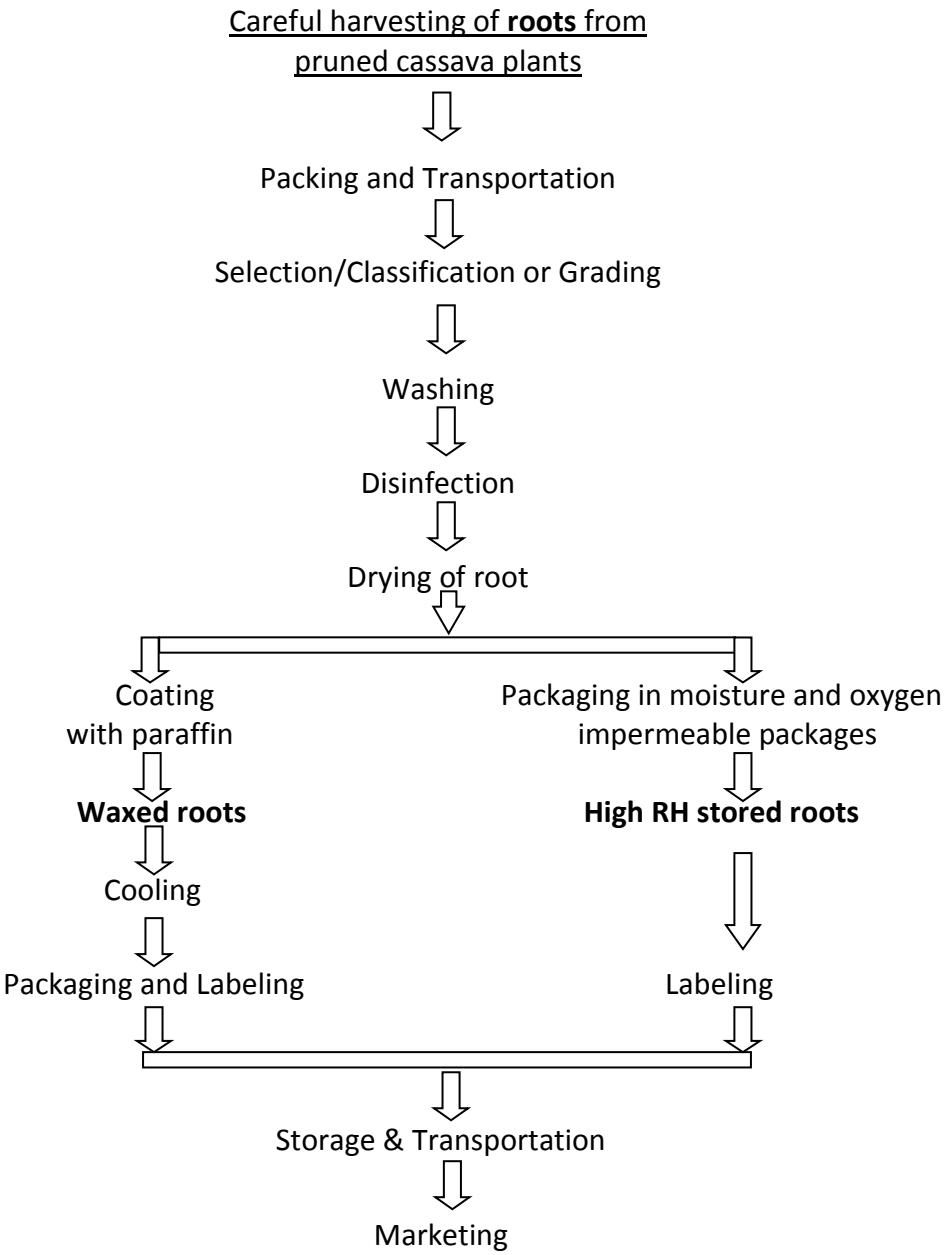


Figure 1: Waxing and relative humidity storage processes

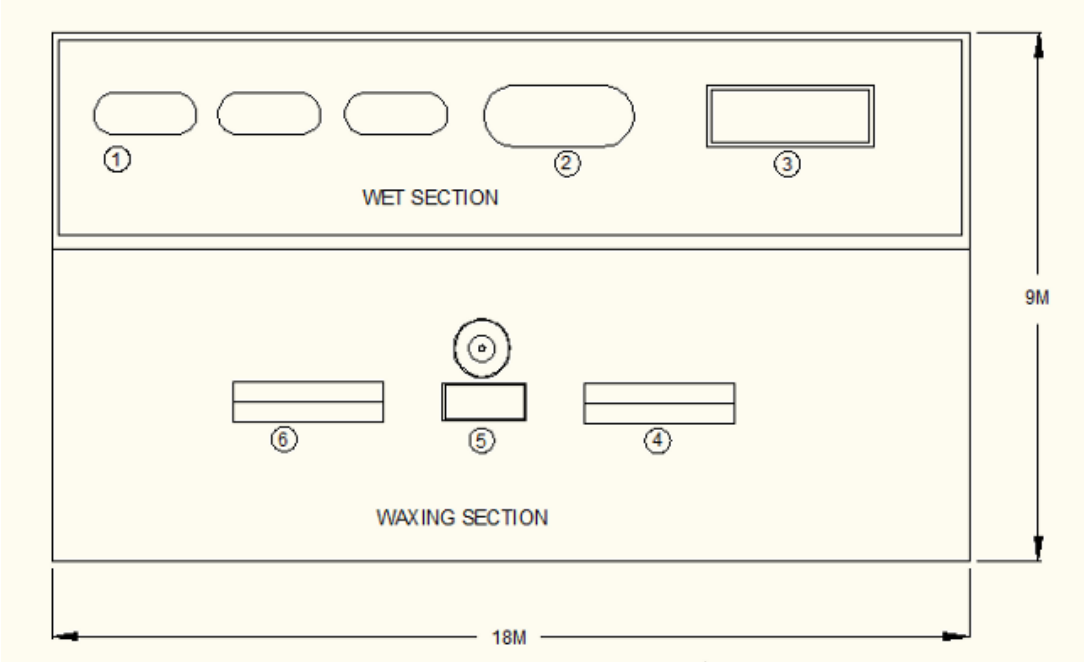
7. CONSTRUCTING A PACKHOUSE

The working areas of a packhouse should have the following sections: sorting, washing/cleaning, first measurement, drying, waxing, final measurement and packing areas.

The wet section (for sorting, washing/cleaning, first measurement) and dry section (for waxing, final measurement and packaging) are built as a single shed (Figures 2 &3). The warm drying area is built as a separate shed (Figure 4).

Cleaning and waxing area

The floor plan and layout of cassava cleaning and waxing area is shown in Figure 2 and the pictorial view of the shed is shown in Figure 3.



Legend:
1. Pre washing plastic basins (3 or more); 2. Final plastic washing basin; 3. Stainless steel treatment bay; 4. Mild steel pre wax stand; 5. Stainless steel waxing pot and gas unit; 6. Mild steel post wax cooling stand

Figure 2: Floor plan & layout of cleaning and waxing area

It has a wet section where sorting, washing, weighing, desinfection, and packing of roots for RH storage are carried out. In the dry section, final measurement and packing of waxed roots are carried out.

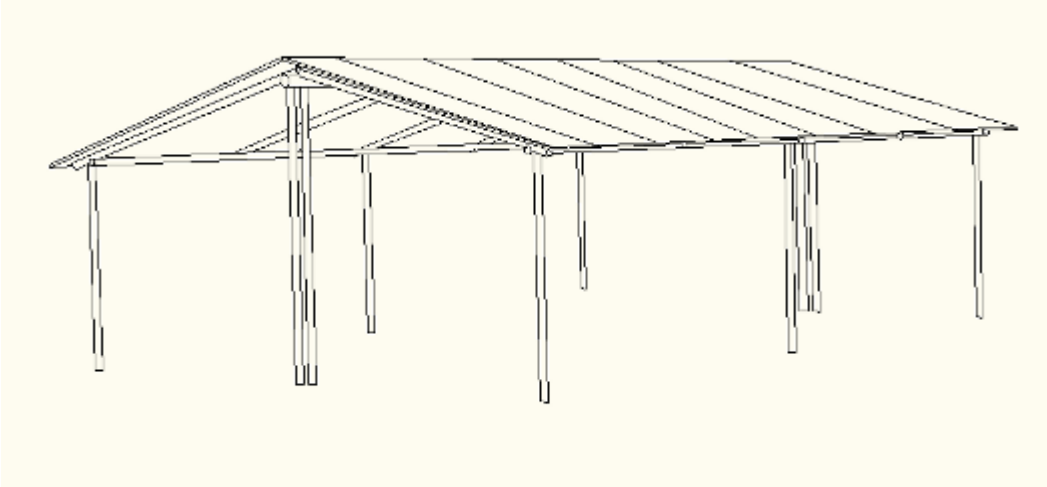


Figure 3: Pictorial view of cleaning and waxing shed (18M x 9M)

The bill of materials for building the cleaning and waxing shed is shown in Table 2 below.

Table 2: Bill of materials for building the cleaning and waxing shed

No	Description	Unit	Qty
1	Poles	Number	50
2	Aggregate	Truckload trips (5 ton)	3
3	Baked blocks	Number	2000
3	Sand	Truckload trips (5 ton)	3
4	Cement	Bags	20
5	GALVANISED ROOFING SHEETS	Number	60
6	Murram	Truck load trips (5 ton)	5
6	Nails	Kg	15
7	Labour	Man-hour	168

Warm-air drying area

The warm-air drying area for drying of roots after disinfection and after waxing operation is shown in Figure 4.

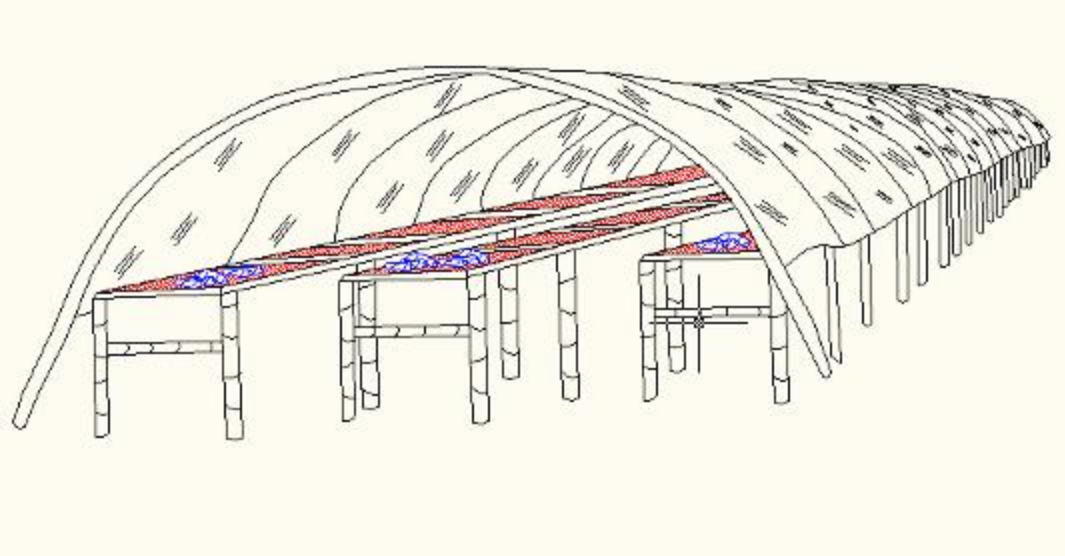


Figure 4: Warm air-drying shed for washed and waxed cassava roots (6M x 20M)

The bill of materials for building of warm-air drying shed is shown in Table 3.

Table 3: Bill of materials for building of warm-air drying shed

NO	DESCRIPTION	Unit	OTY
1	Poles	Number	50
2	Aggregate	Truckload trips (5 ton)	3
3	Sand	Truckload trips (5 ton)	3
4	Cement	Bags	10
5	UV-sheet	Meters	400
6	Labour	Man-hour	140

8. TOOLS AND EQUIPMENT FOR A PACKHOUSE

The following are the basic tools and equipment for the various operations in a packhouse.

Handling and dry cleaning

1. Weighing scale (2 pieces)
2. Plastic crates
3. Secateur or sharp knives (4 pieces)
4. Semi-hard bristle brushes (4 pieces)

Washing

1. Secateur or sharp knives (4 peices)
2. Semi-hard bristle brush (4 pieces)
3. Water supply with overhead storage tank (1)
4. Washing plastic basins (4 pieces)
5. Washing plastic stand (4 pieces)
6. Fungicide mixing bay (1 piece; see Figure 5)

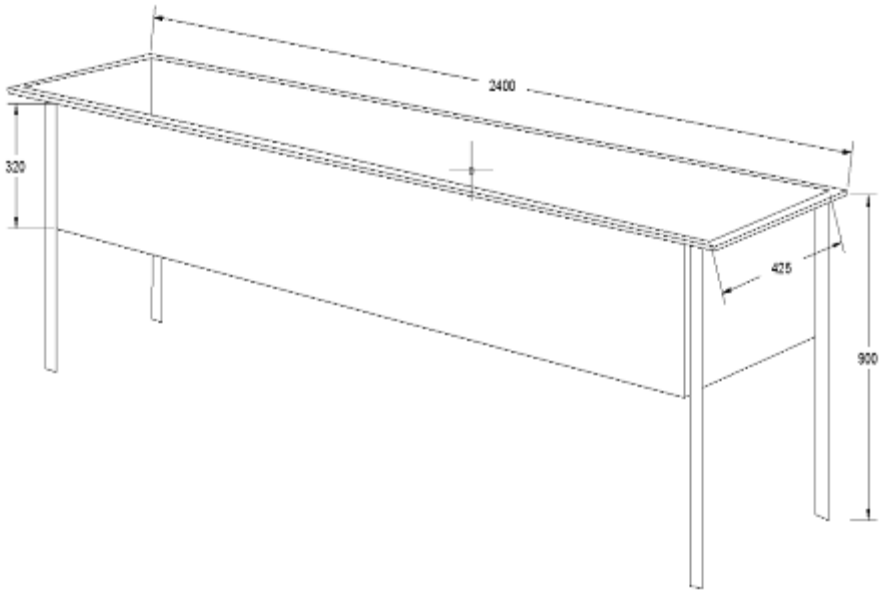


Figure 5: Fungicide mixing tank

Waxing

1. Stainless steel waxing pot (1 piece)
2. Gas burner and cylinder (1 set)
3. Mild steel post-waxing cooling stand (1 piece)
4. Waxing basket (1 piece; Figure 6)
5. Mild steel pre-wax stand also used as post-wax stand (1 piece; see Figure 7)

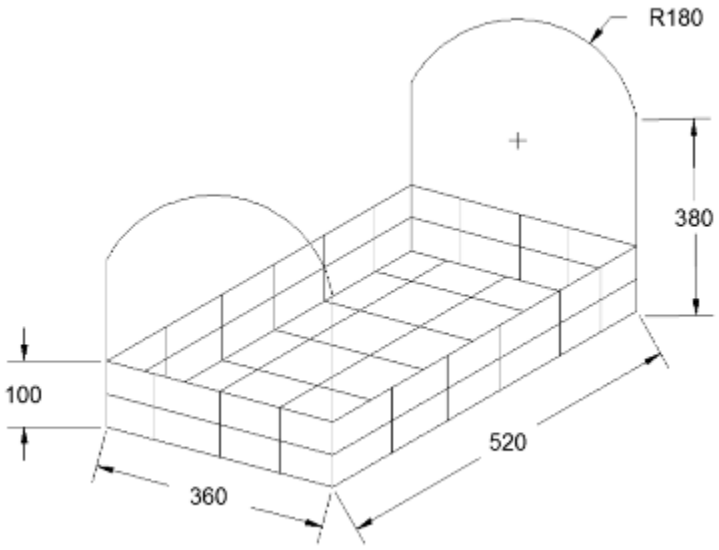


Figure 6: Dipping basket for cassava waxing

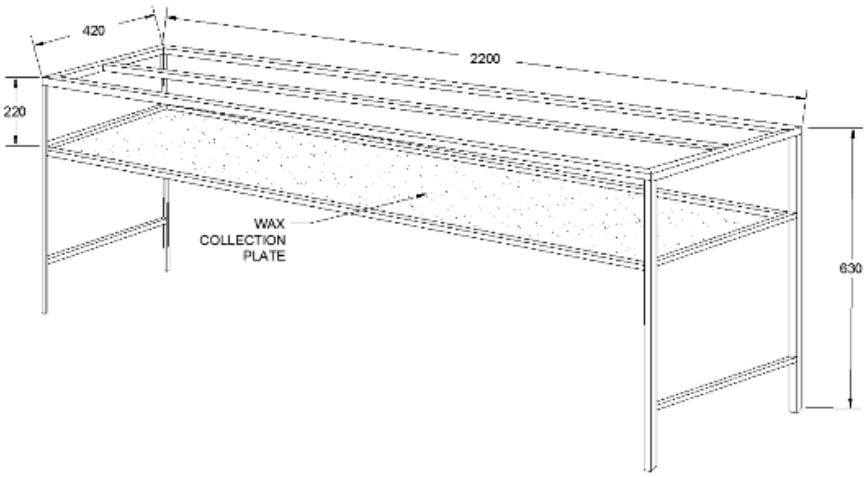


Figure 7: Pre and post waxing stand

Quick description of operations and required equipment and tools:

The cassava is harvested when pruned (Figure 1) then sorted and carried in crates to the processing area (Figure 2 and 3) where the roots are cleaned and washed using soft bristle brushes, and long tips removed using secateurs, then disinfected in the fungicide tank (Figure 5). Roots are taken to the drying shed (Figure 4). After drying, the roots for relative humidity storage are packed in impermeable bags while the ones for waxing are placed in crates on the pre-waxing stand (Figure 7), waxed in the waxing tray (Figure 6) and finally placed on the post waxing stand (Figure 7) ready for packing and selling. More detailed explanations are presented in the user guide “Fresh cassava roots handling for waxing and relative humidity storage”.

9. CONCLUSIONS

The fresh cassava value chain is currently faced with the high perishability of the roots and subsequently high postharvest losses. The packhouse described in this manual allows for proper undertaking of waxing and relative humidity treatments of fresh cassava roots for extending their shelf-life. The packhouse can serve as a hub for coordination and governance of cassava supply chain in which market demands dictate production practices and activities. Its proper set up in a suitable location can improve market access, facilitate technical and commercial innovations, and ensure successful operation of the business. Ideally commercial arrangements that ensure efficient farm-packhouse-market linkages and coordination offer an opportunity to maximize economies of scale, and improve profitability of farmers as well as the processors involved in the shelf-life extension treatments.

10. REFERENCES

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