GUIDELINES
FOR DRYING FRUITS, VEGETABLES AND UNDERGROUND FRUITS

developed within the project

"DRYING FRUITS AND VEGETABLES AT
NEW GENERATION SCHOOL GARDEN"

funded by Stiftung WissenWecken

In the northeastern part of Madagascar grow a lot of plants, many of them providing edible fruit. Furthermore, the wet and warm climate on the island offers good conditions to grow vegetable. However, people in Madagascar have limited options to store or preserve fruits and vegetable after the harvest due to high temperatures. Only a few families own a fridge or freezer. Drying fruits and vegetables is also an environmentally friendly method of preservation, particularly as it uses sun drying as a natural method.

Together with WissenWecken GmbH and a Malagasy expert, the school garden NEW GENERATION built and tested a drying table with the goal to offer a cheap and easy system for people to preserve their fruit.

Benefits of drying fruits and vegetables: When fruits and vegetables are dried, their water content is removed, the nutrients are optained. Dried fruits, for instance, can provide more fiber, vitamins, and minerals per gram than their fresh counterparts. Given that by preserving fruits and vegetable also their nutrients are preserved, it becomes an important source of nutrients for people around the world. Madagascar is one of the poorest countries globally, with many people, especially kids facing malnutrition. Drying of fruit and vegetable can therefore offer an opportunity to provide nutritious food to people and therefore fight malnutrition. Furthermore, people can sell the dried fruit and vegetable providing income to them.

How can this project be a benefit for the community? In Madagascar, the power suppply is unstable, many households are not connected to the electricity net. Drying is one of the oldest methods of food preservation, dating back thousands of years. Ancient civilizations, including the Egyptians and Romans, used sun drying to preserve fruits, vegetables, and meat for long-term storage. Therefore, we developed and tested a drying technique which is independent of electricity and needs few materials and time to accomplish the drying process. We believe that the drying technique we developed and tested is a technique everyone can use at home. In this report, we would like to explain and share the building process (step 1), the drying stages (step 2), and the results (step 3).

1. Manufacturing the dryer

To dry fruits and vegetables, we need to build a dryer if there is no modern equipment that follows the current technology. This "wooden dryer" meets the requirements for drying:

It is clear that the dried products inside the dryer are healthy and clean. The nutrients inside are optained because the temperature is moderate.

A dryer is the key device. The size is variable and can be adjusted to your needs.

Equipment

The list shows what is needed to build a dryer with this size: length: 320 cm, height: 80 cm. The following tools and material are needed for 1 x drying table:

Materials :	Quantity/Size
Square	1
Plank	3
Rod of 6	7
Rod of 3	12
Veil	2m
Bass Black	3 m 10
Transparent plastic sheet	4 m 20 (200 à 400µ)
Anti-jamming mesh	3 m 10 (1)
Gravel	8 bags of cement
Pommel	04

Manufacturing stage

A Table for drying

To construct the drying table, the following materials are required

- Board : 3m20×2 in length, 80cm in width,
- Square : 80cm×2, 75cm×2,
- Rod of 6 : 80cm×32, two of which measure 85cm between them, supporting feet),
- Rod of 3 : 3m 10×2,
- Bass Black : 3m10×1,
- Stone : 8 bags of cement,

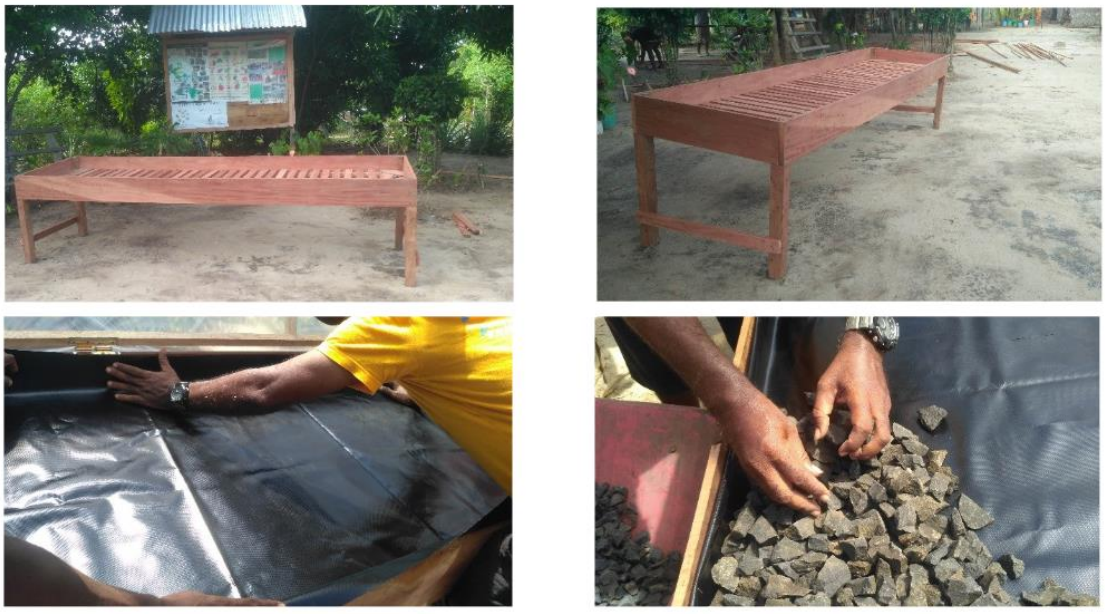


Figure 1 Manufacturing drying table

To keep in mind: Normally, the stones should be clean and washed with boiling water (see Figure 1). It should also be noted that the dryer should be positioned at an angle.

B Roof

To construct the roof, the following materials are needed:

- Rod of 3 :
  - 3m20×3 L, 80×2l,
  - 64Cm×4 Tensioner
  - 60Cm×4 Tensioner,
  - 36Cm×2,
  - 33Cm×2.
- Sail: 100 cm for window,
- Transparent plastic sheath 400µ 4 m 20,
- Pommel: 04 to fix the table and the roof

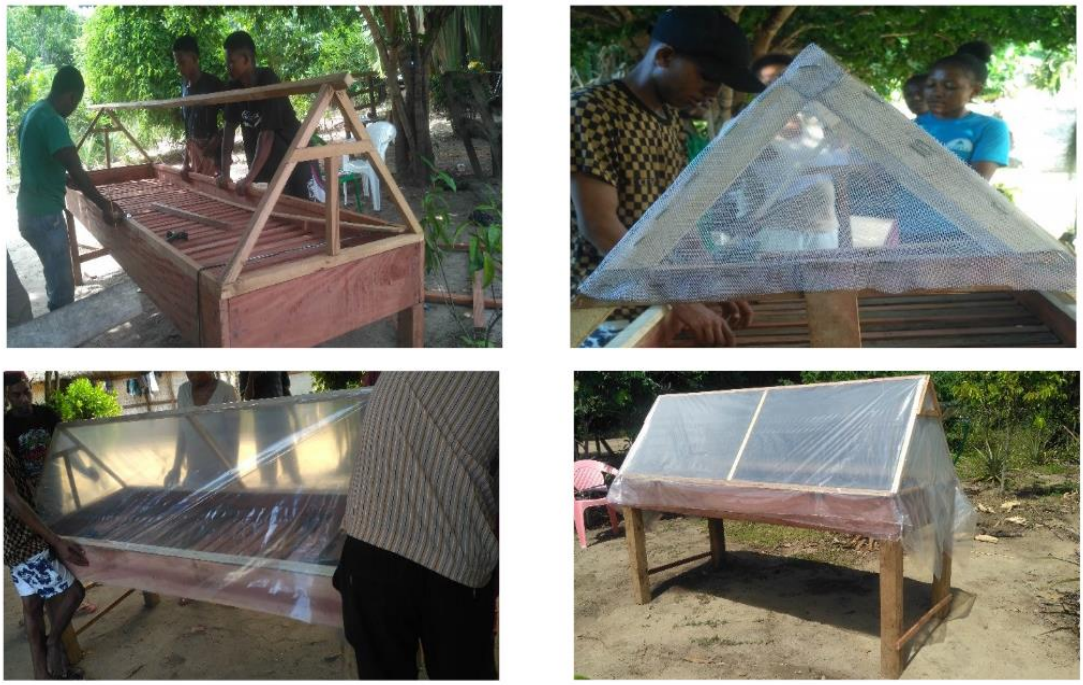


Figure 2 Manufacturing drying roof

2. Process of drying plant products

Which types of fruits/vegetables can be dried?

- Fruits: Banana (ripe or unripe), pineapple, bread fruit, jackfruit, mango, papaya…
- Vegetables: cabbage, carrot, moringa (agnanambo)
- Plants that bear fruit in the ground: yam, taro, sweet potato
- Spices used in food: Curcuma longa (Tomato or dingiza), Ginger, cinnamon

The drying process consists of a total of six stages:

Stage 1: Collect and wash the product

a) Collection of the product: 1st weighting,
b) Quality sorting,
c) 1st wash: wash with bark,
d) 2nd wash:
   - Peeling,
   - 2nd weighting: peeled fruits, waste must also be weighted.

Stage 2: Preparing product for drying

In this stage, we take some fruits as “guinea pigs” in order to test the drying process.

According to the standards of this process, it is crucial to know the distinction between products that are going to be soaked or not (stage 3). This distinction will be presented in the table bellow:

Products to soak	Products that cannot be soaked
Ripe pineapple	Legume
Ripe lychee fruit	Ripe mango
Tuber	Ripe avocado
Breadfruit	Ripe banana

Stage 3: Immersement technique

These steps must be followed when immersing or pouring the products into the water:

a) The fire must be well heated and the water should be kept at a temperature of 70°C as well.

The product should be put in a sack or pannier and cloth before pouring it.

b) The heat decreases when the product is in the water, however you must let it heat until the water reaches 70°C again before removing.
c) It is good if there are some aromatic herbs in the water, such as the wild cardamom (longoza) leaves, traveler’s tree leaves (ravinala)...

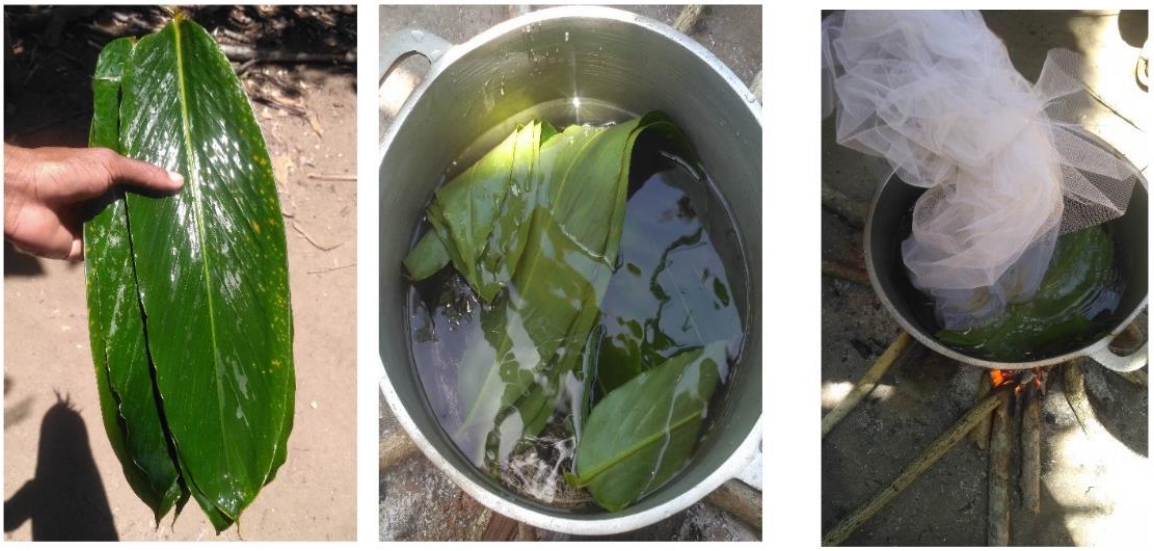


Figure 3 Soaking process

Stage 4: Take the product out of the water and put it immediately in the dryer

The goods must be turned after one day of drying and also frequently until it is completely dried.

It is better to wrap up the products in a dryer so that it will not get full of dust.

We have two possibilities to use the dried vegetables that grow under the ground: Store it immediately and consume it later or produce flour out of it.

Stage 5: Let the dried product rest for 5 days. Please note that if it rains, it can last 7 to 10 days or even 15 days.

Stage 6: Preservation The preservation can be done in a glass box or vacuum bags or even in food packing.

Below you find examples of drying processes for some products we mentioned in the table above.

Banana:

We found Banana almost all over the region, it is one of the most popular food and has a lot of nutrients elements that makes our body healthy: vitamins, potassium and it is also a medicine.

There are a lot of different ways to eat it, whether it is eaten raw or made into juice and we can also dry and cook it. It is also possible to store it in order to last longer because it is one of the perishable seeds that do not last long when it is ripe. The raw can be turned into flour but here we are only talking about ripe banana.

The goal is to dry it and to make it last longer.

According to the drying process, drying process can be done in two ways: unripe and ripe.

- For the unripe banana, the product must be soaked in hot water which varies between 65º and 70º containing 6 leaves of wild cardamom. After this, the banana should be made to flour as a final preservation mechanism.
- For the ripe banana, the product should only be washed and peeled. After peeling, the banana must be put in the dryer immediately.

The steps to carry out for the ripe banana drying are the following:

1. Wash the bananas,
2. Weight with peels,
3. Weight second time but without the peels,
4. Slice the bananas into desired shape,
5. Put the bananas in the dryer.

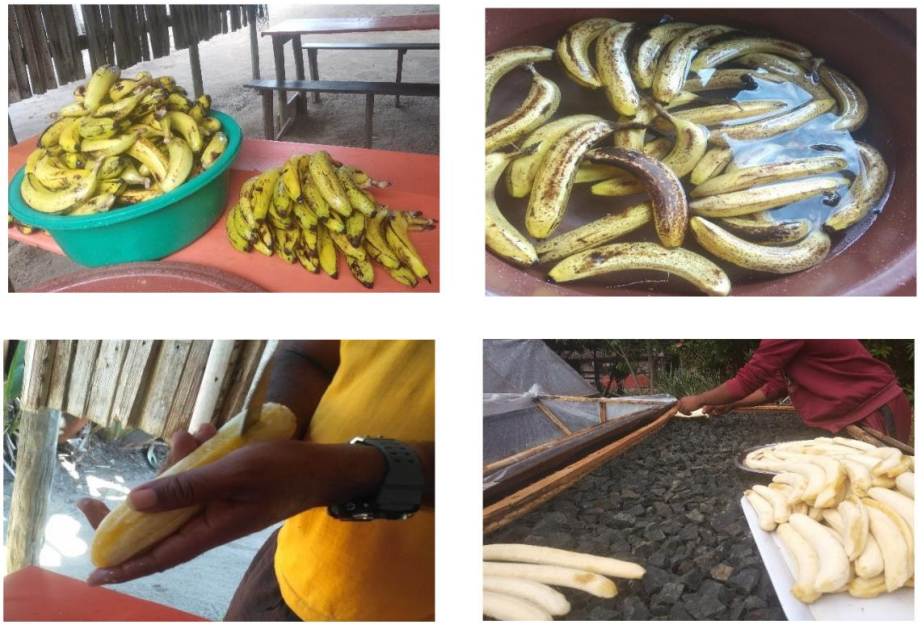


Figure 4 Drying banana process

Please note: In the normal process, drying takes five to ten days in the dryer, it is crucial to spill bananas every day; the latter concerns precisely the maintenance which is obligatory during the drying process. The images above clarify all the explanations provided.

Pineapple

Drying pineapple: The drying of pineapple is almost the same as drying ripe bananas. For pineapples it is really important that the drying is performed with only ripe and good quality pineapples. The images below will clearly show the steps followed during the drying process.

Figure 5 Drying pineapple process

Mango

Drying mango: In Madagascar, mangos are seasonal fruits, and so we took it as a taste test. The images below show the drying process for this fruit.

Figure 6 Drying mango process

Moringa leaves

Drying moringa leaves (moringa oleifera): Moringa, often referred to as the "miracle tree," has gained significant attention in Madagascar for its nutritional and economic potential.

The following images show the fascinating process of its drying and its preservation:

Figure 7 Drying moringa leaves process

Breadfruit

Drying breadfruit: First of all, the breadfruit has a lot of importance in SAVA region and it is one of the most consumed fruits.

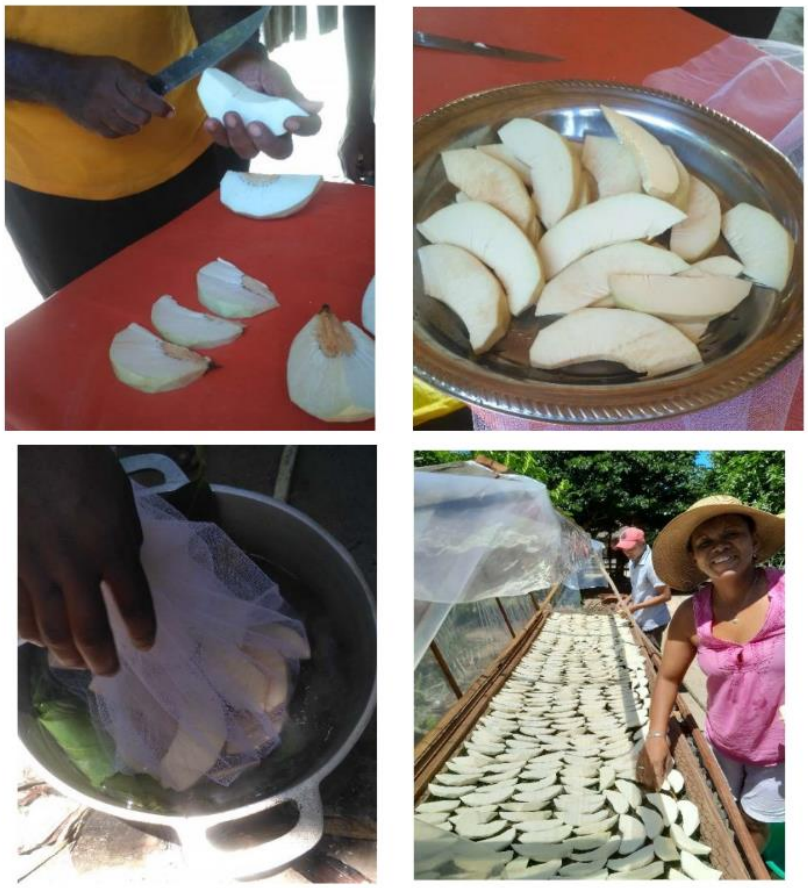


Figure 8 Drying breadfruit process

Taro

Drying taro: Taro preparation and storage processes are similar to those of other tubers. We include here examples of taro and also of yam.

Figure 9 Drying taro process

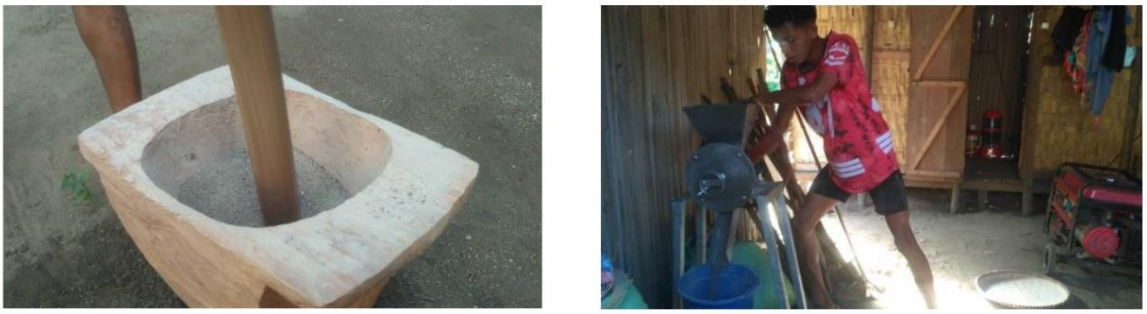
Yam

Drying yam: All types of yams (purple or white) can be preserved for a long time. The images below clearly show the steps followed during its drying:

Figure 10 Drying yam process

Please note: All tubers, whatever their type, must have gone through a soak in hot water with 6 to 12 leaves of wild cardamom (depends on the amount of water used). Except the breadfruit which is similar to most of tubers, it must be soaked and grounded into powder.

All processing of tubers and breadfruit including moringa, are all reduced to powder in a mortar or mill in order to preserve it for a long time (likely for one or two years).



Mortar for pounding

Mill for powdering

Figure 11 Drying yam process

Carrot

The carrot is one of the vegetables which contains a lot of healthy nutrition. In the SAVA region, most people import it from Tana and Andapa. Although it has a specific harvest seasons, many people widely use it as food. It contains a lot of nutrient elements like calcium and it is used as food decoration as well.

It is highly important to store it well so that it can last longer.

Preparation

- Clean well
- Weight well
- The peel should not be removed
- Cut in desired way
- Pass it in hot water
- Put it in a dryer

Cabbage

The cabbage (sosoty) is commonly found in colder areas, especially in Antananarivo and Andapa, but it also grows in a few places in the Sava region. It can be used in many ways, such as making salads, mixing with other stews. Cabbage is a healthy food, however there are some seasons when it can be found hardly. It is also possible to dry it.

Procedure

- Clean up
- Peel
- Cut in desired way
- Put it in a dryer

Cabbage and carrots are those vegetables which do not only have to turn into flour, but they can also be stored when they are completely dried.

These are the samples of fruits and vegetables that can be dried before consuming, however there are still many other fruits and vegetables that can be used too. In fact, they should not be thrown away because the can be stored for long-term consumption and for sale. This avoids a lot of food waist.

3. The result

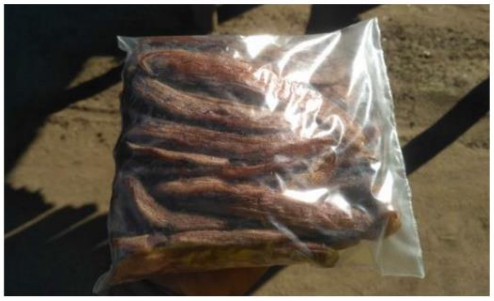
Dried fruits and vegetables take up significantly less space than fresh produce, making them an excellent option for storage, especially in areas with limited space. The team decided to put them inside a plastic film and in a food packing after drying. Both options are optimal and the decision on the packing depends on the type of fruit and vegetable you are drying.

Below we show some examples on how the dried fruits and vegetables are packed for storage.

Moringa flour

Taro flour

Dried mango



Dried banana

Figure 12 Packing and storage