



**MANUAL ON SAFETY  
AND USAGE OF A DIRECT  
SOLAR DRYER  
BY UNEP-EBAFOSA  
UGANDA**

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# INTRODUCTION

Solar dryer technology can be utilized in small-scale food processing industries for producing hygienic, high-quality food products. Solar dryers use solar radiation to heat air that is used to remove moisture from material placed inside the enclosure.

## Steps to be followed while using solar dryer:

**Step 1:** Food product should be first peeled, cleaned with clean fresh water to remove all the dirt and soil particulars. Then it should be first rinsed properly with clean water. Let the product stay in water few minutes while you can stir it. For example if its cassava roots they are peeled, cleaned, grated/ chipped into smaller sizes which can dry very fast.

**Step 2:** After separating product from water as possible, it is cut, chipped or sliced into small size using a clean knife or grater with stainless surface. If they are vegetables and fruits should neither cut too small it will stick on the net of the tray. And then when they dry it will be difficult to remove/ pick them from the tray, however nor too big otherwise it will take long drying time. Its thickness must be between 6 - 8 mm.

When cutting agriculture produce clean surfaces, containers must be used and make sure the equipment, working is clean and workers are putting on head gears and masks.

**Step 3:** Solar dryer Loading: When loading the solar dryer trays, only clean and chipped food items must be carried in a clean container/ bucket/ basin near the solar dryer to enable placing of chipped food on the trays with a clean plate.

### **Other requirements when loading product in the solar dryer**

- i. The dryer should be positioned in a level area with no trees or buildings so that it is fully exposed to the sun throughout the day.
- ii. If the wind blows predominantly in one direction for long periods the dryer should be placed end-on to the wind. This will reduce the cooling effect of the wind blowing direct into the drying cabinet, lengthening drying times. It will also reduce the possibility of dust entering the cabinet.
- iii. Before loading, the inside of the drying cabinet/ trays should be cleaned and then wiped out with a clean, damp cloth.
- iv. The doors should be closed immediately after each tray has been loaded and not left open until the next tray is loaded.

**Step 4:** Product arrangement: Products need to be arranged evenly over the solar dryer otherwise some products at the bottom surface don't dry in proper time. Spread well the products to enable faster drying. There should be no heaping of product.

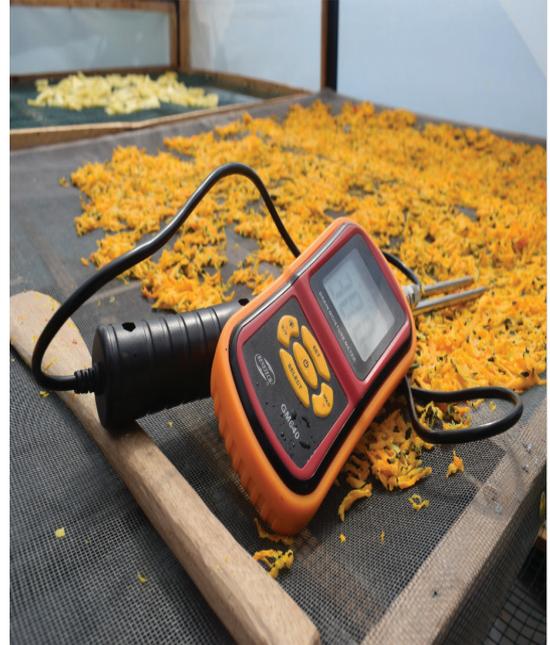


*Cassava chips dried in the solar dryer*

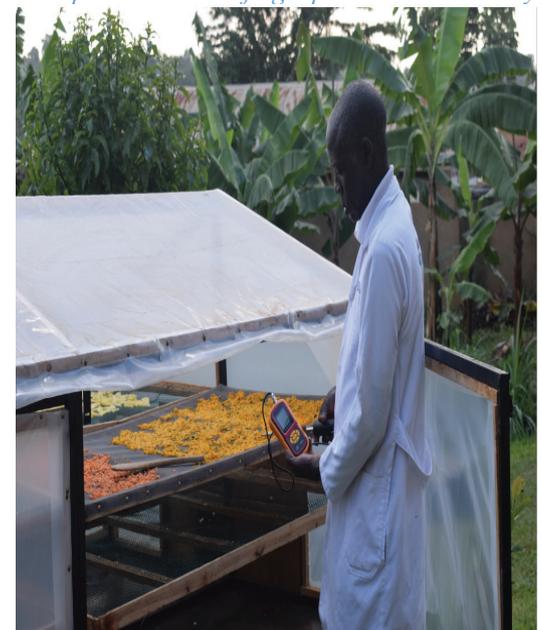
*Pineapples spread on tray inside solar dryer*



*Pumpkins dried in the solar dryer trays. With a moisture content.*



*A staff of EBAFOSA Uganda recording the moisture and temperature rates of agri-products in solar dryers*



Drying can't be possible in drying time, when UV stabilized sheet open again and again.

**Step 5:** After regular interval, mix the product evenly or turn over so that both the sides dry evenly.

**Step 6: Product unloading:** Before taking products out of dryer make sure that the product is dry at moisture content of below 10% moisture content or maximum 12%. This the standard quantity needed to prevent growth of mold, yeast, aflatoxins, and other mycotoxins. It should be ensured that products is dried sufficient to store. To test if food is sufficiently dried, remove a piece and let it cool.

Vegetables should be brittle, whereas fruits because of their sugar content, they may never get beyond a firm bend and leather quality and it is okay they are little brittle. They just need a little more soaking or chewing time for full flavour to develop. Proper care should be taken otherwise product may overcook.

### **Other requirements when unloading a solar dryer**

- i. When the product is considered to be dry, the dryer should be unloaded as soon as possible. This must not be carried out in the early morning because dew and high humidity overnight may cause condensation of moisture onto the fruit. The best time to unload is in the afternoon on a sunny day.
- ii. Trays should be removed from the dryer and taken to a clean and covered area for removal of the dried product.
- iii. The food handler must wash his/her hands and ideally wear clean gloves when handling the fruit.
- iv. The dried fruit should be stored temporarily in clean dry baskets before packaging so that the product can cool down
- v. Products must be removed from the solar dryer , and when removing product should be handled with care and hygienically to prevent foreign matter from entering into the dried food including insect fragments, rodent hairs and other extraneous matter

### **Step 7. Food Safety**

To store the dried products, for people on the move or with limited storage space, plastic freezer bags are safe, durable and easily transported or air tight bags or PIC bags food grade are recommended to use to store food for some time.

Food should be put in small clean bags, labelled and dated. The smaller bags can be grouped into larger freezer bags, giving larvae two layers to penetrate if they attempt to invade. For those who avoid plastic, glass jars or metal containers with tight lids do well. Pack to eliminate air.

## General Requirement for food safety

- i. The manufacturer/ food handler managing food at solar dryer shall establish specifications for raw materials, in process materials and finished product and shall take adequate precautions to ensure that food is free of foreign bodies.
- ii. All contaminated food shouldn't be packed.
- iii. It shall be the responsibility of the manufacturer to test, or have tested, raw materials, in process materials and finished product at a frequency commensurate with the risk to the safety of the finished product
- iv. It shall be the responsibility of the food handler firm to identify, monitor and record all critical parameters in the process to ensure that the finished product is microbiologically safe.
- v. Records of food in the dried in the solar dryers should be recorded on daily basis in a black book or sheet of paper placed in a file. records can include hygiene, cleaning procedures, temperature and kilograms dried inside the dryer.
- vi. Packaging material used in contact with food, shall be free of contamination, shall not taint the food and shall comply with the relevant East African Standard Packaging Code
- vii. The food handler at the solar dryer centre should take necessary precautions to ensure that the food is free of foreign matter other than unavoidable defects. Precautions shall include inspection of raw materials, keeping the production area free from extraneous material and the proper control of birds, rodents or insects.
- viii. No glass containers should to be used for finished dried product packaging for food from the solar dryer
- ix.
- x. Glass windows if broken shall be reported immediately to the designated person, whose responsibility it is to identify and have destroyed any food that could possibly have been contaminated by glass. These windows shall be replaced as soon as possible but not during production unless adequate screens are installed
- xi. NOTE Measuring instruments used to monitor critical parameters should be calibrated at appropriate intervals; to ensure that the accuracy of the measurement instruments is within defined limits.
- xii. No toilet facilities, shall be located near a solar dryer centre
- xiii. Solar dryer should not be installed under a tree or shade. It must be installed in an open compound where both sides of the dryer can receive sunrays at all times.
- xiv. In cases where employees develop chronic pathogen infection, cough and flue such employees shall not be permitted to have access to the solar dryer centre.
- xv. Moisture meters should be used to test moisture content of the product or temperature

## Personnel Hygiene Requirements

One of the best ways to maintain good health and wellness is to maintain proper personal hygiene. We must understand that people are a potential source and transporter of diseases and germs producing micro-organisms which live in certain parts of the body; hair, nose, mouth, throat, hands and clothes

Personal hygiene helps you to stay clean and the rounding environment, it prevents the food items in the solar dryer and when loading and offloading the producing from getting infested with micro-organisms.

### Handwashing

Clean hands are the most important food safety tool. You cannot see germs so even if your hands look clean, they could be contaminated. Be aware of what your hands are touching at all times in order to recognize when they may have become dirty and use the following guidelines. Washing your hands often is the most important thing you can do to keep yourself healthy and the food you prepare safe.

#### When to Wash:

- i. Upon arriving at work.
- ii. Immediately before any food preparation which includes working with any food, clean equipment.
- iii. After touching any part of your body or uniform.
- iv. Before putting on gloves to handle food and between glove changes.
- v. Before and after touching any raw foods or switching tasks.
- vi. After using the bathroom.
- vii. After handling any dirty equipment, dishes, or utensils.
- viii. After any other activity which may contaminate your hands such as sweeping the floor, taking out the garbage,
- ix. coughing or sneezing

### Preventing cross contamination at solar dryer centre

Cross contamination can happen when germs from raw food, outside surfaces contaminate food in the solar dryer or food landing into contaminated surfaces

#### Tips to Avoid Germ Transfer

- a) Always wash hands before loading food into the solar dryer and during preparation of food and after offloading the products from the solar dryer.
- b) Wash rinse surfaces every time you finish a task and between preparing different foods going into the solar dryer.
- c) Prepare raw agricultural products indoor in a designated area on clean surface boards.
- d) All foods products dried in solar dryer should be covered during storage and in labelled containers.
- e) Store Equipment used in clean dry place.

## PART 3: CLEAN AND MAINTAINING OF SOLAR DRYER

### Maintenance of solar dryer;

- i. UV sheet should be clean with cloth in every twice a week. Dirty UV sheer cannot absorb the solar energy efficiently. The main source of dirty is dust which can easily be removed with a clean dump cloth.
- ii. The drying area should equally be cleaned to keep it free from dust and dirt. Cleaner the drying surface the more effective the drying of products.
- iii. Inside dryer should be clean in every 3 weeks.
- iv. Mesh should be cleaned after every use and if some products stick on mesh, Place wet cloth over it for 1-2 hr and then rub to remove.
- v. Wash cloth piece after every use.
- vi. Cleaning includes removal of all dust from the UV sheet, trays, net mesh
- vii. Perform visual checks of the condition of the dryer components that are key to efficiency – i.e., the UV sheet (check for puncturing; folding that may trap rainwater & evacuate all water collected; check tightness of the sheet); check that the doors close tightly; check that the trays are not torn on the mesh; check that the mesh liners are not blocked etc.; check that dryer legs are well balanced.
- viii. Inform EBAFOSA technical lead in case any issue compromising dryer efficiency has been identified.

### Transportation of the solar dryer

How To transport A Solar dryer in Back Of Your Pick-Up Truck?

**Moving a solar dryer is very easy. But it's something you'll have to do when you have received an order. When the solar dryer has been fabricated from the workshop not on site you need to involve a vehicle. Here are some tips/steps for transporting your solar dryer in the back of your pickup truck;**

1. Understand the size of the solar dryer before hiring a vehicle to transport it.
2. Load the solar dryer onto the truck. Make sure you have enough labour on site to will help you carry the solar dryer frame. And make sure you dress the solar dryer with a UV polythene sheet on delivery in order to prevent damages of the sheet when loading and off loading the dryer.
3. Secure the solar dryer. Great the solar dryer is loaded. Next, load the trays of the solar dryer and arrange them in side the solar dryer to enable the truck and dryer have balance.
  - Use a rope to tight the solar dryer to prevent it from falling off the truck.
  - This is especially important if you are moving cross country. You need to tighten the solar dryer and trays.
4. Take care of the required fees. You'll typically be asked to pay a certain amount for transportation fee before the product come to site.

- Altogether, the cost of having your solar dryer transported will likely be something between 100,000 UGX – 250,000 UGX within district were its made.
  - Inquire about financing options if you're unable to afford the entire amount at once.
5. When the solar dryer has reached on the site, clean and dust to start putting the UV polyethene sheet on it
  6. Make sure you locate the solar dryer in an open space to receive sun ray. NOTE Don't put a solar dryer under shade, tree or in a house.
  7. Inspect your solar dryer for signs of damage. Before the fabricators leave the site. And make sure you get contacts of the EBAFOSA Uganda fabrication team to support you incase of training and replacing trays etc

### **What should I check for once the solar dryer has been delivered?**

- i. Look for obvious signs of damage, as well as other spontaneous issues type of the metallic used to fabricate and they type of polythene sheet dressed on the solar dryer.
- ii. Portability of the solar dryer
- iii. Quality of the sheet polythene it must be clear UV polythene
- iv. Ventilation space at the roof of the solar dryer
- v. Blower which enables air to enter into the solar dryer
- vi. Trays or shelves inside an drying chamber of the dryer and the handles of the trays must be functioning properly.
- vii. The solar dryer doors must have locks and easy to both open and close
- viii. Test the Temperature of the solar dryer for example during morning, afternoon and evening to see its performance before leaving he site.

### **Advantages of using a solar dryer**

The advantages of solar dryers over traditional open-sun drying include;

- i. a smaller area of land in order to dry similar amounts of crop,
- ii. relatively high quality of dry crop, because insects and rodents are unlikely to infest it during drying,
- iii. shortened drying period,
- iv. protection from sudden rain, and
- v. low capital and running costs.

## Frequently asked questions

### 1. What is solar dryer?

Solar dryer are devices that use solar energy to dry substances. Devices that use solar energy to evaporate water and collect its condensate within the same closed system are called solar stills.

### 2. How do solar dryer work?

Answer: Solar Dryer works on the principle of greenhouse effect, in which solar radiation gets trapped inside the closed chamber. It has two section: one is collector area, where heat is generated using black floor and second is drying area, where fresh products are kept to dry. The trapped radiation produces heated air in collector which is then blown over fresh products using a constant air supply from blower results in vaporisation of moisture and then moisturised air goes out from other side through the vent.

This dryer has a blower which lets in air and vent which lets out moisture. The black sheet surface also absorbs heat which produce heat and products dry faster.

### 3. Do we have to take out product during night?

Answer: No, you don't have to take them out.

### 4. Do we have to take out product during rain?

Answer: No, you don't have to take them out

### 5. Is the solar dryer rain proof?

Answer: Yes, it is rain proof unlike open sun drying, where you have to worry about sudden rain, cloudy condition. It won't damage your products inside your solar dryer. You can keep your produce inside for more than 2 days incase of continuous rainfall. If it exceeds, then you have to take out product and keep them inside otherwise it will absorb moisture again and get spoiled

### 6. Will solar dryer work during rainy season mainly March-April-May long rain season?

Answer: Solar dryer require sunlight to operate, which is available 365 days in Africa and solar energy is free no one pays to have the sunlight in his compound. But, when the conditions are cloudy, try to dehydrate low moisture products, whereas during rainy season, it doesn't work well because of high moisture in air, which might affect your product quality.

### 7. Is there any national standard on usage and fabrication of solar dryer?

Answer: Regarding solar dryer standard as per now no available standard. However, you can check with your national standard body

### 8. What is the average quantity a solar dryer can load/ dry?

Answer: the average kilograms dried is according to the size and shape, however dryers fabricated by UNEP-EBAFOSA Uganda, the dryer can dry range of 200 to 300 kilograms

### 9. How does and indirect solar dryer work?

Explanation: An indirect solar dryer heats the incoming air with the help of a black surface. Then this heated air is passed over the substance to be dried thereby drying the substance.

#### 10. How does the Indirect solar dryers work on natural air convection

Answer: Indirect solar dryers work on natural air convection. This is because the incoming air is heated by a black surface. As the air is heated, it rises thereby giving room for the heavier colder air to get heated.

#### 11. What are the two general types of solar dryer?

There are two general types of solar dryers: Direct and indirect. Direct solar dryers expose the substance to be dehydrated to direct sunlight. They have a black absorbing surface which collects the light and converts it to heat; the substance to be dried is placed directly on this surface. In indirect solar dryers, the black surface heats incoming air, rather than directly heating the substance to be dried. This heated air is then passed over the substance and exits through a chimney, taking moisture from the substance with it. Dependency from sun radiation can be reduced by combination with other available heat sources.

### References

Uganda Standard: US 28 EAS 39, 2<sup>nd</sup> Edition 2002-12-14: **Hygiene in the food and drink manufacturing industry — Code of practice**

UGANDA STANDARD: **US EAS 38 First Edition 2014-10-15:**

**Labelling of pre-packaged foods — General requirements**



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