



COLLECTION
PRO-AGRO

Construction of solar cookers and driers

Christelle Souriau & David Amelin

Contributors

COORDINATOR

E. Lionelle Ngo-Samnick

AUTHORS

Christelle Souriau and David Amelin

SERIES REVIEWER

Rodger Obubo

REVIEWERS

Pascale Cognet, Jean-François Colmant and
Pascal Nondjock

ILLUSTRATIONS

Joseph Samuel Samnick and J.M. Christian Bengono

TRANSLATION

BLS

MISE EN PAGE

Stéphanie Leroy

The Pro-Agro Collection is a joint publication by Engineers Without Borders, Cameroon (ISF Cameroun) and The Technical Centre for Agricultural and Rural Cooperation (CTA).

CTA - P.O. Box 380 - 6700 AJ Wageningen - The Netherlands - www.cta.int

ISF Cameroun - P.O. Box 7105 - Douala-Bassa - Cameroon - www.isf-cameroun.org

© CTA and ISF 2014

Cover photo: © Hollandse Hoogte/Fred Hoogervorst

ISBN (CTA): 978-92-9081-567-9

Contents

1	Solar cookers	05
1.1	Types of solar cookers	05
1.2	Essential factors for solar cooking	06
1.3	Construction and use of the box cooker	10
1.4	Construction of the solar panel cooker	14
1.5	Use of solar cookers	17
1.6	Cost of solar cookers	22
2	Solar driers	24
2.1	Different types of driers	24
2.2	Construction of a direct solar drier	25
2.3	Construction of an indirect solar drier	27
2.4	Use of solar driers	33
2.5	Cost of solar driers	34
3	Additional information	36
3.1	Bibliography	36
3.2	Useful contacts	37



General

information

Drying food using the sun and the air flow is an age-old practice that does not always produce the best results. Cooking of food is traditionally done using wood, oil, charcoal or gas, which requires a lot of attention and energy.

Although improved techniques for using solar energy are not that well-known, they nevertheless provide better results in terms of economy, ecology, quality and simple usage. Solar cookers and driers capture the sun's rays to heat and dry food.

This guide presents simple methods for construction and use of solar cookers and driers: a box cooker, a solar panel cooker, a direct solar drier and an indirect solar drier. Easy to make and use independently, they provide an economical way to meet the food processing needs of diverse populations.

The solar cooker saves time, money and energy at no risk for the environment. It can be used to cook all types of food (vegetables, fruits, meat, cereals, bread, etc.). Solar cooking is slower than traditional cooking methods and consequently enables the production of healthier dishes, preserving both taste and nutrients and making meat more tender. Vegetables, fruits and meat cook perfectly without water, thereby accelerating the cooking process, while cereals and starchy foods need less than a third of the amount of water required for traditional cooking.

Compared to air-drying, solar driers allow better preservation of food quality. With higher temperatures, solar drying is much more thorough. Food dries 2 to 5 times more quickly in a solar dryer than in open air. Furthermore, it reduces health risks by eliminating contamination with mould, insects, animals, dust and many other threats. A solar drier reduces the need for handling as well as the drying time. It enables to obtain better quality products. As handling is reduced, the risk of food products crumbling or breaking up is eliminated.

1

SOLAR COOKERS

This practical guide presents two main models: a “box cooker” and a “solar panel cooker” that can reach temperatures of between 120 and 150 °C for cooking, roasting or boiling. It should be noted that there are other types of solar cookers that can reach higher temperatures for frying or grilling food.

1.1 Types of solar cookers

There are three different types of solar cookers:



Solar cooker with parabolic reflector

Also called “parabolic solar cookers”, curved concentrator solar cookers rapidly reach very high temperatures, but require frequent adjustments and many safety precautions. With an estimated power of 400 W, they are the most expensive. The parabola enables all types of cooking, including frying.



Box cooker

Solid and efficient, the box cooker is composed of an insulated wooden box containing a smaller box with a black base and internal walls covered in aluminium. A double-glazed glass top covers the assembly and produces a greenhouse effect. It can be made using local materials (wood, sheep’s wool, etc.) and can easily reach a temperature of 120 to 150 °C. Easy to make, the box cooker is the one most frequently used.



Solar panel cooker

Solar panel cookers combine elements of the box cooker and the parabolic cooker. Very easy to construct, the solar panel cooker has neither glass nor an insulation system. Its reflective surfaces are safe for the eyes. As the temperature is regular, it does not require any adjustment during cooking. It can simply be folded for storage purpose.

1.2 Essential factors for solar cooking

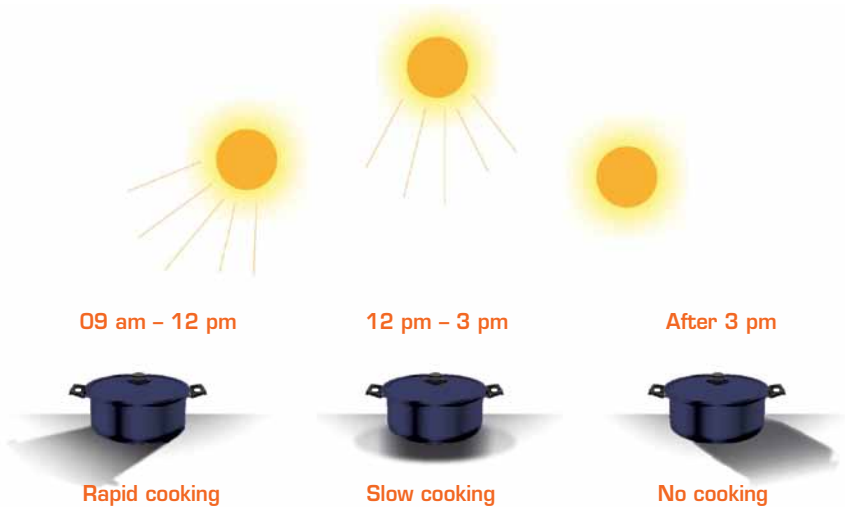
Location of the solar cooker

The solar cooker must be placed outdoors, in a sunny spot exposed to the wind, but protected from very strong winds, storms, fog, dust and shade from nearby trees or buildings, all of which reduce the amount of sunshine and increase the cooking time.

The selected location must be at a distance from sites used for disposal of human or animal waste and waste water. It is preferable to fence the site to keep out domestic animals.

Optimum time to use the solar cooker

The solar cooker must be used when the size of the shadow on the ground is shorter than the actual height of the cook. The sun must therefore be quite high in the sky to enable cooking. Solar cooking is not possible early in the morning or after sunset. The ideal time to cook is therefore between 09.00 am and 3.00 pm.



The best times for solar cooking

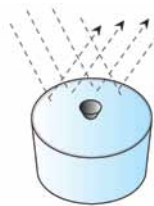
Types of container used for cooking food

It is preferable to use containers of a dark colour, as they absorb heat best, while light colours reflect the sunlight.

Capture or reflection of sunlight



Capture



Reflection of sunlight

Cooking time

The amount of time required for solar cooking depends on the time of year, the time of day, the degree of sunshine, the type of container used, the dish to be cooked and the quantities of food prepared.

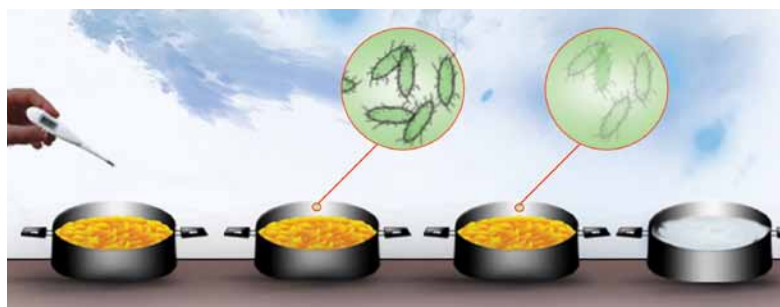
↓ **The essential factors for solar cooking are represented in the following table**

	Rapid cooking	Slow cooking
Time of day		
Sun intensity		
Wind		
Thickness of container		
Amount and size of food		
Quantity of water		

Solar cooking is not suitable for preparing dishes that require occasional stirring. It is recommended to include all ingredients at the beginning of the cooking process.

Temperatures for cooking food

In normal conditions, simple solar cookers can reach a temperature of 120 °C. To avoid the proliferation of bacteria, it is necessary to cook food at a temperature above 60 °C. Between 82 °C and 91 °C, food cooks without boiling and does not lose its nutrients. The cooked food can remain in the cooker without any risk until meal time.



22°C
Ambient
temperature

22°C à 49°C
Presence of
bacteria in food

60°C
Disappearance of
bacteria from food

65°C
Pasteurisation
of water



71°C
Pasteurisation of
food

82°C
Cooking

100°C
Boiling point
of water

100°C - 130°C
Simple solar
cooking

Solar cooking generally takes twice as long as traditional cooking. Approximate solar cooking durations for 2 kilograms of food in sunny weather are shown in the following table.

↓ Approximate cooking times

1 – 2 hours	3 - 4 hours	5 – 8 hours
 <p>Eggs</p>	 <p>Potatoes</p>	 <p>Roast meat</p>
 <p>Rice</p>	 <p>Beans</p>	 <p>Soup</p>
 <p>Fruit</p>	 <p>Cassava</p>	
 <p>Vegetables</p>	 <p>Meat</p>	
 <p>Fish</p>	 <p>Bread</p>	
 <p>Chicken</p>		

Cooking times vary according to the type of food. As in traditional cooking, meat and soups should be cooked longer.

1.3 Construction and use of the box cooker

Equipment and materials required

- 2 wooden boxes of different sizes, one slightly smaller than the other and able to fit inside the other. The external box can be made of wood or plywood, the internal box of metal (preferably aluminium).
- A question of choice and availability: polystyrene, blocks of insulating foam, crumpled up balls of newspaper, sheep's wool, dried plant fibres (rice, banana leaves, coconut fibres, etc.), feathers or ashes to insulate the space between the two boxes. (No polyvinyl and no glass wool or other plastics that give off smoke at high temperature). Sheep's wool and ashes should be available in large quantities. Ashes, however, will increase the weight of the cooker.

Materials required

- Some cardboard
- A very rigid cardboard box (for the reflectors)
- Some aluminium foil
- A transparent pane of glass a little larger than the smaller box (or a sheet of plastic of this size, if glass is not available)
- Non-toxic glue
- Sticky tape
- Assorted pieces of wood
- Scissors
- A ruler
- A whiteboard marker



Large box



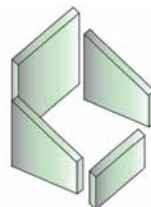
Small box



Insulation I
(Foam for base of large box)



Wooden battens



Insulation II



Black cardboard
(to cover the base of the small box)



Cardboard
(to be covered with aluminium for the reflectors)

+



Aluminium foil
(to stick on the inside walls of the small box)



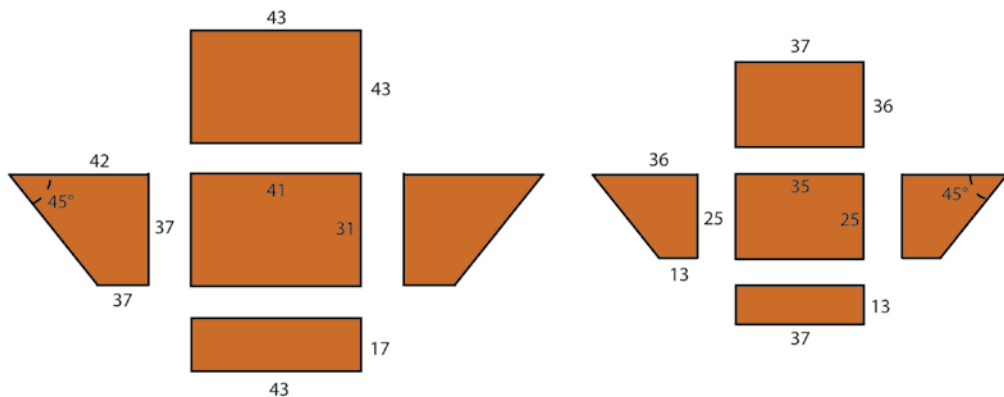
Glass + frame

Construction of the box cooker

The box cooker is composed of two wooden or cardboard boxes; one must be three centimetres bigger than the other in all directions.

>>> **Constructing the two boxes**

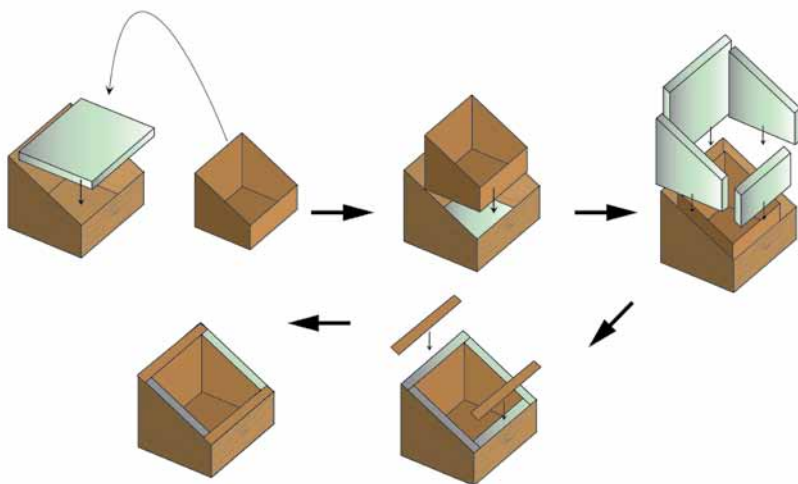
Use the plans below to make the boxes from wood or cardboard.



* All measurements are in centimetres.

>>> **Assembling the two boxes**

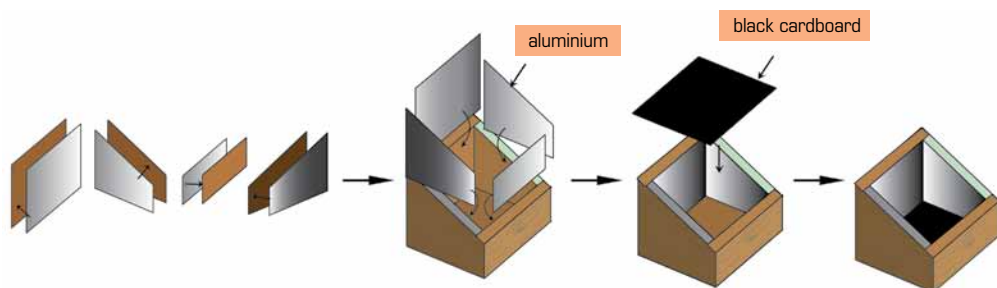
- Fill the base of the larger box with insulation material up to 1 to 3 cm height.
- Place the second box inside the first. Fill the empty spaces between the boxes with the same material used for the base without deforming the boxes, while ensuring that they do not move.



- Insert pieces of foam on top of the insulation to fill the space between the boxes completely.
- Close off the top gap between the boxes with four wooden battens so that the edges fit snugly.

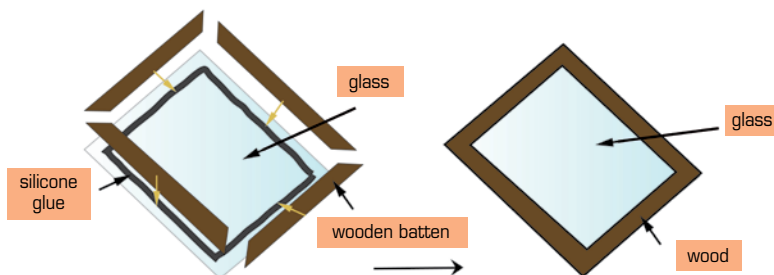
>>> Making of the reflectors for the interior of the box

- Cut pieces of cardboard to fit the inside walls of the smaller box. Cover with aluminium foil. Stick the aluminium foil to the cardboard, making sure that it is smooth and has no folds or air or glue bubbles.
- Staple the cardboard covered with aluminium foil onto the internal walls of the oven. Cover the bottom of the inside box with black cardboard to absorb the heat.

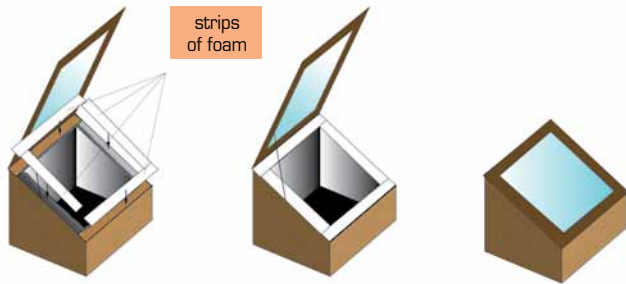


>>> Generating the greenhouse effect

- To improve cooking, place the dish in a “heat trap”, i.e. under a pane of glass or plastic.
- Construct two wooden frames to the measurements of the cooker. Select a panel of the same size and place it on the first frame. Attach it with silicone adhesive. Position the second panel and attach it in the same way.



- Attach the glass or plastic panel to the top of the cooker with two small hinges. To ensure that the oven remains airtight when closed, place four strips of foam on the top edges of the 4 walls (matching the frame of the glass panel). The glass top will rest against the foam joint and prevent the escape of hot air.

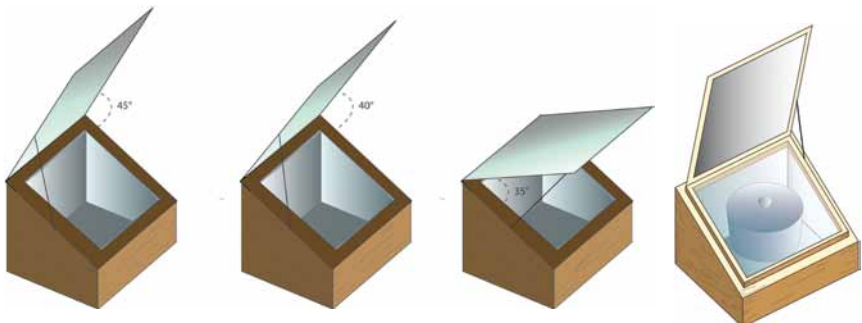


>>> **Making of the top reflector**

For the reflector, use a very rigid piece of cardboard. Cover with a sheet of aluminium foil. Use a hinge or a smaller piece of cardboard to attach the reflector to the rear of the oven.

The reflector must be maintained in a vertical position above the box. The reflector's support will allow the angle between the reflector and the box to be adjusted. This will make a number of positions available to ensure optimum reflection of sunlight.

To make the support, attach a small piece of cardboard (5 cm x 2 cm) onto the frame of the box and another onto the reflector. Take a stiff piece of iron wire of 40 cm length and bend the ends to 90°. Insert each end of the wire into the corrugations of the cardboard. A number of different positions can be selected in this way to adjust the angle of the reflector.



1.4 Construction of the solar panel cooker

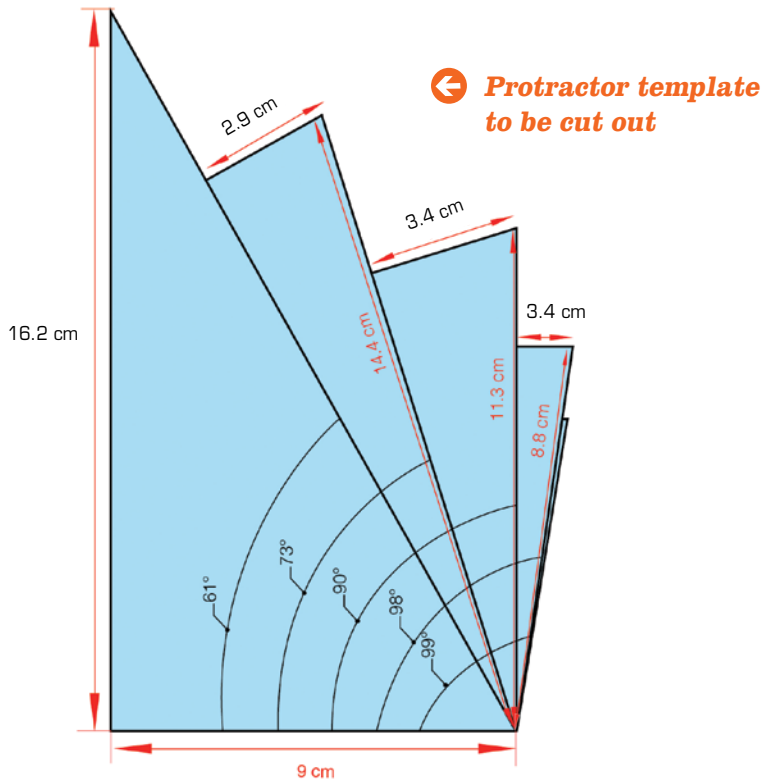
The solar panel cooker is made of cardboard covered with aluminium foil. Folded around a food container, the cardboard reflects the sunlight. Simple and easy to carry around, this cooker can be made in just one to two hours. You can make it bigger if necessary.

Required materials

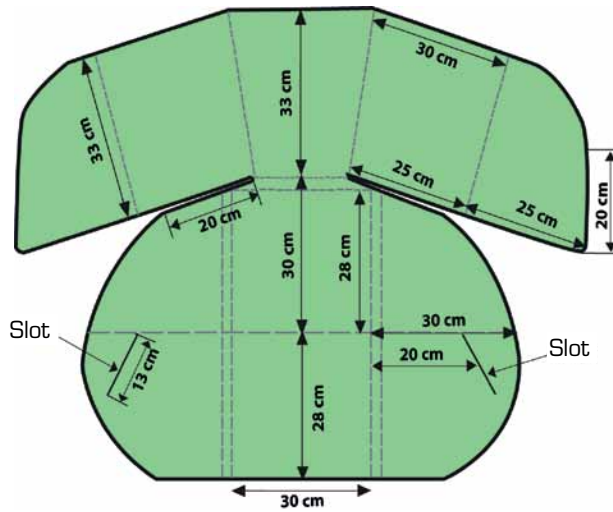
- Corrugated cardboard 0.9 m x 1.2 m
- Aluminium foil sheets
- Non-toxic glue
- Black paint

Construction

- In order to ensure that the angles are accurate, cut out a protractor template using the pattern below.

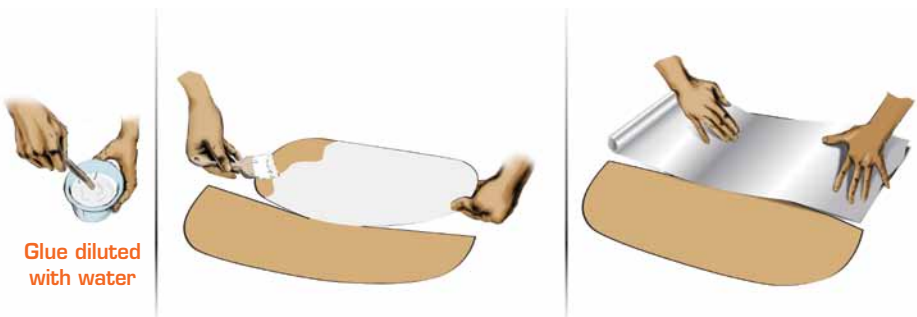


- Place the cardboard on a flat surface and draw the outline of the cooker using the plan below.



⬆️ *Plan of solar panel cooker*

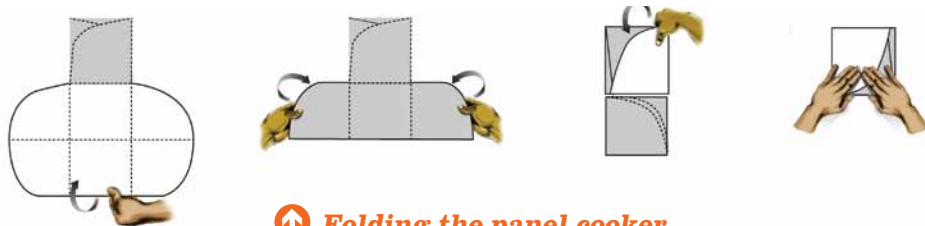
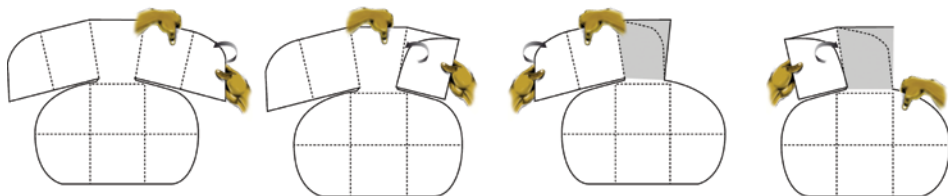
- To obtain the shapes of the cooker, carefully cut out the 2 slots, making sure not to make them any larger. The width of the slots is crucial to the stability of the structure.
- Mark the folding lines with an appropriate instrument (spoon handle, knife handle, ruler). Fold the cardboard along the folding lines.
- To preserve the cooker and avoid humidity, paint the back of the cardboard (non-reflective surfaces). Leave to dry.
- Stick a sheet of aluminium foil over the front surface of the cooker. Make sure the folding areas adhere firmly. Leave to dry.



Glue diluted with water

⬆️ *Binding the aluminium foil to the panel cooker*

- Fold the cooker and assemble it. The solar panel cooker is now finished.
- The cooker can be folded in two or folded so as to measure only 33 cm².



Folding the panel cooker

- Store the cooker away from humidity and animals. Wipe the reflective surfaces with a dry cloth occasionally. If the cardboard panels get damp, place them flat (shiny surface toward the sun) until they get dry. Take care not to damage the shiny surface.
- The plastic bags can be used more than ten times. If they get torn, you can repair them with adhesive tape to prolong their use.



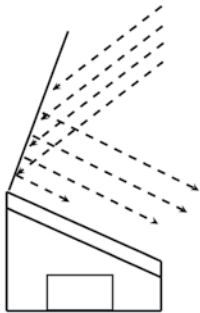
1.5 Use of solar cookers

To avoid any food contamination while using solar cookers, it is essential to observe the following rules of hygiene:

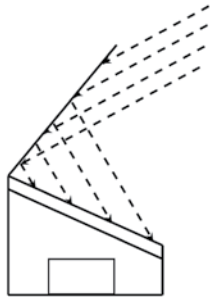
- wash your hands with soap before handling food
- wash and dry utensils before use
- clean food preparation surfaces
- consume the food soon after it has been cooked. The higher the temperature, the more difficult it is to preserve cooked food.

Using the box cooker

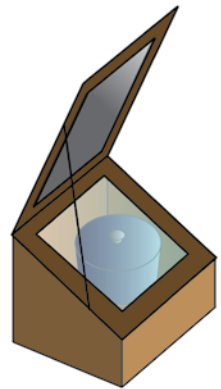
- Before you start cooking with the box cooker, adjust the reflector to the best angle to reflect the sunlight onto the food. The ideal angle reflects the maximum amount of sunlight onto the glass top, as shown in the figure below.



Incorrect angle



Correct angle

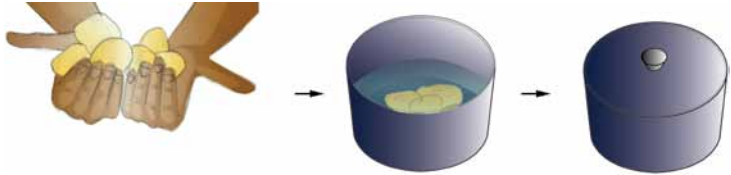


Positioning the reflector for optimum sunlight

- Place the food in a dark-coloured container with a lid.
- Place the food container in the centre of the box cooker and leave the meal to cook without stirring the food during the cooking time. Avoid opening the cooker while it is cooking, as this causes heat loss.
- Position the solar cooker so that it is best placed to capture the sun's rays. Reposition it every hour to ensure maximum efficiency.

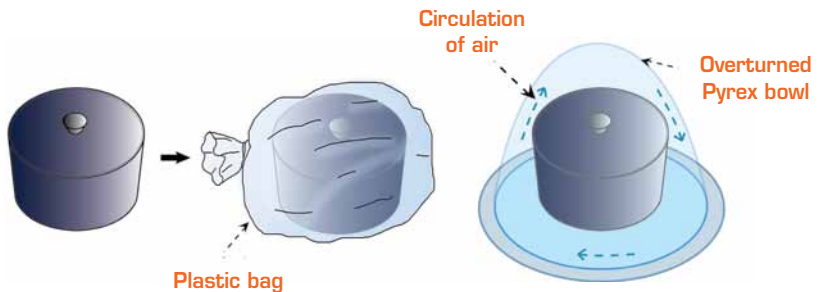
Using the solar panel cooker

- Place the food in a dark-coloured container with a lid.



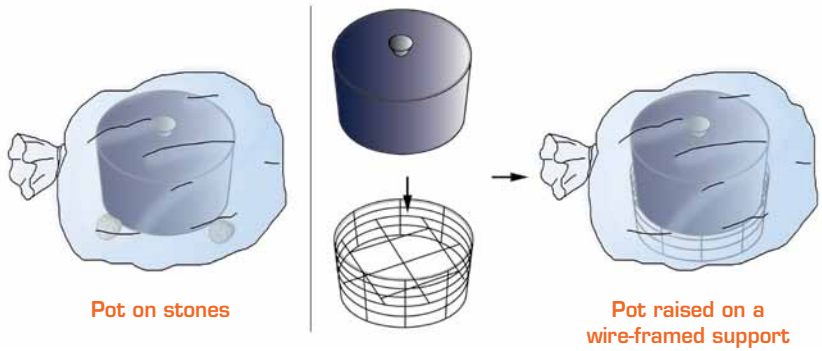
⬆️ *Filling the cooking pot*

- To increase the efficiency of solar panel cookers, place the pot in a transparent “heat trap” that allows the sun’s rays to pass through. Overturned Pyrex bowls can be used, but in this case, you must provide a glass base to place them on to avoid damaging the cooker.



⬆️ *Making a heat-trap*

Place the cooking pot on a raised support made from wire mesh or pebbles to create a current of air around the pot without losing heat. Make sure to use a stable support, i.e. wider than the container. The pot should rest on the support at approximately 6 cm above the base. This support enables the sun’s rays to be reflected onto the top and sides of the pot, as well as underneath. Close the bag.



⬆ *Setting up the cooking pot on a stable support*

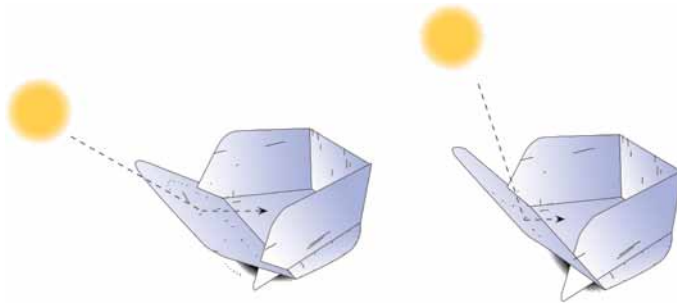
- Place the cooker in a sunny spot with no shade. There must be full and continuous sunlight.
- Place the cooker so that its shadow is directly behind it and not on one side. To speed up the cooking, adjust the position every two hours.
- Prepare the meal by cooking at around 9 - 10 a.m. so that it is ready for lunch. Prepare the meal by cooking at around 1 - 2 p.m. so that it is ready for the evening meal.
- If you want a dish to cook throughout the day, place the cooker in the direction of the sun's position at midday or early afternoon.
- If necessary, adjust the position of the cooker's front panel.



⬆ *Folding the cooker*

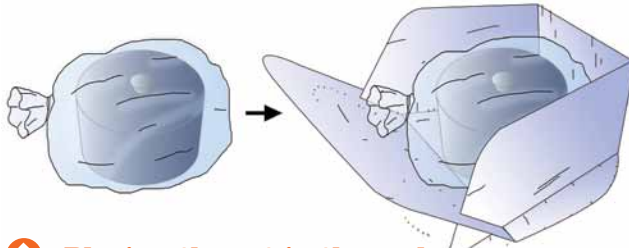


⬆ *Positioning the cooker in relation to the sun*

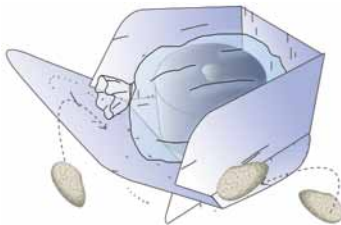


↑ **Position of the cooker's front panel**

The shadow of the front panel must always be small. The panel must be raised when the sun is high in the sky and lowered when the sun is low in the sky. The reflection of the sunlight must be as great as possible.



↑ **Placing the pot in the cooker**



In case of strong wind, add stones or bricks on each side of the cooker to stabilise it. Do not insert any stone inside the cooker, as they could impede the reflected sunlight.

↑ **Stabilising the cooker in windy conditions**

- Leave the food to cook without stirring. Avoid opening the bag during cooking to prevent loss of heat.
- When the cooking is finished, wear sunglasses to prevent the reflected sunlight from damaging your eyes and use cooking gloves or tea towels to avoid burns, as the pot will be very hot. Position yourself in front of the cooker with your back to the sun, then remove the cooking pot. Avoid the steam that will be released when you open the plastic bag, as it is very hot and can cause burns.



← **Removing the pot from the cooker**

Using the box cooker or solar panel cooker to pasteurise food

In addition to cooking, solar cookers can also be used to pasteurise liquids and food. To avoid food contamination, it is essential to observe the basic hygiene rules described below.

In addition, it is essential to preserve pasteurised food and liquids in dry, hermetically sealed containers.

>>> Pasteurisation of liquids and food

Impure water is a serious health problem, as it leads to diseases such as cholera, dysentery, typhoid, Guinea worm disease and hepatitis A. Pasteurisation kills germs by exposing them to heat. Solar cookers heat water to high temperatures reducing the risk of microorganism contamination (Escherichia coli, rotavirus, Giardia lamblia, hepatitis A virus). Milk and food products are pasteurised when they are heated to 71 °C.

>>> Checking the pasteurisation of water

To ensure that water has been correctly pasteurised, you can use a WAPI (Water Pasteurisation Indicator). This simple and reusable device contains a piece of wax that melts when it reaches the pasteurisation temperature, thus indicating that the water has reached the correct temperature.



It is not useful to boil liquids if you have a measuring device showing that pasteurisation has been successful.

If you do not have an indicator, boil the water for 5 minutes to ensure that all of the bacteria have been completely destroyed.

Pasteurisation does not purify the water from dangerous chemical products such as mercury or arsenic. To counter heat-resistant fungi, it is essential to sterilise water, liquids, food products and medical instruments with special, very powerful cookers that can reach high temperatures (more than 150°C).

1.6 Cost of solar cookers

In Africa, wood, charcoal, gas and agricultural residue (palm nut husks, cow dung, etc.) constitute the most popular source of domestic fuel. A household consumes on average 5 kg of wood per day. Therefore a typical family needs 1,825 kg of wood per year. With the average price of wood at FCFA 80 per kg, the annual expenditure on wood is approximately FCFA 146,000 (€ 222.5) per household. Gas consumption stands at an average of 12.5 kg per month per household, which is 150 kg of gas per year. The price of a 12.5 kg gas cylinder is approximately FCFA 6,000, so annual expenditure of gas is FCFA 72,000 (€ 109.7) for each household.

Although solar cookers can only be used in sunny weather, they represent interesting alternatives as far as energy source used being free and due to their minimal impact on the environment (no air pollution, less deforestation).

THE FOLLOWING TABLE SHOWS THE COST OF MAKING A BOX COOKER

	<i>Unit</i>	<i>Quantity</i>	<i>Unit price in FCFA</i>	<i>Total price in FCFA</i>
Piece of wood measuring 1.5 m x 1.5 m (in the absence of wood, make two cardboard boxes, one approximately 45 cm x 45 cm and the other approximately 40 cm x 40 cm)	1	1	10,000	10,000
Household aluminium foil	1 roll 5 m	1	2,500	2,500
Sheet of glass or plastic 3 mm thick measuring 43 cm x 37 cm	1 sheet	1	10,000	10,000
Blocks of foam, newspaper, sheep's wool, ashes or dried plant fibres	assorted	0,5 m ²	2,000	2,000
Rigid cardboard box 1 m x 2 m	1	1	2,000	2,000
Glue	1 pot 100 to 200 ml	1	5,000	5,000
Screws, nails	1 box		5,000	5,000
Equipment (scissors, ruler)	2	1	5,000	5,000
Labour			10,000	20,000
TOTAL				61,500

The total cost of a rigid box cooker is approximately FCFA 61,500 or € 93.75.

THE FOLLOWING TABLE SHOWS THE COST OF MAKING A SOLAR PANEL COOKER

	<i>Unit</i>	<i>Quantity</i>	<i>Unit price in FCFA</i>	<i>Total price in FCFA</i>
Sheet of paper 1 m x 1.30 m	1	1	2,000	2,000
Rigid cardboard box 1 m x 1.30 m	1	1	3,000	3,000
Glue	1 pot medium size	1	5,000	5,000
Household aluminium foil	1 roll 5 m	1	2,500	2,500
Equipment (scissors, ruler)	1		5,000	5,000
Labour		1	10,000	10,000
TOTAL				27,500

The total cost of a solar panel cooker is approximately FCFA 27,500 or € 41.90.

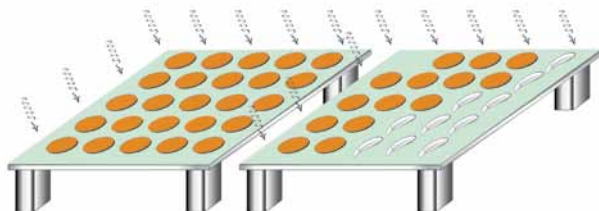
These investments are generally recouped in less than one year of use. The profitability of these cookers depends on how frequently they are used

2

SOLAR DRIERS

2.1 Different types of driers

Food is traditionally dried in the open air, spread out in the sunlight. This traditional method requires a lot of handling and leads to considerable loss due to contamination by insects, sand and gravel. This guide demonstrates improved drying techniques (**direct solar drier or indirect solar drier**) that limit losses due to contamination, save time and achieve better quality results. It is therefore important to choose the drier best suited to the needs and capacities of each household.



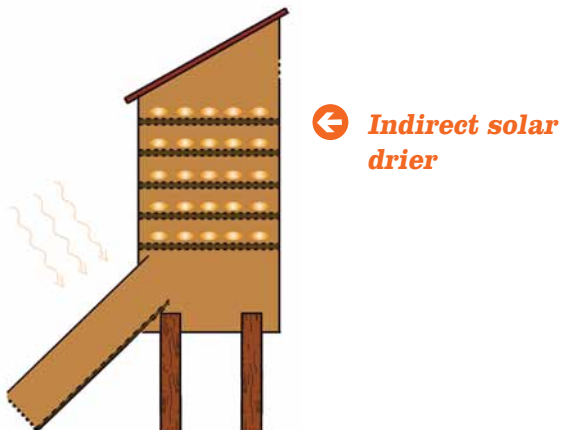
↑ *Traditional drying method*

The direct solar drier technique is more efficient than the traditional method, because food is protected behind glass, which allows to obtain higher temperatures. Moreover, food is protected from possible contamination (dust, sand, etc.) thanks to the glass. The sun, amplified by the glass, shines directly on the food and dries it. However, these rays also destroy the vitamins and nutritional elements, eliminating food flavours and colours. Furthermore, in case of inadequate ventilation, this can lead to mould issues in humid conditions.



← *Direct solar drier*

The indirect solar drier technique takes longer to build and is more expensive but it saves vitamins, nutritional elements and food colours. The sun's rays do not make direct contact with the food, but the sun's ray hit a transparent surface with a black base which acts as a solar collector. The air heated in this way by the collector circulates toward the drier and dries the food. The circulation of hot air provides good ventilation and eliminates any humidity issues. The food does not lose its nutritional qualities.



2.2 Construction of a direct solar drier

The food is spread out on grids inside a box with a glass top to increase the temperature and protect the food. Holes in the rear of the drier provide a small amount of ventilation.



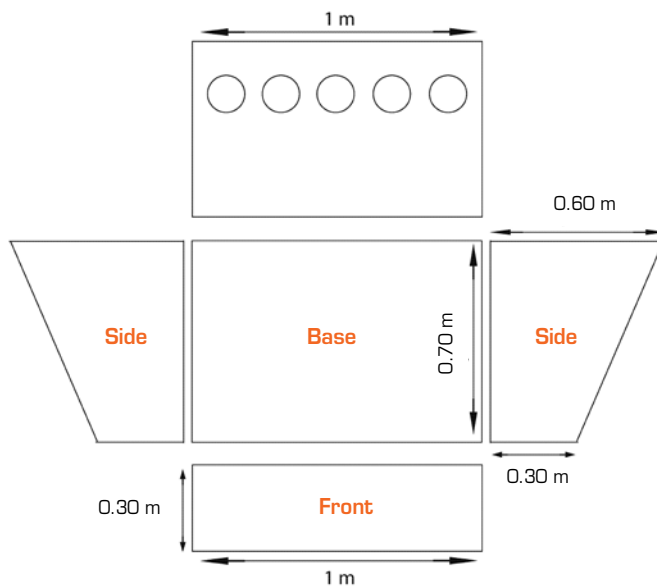
For the solar drier to operate most efficiently, the glass top must be at an angle of 45° to the sun, and the drier must be positioned to face south.

Required materials

- Several pieces of wood between 0.5 cm and 2 cm thick
- A sheet of plexiglas or glass measuring 1 m x 60 cm
- Wooden battens of a total length of 3.50 m
- Hinges
- Handles
- Screws and nails
- Silicon glue
- A mosquito screen

Construction of the direct solar drier

- Cut the wood as indicated in the schematic representation below.



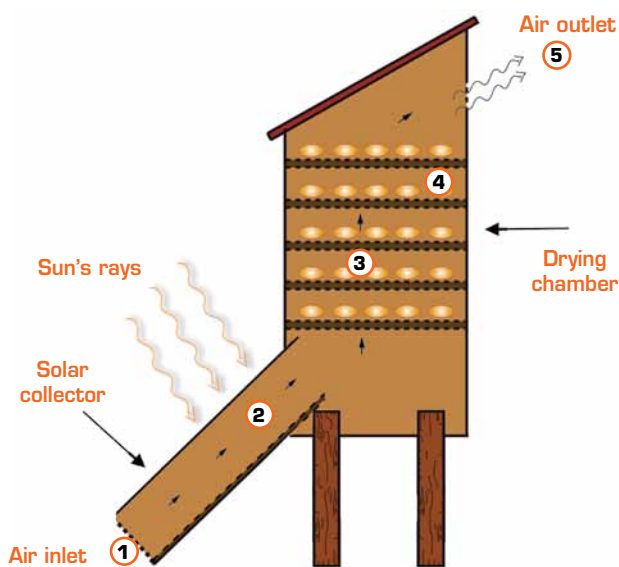
- Make some holes in the base and rear sections. These holes will provide the drier with ventilation.
- Join the parts together: attach the sides to the base, then attach the rear and the front.
- Make two wooden frames to the measurements of the box. Place the glass top on the first frame, seal the joint with a silicon sealant, and then attach the second frame to the other side of the glass top in the same way.
- Attach two hinges joining the frame of the glass top to the rear of the box.
- Bind the battens to the inside of the box as indicated below. These battens will support the grids.

- Make the grids with the battens. Make wooden frames measuring 95 cm x 55 cm and attach the mosquito screen to it.
- Fix the mosquito screen over all of the ventilation holes, as well as under and to the rear of the drier.
- Bind two pieces of wood to each side of the box to raise it above the ground, as shown in.

2.3 Construction of an indirect solar drier

The two most important factors for ensuring that the drier works efficiently are its position in relation to the sun and ventilation. The drier should always be positioned at an angle of 35° to 45° away from the south and also correctly ventilated.

All indirect solar driers are composed of two parts: the solar collector and the drying chamber (see plan). This technical guide demonstrates the simple and rapid construction of a vertical solar drier, which means that the solar collector is located below the drying chamber. The plan below can be adapted to construct driers of different sizes.



- 1/** Air intake.
- 2/** The solar collector is made from black materials covered with a glass top. The sun's rays strike the glass and heat the air.
- 3/** Hot air circulates in the drying chamber. The food spread out on the grids is dehydrated by the circulation of hot air.
- 4/** Two lateral windows can be opened to regulate the temperature inside the drying chamber.
- 5/** Hot air is evacuated through an opening situated above door A.

↑ The different parts of the solar drier

Ideally, the temperature inside the drier should be 45 to 50 °C. It can be adjusted by opening or closing the windows on the sides. It is helpful to check the temperature with a thermometer. If the temperature is too high, it will cook the food and, if it is too low, the food will not dry and will decay.

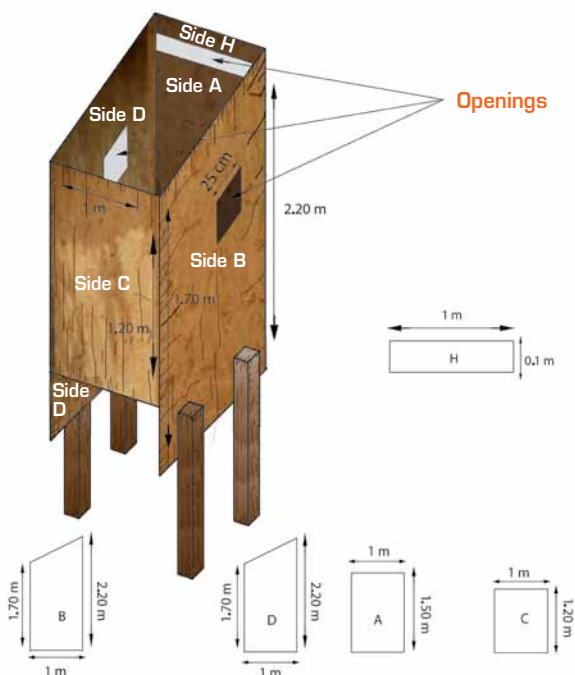
Required materials

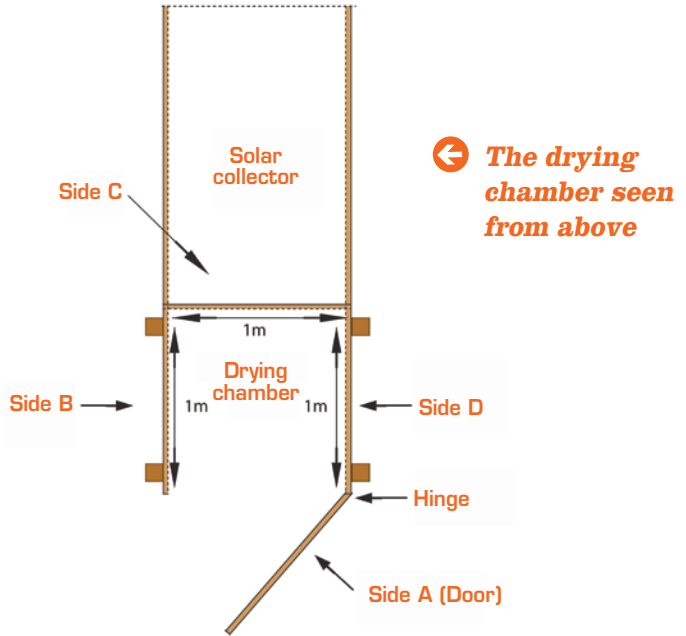
- Plywood or recycled wooden boards or planks
- Galvanised sheet metal
- Wooden battens or slats
- Silicon insulation gasket
- A sheet of plastic (or glass if it is impossible to obtain plastic)
- Black paint
- Screws and nails
- 4 hinges
- 3 door latches
- Wire mesh or mosquito screen for the air intakes and outlets
- Synthetic foam (optional)
- A thermometer (optional)

Construction of the drying chamber

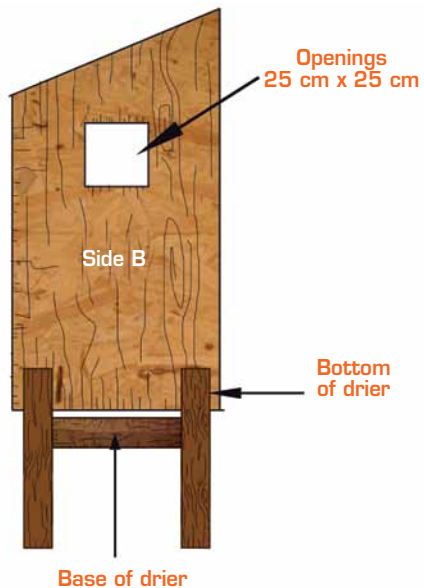
- Cut up wooden sections A, B, C, D and H using the measurements shown on the representation. Section A will form the door. It will be located opposite the solar collector. The solar collector will be bound under section C.

→
The different sections of the drying chamber

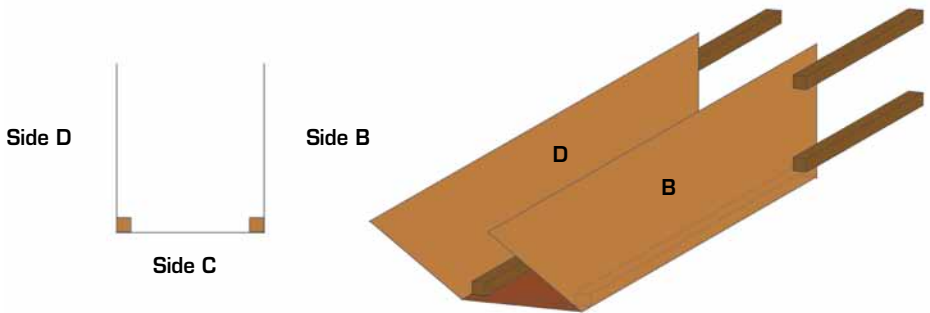




- Cut a 25 cm x 25 cm square to form Side B as shown above.

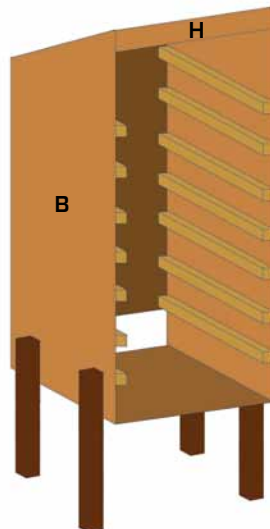


- Repeat the same with side D. These openings allow the temperature to be regulated.
- Cut the drier base legs: 4 lengths of 10 cm wide and 70 cm long wood. The thickness of these battens is important, as they will form the base that will carry the drier assembly.
- Bind two pieces of wood to the outside of side B and two others to the outside of side D, as shown above. Add a supporting batten between these legs to ensure stability.
- Assemble sections B, C and D using the slats or battens on the internal sections, as shown above.



Assembling the sides of the drying chamber

- Cut six 80 cm lengths of wood. Bind them to the inside of Sides B and D, 20 cm apart, as shown in the plan. They will act as supports for the grids.

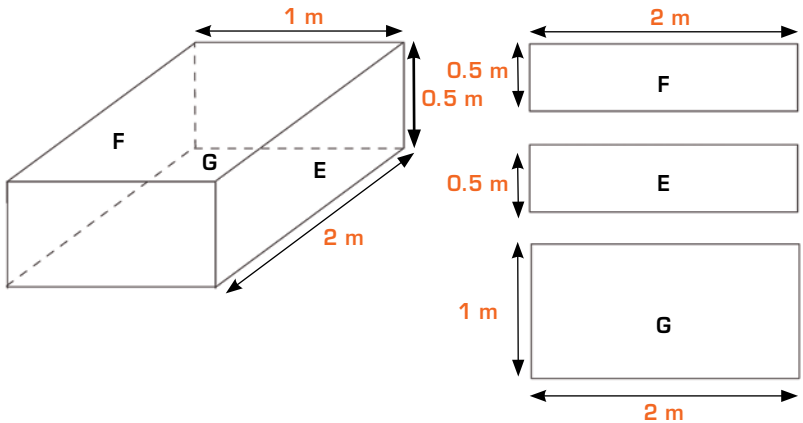


Grid supports

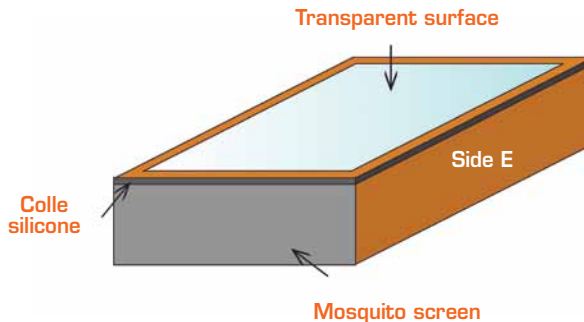
- Bind section A, which will form the door, and leave a 10 cm opening above the door. Attach two hinges and a latch. Place Side H between Sides B and D above the opening for the air outlet.

Construction of the solar collector

- Cut up sections E, F and G using the measurements in the schematic representation. Paint the internal surfaces of sections E, F and G with black paint.



- Assemble sections E, F and G using battens placed on the inside.
- Position the pane of glass on top of the solar collector, then bind it to sides F and G with the silicon glue.
- Position the mosquito screen on the side, as shown above. The mosquito screen will allow air to pass through while preventing insects from entering the drier.



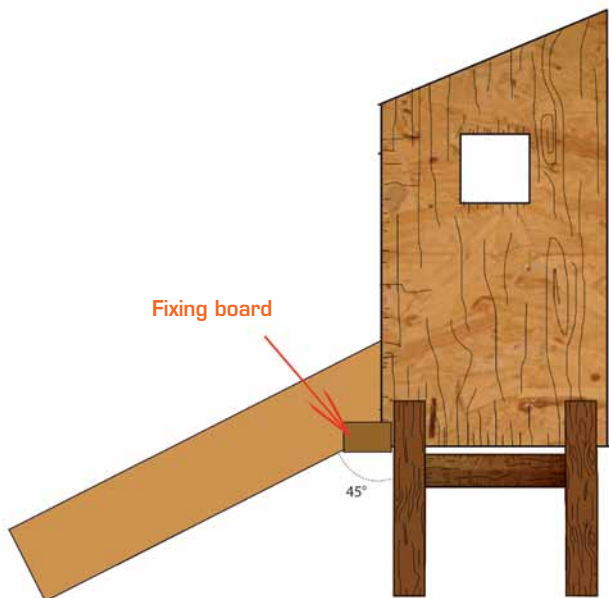
↑ Solar collector

Construction of the drying grids

- The 5 drying grids are 97 cm x 97 cm squares. They are built as wooden frames. A fine wire mesh or mosquito screen is attached to each frame, as shown above.

Assembling the solar collector and the drying chamber

- Attach the solar collector to the drying chamber with lengths of wood on sides B and D, as shown in the plan. To position the solar collector correctly, the angle between the collector and the drying chamber must be 45 °C.



Connecting the drying chamber to the solar collector

- It is important to ensure that the joints between the solar collector and the drying chamber are airtight in order to obtain good hot air circulation. Seal any gaps with wood or silicon sealant.

Construction of the roof of the solar drier

- Cut a piece of sheet metal of 1.40 m x 1.40 and bind it to the top of the drying chamber.

Finishing the solar drier

- Cut two pieces of wood measuring 27 cm x 27 cm to close the side windows. Use hinges to attach these squares to the openings on sides B and D. Attach latches. All of the openings on the drier must be closed to prevent insects from entering the drier.
- Attach pieces of mosquito screen over the lateral windows.
- Attach a piece of mosquito screen over the hot air outlet.
- Check that the outlet is airtight. Attach pieces of wood or foam to seal the openings if necessary.

2.4 Using solar driers

- Place the drier in a sunny spot facing south.
- Wash the food before drying it, remove any spoilt items.
- To facilitate the drying process, whenever possible cut the food into thin strips or small pieces. Small portions of food can be dried as such.
- It takes 1 to 4 days to dry food in sunny conditions. In case of bad weather, move the drier to a dry and sheltered spot. If bad weather persists, it is possible to complete the heating in an oven at low temperature.
- Preserve the dried food in a clean, hermetically sealed container, preferably in a dry, cool place.

2.5 Cost of solar driers

THE FOLLOWING TABLE SHOWS THE COST OF BUILDING A DIRECT SOLAR DRIER (IN FCFA)

	<i>Unit</i>	<i>Quantity</i>	<i>Unit price in FCFA</i>	<i>Total price in FCFA</i>
2.10 m x 1.60 m piece of wood 0.5 cm to 2 cm thick	1	1	10,000	10,000
Wooden battens or slats totalling 10 m in length	1 m	10	1,000	10,000
1 m x 0.70 m plastic sheet (plexiglas) or pane of glass	1	1	10,000	10,000
Silicon glue	1 tube	1	5,000	5,000
Black paint	1 100 ml tin	1	5,000	5,000
Screws and nails	1 box	1	5,000	5,000
Hinges		1	5,000	10,000
1 m x 1 m mosquito screen		1	5,000	5,000
Labour	2	1	10,000	20,000
TOTAL				80,000

THE FOLLOWING TABLE SHOWS THE COST OF CONSTRUCTING AN INDIRECT SOLAR DRIER (IN CFAF)

	<i>Unit</i>	<i>Quantity</i>	<i>Unit price in CFAF</i>	<i>Total price in CFAF</i>
Pieces of wood 0.5 cm to 2 cm thick with a total surface area of 2.20 m x 5 m		1	10,000	10,000
1 m x 2 m plastic sheet (plexiglas) or pane of glass	1 m	1	10,000	10,000
Wooden battens or slats measuring 2 cm x 2 cm, with a total length of 24m	1 m	10	1,000	10,000
10 cm x 10 cm wooden battens, with a total length of 1.20 m		10	1,000	10,000
Hinges		2	5,000	10,000
Handles door latch		1	15 000	15,000
Black paint		1	15,000	15,000
1.10 m x 1.10 m sheet of corrugated iron		1	5,000	5,000
1 m x 1 m mosquito screen		1	3,600	3,600
Screws and nails	1 box	1	5,000	5,000
Silicon glue	1 tube	1	5,000	5,000
Labour	6	1	10,000	60,000

TOTAL

163,600

The building cost of solar driers starts from FCFA 80,000 (€ 121.95). The drying capacity is 1 to 10 kg of fresh products per day. Their profitability depends on how frequently they are used.

To reduce the cost of driers, use local and recycled materials as much as possible. This investment becomes profitable very soon.

3

ADDITIONAL INFORMATION

3.1 Bibliography

Benkhelfellah R., El Mokretar S., Miri R. and Belhame M., 2005. Séchoirs solaires. Études comparatives de la cinétique de séchage des produits agroalimentaires dans des modèles de types direct et indirect (Solar driers. Comparative studies of the kinetics of drying agrofood products in direct and indirect models), 12èmes Journées Internationales de Thermique Maroc.

Berhinger R. and Götz M., 2009. Cuiseurs solaires : Autoconstruction et recettes (Solar cookers: construction and recipes), Ed. La page.

Dudez P., 1996. Le séchage solaire à petite échelle des fruits et légumes, Expériences et procédés (Small-scale solar drying of fruits and vegetables. Experiences and processes), (CIRAD) Ed. du GRET, Ministry of Cooperation

Lorenz-Ladener C. and Griesmar D., 2011. Séchoirs solaires : Construction et utilisation (Solar driers: Construction and use), Ed. La Plage.

Miri R., Mokrani O., Siad F. and Belhame M., 2002. Étude expérimentale d'un Séchoir Solaire (Experimental Study of a Solar Drier), Rev. Energ. Ren.: Zones Arides, p. 41-48.

Rioux A., 1995. Amélioration et diversification du séchage solaire domestique des fruits, des légumes et des feuilles (Improvement and diversification of the domestic solar drying of fruit, vegetables and leaves), Documents archive of the FAO.



3.2 Useful contacts

■ Association Bolivia Inti

18, rue Gaëtan Rondeau
44 200 Nantes (France)
Tel.: (+33) 02 51 86 04 04
Email: soleil@boliviainti.org
www.boliviainti-sudssoleil.org

■ Association Solemyo

Rue des Gares 15
1201 Genève (Switzerland)
Tel: (+41) 22 734 734 0
Email: solemyo@cuisinesolaire.com, exsol@cuisinesolaire.com,
mickael@cuisinesolaire.com
www.cuisinesolaire.com

In the same collection...



Improved plantain production

E. Lionelle Ngo-Samnack

Rearing grasscutters

E. Lionelle Ngo-Samnack

Rattan production and processing

E. Lionelle Ngo-Samnack

How to make a hand pump

Thomas Simb Simb

Maize production and processing

Maybelline Escalante-Ten Hoopen & Abdou Maïga

Improved technique for hand-crafted soaps and detergents production

Martial Gervais Oden Bella

Raising geese

Irénée Modeste Bidima

Cocoa production and processing

Kokou Edoh Adabe & E. Lionelle Ngo-Samnack

Construction of solar cookers and driers

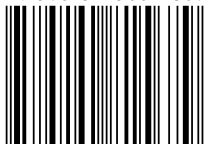
Pro-Agro is a collection of practical, illustrated guides that are jointly published by CTA and ISF Cameroun. They are an ideal source of information for farmers, rural communities and extension workers in tropical and subtropical regions.

This technical guide describes a number of simple methods for building and using solar cookers and driers: a box cooker, a solar panel cooker, a direct solar drier and an indirect solar drier. They meet the food processing needs of diverse populations at low cost. They are economical, environmentally friendly, easy to make and can be used independently.

- **The Technical Centre for Agricultural and Rural Cooperation (CTA)** is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities. CTA operates under the framework of the Cotonou Agreement and is funded by the EU.

- **Engineers without Borders (ISF)** is a network of professionals in more than 52 countries to promote human development through improved access to scientific and technical knowledge. In Cameroon, ISF works together with local people to improve their livelihoods and strengthen their technical capacity by sharing and diffusing information adapted to their needs.

ISBN 978-92-9081-567-9



9 789290 815679 >

