HOW TO MANUFACTURE

SOLAR COOKIT

&

WAPI

Water Pasteurisation Indicator

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How to manufacture the Solar CooKit / WAPI
SCN, The Netherlands
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A. MANUFACTURING COOKITS

1. What is a CooKit?

The CooKit is a reflective panel used to cook with the sun. A black painted pan is placed inside a plastic heat-resistant plastic bag. The CooKits can be made by hand in a shady place or in a workshop by at least 4 people. This manual explains how to make a CooKit (and a WAPI) and what you need to make it.

CooKitset
A CooKit is part of a CooKit set),
- CooKit
- 4 litre black-painted light-weight pan
- cotton bag
- set of 2 plastic heat-resistant plastic bags
- 2 pieces of string
- 2 clothes pegs
- black painted water kettle 3½ litre
- WAPI (water pasteurisation indicator)
- instruction manuals ‘How to use the CooKit & WAPI, etc
- flyer Solar Cooking

2. How to make a CooKit

2.1. General
- CooKits have to be made in a clean, dry and shady workspace.
- The craftswomen / men are selected and trained by a CooKit expert.
- The manufacture of a perfect quality CooKit requires qualified technical and handicraft skills.
- Good quality CooKits are made by using standard working methods as described in this manual.

2.2. The mould
- Always use a plywood or metal CooKit mould for all production steps. The mould matches the CooKit drawing (Annex II) with the exact measurements, lines, points, slots and angels.
- The mould is made of plywood or metal. A metal mould has the advantage that cutting along its edges does not damage it. Indeed, a plywood mould is more easily damaged because of cuts into the soft edges.
- The fold lines are indicated by small punctured slots at the end of each fold line (See drawing, Annex II)
- When you link the punctures with a stick or a ruler, the straight fold line will be in exactly the same place for each new CooKit.

2.3. Rerolling the foil
- Transfer / reroll a segment of aluminium foil onto the PVC pipe for about 6 – 10 CooKit sheets from the big and heavy roll.
- Roll the foil outside in onto the smaller roll.
- During transfer, hold the rolls as close together as possible. The foil will crease less.

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2 Annex I Price indication CooKit set
• Use a stick that is longer than the width of the foil, because rerolling tends to be crooked! 190 cm often is long enough.

2.4. Gluing aluminium foil on cardboard

Preparing the glue
Mix 1 measure of cassava or another type of flour with 3 measures of cold water. Add the water very slowly to the flour while constantly stirring. Stir well while heating in order to avoid lumps. Boil the glue very carefully on gas. The glue is ready when it is as thick as porridge. The glue has to be used cold.

Gluing
• Put the corrugated side of the cardboard down and the smooth side up.
• Apply the cold glue to the smooth side of the cardboard.
• Glue the foil, paper side down, on the smooth side of the cardboard.
• Always use clean brushes.
• Always glue with 4 people
• 2 people start gluing and then slowly and gradually unroll the aluminium foil. If necessary, that is to say if the surface is too dry, more glue can be applied with one hand (the foil is in the other hand).
• At the same time, the other 2 people very gently rub the aluminium foil on the cardboard with a clean rag to ensure that there are no air bubbles and that the foil is thoroughly glued on the cardboard.
• Note! Do not lean on the freshly glued CooKit sheet! It will create creases.
2.5. Drying the sheets
- Stack the glued sheets with 3 strips of used cardboard between each sheet, place plywood on top and add some extra weight.
- Stack up to ± 25 sheets.
- Leave the sheets to dry for a minimum of 24 hours. Wet CooKits are very difficult to cut!

2.6. Drawing cutting lines and folding points
- Select dry cardboard sheets and put the aluminium side down on the table covered with cardboard to protect the wooden table.
- Put the CooKit plywood mould on the CooKit sheet.
- Use clamps to fix the sheet on the table.
- Draw the shape of the CooKit on the cardboard sheet with a black ballpoint or marker (fine point).
- Draw the two slots very precisely. Carefully pierce all 14 folding points and the 2 slot points with a pointer.
- Cutting should take place in a clean and dry place protected from direct sunlight.

2.7. Cutting the CooKit
- Use a very sharp knife (Stanley knife or equivalent) to cut all the outside lines of the CooKit and the 2 slots.
- The slots must be precisely 0.3 cm / 1/8” (Annex II). If the slots are too big, the edges of the CooKit will slip out. If the slots are too narrow, you will force the edges and you will damage them.
- You can cut along the model or you can follow the lines drawn.
2.8. Folding the CooKit
- There is only ONE WAY of folding to obtain a sound marketable product.
- Follow the folding instructions step-by-step. Always do this with 2 people.
- Use the edges of the table and a long flat and smooth piece of wood/ large ruler to bend the cardboard upwards / downwards, etc.
- You can press the folding lines with the ruler before folding with the ruler.

![Use the edges of the table](image1)

![Start by putting the aluminium side up and follow the 6 steps below /next page](image2)
2.9. Folding instructions

Small left part forward
Whole left part backward
Small right part backward
Whole right part forward

Close big part forward

Close small part towards big part

Fold left wing backward

Fold right wing backward

Put a rubber band around the CooKit
Put Cookit in cotton bag
2.10. Finishing

Coloured ribbons for durability
• Take a 2½ cm coloured cotton ribbon: glue the ribbon along the sides and the 2 slots with office glue.

![Detail of the red ribbon](image1)

![Red-coloured CooKit](image2)

Varnishing cardboard side
• Mix transparent varnish with red (or other colour) oxide and a little thinner; stir well before application.
• Open the CooKit and varnish the outside of the CooKit in parallel lines taking care to follow the lines of the cardboard.
• Dry in ± 30 hours!

2.11 Quality control
To achieve the same high quality for all CooKits, they must be checked on a regular basis (at least once every 2 weeks). Assemble the CooKit and check the following points:

Gluing:
*Is the surface of the CooKit smooth, without dents and lumps?*
• Open the new CooKit and check the surface.
*If there is any area where the glue has not stuck well*, repairs will be needed.
• Carefully cut a cross and paste the four corners underneath the cross on the cardboard.
• Or make only one cut, paste underneath and affix the aluminium foil again.
*If there are dents? How were they made? What can you do to avoid them?*
• Discuss the process with the craftswomen / men.
• Do they lean on the glued sheet during the process?

Cutting:
*Are the edges curled or damaged?*
• If curled, repair the edges by gluing a ribbon.
*Do the edges fit in the slots?*
• Are the slots 0.3 cm / 1/8”?
• If the slots are bigger, throw away the CooKit! It won’t work.
• If they are too narrow, cut to the right size.
• Why are they not correct? Do they use the mould?
*Have the edges of the CooKit been cut smoothly and sharply? If not?*
• Check if the cutting knives are sharp enough (such as a Stanley knife).
• If the CooKits have not been left to dry long enough, the edges will fray during cutting.
*Are all the CooKits of the same size? If not?*
• Is the mould used properly?
• Does the mould have the correct measurements? (Annex II)
Repairing gluing after quality control

Controlling sides to adjust front panel

**Folding:**

*Does the folded Cookit resemble a nice square parcel?*

- Check the folding by comparing to the mould (see above).
- Check the Cookit when unfolded and check the corners in order to be able to adjust the front panel.

*Is the Cookit not level?*

- Check the fold lines on the Cookit and compare with the model.

**Cookit sets**

*Are the Cookit sets complete?*

- Check the contents of the Cookit sets. Have all the parts been included? “How to use” instructions as well?

3. **Manufacturing cotton bags**

- Make cotton bags that can contain all the parts of the Cookit sets.

4. **Painting pans and water kettles**

- To paint pans and kettles black use blackboard paint. Do not use glossy paint.

5. **Requisites to manufacture a Cookit set**

5.1. **Space requirements for Cookit manufacturing**

- Minimum space of 6 x 6 metres, suitable for 2 working tables of about 122 x 90 cm, 2 metal rollers and at least 4 people.
- Space to dry (in the shade) and fold.
- Space to paint pans and water kettles black.
- Space to complete Cookit sets.
- Space to make WAPIs.
- Space to sew cotton bags using a sewing machine.

5.2. **Personnel**

Four craftsmen / women work as a team to do the entire job. Each selected for specific handicraft skills.
5.3. Minimum equipment / tools needed

**Furnishing**
2 tables, each 122 x 90 cm (CooKit size). They may be larger but not smaller. Height 80 to 85 cm. These tables are used to unroll aluminium foil, to glue, to cut and to fold. 2 sheets of cardboard or plywood or any other material to protect the table while cutting the CooKits.

**Making the CooKit: materials and tools**

*To unroll the foil*
- rolls of big/heavy (± 25 kg – 40 kg) aluminium foil, rerolled into smaller rolls on 50 mm
- 2 pvc pipes, 50 mm diameter, length 190 cm to reroll the foil.
- 2 metal rollers on stands for big/heavy (± 25 – 40 kg) aluminium rolls.

*To glue:*
- corrugated cardboard from local market: 48”/ 122 cm x 36”/ 91 cm for each CooKit sheet
- small roll of foil (see above)
- 1 heater to prepare glue (and make WAPIs)
- 1 big pan and spoon to prepare glue
- 2 buckets for water
- cassava flour
- 2 large brushes to apply glue
- 4 (old) soft and always clean cloths to rub glued surfaces

*To cut, fold and finish:*
- **CooKit mould:** 2 standard plywood or metal/aluminium templates with standard cutting, piercing and fold lines
- 4 clamps to fix plywood / metal on cardboard.
- Pencils and awl
- 8 very sharp cutting knives
- cotton fabric / ribbons around the CooKit
- red (or other colour) varnish for outside surface of the CooKit
- metal (or wooden) ruler for folding

*To dry:*
- 2 sheets of plywood ± 120 x 100 cm, thickness min. 12 mm to put on top of glued cardboard during drying

*To paint the pan*
- black paint (blackboard) and brush

*To finish*
- sewing machine to make cotton bags and cotton fabric
- red varnish and ribbon around the CooKit

**Does the folded CooKit resemble a nice square parcel?**
- Check the folding by comparing to the mould (see above).
- Check the CooKit when unfolded and check the corners in order to be able to adjust the front panel.

**Are the CooKit sets complete?**
Check the contents of the CooKit sets. Have all the parts been included? “How to use” instructions well?

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3 Annex II Checklist manufacturing CooKit
4 CooKit drawing in Annex
B. WATER PASTEURISATION INDICATOR (WAPI)

1. What is a WAPI?

The WAPI is a clear plastic tube partially filled with some soybean wax or Myverol that melts at about 70˚C (158˚F). With the solid wax at the top end of the tube, the WAPI is placed at the bottom of a black-painted water kettle that is solar heated. If the wax melts and falls to the bottom of the tube, it ensures that water pasteurisation conditions have been reached. The WAPI has a stainless steel washer around it to keep it at the bottom of the kettle. There are small holes at both ends of the WAPI through which nylon fish line is threaded; a small stainless steel washer is placed at each end - one end is kept outside the kettle in order to be able to remove the WAPI.

2. How to make a WAPI

1. Saw an 8 cm length of plastic tube. If a BIC tube is used, avoid the part with the small hole! It is faster and easier with 2 people (1 to hold, 1 to saw).
2. Soften one end (1 cm) of the plastic tube by warming it above the candle flame;
3. Try to flatten the 1 cm part immediately with a hammer and with some grease to avoid sticking to the plastic or use a pair of flat pincers. You can also use a small bottle on a flat protected table. Make the hole immediately as well with a nail. It happens that you have to heat again.
4. Put one stainless steel washer around the tube (see photo / drawing).
5. Put 1½ cm soybean powder (Myverol) into the tube
6. Close the other end of the tube by softening it above the candle flame
7. Put the nylon fish line (50cm) through the holes at each end of the WAPI and attach 2 small stainless steel washers on both ends.
8. Heat the water in the pan and put the finished WAPIs for about 5 minutes in nearly boiling water until the wax powder has melted and is transparent. Keep an eye on the WAPIs and avoid melting of the plastic tube!

5 1 kg Myverol is enough for 1000 WAPIs
3. Quality Control

- Remove the WAPIs from the water and check that the wax is not leaking. If so, throw the WAPI away: it won’t work.
- Why does the WAPI leak?
- Has it not been pressed closed properly?
- Has the hole been made in the wrong place?
- Did the BIC Ballpoint already have a hole?

4. Materials

**WAPI materials**

- Plastic tubes, e.g. empty BIC ballpoints
- Nylon fish line (for 1 WAPI: ± 50 cm length)
- Stainless steel washers (for 1 WAPI: washers; size: + + diameter tube)
- Soybean wax powder / Myverol 18-8 K

**Tools/ equipment**

- Candle, matches (to make the plastic ends warm – soft)
- Hammer / pair of pincers (to flatten both ends) or small glass bottle
- Small saw (to saw the WAPI part of the plastic tube)
- Nail (to make small holes in the soft plastic)
- Pan with water (to boil the soybean powder into wax)
- Heater (gas or kerosene)
- Scissors (to cut fish line)
- Water to cool down your fingers (if necessary!)

Sources:

Solar Cookers International, Sacramento, California, U.S.A.
www.solarcookers.org
www.solarcooking.wikia.com

Photos de femmes ingénieurs, membres de l’AFIMA, Mali Bamako 2003

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Changes to photos, drawings and text to be made in consultation with SCN

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6 Annex IV checklist to make a WAPI
ANNEX I  CooKit sheet standard model  with measurements/lines
### ANNEX II Checklist tools, equipment to make a CooKit and WAPI

<table>
<thead>
<tr>
<th>CooKit</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2 tables 120 x 240 cm each</td>
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<tr>
<td>2 sheets of cardboard or plywood</td>
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<tr>
<td>A model of the CooKit</td>
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<td></td>
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<tr>
<td><strong>To unroll the foil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foil (big rolls and small rolls)</td>
<td></td>
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<tr>
<td>2 pvc pipes 5cm diameter, 190cm long</td>
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<td></td>
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<tr>
<td>2 metal rollers on stands</td>
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<tr>
<td><strong>To glue</strong></td>
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<tr>
<td>Corrugated cardboard (see text)</td>
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<tr>
<td>Small roll of foil</td>
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<tr>
<td>1 heater (for CooKit and WAPI)</td>
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<tr>
<td>1 big pan</td>
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<tr>
<td>1 spoon for stirring</td>
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<tr>
<td>2 water buckets</td>
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<tr>
<td>Cassava flour</td>
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<tr>
<td>2 large brushes for gluing</td>
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<tr>
<td>4 (old) soft, clean cloths</td>
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<tr>
<td><strong>To cut, fold, finish</strong></td>
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<tr>
<td>CooKit mould / template / model</td>
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<tr>
<td>4 clamps</td>
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<tr>
<td>Pencils</td>
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<td>8 sharp cutting knives</td>
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<tr>
<td>Awl</td>
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<tr>
<td>Cotton fabric / ribbons</td>
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<tr>
<td>Red varnish</td>
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<td></td>
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<tr>
<td>Metal (or wooden) ruler for folding</td>
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<tr>
<td><strong>To dry</strong></td>
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<td>2 sheets of plywood 120 x 100cm</td>
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<td><strong>To paint the pan</strong></td>
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<td>Black paint (blackboard)</td>
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<td>1 brush</td>
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<tr>
<td><strong>Finish</strong></td>
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<tr>
<td>Red varnish</td>
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<tr>
<td>Ribbon around the CooKit</td>
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<td>Sewing machine</td>
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<td>Cotton fabric</td>
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<table>
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<tr>
<th>WAPI</th>
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<tr>
<td><strong>WAPI materials</strong></td>
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<tr>
<td>Plastic tubes (BIC ballpoints)</td>
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<tr>
<td>Nylon fish line</td>
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<td></td>
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<tr>
<td>Stainless steel washers</td>
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<tr>
<td>Wax powder</td>
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<td><strong>Tools, equipment</strong></td>
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<tr>
<td>Candle, matches</td>
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<tr>
<td>Hammer or pair of pincers, or glass (bottle)</td>
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<td>Small saw</td>
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<tr>
<td>Nail</td>
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<tr>
<td>Pan with water</td>
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<tr>
<td>Heater</td>
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<tr>
<td>Scissors</td>
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<tr>
<td>Water (to cool off your fingers!)</td>
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<tr>
<td>Flat material to protect the table</td>
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ANNEX III  CooKit set and cost price indication

<table>
<thead>
<tr>
<th>Item</th>
<th>Price (Birr)</th>
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<tbody>
<tr>
<td>CooKit sheet</td>
<td>75</td>
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<tr>
<td>Cotton bag</td>
<td>5</td>
</tr>
<tr>
<td>Set of 2 plastic heat resistant plastic bags,</td>
<td></td>
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<tr>
<td>2 pieces of string, 2 clothes pegs</td>
<td>5</td>
</tr>
<tr>
<td>4 litre black-painted lightweight pan</td>
<td>50</td>
</tr>
<tr>
<td>Black painted Water kettle 3 ½ litre</td>
<td>65</td>
</tr>
<tr>
<td>WAPI</td>
<td>10</td>
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<td>Instruction manuals:</td>
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<tr>
<td>‘How to use the Cookit &amp; WAPI, etc</td>
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<td>Flyer Integrated Solar Cooking &amp;</td>
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<td>Water pasteurisation</td>
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