This manual is the result of 30 years of POSTCOSECHA experience in making metal silos in Central America, Cuba, Perú, Paraguay, Kenya, and other countries where POSTCOSECHA supported activities for grain storage.

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Preface

Since 1980 SDC has sponsored the “POSTCOSECHA” postharvest loss reduction Programme for maize and beans in Central America. With lasting impact: The massive spread of simple metal silos manufactured by local tinsmiths has enabled smallholder farmers to considerably reduce crop loss and enjoy much greater food security. At the same time, the activity created rural businesses, which in turn have generated employment.

Be it in Honduras or Guatemala, Nicaragua or El Salvador: The silver grey cylindrical silos sponsored by the SDC’s POSTCOSECHA Programme are dotting the Central American landscape. POSTCOSECHA, the Spanish term for “post-harvest”, has become the label of the metal silo approach in helping to ensure that agricultural products can be stored for personal consumption or later sale. Metal silos are easy to handle and come in various sizes. Any farmer who has a silo on his farm can eat maize or beans all year round and is free to decide when to bring his surplus harvest to market. POSTCOSECHA introduced and scaled-up massively the new storage technique in four countries from 1980 to 2003. By 2007, there were over half a million silos being used in these four countries. Moreover, the silo manufacturing activity is a welcome additional source of income for nearly 900 farmer tinsmiths: when they are not working in the fields, they spend their time producing silos. Farmers in Central America nowadays are able to save an estimated 50,000 tonnes of agricultural products from crop loss each year, which amounts to about USD 12 million in preserved value.

The present manual is the result of a revision of the manuals prepared in 1985 and 1991. Neither design nor technical specifications have been changed since 1984, but a digitalization of all manual components was organized in 2008. Practical experience has made it possible to improve the technical and didactic contents of the manual, especially concerning the topic of artisans as entrepreneurs. This manual has been developed to serve as accompanying material for a practical course in silo manufacturing under the guidance of an instructor. Adequate selection of artisans is crucial to success. Upon completion of the course, artisans can use the manual as a guide and reference work. We hope this manual will also be useful for institutions involved in ensuring food security, as it contains crucial knowledge for building, promotion and marketing of metal silos.

Currently SDC is promoting a two-year project which targets and experimentally implements the “POSTCOSECHA” metal silo approach in selected pilot areas and countries of East and Southern Africa (ESA), drawing on SDC’s highly successful experiences in Central and South America and the Caribbean and validating its application potential in ESA. Apart from initiating the program in Africa, the project will provide SDC with conclusive insights on the viability, impact potential and actual scale-out pathway for a longer-term program in ESA.

If you have any further questions, please do not hesitate to contact the Head Office of SDC, through www.postharvest.ch.

Bern, Switzerland; November 2008
Max Streit
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EXPLANATION REGARDING ADEQUATE USE AND HANDLING

Advice on the Handling of Grain and the Metal Silo

Dear Artisan ...

Each Silo Should Carry a Poster

METAL SILO USE AND HANDLING

In the following, you will find an explanation for each illustration on the “Metal Silo Use and Handling” poster, intended to guarantee appropriate silo use and handling.
Remember to fill the silo with healthy, clean, dry and fresh grain.

1. Drying and Cleaning

2. Correct Silo Location

3. Wrong Silo Location

4. Amount of Tablets

5. Use only phosphine tablets

6. Sealing the Silo

7. 3 to 5 hours later

8. Checking for Leaks

9. Correct Emptying

10. Wrong Emptying

11. Silo Maintenance

12. Wrong Emptying

13. Seal the silo for 10 days
USE AND HANDLING

4. Grain Fumigation

5. Incorrect Placement of Tablets

9. Fumigation and Time

10. Periodical Checking

Artisan's Name _______________________
Name of the Institution _______________________
Date of Manufacture _______________________
Silo Holding Capacity _______________________
Number of Tablets for this Silo _______________________
Silo Price _______________________
Number of Silo _______________________
1. Drying and Cleaning

- When the grain comes from the field it is ready for open-air storage but not for the silo.
- The grain is dry when it makes a prattling sound upon being tossed or is hard to bite.
- If you believe the grain is thoroughly dried out, leave out under a strong sun for three more days.
- Once the grain is completely dry, allow it one more night for cooling.
- If you store grain that is not dry enough it will develop fungi, a bad smell, lumps and fermentation, which in extreme cases may even cause the silo itself to burst open and thus be ruined.

2. Correct Silo Location

- The silo should be placed under a roof, either in the house corridor or inside the house itself (though not touching the walls). Under no circumstance should the silo be exposed to the sun.
- The silo should be placed on an even wooden platform so as to avoid contact with the ground.
- The silo should be located in a clean place.
3. Wrong Silo Location

- Protect the silo from the sun and the rain.
- Place the silo on an even wooden platform.
- Do not put bags containing fertilisers close to the silo. They may cause oxidation.
- Do not put heavy objects on top of the silo.

4. Grain Fumigation

- Once the grain to be stored is inside the silo, fumigate it with phosphine tablets under a number of trade names (PHOSTOXIN, GASTION, DETIA, QUICKPHOS or CELPHOS tablets) to destroy any insects remaining from the field.

- To eliminate the insects the number of tablets should be the same regardless whether the silo is full, half-full or less than half-full.

- Always put the tablets on the surface of the grain. The tablets should be wrapped in paper or maize husks.

- The tablets are toxic. Avoid touching them.
5. Incorrect Placement of Tablets

- Never put the tablets amidst the grain while filling the silo.
- Avoid breathing gas fumes from the tablets. They are dangerous to human health.
- The tablets should be placed on the surface of the grain wrapped in paper or maize husks. This allows for easy later disposal of the used tablets.

6. Amount of Tablets

- The number of tablets to be used for one fumigation depends on the volume capacity of the metal silo and not on the amount of grain in the silo.
- As a general rule, 1 tablet is used for every 227 kg of silo holding capacity.
- The tablets should never be broken up. For example, if you fumigate an 800 kg silo you must use 4 tablets and not 3.6 tablets.
7  Sealing the Silo

- All of the materials to be used should be at hand before the tablets are placed on the surface of the grain.

- The silo can be easily and comfortably sealed hermetically with tallow, soft soap, wax, and grease or by means of a rubber band or tape.

- Before putting tablets into the silo, seal the seed outlet with its soldered interlocking joints facing upward.

- After putting tablets into the silo, seal the intake throat with its soldered interlocking joints facing forward.

8.  Checking for Leaks

- Once tablets have been put on top of the grain, wait 3 to 5 hours before checking if gas fumes from the tablets are leaking.

- If there is a leak of gas fumes, there will be a smell like that of garlic.

- Cover the spot from which gas fumes are escaping with wax or soap, or call in an artisan to make the necessary repairs in case the leak is due to a manufacturing error.

- Continue to check for leaks on a daily basis.
9. Fumigation Period

- For fumigation to be effective the silo should be hermetically sealed, with no leaks that allow gas fumes to escape. The silo should be kept closed and tightly sealed for 10 days.

- The grain is ready to be eaten 1 day after the fumigation period is over.

- Keep the intake throat and seed outlet closed in order to prevent new insect infestations.

10. Periodical Checking

- Check the grain both at the intake throat and at the seed outlet every 15 to 30 days.

- If the grain contains moisture, remove it from the silo and expose it to the sun, as shown in drawing 1.

- If live insects are detected, you will have to fumigate again using the same recommended amount of tablets, based on silo capacity. Remember to seal both lids with tallow, soap, or grease for 10 days.
11. Correct Emptying

- For complete emptying of silo, use a small wooden hoe.

12. Wrong Emptying

- When there is little grain left, never tilt the silo to pour grain out. The silo may be damaged, dented or its bottom may become detached.
13. Silo Care and Maintenance

• Once completely empty, the silo should be cleaned both inside and outside.

• A slim person can crawl into the silo to clean the inside.

• The immediate surroundings of the silo should be also clean.

• After several years of silo use some oxidation may occur. Oxidation spots must be scrubbed with sandpaper and painted with anticorrosive silver paint.

• In case of damage to the silo, call a Postharvest artisan to perform necessary repairs.

14. Each Poster Contains the Following Information:

• Name of Postharvest artisan
• Name of the institution that transfers the silo
• Date of silo manufacture
• Silo capacity in kg
• Number of tablets to be used when fumigating
• Silo sale price
• Silo number assigned by the artisan

This information is also recorded in the artisan’s notebook.

By following these recommendations you may be certain the stored grain will maintain its quality for many months and you will feed your family with healthy and nutritious meals.
For greater security you can put a lock on the seed outlet.
To transport the silo on foot: Tie a long pole to each side of the silo, as shown in the drawing.
To transport the silo by truck:
Tie the silo platform (bottom) or a temporary wooden frame (top) down firmly, using 4 ropes attached to the sides of the truck bed, as shown in the drawing.
Materials to Buy:

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanised Sheet</td>
<td>calibre 26; 3’x6’(91cmx183cm)</td>
</tr>
<tr>
<td>Tin</td>
<td>50/50 (=lead/tin)</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>(HCl)</td>
</tr>
<tr>
<td>Pine Resin</td>
<td>(or ammoniumchlorid)</td>
</tr>
<tr>
<td>Soap powder</td>
<td>(detergent)</td>
</tr>
<tr>
<td>Charcoal</td>
<td></td>
</tr>
<tr>
<td>Aluminum Paint</td>
<td></td>
</tr>
</tbody>
</table>
GALVANISED SHEET

- A galvanised sheet is a sheet with a molten zinc surface. Tinsmiths prefer to use these sheets because they are easy to work with and are not damaged by gentle tapping with a mallet or hammer. The sheet is 0.5 mm thick, and is known as gauge 26.

**A 26 gauge good quality sheet should be used:**
- The zinc covering should not come off when the sheet is being cut or folded.
- The surface should be even and smooth, not rough.
- The galvanised sheet should not break when folded (as is the case with a non-tempered sheet).

- Bad galvanisation may produce oxidation of the sheet and lead to leaks. If the galvanisation is damaged it should be painted over.

- In Central America, the “Postcosecha” metal sheet is 6 feet long by 3 feet wide or 180 cm by 90 cm.

TIN BAR

- Tin for soldering contains 50% tin and 50% lead. You can melt your own lead-tin alloy.

ACID

- Hydrochloric acid can be bought at the chemist's. One litre is enough for 50 silos. Make sure you do not spill the acid!

PINE RESIN

- Resin is used to clean and tin the soldering irons. One kilogram of resin is enough for 10 silos. Ammonium salt can be used for the same purpose, but its use should be avoided because it may affect your health and damage the soldering irons rapidly.

ALUMINUM PAINT

- Aluminum paint protects the sheet from corrosion and improves silo appearance, which makes it more presentable for sale. Due to Hydrochloric acid stains all soldering must be painted from the inside and outside. One quarter (1/4) gallon (approximately 1 litre) will be enough for 25 silos of 1,360-kg capacity.

CHARCOAL

- Use charcoal to heat the soldering irons. One silo requires approximately 7 kg of charcoal.
## Tools to Buy

- **Tape measure** 3m long
- **Square** Carpenter No. 12.
- **Two straight soldering-irons** Insertion of the copper point weighs from 500 to 800 grams
- **Wire brush** Four rows
- **Ball pin hammer** 500 grams is acceptable
- **Chisel** 1 cm wide
- **Shears** No.12, good quality with sheathed handles.
- **Pliers** 1 cm wide
- **Screwdriver** 7 mm wide
- **Heating iron or an iron** With a square edge and curved iron sides 20 cm x 10 cm and 2-3 cm thick.
- **Paint brush** 2.5 cm wide
- **Wide bender** 20-25 mm with a slot exactly 5 mm deep
- **Narrow bender** 10 mm with a slot exactly 5mm deep
- **Metal plate** 3 cm x 40 cm x 0.6 cm square edge
- **2m Angle** 2 m x 2”x0.6 cm square edge
- **Round beam** 10 cm diameter x 1m long
- **Workbench** Firm, made of wood, 2.5m long
- **Piece of square beam** 5 cm x 10 cm x 240 cm used for hammering, must be hardwood
Tools to be Made before Manufacturing the Silo

- Workbench
- Mallet
- Gage marker
- Container for tinning
- Small brush
- Benders
- Portable Heating Appliance for Soldering Irons

The workshop

- Make sure you have enough room to work in.
- Your working place should have a roof.

- Levelling the Ground:
  If there is no cemented space, level the ground by
  - digging,
  - cleaning it of all stones,
  - wetting and flattening the ground.
Workbench

• Build yourself a workbench.
  2.5 m long
  90 cm wide
  80 cm high or according to your hip height (see also p.64)

• Hold the angle with 3” (8cm) nails or screws. Make sure the nails do not stick out.

Correct the Angle:

• Check visually to make sure that the angle is straight on both sides of the bench mark.

• If the angle requires correction, take out any nail where the line along the bench is not perfectly straight and nail it back in while applying pressure from the side.

• If the edge of the bench is still not good enough, you must plane it down until is is perfectly straight, using a carpenter’s plane.

NOTE: If the angle is not placed correctly, the folded edges will be of poor quality!

• Install a round beam or a pipe.
• Using a couple of strips, fasten a 1m long round beam with a 10 cm diameter to the workbench.
Small Brush for Hydrochloric Acid

- Cut out a small 2 \times 8 \text{ cm} strip.
- Shape it into a channel form.

- Slip in a little bristle at the tip.
- They should overlap to allow for the introduction of the bristle.
- Close the tip firmly.

- Even the bristles, leaving them 1 \text{ cm} long.

*NOTE:* 1 cm length is best for applying the acid.
GAGE MARKERS

• Take a piece of galvanised sheet and cut the gage markers at:
  - 5mm for folding edges.
  - 8mm for toothing.
  - 10mm for marking the slanted angle.
• Keep correcting if necessary until the measurements are exactly correct.

BENDERS
You will need a 10 mm wide bender and a 20-25 mm wide bender.

• Cut an 8-cm strip from a metal plate 6 mm thick.
• Carefully cut a slot 5mm deep along the length of the strip.
• Use a file to make a diagonal slant on the wider side of the strip.

**NOTE:** For the bender to be accurate, it should be made in a workshop that has a bench vise.

MALLET

• Use a piece of wood at least 1 inch thick (25.4 mm). Make a wide end and a handle as shown in the photo.
Sheet Scriber

• Determine the radius of the scriber you need.

• Cut off a narrow strip, 2 cm longer than the radius.

• Pierce the strip on one side with a nail.

• Measure the radius starting from the centre of the pierced hole and score the length of the radius and add 2 mm for the bent tip.

• The tip is cut by shears as shown in the photo. Then it is bent.

Container for Tinning

• The container diameter should be at least 25 cm.

• Use a piece of leftover galvanised sheet and a pair of pliers to make a rim for the container.

NOTE: Nail the container to a piece of wood to achieve a fixed position.
Measuring

<table>
<thead>
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<th>Measurement Conversions:</th>
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<tbody>
<tr>
<td>1 foot = 30.5 cm</td>
</tr>
<tr>
<td>1 inch = 2.5 cm</td>
</tr>
<tr>
<td>1 foot = 12 inches</td>
</tr>
<tr>
<td>1 m = 100 cm</td>
</tr>
<tr>
<td>1 cm = 10 mm</td>
</tr>
</tbody>
</table>

Exercises

1.5 cm = _____ mm
5 mm = _____ cm
2 inches = _____ cm
3 feet = _____ cm

- Circles

**Cylinder:**
- The body of a silo or portable heating appliance for soldering irons forms a _____ with a lid and a bottom.

**Circumference**
- A circumference is the result of multiplying the diameter of a circle by 3.14.

**Diameter**
- The lid and bottom of a cylinder form a circle of a particular diameter.

**Radius**
- Half the diameter is a ____________, which is the distance from the centre of the circle to its rim.

**Scriber**
- A scriber is set to the radius desired. A radius multiplied by two gives us the ____________________.
STEPS FOR MAKING A PORTABLE HEATING APPLIANCE FOR SOLDERING IRONS

1. Preparing the Metal Sheet to Make the Cylinder
2. Making the CYLINDER
3. Making the BOTTOM
4. Joining the BOTTOM to the cylinder
5. Making the SOLDERING IRON HOLDER and attaching it to the cylinder
6. Making the LUGS and the HANDLE and attaching them to the cylinder
7. Making the CHARCOAL HOLD and placing it inside the cylinder
8. Making the CYLINDER LID and joining it to the cylinder.
9. FINISHED PORTABLE HEATING APPLIANCE FOR SOLDERING IRONS
The Future Artisan

As a future manufacturer of metal silos you are about to be assigned your first practical task.

The Portable heating appliance for soldering irons

This appliance will allow you to heat the soldering irons.

It will also be useful as a toolbox to carry your instruments over long distances.
3 Scoring the Folded Edges

• Use a 5 mm gage marker to score both sides at the 30 cm length to fold the edges.

• Mark the corners with another line on both the 68 cm length sides, as shown in drawing 1.
Cutting the Corners

- Cut the corners with the tip of the shears.
- Observe that one side is cut so that it is slanted.

Scoring an Opening for the Soldering-irons

- Mark a 4 cm line from the edge of the galvanised sheet, as shown in the drawing.
- Set the centre of a semicircle by measuring 9.5 cm from the edge also.
- Mark the centre by using a nail and tapping it gently.

**NOTE:** Be sure not to pierce the sheet when tapping the nail!

Scoring a Semicircle

- Make a 5.5 cm scriber.
- Place a nail at the centre and score the semicircle.
- Be sure the scriber starts and ends at the 4 cm line when scoring the semicircle.

**NOTE:** To avoid mistakes, the nail should fit snugly into the hole of the scriber.
7  Marking Air Vents

- Air comes in through the vents, thus keeping the charcoal burning in the portable heating appliance for soldering irons. This keeps the required temperature steady when heating the soldering irons.

8  Triangle Template

- Cut a 7.5 x 5 cm piece of galvanised sheet and trace a line as shown in the drawing.
- First cut a template for scribing triangles.

9  Marking Triangles

- The cylinder sheet is scribed as shown in the photo (No.7) and drawing (No.8), above.

**NOTE:** The base of the 7.5 cm long template is used as reference.
Cutting out the and Opening for the Soldering-Irons

- Put the sheet on a square beam or joist.
- Begin cutting with the chisel.
- The chisel should be in a slanted rather than vertical position.
- Finish cutting with the shears.

*NOTE: The chisel should be sharp.*

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Smoothing out the Rim

- Smooth out the rim with a hammer.

---

Cutting Triangles

- Cut both sides of each triangle with the chisel.
- Do not smooth out the rims!

*Note: Further on the triangles will be folded.*
THE FOLDED EDGE

13 The Folded Edge is Made in Three Steps

1. Fold the edge to a 90 degree angle.

2. Set the folded edge.

3. Form a 30 degree slanted angle.

14 Folding the Edge

- At each of the 30 cm long sides, fold the edge with a mallet in such a way that one faces upward and the other faces downward.
- Place the sheet in such a way that the 5 mm score line is over the angle.
- Fold a section along the right side.

Note: Use three fingers of your left hand to hold the sheet down, as shown in the photo.

15 Folding the Edge

- Make a 90 degree fold by delivering heavy blows with a mallet along the scored line.
- Press the folded edge tightly against the right angle.

Note: Remember to hold the sheet down with three fingers along the angle and move them forward as you advance with the mallet.
Setting the Folded Edge with the Mallet. Step 1

- With the mallet tilted, begin setting the folded edge.
- Tap along the length, gently and evenly.

*Note: Tap the mallet in a regular and even manner.*

Continuing to Set the Folded Edge. Step 2

- With the mallet still in a somewhat inclined position, continue to set the folded edge.
- Again, tap along the length, gently and evenly!

Flattening the Folded Edge. Step 3

- With the mallet now in a fully horizontal position, tap the folded edge downwards until it nearly touches the sheet.
19 **Checking and Correcting the Folded Edge. Step 4**

- The folded edge should be uniformly 5mm wide.
- Use a gage marker to check for imperfections.
- Faulty folded edges must be corrected.

*Note:* A folded edge must have no faults whatsoever, otherwise the interlocking folded joints will be weak and the galvanised sheets will come loose.

20 **Scoring for the Slanted Angle**

- Score along the folded edge using a 1cm gage marker.

21 **Forming a Slante 30 Degree Angle**

- The slanted angle is made with a single heavy blow using the mallet.
- First form the slanted angle on the right side of the sheet. This will allow the helper to hold the sheet in place.
- Starting from the left, fold the entire sheet until you have completed the slanted angle.
Filing the Screwdriver  22

- Use a file or a sharpening stone to round off one of the screwdriver edges.
- This will make the screwdriver slide along better when opening the folded edge.

Opening the Fold  23

- Slide the screwdriver along the folded edge to open the fold.
- Press the screwdriver against the folded edge.
- Remember to hold the sheet firmly with your left hand.
- Keep your left hand behind the screwdriver at all times to avoid accidents.
24  Rounding the Sheet

- Use the round beam to round the sheet.
- Apply pressure with your hands and slide the sheet around the beam, starting from the edge.
- The cylinder circle is shaped gradually to avoid creasing.

25  Interlocking

- Join the sides of the circle and interlock the folded edges firmly together.
- Slide the cylinder over the round beam.
- Hammer the right-hand side first.
- Set the folded edge by hammering steadily from left to right.

Note: Hammer vertically. Do not strike the sides of the folded edge to avoid denting the sheet.

26  Securing the Interlocking Folded Joint

- Secure the interlocking joint with three chisel stitches on each side.

Note: This is done because a portable heating appliance for soldering irons has no soldered edges.
Folding the Cylinder Edge  27

- Fold both ends of the cylinder using the square side of a 5 mm narrow bender.
- Do not fold the cylinder edge close to the interlocking joint.

Evening up the Folded Edge on Both Ends of the Cylinder  28

- Holding the cylinder over the angle, make sure the edges are even on both sides of the cylinder.
- Cut the folded edge with the shears to make it even at the interlocking joint.
29  Bottom and Lid

• The portable heating appliance for soldering irons has a bottom and a lid. The lid has an opening for letting the smoke out.

30  Rounding the Cylinder

• Round the cylinder with your hands.

31  Bottom Diameter

1. Measurement:_________ cm
2. Measurement:_________ cm
   Sum: _________ cm ÷ 2 = ___ cm

<table>
<thead>
<tr>
<th>Diameter of the cylinder mouth</th>
<th>cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add for the folded edge</td>
<td>+ 1 cm</td>
</tr>
</tbody>
</table>

Bottom Diameter

• Take two cross-measurements.
• Find the average of the measurements.
• Add 1 cm for the folded edge.
Scriber

- Radius of the bottom is ____ cm.
- Make a scriber of that size.

Scoring the Circle

- First score two lines in opposite directions, so that they cross each other.
- Check size with a tape measure.
- When the measurements are correct, score the circle.
- Score the lid using the same measurements.

*Note: The diameter of the circle must be precise. If you have to repeat scoring, do so on the back of the same sheet.*

Cutting the Bottom and the Lid

- Check the measurements before cutting.
- Use the shears to cut the bottom and the lid.
35 Bottom Folded Edges

- The folded edge is made with the 5 mm narrow bender, holding the slanted side inwards.

36 Placing the Bottom

- First, put the bottom in place.

37 Tapping the Folded Edge

- Tap the folded edge little by little.
- Hold the metal plate in an inclined position.

*Note: Avoid forming corners along the folded edge by slow an even tapping along the entire circumference.*
38 Setting the Folded Edge Little by Little

- Do not set the folded edge too tightly.
- When the bottom is well in place, put the coal heating iron under the portable heating appliance for soldering irons.
- Use the coal heating iron underneath as a support to set the folded edge.

39 Setting the Bottom

- Turn the appliance upside down.
- Place the folded edge over the angle.
- Set the folded edge with the hammer.

*Note: Be sure to hammer the folded edge on a hard surface.*
40 Soldering Iron Holder

- A soldering iron holder is attached to the portable heating appliance for soldering irons.

41 Soldering Iron Holder

- Cut out a 16 cm x 18.5 cm sheet.
- Score it as shown in the drawing.
- Cut the corners at 2 cm x 4 cm.

42 Straight Cut

- Make two cuts 4 cm deep, starting from the edge.
Folding the Sides

• Fold the sides of the holder until they form a channel.

Holes

• Use a chisel or nail to make holes along the 4 cm cuts.

Bending the Lugs

• Bend the lugs as closely as possible to the cylinder.
Mark the Placement of the Holder

- Incline the holder a little.
- Mark places for holes on the cylinder. These are for the holder.

Piercing the Marks

- Over a wooden beam, pierce the marks with a chisel to make the holes.
Making a Rivet

- Cut two 5 mm x 5 cm strips.
- Fold the strip in half.

Applying Pressure

- Apply pressure with a pair of pliers and hammer the head of the rivet.
- Cut the corners off.

Placing the Rivet

- Place the rivet with its head on the outside.
- Rest the cylinder on the angle.
51  Riveting

- Use pliers to set the sheet.
- Open the rivet with the screwdriver and hammer it into place.

52  Bending the Air Vents

- Bend all the air vents inwards with the chisel.

*Note: The triangles support the charcoal hold.*
Lugs for the Handle  53

- Lugs are needed to hold the handle wire.

Lugs  54

- Cut out a 7.5 cm x 7.5 cm strip from the sheet.
- Score each side at 2.5 cm from the edge.

Folding the Strip into Three Parts  55

- Fold the sheets along the marks.
- Set the lugs.
56 Cutting the Corners

• Cut 2 mm corners with the shears.

57 Slanted Angles on Lugs

• Form a slanted angle running in two opposite directions.

58 Piercing the Lugs

• Place the lug on a square beam.
• Make a hole on one end with the chisel and on the other with a punch.
Piercing the Cylinder

- Measure 10 cm down from the top.
- Pierce the cylinder with the chisel.

Riveting the Lugs

- Place a rivet in place with its head on the outside.
- Place the cylinder on the angle.
- Use pliers to set the sheet.
- Open and set the rivet in place.
61 Charcoal Hold

62 Measuring the Diameter

• Measure the bottom diameter of the portable heating appliance for soldering irons.

63 Cutting the Disk

• Take cross-measurements.
• Calculate the average of the measurements.
• Score and cut the disk according to your diameter calculations.

**Note:** Make sure the diameter is correct before cutting.
Charcoal Hold  64

• Use a triangle template to mark the disk as shown in the drawing.
• Cut two sides of each triangle with the chisel.

Installing the Charcoal Hold  65

• Fold the triangles downward.
• Introduce the charcoal hold into the cylinder with the triangles in a downward position.
66 Cylinder Lid

- You have already cut the lid.
- Using a 5.5 cm scribe, score an opening for the smoke escape.
- Mind the diameter!

67 Cutting the Smoke Escape

- Cut the scored opening with the chisel, following the mark.
- Do not smooth out the inner rim.

68 Folding the Inner Rim

- Without smoothing the inner rim, make a narrow fold with the pin of the hammer.
- Hammer the inner rim so as to fold it.
Setting the Fold

- Set the fold, now using the hammer head.

Folding the Edge of the Lid

- A folded edge is made with the slanted side of the 5 mm narrow bender held toward the inside.

Placing the Lid

- Put the charcoal hold inside.
- Tap the folded edge little by little using the metal plate.
- The metal plate must be held in an inclined position.
- Place the lid atop the angle and use the hammer to set the folded edge.
72 Setting the Folded Edge

- At the lug, set the folded edge with the metal plate, as shown in the photo.

73 Placing the Handles

- Cut a 1 m long piece of thick wire.
- Hook the wire up to the lugs.

74 Congratulations on your first job as an artisan!
These are silos of various holding capacities as recommended by POSTCOSECHA
1. Building the THE CYLINDER

2. Making THE BOTTOM

3. Installing CYLINDER BOTTOM.

4. Making CYLINDER LID

5. Making INTAKE THROAT and soldering it to cylinder lid.

6. Placing and soldering LID AND BOTTOM to cylinder

7. Making LID for intake throat

8. Making SEED OUTLET AND LID and soldering to cylinder

9. PAINTING / PLACING POSTER on cylinder

10. Ensuring GOOD HANDLING by providing instructions to farmers
Checking the Galvanised Metal Sheets

• Place the sheets on the workbench.
• Line up the sheet corners.
• Check the 4 corners with a square.

Note: Mark any flaws found in the corners of any of the sheets.

Checking for Width and Length

• Check the width and length of each sheet.
• The sheet is ____cm long and ____cm wide.

One Sheet Is Shorter than the Other

• If necessary, sheets are marked in accordance with the shortest sheet.
• Cut off the leftover piece of each sheet.

Note: For marking purposes, use a strip of sheet as a guide.
The Three Folding Stages

1st.  Folding the edge at a 90 degree angle.

2nd.  Set the folded edge

3rd.  Form a slanted angle.
Marking the Sheet with a Gage Marker

- Mark the sheet lengthways with the 5mm gage marker.

*Note: The gage marker is held vertically when marking the sheet.*

Marking the Corner before Making the Cut

- Mark the two corners of the sheet with the 5mm gage marker.
- Use the tip of the shears to make a diagonal cut in the corner of the side to be folded, as shown in the photo.

Folding the Edge

- Align the sheet with the gage line directly over the edge of the angle on the workbench.
- A helper holds down the left side.
- Part of the edge is folded along the right side.

*Note: Three fingers of the left hand hold down the sheet, as shown in the photo.*
8  Using your Hip to Apply Pressure!

- Change sides with your helper. He should hold the sheet against the angle on the right side.
- Press firmly with your hip against the sheet to make sure it stays in place while you fold it.

9  Folding the Edge

- Tap firmly with the mallet to fold the edge of the sheet.
- Set the edge. It should butt firmly against the angle, at 90 degrees.

10  Turning the Sheet Over

- Hold the sheet by the middle, lift it up and turn it over.

Note: Only one person should turn the sheet over to prevent any bending.
Folding the Second Edge  11

• Repeat the same folding procedure.
• The folds must be opposite each other, one facing downward and the other facing upward.

Switching the Sheet  12
Around on the Bench

• Switch the sheet around on the bench, as shown in the photo.

Setting the Folded Edge  13
with the Mallet

• Place the sheet over the angle.
• Tap the sheet with the mallet slightly slanted.
• Tap gently and uniformly along the length of the sheet.

Note: Tap the sheet gently and regularly.
14  Continuing to Set the Folded Edge

- Hold the mallet in a slanted position and repeat the procedure described.
- Tap gently and uniformly along the length of the sheet.

15  Flattening the Folded Edge

- Tap the edge downward with the mallet in a horizontal position until it is close to the sheet surface.

16  Checking and Correcting the Edge

- Use the gage marker to check if the edge is uniform to within 0.5 mm (half a millimetre).
- Irregular folded edges should be corrected.

Note: Try not to leave irregularities along a folded edge, as they will result in weak interlocking joints and may come loose later on.
Checking the Edge

- The visual test is another way of making sure that the edge is uniform.

*Note:* This method requires practice.

If Necessary, Widen the Edge

- Use the screwdriver to open the narrow part (toward the gage line).
- Hammer along the edge so as to “roll it back” (inwards).
- Hammer as much as is necessary, depending on the extent of the flaw.
- Finally, set the edge down and check with the gage marker to make sure it is uniform.

*Note:* In case of very serious flaws, it may be necessary to open the whole edge up again and start over.

If it is Necessary, Narrow the Edge

- In minor cases, hammer the edge toward the outside.
- In more severe cases, open the edge and hammer it down, then fold it again toward the inside.
20  Marking the Slanted Angle

• Use the 1 cm gage marker to mark a line along the edge.

21  Forming the Slanted Angle

• Form the slanted angle with a single hard blow.
• First, form the slanted angle on the right side of the sheet. This will allow the helper to hold the sheet in place.
• Starting from the left, form the slanted angle along the entire sheet.

22  Holding the Sheet Firmly

• The helper holds the sheet down as shown in the photo.
• The sheet must be held down firmly.
Opening the Folded Edge 23

- Slide the screwdriver along the folded edge to open it up.
- Press the screwdriver against the folded edge.
- Make sure that the left hand firmly holds down the sheet.

Pressure must be applied behind the screwdriver at all times, so as to prevent accidents.

*Note: It will be easier to slide the screwdriver along the folded edge if it is not too tight.*

Finishing the Second Side 24

- Hold the sheet by the middle, lift it up and turn it over.
- Repeat the folding process and form the slanted angle.
25 The Seed Outlet

• Before joining the sheets, cut the seed outlet as shown in the photo.

Note: Measurements are slightly different for 180 and 360 kg silos. See “Measurements for silos with a holding capacity of 180 and 360 kg.”

26 Marking the Hole

• Score a straight line in the middle of the sheet.
• Mark the centre of the hole at 10.5 cm from the edge of the sheet.
• Score the circle with a 7.5 cm scriber.

Note: For 180 and 360 kg silos, the centre of the hole is marked at 8.5 cm from the edge of the sheet. Use a scriber set at 6 cm.

27 Cutting the Hole

• Place the sheet on a board. Make the initial cut with the chisel until you can use the shears to finish cutting the hole.
• Smooth down the edge of the hole.
INTERLOCKING THE SHEETS

Putting the Sheets in Place  28

• Place a square beam or joist on the floor.
• Place the first sheet with the edge on the square beam.
• The folded edge must be facing upwards.
• The helper takes the second sheet and interlocks its folded edge with that of the sheet on the floor.

Note: The trade name, Postcosecha seal or sheet calibre must show on the outside surface so as to be visible once the cylinder has been interlocked.

Securing the Interlocking 29 Folded Joints

• Use your foot to put pressure on the interlocking folded joints.
• Align the edges of both sheets.
• Set an interlocking folded joint at one end.

Note: Make sure that the sheets are perfectly interlocked.

Hammering Down Three 30 Sections

• The sheet is always held down by the helper.
• Use the hammer to make sure that the sheets are well interlocked.
• Set an interlocking folded joint in the middle of the sheets.
• Before setting down the other end, make sure that the edges of both sheets are exactly aligned.
Sometimes the sheets are not interlocked in the middle.

This results in joints that are not properly interlocked when setting the folded edges with a hammer. In such cases, it becomes necessary to detach the interlocking folded joints by opening the folded edges with a screwdriver. The process of detaching the folded edges is completed on the workbench. A 2 cm strip is cut off from the edge before starting the whole process of once again interlocking the folded joints.

31 Hammering the Interlocking Folded Joints

• Set the interlocking folded joints from one end to the other of the galvanised sheet applying regular blows with the hammer.
• Repeat the process 2 or 3 times until the interlocking folded joints are well and uniformly set.
• Continue interlocking the sheets.

32 Silos with all Holding Capacity: Measure Sheet Length

• Measure the length of the sheets being used to form the cylinder.
• Result: _____ cm
• Avoid walking on the sheets.

**Note:** Later, the same measurement is used to determine the bottom diameter.
Turning over the Sheets

- The hammered interlocking folded joints must be on the outside of the cylinder.
- The cylinder must be soldered on the outside.
- When being turned over, the sheets must be handled by a single person.

Interlocking the Sheets to Form the Cylinder

- Place the square beam or joist on 2 chairs or boxes.
- Interlock the folded edges of the two sheets.
- Align the edges of both sheets.
- Set down 3 sections: one on each end and another one in the middle.
- Set the interlocking folded joints from one end to the other until well set.

*Note: Before beginning to hammer down the interlocking folded joints, make sure they are properly placed.*
Ensuring Air-tightness

The soldering must ensure air-tightness, otherwise grain fumigation will not be effective. In addition to ineffective fumigation, the farmer’s family will be exposed to the risk of toxic fumes escaping from the silo.

35 Soldering Material

- Heat two straight 500 gram soldering irons in the portable soldering device.
- Prepare:
  - 50/50 Tin
  - Hydrochloric acid
  - Small brush
  - Resin or ammonium
  - Wire brush
  - Soap and water
  - 3 pieces of cloth (one to clean the soldering irons, one to clean the soldering and another one to dry it).
Forging the Soldering Irons  36

• If the soldering irons are old, use the hammer to reshape the point of the copper insertion.
• Heat the copper points until they are red hot.
• Forge the tip with the hammer on an iron base to get four even surfaces on the copper point.

The Temperature: Neither  37
Too High nor Too Low!

• The soldering iron requires the appropriate temperature for soldering.
• After heating the soldering iron in the portable heating appliance for soldering irons, hold the soldering iron near your face (approximately 15 cm) if you feel the heat, you can begin soldering.

  Note: Never overheat a soldering iron (that is, at red heat) because it wears out faster. Additionally, overheating causes soldering problems.

Tinning the Soldering Irons  38

• Prepare resin, tin, and fine sand.
• Clean the face of the soldering iron, first with the wire brush and then in the tinning plate with sand and resin, and tin it before soldering.

  Note: As a tinning plate, use a 25 cm diameter sheet disk, fold the edge with the pliers and nail it to a piece of wood.
39  Cleaning the Soldering Iron

- Rub one face of the soldering iron in the resin with some sand and tin.
- This must be done rapidly to prevent the soldering from cooling down too much.
- Clean the face of the iron with a damp cloth. If the whole face is not shiny, repeat the cleaning or forging procedure.

Note: The iron’s face must be clean. Good soldering depends on this! If the iron’s face is not clean and shiny, the tin will not melt well.

40  Applying Hydrochloric Acid

- Have the soldering iron ready, clean and shiny.
- Use a small brush to apply hydrochloric acid on the crease of the interlocked folded joint. Calculate the distance which can be soldered with a soldering iron.
- Apply acid immediately before soldering.

Note: Do not expose yourself too much to acid fumes, as this may be harmful to human health. Be careful not to stain the galvanised sheet outside the soldering area, as this causes corrosion.

41  Soldering Position

- The piece to be soldered must be in a slightly tilted position. Use an appropriate object to hold it in place.
- Begin by soldering the upper part and soldering downward.
Applying Tin

- Hold the soldering iron with the tip on the interlocking folded joint.
- Melt a small amount of tin on the iron’s clean face.
- Turn the clean tinned face downwards to the soldering place.

Take Your Time!

- Set down the soldering iron until it is entirely face down on the sheet or interlocked folded joint.
- Once the tin has been molten, slowly move the soldering iron downward.
- If the tin does not melt, the soldering iron is no longer hot enough.
- Clean the face of the soldering iron being used for soldering with a piece of cloth before heating it again in the charcoal of the portable heating appliance for soldering irons.
- Replace it with the other hot soldering iron.
- Clean the face of the soldering iron being taken out of the charcoal with the piece of cloth before soldering again (see steps in point 42).

Note: Repeat the process of cleaning, soldering, cleaning, and heating until the iron’s face no longer shines with tin. Then, tin the soldering iron again with resin, tin, and fine sand.
45  Never Use the Tip of the Soldering Iron

• Do not use the tip when soldering because the soldering iron does not transfer heat to the sheet or the joint to be soldered.
• Raise the soldering iron only when you need to melt the tin on the bar, but without removing the tip from the sheet.

Note: It is very important to heat the part of the interlocking joint in order that the tin be able to penetrate the joint. A superficially soldered joint breaks up should the interlocked joint suffer a blow during the handling of the silo. This means the silo is no longer air-tight and effective fumigation cannot be guaranteed.

46  Cleaning with Soap and Water

• Clean the soldering thoroughly using a cloth, soap and water.
• Dry the soldering with another piece of cloth.

47  Checking the Soldering

• Look for any small holes or deficient soldering.
• Go over the weak parts again and apply Hydrochloric acid. Whenever necessary, apply a small additional amount of tin.

Note: It is important to check the soldering to ensure that the silo is air-tight!
SOLDERING AND FOLDING THE EDGE OF THE CYLINDER

SOLDERING

• Use any appropriate tool to hold an end of the square beam or joist so as to keep the sheet tilted.
• Solder the interlocking folded joints.

Placing the Cylinder in an Upright Position

• Remove the square beam or joist.
• Place the cylinder in an upright position, with the seed outlet on the upper end.

Note: The seed outlet must be on the upper end because the bottom of the cylinder is to be put in place first.

Folding the Bottom Edge

• Round the cylinder interlocking joints.
• Use the wide bender with the square side toward the outside to fold the cylinder edge.

Note: Do not make full folds with the bender next to the interlocking joints.
Folding the Edges at the Cylinder Interlocking Joints

To complete the folding of the bottom edges, match the edge of the cylinder interlocking joints with the coal heating iron and hammer at the cylinder interlocking joints, as shown in the photo.

Aligning Matching the Folded Edges

- Hammer the folded edge.
- Place the heating iron at a right angle. It should butt against the cylinder.

**Note:** Be sure not to miss any blows with the hammer on the firmly held coal heating iron, as this could cause deformations along the edge.

Aligning the Folded Edges and Interlocking Joints

- Match the folded edges at the sheet interlocking joints by cutting any points of the sheet that stick out.
### Conversion Table To Obtain Bottom And Lid Measurements For Postharvest Metal Silos (181 Kg, 363 Kg, 544 Kg, 816 Kg, And 1,360 Kg)

<table>
<thead>
<tr>
<th>Size of Silo</th>
<th>Length of interlocked sheets see P. 72, step 32</th>
<th>Bottom Diameter cm</th>
<th>scriber radius or length cm</th>
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<td>180 kg</td>
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<tr>
<td>179</td>
<td>59.1</td>
<td>29.6</td>
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<tr>
<td>180</td>
<td>59.4</td>
<td>29.7</td>
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<td>181</td>
<td>59.8</td>
<td>29.9</td>
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<td>39.1</td>
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<td>240</td>
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</table>

#### SILO

#### BOTTOM AND LID FOR SILOS UP TO 1,360 KG

These measurements work only with folded edges of exactly 5mm.

**Note:** The bottom diameter in this table has been calculated as follows:

\[ \text{Diameter} = (\text{Length} - 0.8) \times 3.1416 + 2.4 \]

Diameter = length in cm of the interlocked sheets (see p.72, step 32); minus 0.8 cm, which represents the last interlocking joint in the making of the cylinder, divided into 3.14 plus 2.4 cm for the folded edges on both sides of the bottom.)
Diameter of the Cylinder Bottom and Lid

- Depending on the length of the sheets, see page 72, step 32 for measurements of bottom diameter and scriber radius or length, as provided by the conversion table on the preceding page.
- For instance, sheet length for a 540 kg silo is 271 cms.
- The bottom has a diameter of 88.4 cm.
- The scriber radius or length is 42.2 cm.
- To check scriber length, score two lines. Adjust the scriber if necessary.

Cutting the Cylinder Bottom and Lid

- Mark a circle with the scriber.
- Check the measurement.
- If a mistake has been made, turn the sheet over and mark the other side.
- Cut the galvanised sheet.

**Note:** These measurements work only with folded edges of exactly 5mm. One galvanised sheet is sufficient to make the cylinder bottom and lid.

Folding the Edge

- Fold the edge towards the inside with the slanted side of the wide bender. Leave the centre point of the scriber facing the outside.

**Note:** Follow the same procedure to make both the cylinder bottom and lid. However, regarding the lid, attach the intake throat by soldering before placing it on the cylinder.
**57 The Scriber**

- Diameter ÷ 2 = Radius
- Diameter ÷ 2 = ________ cm
- Scriber of the Bottom: ________ cm

- Depending on the length of the interlocked sheets (shown on page 72, step 32) find measurements for bottom diameter and radius as provided in the Conversion Table on page 82
- Bottom diameter is __________ cm.
- Scriber length or radius is: __________ cm.
- Score two lines to check scriber length.
- The diameter of the bottom is larger than the width of the normal metal sheets.

**58 Centre of the First Piece**

- Mark the centre as shown in the drawing.
- Use the scriber to measure the distance from the edge of the galvanised sheet and mark the centre.

*Note: Make sure that the scriber reaches the very edge of the sheet.*

**59 Scoring and Checking the Circle**

- Score two lines to check the diameter.
- Adjust the scriber if necessary.
- Score the circle with the scriber.
- Check the measurement of the circle.

*Note: The measurement must be precise. If you make a mistake, turn the sheet over and mark the other side.*
Cutting the First Piece

- Cut the galvanised sheet.

Making the Shoulder Cuts and Folding the Edge

- Mark the piece lengthways with the 5 mm gage marker to fold the edge.
- Mark the shoulder cuts on the two pieces, as shown in the drawing.
- Make the 15 mm shoulder cuts.
- Fold the edge and form the slanted angle.

Marking the Leftover Piece

- Place the leftover piece over the larger piece.
63 Cutting the Leftover Piece Lengthways

• Mark and cut the leftover piece using the length of the larger piece as reference.

64 Marking the Shoulder Cuts and Folding the Edges

• Mark the length with the 5 mm gage marker.
• Make the 15 mm shoulder cuts.
• Fold the edges and form a slanted angle.

65 Interlocking the Two Pieces

• Place the square beam on the bench and interlock the two pieces.
• The larger piece is left on the bench while a helper holds the smaller piece.
• After hammering the interlocking folded joints for the first time, turn over the bottom and set the folded edge flat on the other side.
Completing the Circle 66

- Mark the rest of the circle on the second piece.
- Cut out the piece you have marked.

Soldering the Centre 67

- Solder the bottom centre point with a clean soldering iron at an appropriate temperature (see p.75, step 37).

Note: Use only small amounts of tin.

Soldering the Interlocking Folded Joints 68

- Soldering the interlocking folded joints as you already know how to do.

Note: Always remember to tilt, clean, and check the bottom after soldering it.
69  Folding the Edge

• Use the slanted side of the wide bender to fold the edge toward the inside. Leave the soldered centre point facing outward.

*Note: Follow the same procedure to make both the cylinder bottom and lid. The only difference is that for the lid the intake throat is put in place before placing the lid on the cylinder.*

• Use the coal heating iron to complete the folding edge at the interlocking point.
Placing the Bottom

• Put the bottom in place with the assistance of a helper.
• The bottom’s interlocking point must not face in the same direction as the cylinder’s interlocking point.

When the Bottom Is Too Large

• Unfold the folded edge.
• Determine how much smaller the bottom should be.
• Correct the scriber.
• Mark the circumference and cut it.
• Fold and even up the edge again. Check if the bottom is now the right size.

Note: Cutting is easy, but as it is not possible to increase the diameter of the bottom, material is wasted if it is too small!

First: Folding the Edge

• Fold the edge a little at 4 points to prevent the bottom from coming off.
• Use a hammer to loosen those portions that are too tight.
• Hold the coal heating iron on top.
• Fold the edge little by little!

Note: Do not set the folded edge too tightly. Excessive pressure will cause the bottom to come off the cylinder.
73 Second: Closing the Folded Edge

- Use the hammer and coal heating iron to close the folded edge completely. Hammer it from below with an upward motion.

74 Third: Set the Folded Edge

- Stand on a chair.
- Press firmly against the folded edge from below with the straight border of the coal heating iron.
- Hammer it down from above.

Note: If the edge is not well set, it takes an excessive amount of tin to solder.
Centre of the First Piece

- Adjust the diameter of the cylinder lid to the actual dimensions of the bottom.
- Mark the centre point.
- Use the scribe to measure the distance from the edge and mark the centre point.

*Note:* Make sure that the scribe reaches the very edge of the galvanised sheet.

Marking and Checking the Circle

- Score 2 lines to check the lid diameter.
- Adjust the scribe if necessary.
- Score a circle with the scribe.
- Check the measurement.

*Note:* The measurement has to be exact. If a mistake is made, turn the sheet over and mark the other side.

Cutting the First Piece

- Cut the galvanised sheet.
SILO

LID FOR 1,360 KG SILO

78 Making the Shoulder Cuts and Folding the Edge

- Mark the piece lengthways with the 5 mm gage marker to fold the edge.
- Mark the shoulder cuts on the two pieces as shown in the photo.
- Make the 15 mm shoulder cuts.
- Fold the edge and form the slanted angle.

79 Marking and Cutting the Leftover Piece

- Mark and cut the leftover piece taking the length of the larger piece as reference.

80 Folding the Edges

- Mark the length with the 5 mm gage marker to fold the edges.
- Make the 15 mm shoulder cuts.
- Fold the edges and form the slanted angles on the two lid pieces.
Interlocking the Two Pieces  81

• Place the square beam on the workbench and interlock the two pieces.
• Leave the larger piece on the bench and have a helper hold the smaller one.
• After hammering the interlocking joints once, turn the bottom over and set the folded edge flat on the other side.

Completing the Circle  82

• Mark the rest of the circle on the second piece.
• Cut the leftover piece that is to be used for seed outlets and bottoms of intake throat lids.

Soldering the Centre Point  83

• Solder the bottom centre point with clean soldering irons at an appropriate temperature (see p.75, step 37).

Note: Use only a small amount of tin.
84  Soldering the Interlocking Joints

- Apply acid.
- Solder the interlocking joints as you already know how to do.

*Note:* Remember to always tilt, clean, and check the lid after soldering.

85  Folding the Edge

- Fold the edge toward the inside with the slanted side of the wide bender. Leave the soldered centre point on the outside of the silo.

86

- The folded edge is completed with the coal heating iron at the interlocking point.
The Cylinder Lid Neck

- The cylinder lid neck is as shown in the photo.

Marking the Intake Throat

- Mark the centre 25 cm from the edge opposite to the interlocking, as shown in the drawing.
- Prepare an 18.5 cm scriber to score a circle with a 37 cm diameter.

Cutting the Intake Throat

- Start cutting with a chisel over a board until the shears can be introduced to finish the cut.
- Smooth down the edge of the cut.
90  Cutting the Strips

- Cut a 123 cm long 11 cm wide strip along an entire galvanised sheet.
- You can make enough strips for intake throats and lids for 5 silos.
- Mark and cut the strips following the measurements shown in the drawing.

**Note:** *Use the leftover portion of the 123 cm long piece of galvanised sheet to cut strips for other silos.*

91  Marking the Strips

- Take a strip from the 123 cm x 11cm piece of galvanised sheet.
- Form a circle, place it in the intake throat and adjust it.
- Mark a point to indicate the extent of the overlap.

92  Cutting the Leftover End

- Use a square to draw a line, taking the point you have marked as reference.
- Measure 4 cm from the line toward the end of the strip and draw another line with the square.
- Cut the leftover end.
Making the Shoulder Cuts

- Make a slanted cut to the 8 mm corner and a straight cut on the 5 mm side.

Folding the 5 mm Edge

- Fold the side marked at 5 mm.
- Fold the sheet over the angle.
- Make the folding inside.
96  Setting the Fold

- Use the mallet to set the fold in wards.
- At a distance of 4 cm from the side opposite to the shoulder cut, the fold is left slightly open and a 5 cm piece of galvanised sheet is introduced.

97  Overlapping

- Use the mallet to round off the ends of the strip over the wooden beam.
- Overlap the ends, leaving the fold inwards.
- Introduce the end of the shoulder cut into the fold and set it.
- Make sure that the edge of the overlap does not stick out.

Note: If the edge does stick out, cut the shoulders back a little.

98  Setting the Overlap

- Use the beam to set the fold overlap.
**Soldering the Overlap on the Outside**

- Hold the intake throat with pliers.
- Apply Hydrochloric acid on the outside.
- The helper uses a screwdriver to put pressure on the overlap.
- Solder the overlap on the outside.

*Note: Applying pressure with a screwdriver avoids using an excessive amount of tin.*

**Soldering the Overlap on the Inside**

- Apply Hydrochloric acid on the inside.
- Solder the overlap on the inside.
- The helper must always use a screwdriver to put pressure on the overlap.
- Clean the soldering.

**Making the Teeth**

- Cut the side opposite to the fold toward the mark, using the width of the pliers.
- The cut must be made exactly at the 8 mm line.
- Use the tip of the shears to make the cut.

*Note: The cuts must not go over the line and must be uniform.*
102  Folding the Teeth

- Make the cut teeth even on the round beam before folding.
- Start with the tooth that is under the overlap.
- Use pliers to fold every other tooth.
- Fold exactly on the mark made.

Note: Irregular folds will cause problems when soldering, since not all teeth will be set equally on the bottom.

103  Placing the Intake Throat in the Cylinder Lid

- Introduce the unfolded teeth into the lid mouth, leaving the overlap interlocking turned toward the front of the silo.
- Tap gently with the hammer to fold the lower teeth.

Note: The outside teeth should butt firmly into the cylinder.

104  Setting the Teeth

- Place the cylinder lid with the intake throat down, over the angle.
- Turn the lid around slowly, tapping gently with the hammer to set the teeth.
- Check that the teeth are well set on both the inside and outside.

Note: Be sure to hammer the folded edge on a hard surface. Hammering must produce a clear sound when tapping the angle.
Soldering the Intake Throat

- Solder the intake throat to the lid.
- Use the soldering iron again on any remaining holes.
- Avoid staining the galvanised sheet with acid as much as possible.
106  Placing the Lid

- Put the cylinder lid in place.
- Both the intake throat and the seed outlet are at the front.
- Set in the same way as with the bottom.

107  Leaning the Silo

- Lean the silo on a wall so as to solder the bottom and the Lid.

108  Soldering the Bottom and the Lid

- While soldering turn the silo with the other hand.
Marking and Cutting the Shoulder Cuts

- Score both edges with the 5 mm gage marker for the folded edge and the fold.
- Score and cut the shoulder cuts.

Marking the Strip

- Use the 123 cm x 7 cm strip.
- Form a circle and adjust the strip to the intake throat.
- Mark a point to indicate the extent of the overlap.
- The strip should fit comfortably, being neither too loose, nor too tight.

Cutting the Strip

- Using a square, draw a line taking the point you have marked as reference.
- Measure 4 cm from the line toward the end of the strip, and draw another line with the square.
- Cut off the leftover piece.
112  Folding the Edge

- Make a fold on the side with the straight cut.
- Set the fold outwards.
- On the side opposite the shoulder cut, leave the fold a little open and introduce a 5 cm piece of galvanised sheet.

113  Overlapping and Soldering

- Round off the points of the strip using a round beam.
- Overlap the strip, leaving the fold toward the outside.
- Make sure that the edge of the interlocking joint does not stick out.
- Apply Hydrochloric acid.
- Solder the overlap on the outside.
- Apply acid to the inside.
- Solder the overlap on the inside. Apply pressure with a screwdriver.

114  Making the folded edge

- Use the square part of the narrow bender to shape the folded edge toward the outside.
- Match the folded edge on the angle.
Diameter of the Bottom 115

• Place the lid’s neck in the intake throat.
• Take 2 cross-measurements of the lid’s neck.
• Calculate the average of the measurements.
• Add 1 cm for the folded edge.

Cutting the Bottom 116

• Make the scriber.
• Mark the bottom. Be sure to use the established diameter.
• Cut the bottom out.

The Folded Edge 117

• Make the folded edge using the slanted side of the narrow bender. Leave the centre point on the outside for soldering.
118 Placing the Bottom of the Lid

- Place the bottom of the lid with the centre point toward the outside.
- On the bench, tap the folded edge downward little by little.
- Tap with the metal plate in an inclined position.

**NOTE:** Do not set the folded edge too tightly. Excessive pressure will deform the lid!

119 Setting the Folded Edge

- Turn the lid over.
- Set the folded edge on the angle using the hammer.

120 SOLDERING

- Solder the lid.
- Solder the centre point, which faces the outside.
- Clean and check the soldering.
Cutting the Strips 121

The process for making the seed outlet is similar to that used for making the intake throat.

• Mark and cut the strips according to the measurements in the drawing.

Note: Use a leftover piece for the strips.

Marking the Strip 122

• Take the 53 cm x 16 cm strip.
• Round off the strip by using the round beam.
• Form a circle and adjust it by half.
• Mark the point at which the strip overlaps.

Cutting Off the Leftover End 123

• Using the square, score a line from the point you have marked.
• Measure 4 cm from the line toward the end of the strip and score another line, using the square.
• Cut off the leftover piece.
124  Scoring the Strip

- Use the gage marker to score an 8 mm edge for the toothing.
- Use the gage marker to score a 5 mm edge for the folded edge.

125  Cutting the Shoulder Cuts

- Cut the shoulder cuts on the slanted wide 8 mm side and the narrow 5 mm side.

126  The Fold on the Edge

- Make the fold inside.
- Make a fold on the side marked at 5 mm.
- Fold the sheet over the angle.
Setting the Fold 127

- Set the fold inwards.
- At a distance of 4 cm from the side opposite to the shoulder cut, the fold is left slightly open and a 5 cm piece of galvanised sheet is introduced.

Rounding Off the Point 128

- Round off the point of the strip over the beam, tapping it with a mallet.

Rounding Off the Strip 129

- The seed outlet strip has the fold turned inwards.
- Use the beam to round off the sheet.
- Squeeze the metal and slide it up and down the wood.
- The cylinder's circle is made little by little, so as to avoid creases.
130 Overlapping

- Overlap the extremes, leaving the fold toward the inside.
- Introduce the end of the shoulder cut into the fold and set it.
- Check that the edge of the joint does not stick out.

*Note:* If the edge does stick out, cut the shoulder cut back a little.

131 Setting the Overlap

- Use the beam to set the fold overlap.

132 Soldering the Overlap

- Hold the outlet with a pair of pliers.
- Apply Hydrochloric acid on the outside.
- The helper uses a screwdriver to put pressure on the overlap.
- Solder the overlap on the outside.
- Apply acid on the inside.
- Solder the overlap on the inside.

*Note:* Applying pressure with a screwdriver avoids using an excessive amount of tin.
Making the Teeth

- Cut the side opposite to the fold toward the mark, using the width of the pliers.
- The cut must be made exactly at the 8 mm line.
- Use the tip of the shears to make the cut.
- Match the tooth cuts using the beam.

*Note: The cuts must not go over the line and must be uniform.*

Folding the Teeth

- Use pliers to fold every other tooth.
- Fold exactly on the mark made.

*Note: Irregular folds will cause problems when soldering, since not all teeth will be set equally on the bottom.*

Placing the Seed Outlet in the Cylinder of the Silo

- Introduce the teeth of the cylinder outlet, leaving the interlocking joint turned upwards
- Fold the lower teeth using a hammer.

*Note: The outside teeth should touch firmly the outside cylinder surface.*
136  Setting the Teeth

- Introduce a hammer or a round iron in the mouth of the seed outlet and hold it firmly in place.
- Use a hammer to set the teeth.
- Be sure to hammer the folded edge on a hard surface. Always hold the part being hammered with a piece of iron.
- Do not hit the teeth and metal sheet of cylinder too hard. Gentle tapping will do.
- In places where there is little room for the hammer, use the metal plate to set the teeth.

**Note:** To check if the teeth are well set, touch them on the inside. They should be flat against the cylinder of the silo.

137  Soldering the Seed Outlet

- Solder the toothing.
- Clean and check to make sure there are no holes.
Marking the Strip

- Use the 53 cm x 11 cm strip.
- Round off the strip.
- Form a circle and adjust the outlet strip.
- Mark a point to indicate the extent of the overlap.

The process is the same as that used to make the intake throat lid.

Cutting the Strip

- Using a square, draw a line from the point you have marked.
- Measure 4 cm toward the end of the strip, and draw another line. Again, use the square.
- Cut off the leftover piece.

Marking and Cutting the Shoulder Cuts

- Score both edges with the 5 mm gage marker for the folded edge and the fold.
- Score and cut the shoulder cuts.
Folding the Edge

141

- Make a fold on the side with the straight cut.
- On the side opposite the shoulder cut, leave the fold a little open and introduce a 5 cm piece of galvanised sheet.
- Set the fold outwards.

Rounding Off the Strip

142

- The lid's strip has the fold on the outside.
- Using a beam, round off the point first and then the entire strip.
- Form a circle and set the overlap.

Soldering the Overlap

143

- Apply acid on the outside.
- Solder the overlap on the outside.
- Apply acid on the inside.
- Solder the overlap on the inside, holding it down with the screwdriver.
Making the Folded Edge 144

- Use the square edge of the narrow bender to shape the folded edge toward the outside.
- Align the folded edge on the angle of the workbench.

Diameter of the Bottom 145

- Place the neck of the lid in the seed outlet.
- Take 2 cross-measurements of the lid’s neck.
- Calculate the average of the measurements.
- Add 1 cm to the folded edge.

Cutting the Bottom 146

- Make the scriber.
- Mark the bottom. Be sure to use the established diameter.
- Cut the bottom out.

Note: This bottom is made of leftovers from the corners of the cylinder bottom.
147 The Folded Edge

- Make the folded edge inward using the narrow bender. The slanted side of the bender should be turned inward.

148 Placing the Bottom

- Put the bottom in place, leaving the centre point toward the outside.
- Tap the folded edge downward little by little.
- Use the metal plate in a slanted position when tapping.
- Turn the lid over.
- Use the hammer to set the folded edge on the angle.

149 SOLDERING

- Solder the lid.
- Solder the outside centre point.
- Clean and check the soldering.
Bending the Wire 150

- Cut 12 cm of 3 mm galvanised wire.
- Fold 15 mm at each end.
- Mark the middle and bend the wire.

Setting the Triangle 152

- If the silo has already been painted, the paint where the soldering is to take place is removed with a brush.
- Solder the triangle to the lid on the side opposite to the overlap. Leave 3 cm free along the edge of the lid for the sealing.
- Solder the triangles to the body.
- Clean and paint the soldered part.

Strip of Galvanised Sheet 151

- Cut a 7 cm strip of galvanised sheet, as wide as the triangle.
- Join the strip to the triangle.
- Match the strip.
- Turn the folded slanted angle upward, so as to solder to a flat surface.
153 Painting the Inside

- Check the soldering of the silo before painting.
- Paint the silo on the inside. Take special care to paint the interlocking joints where the bottom meets the cylinder.
- Paint the toothing of the intake throat and seed outlet.

154 Paint the Outside

- Check the soldering before painting.
- All acid stains should be painted over.
- The lids are to be painted as well.

155 The Platform

- Use boards and a square bean to make the platform as seen in the drawing.
- The platform must have a flat surface.
- The platform must be of a size appropriate to the silo's diameter.
Gluing On the Poster

- Glue on the poster when delivering the silo to the customer.
- Smooth out the vertically placed poster from the centre toward both sides.

Information Carried by Each Poster

<table>
<thead>
<tr>
<th>Artisan’s Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the Institution</td>
</tr>
<tr>
<td>Date of silo manufacture</td>
</tr>
<tr>
<td>Silo Capacity</td>
</tr>
<tr>
<td>Silo Price</td>
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</table>

Numbering the Silo

- To carry a register of all silos manufactured, write a number on each one.
Explaining the Poster

- Explain clearly all necessary advice regarding silo and grain use and handling, as detailed on pages 5 to 17 of this manual.

Drying the Grain

- Explain patiently and very clearly how important proper drying methods are to the successful storage of grain in the silo.

- Grain is ready for storage once it is clean and dry, with less than 14% moisture content (moisture content ranging from 14% to 16% may develop fungi over time, thus damaging the grain. Moisture content higher than 16% will lead to rapid proliferation of fungi - mould - and heat, as a result of which all the grain contained in the silo will be rapidly lost).

- How can one tell in the field that the grains of maize hold less than 14% moisture content?

- You may think that the grain is dry enough to be put into the silo when this is not the case. To be more certain, spread the grain out for 8 hours a day under a hot sun for 3 additional days.

- To be sure use the method to determine moisture content in grains as is described on the following pages.
Method to Determine Moisture Content in Grains

• The best method is the “salt method to determine moisture content in grains”. This method should be explained in a practical demonstration, using the leaflet that is handed out with the silo. The information to be disseminated is as follows:

Introduction

The moisture contents of basic grains (maize, beans, sorghum, and rice) to be stored in a metal sheet silo is one of the most difficult problems faced by farmers.

Due to this situation, the Postcosecha Programme proposes a simple and safe method to determine the appropriate moisture content of basic grains, so they can be stored in metal silos.

Advantages of the Method

• Grains are stored with an acceptable amount of moisture content, thus avoiding losses as a result of rotting.
• It is a simple, practical and effective method, easily available to all farmers.
• The method involves virtually no expense.

MATERIALS

• A glass bottle with a holding capacity of approximately 750 ml. The bottle must have a lid to keep it airtight.
• Common salt
• The grain to be stored
Procedure

1. Dry the salt for two days during hours when the sun is hottest (10 am - 4 pm). Salt should not be dried when the sun is weak, as it may absorb humidity.

To avoid this, the salt that has been put out to dry should be left covered and in a closed container after the first day. The drying process then continues the next day. Another way of drying salt is to use fire (stove, oven). The salt is placed in a flat clay dish or can for 30 minutes or more, and must be stirred for that entire time.

2. The glass bottles (1 or 2) to be used must be entirely dry and clean. This can be achieved by washing and leaving in the sun with the mouth facing downward. Another quick drying method is burning a little alcohol inside the bottle after washing. If the bottle is not entirely dry it is impossible to determine with certainty what occurs when the salt and the grain to be stored are mixed.

How to tell when both salt and bottle are dry?

a. The salt turns hard.

b. Upon putting the salt in a dry glass bottle, it does not cling to the sides. Thus we can be sure that both bottle and salt are dry.

3. Once the salt and bottle are completely dry, fill one third of the bottle with grain (250 - 300 grams, depending upon receptacle size).

4. Add 20 to 30 grams of (dry) salt (2 to 3 tablespoons).
5. Steps 3 and 4 having been taken, proceed to close the bottle and shake vigorously for 1 minute. Let it rest for 15 minutes and then shake again.

6. All of these steps are carried out in the shade.

**How do we know the grain is dry?**

If the salt sticks to the sides of the bottle, forming layers, the grain moisture content is higher than the permissible 14 - 15%. Therefore it must not be stored in the metal sheet silo and the drying process should continue.

If the salt does not stick to the sides of the bottle, the grain contains moisture content inferior to the permissible 14-15%, and may therefore be stored immediately in the metal sheet silo for a long period without further necessity of drying in the sun.
162 Fumigation

• The second most important explanation to be given to the silo user concerns how to fumigate correctly.

• To ensure the effectiveness and safety of chemical insect control (using Phostoxin, Detia, Quick Phos o Gastion), the silo must be hermetically sealed for 10 days, during which time no gas must be allowed to escape.

• The simplest and most effective method should be explained by demonstration.

• Before removing the tablets from their original packaging or sealed flask, prepare all the necessary materials (tallow, tablets, and other teaching implements).

163 Procedure

• Place tablets made of “aluminum phosphate” (Phostoxin, Gastion, Detia) on a maize husk or piece of paper.

• It is recommended that 1 tablet be used for each 227 kg of silo capacity. For example, a 1,360 kg silo would require the use of 6 tablets.

• In the case of this 1,360 kg silo, the amount of tablets used remains the same (6), regardless of the amount of grain it contains at the time of fumigation.
• Place the tablets inside the silo, on the surface of the grain to be fumigated.

• Place the lid over the intake throat, leaving the lid overlap facing the front.

Immediately Seal Both the Intake Throat and Seed Outlet

• The simplest, cheapest and safest way is to use tallow, grease, soft soap, or beeswax.

• To seal, apply tallow, grease, soft soap, or wax on the interlocking joints at the outlet and lid, so that the gas emanating from the tablets cannot escape.

• The second method to seal a silo is with a rubber strip or tape. The following steps should be taken:

• Cut 2 rubber strips, preferably from a bicycle inner tube, both for the intake throat and the seed outlet. The strips should be 4 cm wide and long enough to allow for wrapping 3 times around the lit and neck.

• Make an incision in the shape of an arrow at each end of the rubber strips.
• Make a full cut at the end of each strip.

• Place the lid over the intake throat, with the strip overlap facing outward.

• Place the end of the rubber strip with the arrow-like incision over the end part of the lid neck.

• Tie the strip down. The first wrap should be at the centre and the other two around each side of the first wrap. However, they should not be very much separated, and the base of the intake throat or seed outlet must remain free of wrapping.
• When wrapping the rubber strip around the metal, pull it tight. Also tie it down tightly.

• Apply grease to both sides of the rubber tie around the circumference of the necks. If grease is not available, tallow or soap may be used.

• Once the intake throat and seed outlet are well sealed, so as not to let any gas escape, wash your hands with soap.
• Five hours after fumigation, return to the silo and smell the seals around the intake throat and seed outlet, to detect any escaping fumes. The typical smell released by the tablets is similar to that of onion or garlic juice.

• If from the seals around the intake throat and the seed outlet is not escaping fumes and you still smell the typical smell of garlic around the silo you have to check the interlocking joints carefully and all the soldering.

• If a point is found from which gas appears to be escaping, seal it using tallow, grease or soap.
• If the silo is empty, solder the point(s) at which gas escape was noticed.
• The silo should remain hermetically sealed for 10 days, so there is a strong enough concentration of gas to combat insects in all the stages of development (egg, larvae, pupae, adult).
• One day after the 10-day fumigation period is over, the grain can be taken out and consumed. The grain should be checked every 2 weeks to see if there are live insects present. If the grain is being used on a daily basis, the housewife, who usually is in charge of fetching the grain to be eaten, should check for live insects. If even just one live insect is found, the entire silo should be fumigated again properly.
## Manufacture Control and Silo Sales

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<th>Location of Silo Purchased</th>
<th>Community</th>
<th>Municipality</th>
<th>Province</th>
<th>Price Payment</th>
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- **Note:** Payment = Ca = Cash, Cr. = Credit

**Sold by:**
- **User Name:**
- **Name:**
- **Artisan:**
# Manufacture Control and Silo Sales

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<th>Price</th>
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* Note: Payment =  
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## FREQUENT MISTAKES

<table>
<thead>
<tr>
<th>MISTAKES</th>
<th>CAUSES</th>
</tr>
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</table>
| **Sheet folds**                   | • Pressure was not applied properly with the hips.  
                                  | • Irregular hammer-blows  
                                  | • Wavy angle on the table. |
| Not uniform                       |                                                                                                                                      |
| **Bottom and lid folded edges**   | • Was not held properly with the heating iron.  
                                  | • The artisan did not fold the edge little by little. |
| Poorly matched                    |                                                                                                                                      |
| Not uniform                       | • Folded edge not well set.  
                                  | • The artisan pulled the folded edge in too much.  
                                  | • The bottom or lid is too large. |
| **Cylinder interlocking joints**  | • Folded edges are irregular.  
                                  | • Faulty placement of sheet interlocking joints. |
| Joints have come loose            |                                                                                                                                      |
| **Sides are dented**              | • Blows were not delivered with precision.  
                                  | • Blows were not delivered plumb. |
| **Marks from the hammer**         |                                                                                                                                      |
| **Soldering**                     | • Not enough hydrochloric acid was used.  
                                  | • Interlocking joints were dirty or greasy.  
                                  | • The soldering iron tip was moved too quickly. |
| **Has holes**                     |                                                                                                                                      |
| **Unfinished surface**            | • Soldering iron was cold.  
                                  | • Soldering iron was dirty.  
                                  | • The soldering iron was held too high (only the point made contact). |
| **Displays tin clots**            | • Too much tin was used.  
                                  | • The soldering iron was not turned upward to melt all the tin.  
                                  | • The soldering iron was cold or dirty. |
| **Acid stains**                   | • Acid carelessly applied. |
# FREQUENT MISTAKES

<table>
<thead>
<tr>
<th>MISTAKES</th>
<th>CAUSES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Necks</strong></td>
<td></td>
</tr>
<tr>
<td>Outside overlap</td>
<td>• Instructions not followed.</td>
</tr>
<tr>
<td>Incorrect</td>
<td>• Instructions not followed.</td>
</tr>
<tr>
<td>measurements</td>
<td>• Mouths poorly marked or cut.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Creases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strips were not rounded from the ends.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooothing poorly</td>
<td></td>
</tr>
<tr>
<td>set</td>
<td>• Missed hammer-blows.</td>
</tr>
<tr>
<td></td>
<td>• Heating iron not consistently used.</td>
</tr>
<tr>
<td></td>
<td>• Teeth poorly cut or bent.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Twists</td>
<td></td>
</tr>
<tr>
<td>Uneven edge</td>
<td>• Not soldered squarely.</td>
</tr>
<tr>
<td>Front not</td>
<td>• Was not matched before soldering.</td>
</tr>
<tr>
<td>aligned</td>
<td>• Poorly place bottom or lid.</td>
</tr>
<tr>
<td>No fold on edge</td>
<td>• Instructions not followed.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lids</strong></td>
<td></td>
</tr>
<tr>
<td>Inside overlap</td>
<td>• Instructions not followed. Did not read manual.</td>
</tr>
<tr>
<td></td>
<td>• Incorrect measurements.</td>
</tr>
<tr>
<td>Too loose, too</td>
<td>• Not properly pressed with screwdriver.</td>
</tr>
<tr>
<td>tight</td>
<td>• Too much pressure from the bottom or missed hammer-blows.</td>
</tr>
<tr>
<td>Poor overlap</td>
<td>• Not enough tin was applied.</td>
</tr>
<tr>
<td>Twists</td>
<td>• Forgot to solder</td>
</tr>
<tr>
<td>Centre point</td>
<td></td>
</tr>
<tr>
<td>not soldered</td>
<td>• Poster not available.</td>
</tr>
<tr>
<td></td>
<td>• Institutional oversight.</td>
</tr>
<tr>
<td></td>
<td>• Artisan failed to contact Postcosecha Programme Unit.</td>
</tr>
<tr>
<td></td>
<td>• Artisan did not grant due importance.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>**Poster and</td>
<td></td>
</tr>
<tr>
<td>Platform**</td>
<td></td>
</tr>
<tr>
<td>Not present</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Painting</strong></td>
<td></td>
</tr>
<tr>
<td>Acid stains</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sheets</strong></td>
<td></td>
</tr>
<tr>
<td>Sheets too thin</td>
<td>• Artisan did not use gauge 26 or 0.5 mm thick sheets.</td>
</tr>
<tr>
<td>Poor galvanisation</td>
<td>• Poor quality sheets were bought, contrary to the norms of Postcosecha.</td>
</tr>
</tbody>
</table>
177 Surface Corrosion

- If over years of use oxidation is observed on any part of the silo, it should be eliminated before causing further damage.

- Use sandpaper to smooth the entire affected part.

- Clean and dry with a cloth.

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- Paint the affected part with aluminum or anticorrosive paint.

- To prevent corrosion it is recommended that silos located in coastal zones be painted in their entirety.
Repair of Holes

• Should there be any hole in the silo, due to oxidation or improper handling, it may be repaired as follows:

• Use sandpaper over the affected area until all oxide is removed.

• Cut a piece of sheet large enough to cover the affected area.

• Apply acid and solder on the piece of galvanised sheet.
• Use a cloth soaked in soapy water to neutralise the effect of the acid.
• Clean by rubbing with a dry cloth.
• Paint the affected part with aluminum or anticorrosive paint.

**Note:** These repairs are successful only if the part to be soldered is well cleaned and thus entirely free of oxide. Even the slightest amount of dirt or oxide will cause the soldering to be rejected.
Metal silos have become one of the best technologies to store and conserve basic grains.

The widespread popularity of metal silos is due to the following reasons:

- Easy to handle
- Improved hygiene
- Takes up less space.
- Conserves grain quality.
- Relatively inexpensive
- Makes work easier for women.
- Grains are kept safe.
- Adapted to the needs of small farmers.
- Makes for greater food security.
- Offers marketing advantages during times of scarcity.

The extended use of metal silos in several countries reflect a felt need by small-scale farmers who before anything else seek to ensure their capacity to feed their families.
Small Farmers:  
Main Target Group of the Postcosecha Programme

In most developing countries, a large part of the population lives from agriculture. This sector essentially depends upon the income generated from their parcels, which most often are small in size. Given this situation, it is necessary to offer small farmers support. More often than not they do not feel any incentive to increase their production of basic grains if they do not have anywhere to store them without incurring significant losses. The use of metal silos may help to improve the situation. Their increased use forms part of the Postcosecha Programme transference policy.

Transference Policy

The transference of metal silos takes place through:

- Private and public institutions
- Artisans

Both receive support regarding training, didactic material and follow-up from the Postcosecha Programme headquarters. To be efficient, the system must achieve a multiplier effect, as illustrated by the diagram on the next page.
Postharvest Programme

Institution and Artisan

Farmer

Farmer

Farmer

Institution and Artisan

Farmer

Farmer

Farmer

Institution and Artisan

Farmer

Farmer

Farmer

Promotion
Training
Follow-up
The Role of the Artisan in Silo Promotion

The artisan plays a most important role in silo promotion, as he is the person who builds the silos to be sold and used by the farmers.

The artisan has the following advantages:

- As a member of the community, he knows the farmers.
- He speaks the same language as the farmers.
- His presence in the area is likely to be permanent.
- He can move about rapidly for manufacturing the silo in any sitio.
- He has a personal interest in selling the silo, for purposes of improving his economic situation.
- He can expeditiously satisfy the local demand for silos.

Benefits for the artisan in addition to income

Promotion increases demand
Postcosecha Metal Sheet

Galvanised Metal Sheet

Galvanised metal sheets are the single most important component in the construction of a metal silo. A poor quality sheet considerably reduces the useful like of the silo and with it its profitability.

To establish sheet quality the norms governing international trade are used. These are as follows

<table>
<thead>
<tr>
<th>DIN/UNI/BS NORMS</th>
<th>ASTMA NORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. ST 027 275 NA</td>
<td>N. G90 commercial quality</td>
</tr>
<tr>
<td>DIN 17162, DIN 59232</td>
<td>ASTMA A525</td>
</tr>
<tr>
<td>Thickness: 0.5 mm</td>
<td>Calibre 26 thickness</td>
</tr>
<tr>
<td>Length: 6 and 8 feet, 1.8 and 2.4 m</td>
<td>Length 6 and 8 feet</td>
</tr>
<tr>
<td>Width: 3 feet or 0.9 m</td>
<td>Width: 3 feet or 0.9 m</td>
</tr>
</tbody>
</table>

It is important that the Postcosecha Programme checks the quality of the sheets sold in the market. If the sheet does not comply with quality norms it will be necessary for the Programme to interpose its good offices with the manufacturer or provider so as to improve it.

In Central America, brands or manufacturers who guarantee sheet quality have the Postcosecha seal printed on each one of the sheets available at the various hardware stores. You may request a list of hardware stores that carry quality sheets at the national Postcosecha Programme.
How to Check Sheet Quality

The galvanised surface should not display zinc scratches or spots, or areas without a layer of zinc. The distribution of zinc should be even over the entire surface of the sheet.

Take a piece of a galvanised sheet, fold it entirely and tap the crease with a hammer. Under no circumstances must the galvanisation peel off. If it does, this means that the anticorrosive action is no longer present. In a few days, that part will be of a red colour due to the oxidation and within 2 years oxidation may cause holes to appear in the sheet.

A micrometer is used to measure the thickness of a sheet. What constitutes a quality sheet should be demonstrated in the course.
The following is a description of the Postcosecha Programme training package for artisans who meet requirements. The package consists of 4 courses taught in a logical sequence. After each course the artisan is awarded a certificate. Once the entire training programme is successfully concluded, the artisan comes to be considered a Qualified Artisan.

The artisan who successfully concludes the 4 courses receives the title of

QUALIFIED ARTISAN

which allows the artisan to place the POSTCOSECHA quality seal on the silos
1. METAL SILO MANUFACTURE I

**Objective**

The artisan learns how to make silos of differing holding capacities. He also learns how to handle and use the silo appropriately.

**Requirements**

- To have a place available for a workshop and the necessary equipment.
- To be interested in silo manufacture and have a permanent residence.
- To be an honest person with a good reputation.
- To have manual skills and know how to work with a tape measure.
- To know how to read and write.
- Have enough resources to buy tools.

2. METAL SILO MANUFACTURE II

**Objective**

To strengthen the artisan’s knowledge regarding silo manufacture and to correct mistakes that may occur in the process.

**Requirements:**

- That the institution technician and/or the Postcosecha co-ordinator check the silo and verify that the workshop is fully equipped with the tools described in this Metal Silo Manufacture Manual (see p. 18 to 29).
- That the artisan has built 2-3 unpainted silos.
- That the artisan have enough material with which to build a silo (5 galvanised metal sheets, 500 gram of tin, Hydrochloric acid, resin, detergent, aluminum paint).
3. TINSMITHING COURSE

Objective:

To diversify and strengthen technical and artisan know-how in the use of metal sheets.

Requirements:

- To demonstrate interest in tinsmithing, the manufacture of metal silos and the search for new customers.
- To have built 30 good quality silos.
- To demonstrate initiative in making tin-plate utensils.
- To demonstrate a desire to increase the products sold by his micro-enterprise.
- To have taken complete Notes in the “Artisan’s Notebook”.

4. ADMINISTRATION AND MANAGEMENT COURSE

Objective:

To promote administrative and micro-entrepreneurial capacity to Postcosecha artisans.

Requirements

- To have a sign on his workshop promoting the sale of metal silos.
- To demonstrate interest in establishing a micro-enterprise.
- To have built 50 good quality silos.
- To present ideas for silo promotion.
- To have personally distributed at least 30 good quality silos and provided training and follow-up regarding their use and management.
- To understand how to carry the “Artisan’s Notebook”.

Duration: 5 days
Location: Postcosecha workshop
QUALITY SEAL

WHAT IS THE QUALITY SEAL?

The quality seal is a sign that is posted on the silo to certify that it complies with quality requirements and was built by a qualified micro-entrepreneur artisan recognised by the Postcosecha Programme.

The holder of this card is hereby authorised to stamp this quality seal to manufactured silos and is entitled to the title of Qualified Artisan for successfully participating in the four courses carried out by the Postcosecha Programme Unit.
Who is eligible for a quality seal?

A micro-entrepreneurial artisan may receive a quality seal. To obtain the title of “qualified micro-entrepreneurial artisan” it is necessary to have participated successfully in the following courses offered by the Postcosecha Programme.

1.-Metal Silo Manufacture !
2.-Metal Silo Manufacture II
3.-Tinsmithing Course
4.-Administration and Management Course.

Beyond having taken part in the training courses, the artisan must manufacture good quality silos and know how to manage them. The artisan instructor must check and approve the most recent silos built regarding quality and correct measurements, in accordance with that which is set forth in this manual. Further, the artisan instructor will check if silos have been delivered to users with a professional explanation regarding the poster and silo use and handling.

How can someone obtain the quality seal?

To obtain the quality seal, the following procedure must be followed:

1.- Present an application to the Postcosecha Programme (the application form is available at the Programme).
2.-The programme instructor will verify silo quality and approve the application.
3. -Approval by the Director and Instructor.
4.-The “Qualified Artisan” card.
5.- Upon presentation of the “Qualified Artisan” card at the Postcosecha Office, the artisan will receive quality seals.
THE ARTISAN AS MICRO-ENTREPRENEUR

Characteristics of an Artisan as Micro-Entrepreneur

• To own a properly outfitted workshop (flat floor, workplace and warehouse with a roof). Identification and promotion signs.
• To have participated in all of the Postcosecha training courses.
• To comply with quality norms as established by the Postcosecha Programme in the Metal Silo Manufacture Manual.
• To have a minimum of 300 U$ dollar working capital including material inventory, finished products, and cash.
• To promote metal silos and follow up upon silos transferred to his community.
• To explain the use and management of silos to buyers.
• To build at least 150 good quality metal silos per year.
• To make proper use of the Artisan’s Notebook.
• To have good commercial and financial references so he can be eligible for credit.

Product Quality Leads to Success
ADDITIONAL INFORMATION

THE ARTISAN AS MICRO-ENTREPRENEUR
There are three main phases in the process of transferring metal silos.

1. Obtain financing and purchase material

2. Manufacture the silo

3. Selling the silo
Selling the Silo

Knowing how to sell is crucial for every artisan. The entrepreneurial artisan knows how to:

• Calculate manufacturing costs.
• Sell good quality silos to satisfied customers.
• Promote the silo and make himself known to potential customers.

A good artisan is simultaneously a manufacturer and salesman

To obtain benefits, it is necessary to produce and sell
Take into account that...

...good quality increases sales! People will become aware that you build better silos than the competition.

...selling at reasonable prices will give you an advantage over competing artisans working in the same area.

...the silo must satisfy your customers needs. Visit buyers homes to build silos. Supply tablets, tallow, platforms, etc.

...show you care for your clients. Be polite. Keep promises regarding requests and agreed-upon dates. Never deliver late.

...you must teach customers good silo management. If a buyer looses his or her harvest due to poor silo management, your silo sales will decrease! However, a well-managed silo will benefit the buyer, and he or she will convince other people to buy more silos.

...you should have silos in stock for persons who wish to purchase a silo right away,

...private and state institutions have trained personnel who can promote your silos.

...you should find out if the institution wishes to hire you to build silos.
Dear Postharvest artisans:

The following pages are for writing down your own inventions, so you can present these at artisan meetings or bring them to the Postharvest Programme for publication. These inventions may include special tools (compasses, presses, etc.) tinsmith articles, promotion experiences, etc.

As an example, we present a plan prepared in Nicaragua regarding the cutting of sheets for the manufacture of a 68 kg capacity silo.

This silo can be built using a single 90 cm x 180 cm metal sheet (calibre 26) with a minimum of waste.

Manufacturing technique is similar to that used when building the other silos. This silo has no seed outlet, but if the customer requires one, it can be included. Silos of this size can be sold in urban areas or at stores that sell basic grains. Silo use and management is much like that of bigger silos and are also sold with the explanatory poster.

Build some of these, and have them available for show and sale at your workshop.
THE ARTISAN AS INVENTOR

ADDITIONAL INFORMATION

Measurements for Cutting Pieces of a Calibre 26 Galvanised Sheet for a 68 kg Silo

Cylinder: ................................................................. 134 x 65 cm
Cylinder Bottom and Lid (diameter): ............ 44.4 cm
Strip for Intake Throat: ..................................... 6.5 x 75 cm
Strip for Intake Throat Lid: ............................. 4.5 x 75 cm
Diameter for Intake Throat: ......................... 22 cm
Toothing for Intake Throat: ......................... 5 mm
Lid Overlap Strip: ............................................. 3 cm
Bottom for Intake Throat (diameter): ....... 24 cm
ADDITIONAL INFORMATION

THE ARTISAN AS INVENTOR
### CALCULATING COSTS FOR METAL SILOS

<table>
<thead>
<tr>
<th>Breakdown</th>
<th>Unit Price</th>
<th>1,200 kg</th>
<th>750 kg</th>
<th>240 kg</th>
<th>____ kg</th>
<th>_____ kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit</td>
<td>Price</td>
<td>Unit</td>
<td>Price</td>
<td>Unit</td>
<td>Price</td>
</tr>
<tr>
<td>1m x 2m Galvanised Sheet</td>
<td>Gauge 26</td>
<td>4.5</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin 50:50</td>
<td>Kg</td>
<td>0.5</td>
<td>0.5</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resin /Ammoniumchlorid</td>
<td>Kg</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charcoal</td>
<td>Kg</td>
<td>7.0</td>
<td>7.0</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detergent</td>
<td>50 g</td>
<td>1.0</td>
<td>1.0</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>1 ml</td>
<td>20.0</td>
<td>20.0</td>
<td>10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium Paint</td>
<td>1 ml</td>
<td>40.0</td>
<td>40.0</td>
<td>20.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>Day</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation of Tools (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit (3)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Interest (4)</td>
<td>Month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Silo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Observations:**
1. The total cost of transportation will be calculated according to the cost of transportation of a metal sheet including the expenses of the Artisans personal transportation, meals and lodging if needed.
2. The total depreciation cost of tools is divided into the total amount of silos to be made before renewing the tools (80 silos). An average of silo capacity can be taken, then sum or substrate values if in case the silo capacity is above or below the average.
3. Profit or Margin of cost. Initially the Artisan can calculate a 10% of the cost of material. After an acceptation of the metal silos by the farmer he can increase the profit to 15% of the sales price.
4. The Artisan should calculate the interest at 1-month term, at the average interest rate in the Country. This percentage should multiply the total amount of the cost before calculating the profit.
CALCULATING COSTS FOR METAL SILOS

<table>
<thead>
<tr>
<th>Breakdown</th>
<th>Unit Price</th>
<th>1,360 kg</th>
<th>800 kg</th>
<th>540 kg</th>
<th>360 kg</th>
<th>180 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit</td>
<td>Price</td>
<td>Unit</td>
<td>Price</td>
<td>Unit</td>
<td>Price</td>
</tr>
<tr>
<td>3&quot; x 6&quot; Galvanised Sheet (0.93 x 1.86 m)</td>
<td>Gauge 26</td>
<td>6.2</td>
<td>4.5</td>
<td>4.5</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Tin 50 : 50</td>
<td>kg</td>
<td>0.5</td>
<td>0.35</td>
<td>0.35</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Resin/Ammoniumchlorid kg</td>
<td>0.1</td>
<td>0.1</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Charcoal kg</td>
<td>7.0</td>
<td>5.0</td>
<td>5.0</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Detergent gram</td>
<td>50.0</td>
<td>40.0</td>
<td>40.0</td>
<td>30.0</td>
<td>30.0</td>
<td></td>
</tr>
<tr>
<td>Hydrochloric Acid ml</td>
<td>30.0</td>
<td>30.0</td>
<td>20.0</td>
<td>15.0</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>Aluminium Paint ml</td>
<td>50.0</td>
<td>50.0</td>
<td>40.0</td>
<td>20.0</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transportation (1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Day/pers</td>
<td>1.0</td>
<td>1.0</td>
<td>0.75</td>
<td>0.75</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Depreciation of Tools (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit Margin over cost (3)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Interest Rate (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Silo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations: The 540 kg silo will require 3.5 galvanised sheets. However, when buying materials calculate 4.5 sheets since three 60 x 90 cm pieces, equivalent to 1 sheet, will be left over.

(1) The total cost of transportation will be calculated according to the cost of transportation of a metal sheet including the expenses of the Artisans personal transportation, meals and lodging if needed.

(2) The total depreciation cost of tools is divided into the total amount of silos to be made before renewing the tools (80 silos). An average of silo capacity can be taken, then sum or substrate values if in case the silo capacity is above or below the average.

(3) Profit or Margin of cost. Initially the Artisan can calculate a 10% of the cost of material. After an acceptation of the metal silos by the farmer he can increase the profit to 15% of the sales price.

(4) The Artisan should calculate the interest at 1-month term, at the average interest rate in the Country. This percentage should multiply the total amount of the cost before calculating the profit.