PLATE
CISTERN

CONSTRUCTION, USE AND CONSERVATION

Beyond Cotton | WFP World Food Programme Centre of Excellence against Hunger | IBA Brazilian Cotton Institute | ABC Brazilian Cooperation Agency | Ministry of Foreign Affairs | Brazilian Government Brasil Uniting and Rebuilding

Alternatives for the Disposal of Cotton By-Products and Accessory Crops in Africa
Beyond Cotton Project (Project-Country: Tanzania)

PLATE CISTERNS: CONSTRUCTION, USE AND CONSERVATION

Technical Data Sheet

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WHAT IS THE **PLATE CISTERN**

This booklet is an integral part of the Training in Cistern of Plates of 16 thousand liters. We will talk about its construction, maintenance, use and treatment of water for human consumption and how to make good use of technology.

It is part of the Beyond Cotton Project, which aims to support small cotton farmers and public institutions in African countries (Benin, Mozambique and Tanzania) to market cotton by-products (such as crude oil and cotton seed bran) and cotton rotation products and associated crops (maize, beans, grasses, sweet potatoes, chickpeas, etc.). The trilateral South-South technical cooperation project is an initiative developed by the Brazilian government - through the Brazilian Cooperation Agency (ABC, in Portuguese), the World Food Programme (WFP) Center of Excellence against Hunger Brazil, in Brasilia, with the financial support of the Brazilian Cotton Institute (IBA, in Portuguese).

The plate cistern has a cylindrical or rounded shape, is covered, to avoid pollution and evaporation of stored water, and semi-buried, approximately two-thirds of its height, to ensure the safety of its structure. The water captured in the cistern comes from the roof of the houses, conducted by zinc or PVC gutters, which direct the water to the storage tank of the cistern.

It is a social technology, of low cost, developed by a Brazilian farmer that consists of a rainwater harvesting reservoir, built with precast cement plates, whose purpose is to store water for the basic consumption of rural families, living in regions of long periods of drought or when there is no availability of quality water for residential consumption.

POINTS TO BE OBSERVED AND **CHOICE OF THE LOCATION OF THE CISTERN**

When deciding to build a cistern of plates it is important to highlight some key points to have better security in the design of the work, in the feasibility of the construction and in the effectiveness of its use. Each cistern can hold 16,000 liters of water. This amount, taking into account that a person needs 14 liters of water per day, will be enough for the main needs of the family, such as hydrating, cooking and brushing teeth.

In order for the water in the cistern to last, it is very important to plan the consumption. We need to note the number of people who will use the cistern; the purpose of consumption (drinking, personal hygiene, cooking or washing dishes); the period of use (in months); the knowledge of the area and the height of the roof available to capture the water, which must be on a higher plane than the cistern. This position allows the water to descend through the gutters until it reaches the storage tank of the cistern by gravity. We also need to take into account the local average rainfall in millimeters of rainfall per year and the limitations or type of land where the construction of the cistern will be carried out.

Sandy terrain is more appropriate. A stony and shallow terrain hinders the construction because it reduces the storage capacity of the cistern. The clay is unsuitable because, when soaked, it dilates and dries, contracting. This movement may cause cracks in the walls of the cistern.

Avoid building in places near trees, whose roots can damage the walls, causing leaks

Avoid a place near cesspools, corrals or garbage dumps, to avoid contamination.

Ideally it should be built near the kitchens, to facilitate the supply of the house.

MARKING OF THE SITE AND EXCAVATION OF THE FOUNDATION OF THE **STORAGE TANK**

For a cistern with a storage tank capacity of 16,000 liters, the roof area must be a minimum of 33 square meters. The cistern will have a height of 1.80m and the depth of the excavation, from the level of the terrain, of 1.30m with a diameter of 3.40m.

Although it is 3.40m, the diameter of the excavation will be 5m, to facilitate the work of the workers during construction. Make the marking with the aid of a rope or string of 2.5m, with two pickets tied to the ends of the rope. One of the pickets will be fixed to the ground in the center. The other, with the rope stretched at the other end with a distance of 1.70m, will serve as a marker of the circle to guide the excavation of the storage tank, as illustrated below.

Figure 1 – Marking the Cistern Site

Figure 2 – Excavation Dimensions

Figure 3 – Excavation of the Foundation

PREPARATION OF THE **TEMPLATES**

Walls of the Cistern

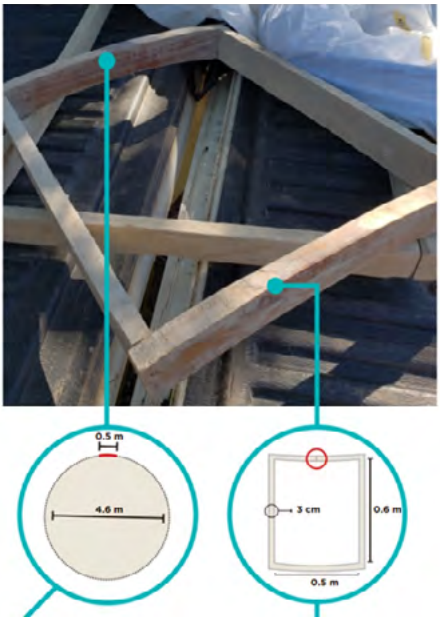

Figure 4 – Step by step of the Plate Template

The jigs (molds) of the plates of the walls of the cistern are made of wood in the dimensions of 50cm and 60cm and thickness of 2cm with a slight curvature in the smaller part that will be vertical, giving rounded shape to the cistern.

Figure 5 – Photo and Drawing of the Rail Gauge of the Cistern Cover

The jigs of the rails that make up the lid are made of rafterwood and they will be 1.70m long, 3cm thick and 8cm high, in the part that will be on the walls of the cistern. At the other end of the rail that will be in the center the jigs will be 6cm high.

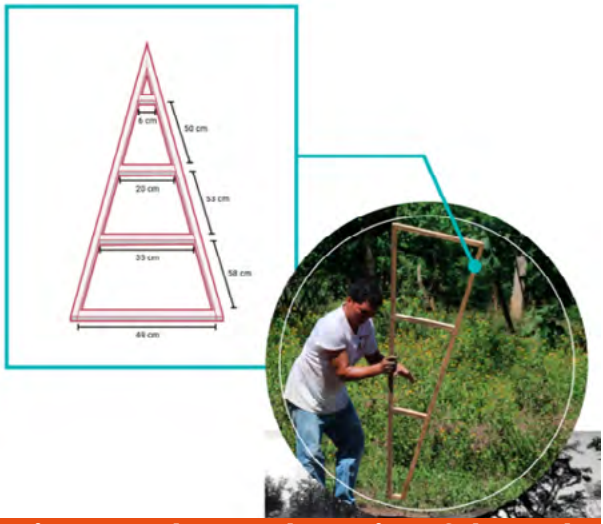

Figure 6 – Photo and Drawing of the Tank Cover Plate Template

The jigs of the lid plates should be trapezoid shaped, with a base of 51cm divided into 3 parts (3 trapezoids), which will form the lid plates. They have the same length as the rails, 1.70m.

MAKING OF THE **WALL PLATES**

Choose a washed, coarse and good quality sand to give strength, durability and impermeability to the plates. The mortar should have one bag of cement to 4.5 cans of sand. Sixty-three plates will be built for each cistern, 21 of which with dent, to receive the rails of the lid.

One of the plates should have a 40mm hole to act as a sigh and should be located approximately 1cm from the top edge.

At the time of making the plate, a small cavity should be made with the tip of the masonry trowel to facilitate the anchoring of the assembly of the plates.

ATTENTION: three to five spare plates must be made in case of breakage or defect.







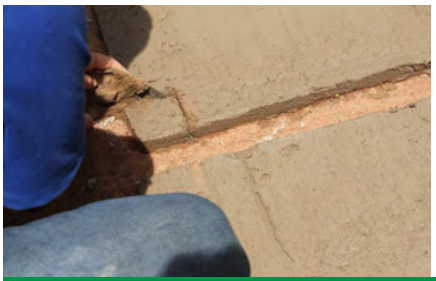


Figure 7 - Photos and figures with all the details of the plates

MAKING OF THE **LID RAILS**

Each rail should be reinforced with two iron rods 1/4' and 1.7m long. The mortar should have one bag of cement to two cans of sand and two cans of gravel 1 (from 9,5 to 19mm). Twenty-one rails are required for the 16,000-liter tank lid. For the making of the rails, 42 pieces of iron 1/4' are cut with a length of 1.70m, folding each iron at one end, with 5cm to form the hook, resulting in a length of 1.65.






Figure 8 – Size and Shape of the Irons for the Rails

MAKING OF THE **LID PLATES**

The 19 plates of the lid will be made using a template, as shown in Figure x. In the manufacture of the cover plates, one will have a hole of 75 or 100mm to fit the capture pipe, as Figure 9. For the placement of the pump pipe, one of the cap plates must have a hole with a diameter between 32 and 40mm. These two slabs should be built with cement reinforcement.

Figure 9 – Detail of the Plate with a Hole for Water Capture

The mortar to be used for making the plates of the tank cover must be the same used for the side walls, which means one bag of cement to 4.5 cans of sand.

Note: wet the plates and rails for a better cure of the cement.

ASSEMBLY OF THE **PLATE CISTERN**

Construction of the floor of the bottom of the cistern

After the excavation, the floor begins to be made, with a layer or wall of 3cm of concrete, which fills the entire diameter of the bottom of the cistern with the indicated mortar, in a level way. On this, a 1/4' iron mesh is placed, made on site.

Figure 10: Demarcating the bottom of the cistern to build the floor

Figure 11: Level marking and floor construction







Figure 12 – Structure of the ¼' Iron Mesh at the Bottom of the Cistern

Placed the mesh on the wall, this is covered with another 4cm of concrete, leaving the floor with a total slab of 7cm to support the weight of the water.
The mortar to be used should have one bag of cement, three cans of sand and four cans of gravel (from 9,5 to 19mm). In case the excavation reaches the stone or compact soil, there is no need to make this iron mesh.

Figure 13 – Aspect of the Floor of the Cistern

Mounting of wall plates

The assembly of the plates will be carried out in a circular way, obeying the diameter of 3.40m. Before placing the plates, a previous measurement is made with a jig identical to the plates, of length of 50cm, leaving a gap of 1.5cm between the measurements, to make the grout.

Twenty-one measurements will be made, which is the exact number of plates that will make up the first row. Ideally, after 18 measurements with the template, there is a space of 9cm, placing the last three plates in a way that the space is equal between the three.

In the assembly of the first row, seven initial plates are placed and the grout is made; then seven more plates are placed and they are rejoined (brazed). A new measurement is then made so that the distance between all the plates is as identical as possible.

In the placement of the plates, wooden struts (sticks) are used on the inside and outside of each plate, in addition to the placement of six sections of galvanized wire 12 BWG in each row for lashing, as seen in Figures 14 and 15.

The grout of the plates is made with a bag of cement to two cans of sand. The struts will be removed after drying the grout. In the following rows, as in the first, the grouts of the plates should be according to figure 14, in the center of the bottom plate, for good fixation. In the third and last row, the 21 plates should have a dent of 8cm for placement of the rails that will support the plates of the lid, as shown in Figure 15. The measurement procedure is the same as the previous one, with the dent facing upwards.

Figure 14 – Assembly of the 1st. Row of Plates

Figure 15 – Details of the Assembly of the 2nd. Row

Cover mounting

After the preparation of the floor and the assembly of the vertical plates of the wall of the cistern (note that the grouts must be totally dry), a vertical pile of 2.07m is fixed in the center of the floor of the cistern, which will have at the upper end a circular board (round) of 3cm thick and 50cm in diameter. The rails will have one end fitted to the dent of the upper row plate. The other end with the iron hook will be resting on the wooden disc in the center of the cistern. All iron hooks will be fastened together and tied with galvanized wire 12 BWG so that they are firmly attached.

Figure 16 – Details of the Structure of the Cistern Cover

After fixing the rails, the entire area of the wooden disc is filled with concrete, so that the ends of the rails are covered with concrete. The grout of the plates should be done with the same ratio as the plaster (1:5).

After drying, the lid plates are fitted on the rails and, before grouting, three sections of wire 12 are placed, encircling all the rails on the outside of the tank. It prevents them from detaching during the application of the grout. One of the larger plates, closer to the edges, should be left loose for access to cleaning, maintenance and water removal.

Figure 17 – Details of the Assembly of the Tank Cover

Cistern plaster

The external plaster will be started, preferably, after the placement of the first two rows of plates that should already be rejoined, in the 1:5 ratio.

Figure 18 – Aspects of the External Plastering of the Cistern

After the placement of the three rows, which should already be rejoined, the plastering begins inside the walls and the floor. This operation should be carried out on the same day, to facilitate the seam between the plaster of the walls and the floor. The ratio of the mortar, for the inner plaster and floor, is 1:3 and for the lid is 1:5. After 24 hours of the completion of the internal plaster and the floor, a mixture of cement and water and 2l of waterproofing is made, brushing the entire interior of the cistern, thus ensuring the absence of leaks. The lid is plastered only from above.

Painting

The cistern should be painted on the outside, with supercal or similar, in three coats. Keep the cistern always painted. The white color reflects sunlight and makes the temperature drop, almost 2ºC (35.6ºF). In addition, the paint helps prevent cracks and leaks.

Gutters

The gutters in galvanized sheets should be fixed on the eaves of the roof of the house and interconnected with sufficient slope so that rainwater runs towards the installed pipe.

The piping and connections should be made with white PVC pipes DN 75mm, with joints and rings in the fittings to prevent leaks.

In order to prevent contamination and facilitate the withdrawal of water, it is recommended to install a manual hydraulic pump.

Figure 19 – Plate Cistern with Water Capture and Withdrawal System

The recommended specifications for the pump are: suction height 10 m; height of repression 5m; cylinder diameter 21/2'; suction pipe diameter 1'; water flow 3,000l/h; base, screws and rod: galvanized drawn steel; group-type soles; metal-bronze type joint; gasket and cast iron type hardware.

MANAGEMENT OF STORED WATER AND **MAINTENANCE OF THE CISTERN**

Water Management

The supply of water to the family, by means of cistern of plates, should always happen on individual bases, that is, a cistern for each house. A cistern of 16,000 liters is enough to meet the needs of a family of four for nine months (14/day/person).

The waters of the first rains should be discarded, as they are responsible for washing the roof. As for the management of stored water, it is recommended:

Placement of a filter (screen) at the water inlet of the cistern;

Filtration or boiling as a method of water treatment; chlorine addition;

Use the hand pump to collect the water. This prevents direct contact of the hands with water and possible contamination;

Do not remove water from the cistern by means of buckets or cans, but leave a bucket prepared for use in case the pump breaks. This bucket must always be clean and cannot be stored on the floor;

Keep the surroundings of the cistern clean;

Sanitize hands and utensils for direct contact with these stored waters;

Teach children over the age of 10 and young people to wash their hands and arms before drawing water from the cistern. The more careful with hygiene, the lower the risk of water contamination;

Keep cisterns closed at all times and never leave children alone near the structure when the lid is open to prevent accidents and avoid water contamination.

Conservation and Maintenance

Using a cistern requires knowledge, discipline and awareness of the water limitations of the semiarid region.

With regard to the care with the longest life of the cistern, it is recommended:

Do the annual cleaning (internal and external):

Empty the plate cistern completely and wash the cistern with a washing brush or sponge and soap;

Wait 30 minutes for the cleaning to take effect;

Wash the cistern again with clean water;

Remove all water used in cleaning;

The plate cistern is ready to start storing rainwater:

Make the preventive and corrective maintenance of the physical structure and capture of the cistern;

Prevent the cistern from remaining empty for a long time with risks of cracks;

Carry out technical and behavioral training of the beneficiaries, focused on conservation and maintenance.

ATTACHMENT

REQUIRED MATERIALS

QUANT.	MEA	PRODUCT/SERVICE SPECIFICATIONS
14	KG	GALVANIZED WIRE 12 BWG - 2,60MM - 48,00 G/M
4,5	M3	MEDIUM SAND
0,5	M3	GRAVEL
1	UNIT	CHROME BRASS PADLOCK H = 25MM
1	UNIT	HYDRATED LIME FOR PAINTING PACKAGE 7kg
1	UNIT	WELDABLE PVC CAP CONNECTION FOR BUILDING SEWER DN 75mm
18	UNIT	COMMON PORTLAND CEMENT CP II-32 50kg
8	UNIT	TE PVC SERIES R FOR BUILDING SEWER 90G 75 X 75MM
24	M	PVC PIPE FOR BUILDING SEWER DN 75MM
6	UNIT	KNEE PVC R SERIES FOR BUILDING ESG 90G DN 75MM
19	KG	CA-60 STEEL - 8,0MM (18,96kg=4 bars)
1	UNIT	75mm X 50mm LONG WELDABLE REDUCTION BUSHING
2	M	50mm COLD WATER WELDABLE PVC PIPE (CUT THE PIPE EVERY 20cm)
1	UNIT	50mm WELDABLE BALL REGISTER FOR COLD WATER
1	PIECE	PUMP - PLATE - CAP - CLAY FILTER

Tools you need	
Hoe	Mason level
Mattock	Nylon line
Buckets	Pincer pliers
Wheelbarrow	Sledgehammer
Masonry trowel	Hammer
Personal protective equipment	Plummet
Measuring tape	Pliers

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