RAIN WATER HARVESTING IN AFRICA

CALABASH CISTERN MANUAL 2019

€ 240,-
for 5000 L.
✶Page 8

www.cleanwaterhealthyvillage.com
www.degevuldewaterkruik.nl

Foreword Hans Hartung M.Sc

Hans Hartung is an independent water and energy consultant with more than 30 years' experience in the sector. He is associated to FAKT (Stuttgart, Germany) and is a former vice-president of IRC-SA (International Rainwater Catchment Systems Association)

Dear reader,
Here you have a simple, low cost and sturdy tank or cistern. Get yourself engaged in spreading the cistern! Many ideas are possible: building the cisterns yourself after you got training, get trainers trained, finance the training of trainers and/or the materials for the cisterns, spread the idea and distribute this booklet. You can be assured that: many people benefitting from rainwater of the cisterns will be grateful to you!

Congratulations to Paul Akkerman,
Congratulations to Sadjaliu Djalo, Julio Nahonta and all the other trainers and masons in Guinea Bissau!

Your work, as I have seen it, is truly impressive. The speed of scaling up rainwater harvesting in Guinea Bissau especially (and other countries as well) is impressive. And you have done this without big international or national backing. It shows how the approach and the technology is valued by the people in need of clean water.
The impressive thing is not only the numbers of rainwater cisterns built and used, but also the constant improvement of the cisterns. They are made simpler to construct and sturdier. The new Cistern Calabash is the optimised cistern incorporating a long experience.

It deserves to be spread to countries in Africa and beyond in big numbers!


Hans Hartung


Han Heijnen

Foreword Han Heijnen M.Sc

Han Heijnen is Vice President (external relations) of IRCSA (International Rainwater Catchment Systems Association) and President of IRHA (International Rainwater Harvesting Alliance)

Dear reader
This manual describes in detail the construction of the Cistern Calabash. In doing so, it shares the experience of developing a good design with all who want to copy the cistern in their own locality. There are many parts of Africa and the wider world that can benefit from the Calabash experience. The readiness of the project team to provide training to interested colleagues will create further capacity to apply this technique.

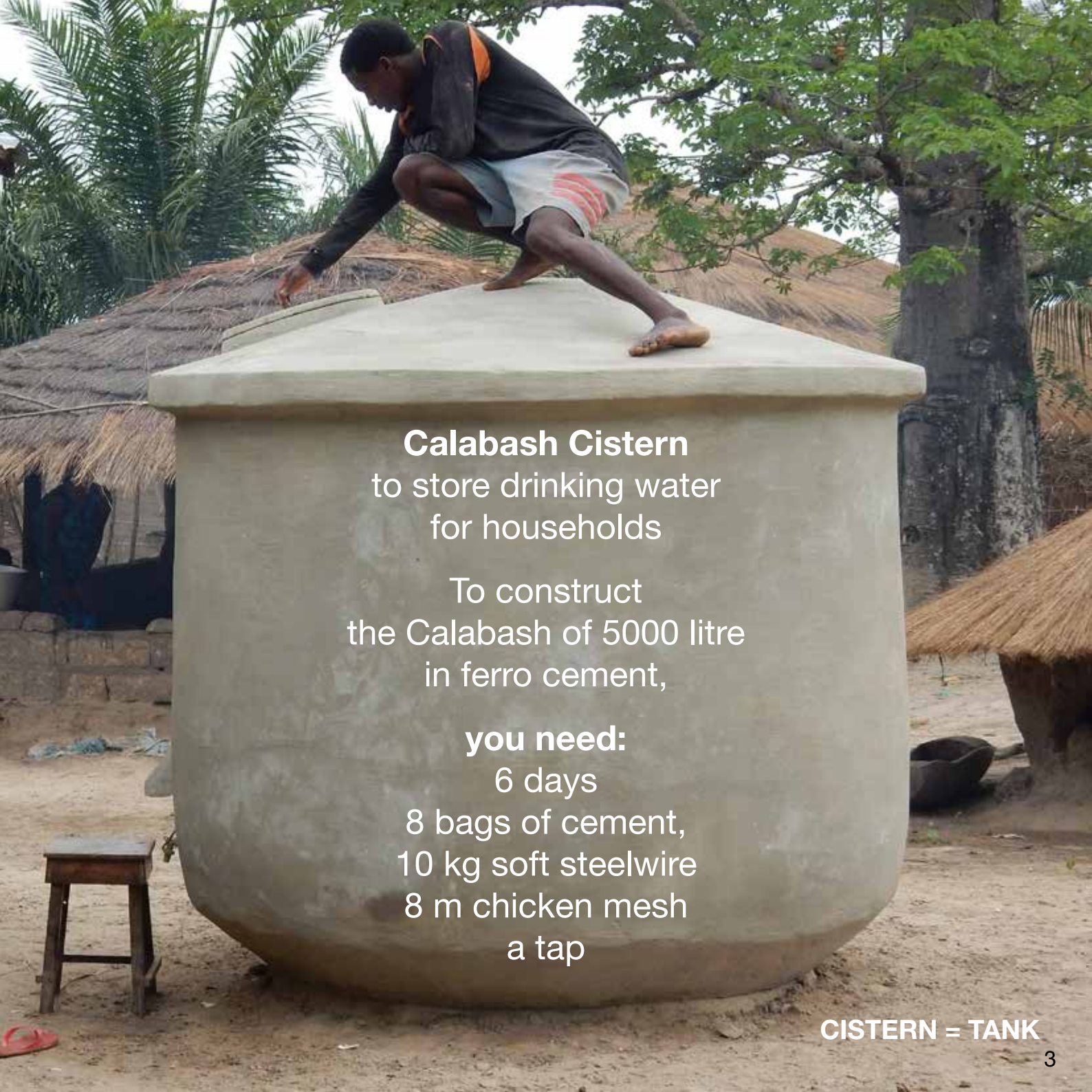
De Gevulde Waterkruik - Clean Water-Healthy Village - project team has shown that rainwater harvesting is a viable and appreciated source of water in the islands and coastal areas of Guinea-Bissau. During the last decade a team of local artisans has developed and refined their skills in constructing reservoirs that are sturdy, based on local solutions and – with a little support - affordable for a household.

Rainwater that is collected from a clean surface will further improve during storage. Bacterial die-off in the cistern can be substantial while bio-films developing at the cistern-water interface are also considered to have a positive effect on the water quality. Thus, a well-managed cistern should only be cleaned every 3-4 years. (More information about water quality and treatment further in the Manual).
Safely collected rainwater provides good quality water for drinking and cooking. It is a source of enjoyment and health. Use it well!

I wholeheartedly recommend the Guinea-Bissau team for promoting Rain Water Harvesting as a component of the Pure Water – Healthy Village Project.

Good luck for all rainwater harvesting practitioners in using this inspiring manual!

Author of the MANUAL:
Paul Akkerman B.Sc, projectleader CLEAN WATER - HEALTHY VILLAGE, Netherlands / Guinea-Bissau



Calabash Cistern
to store drinking water
for households

To construct
the Calabash of 5000 litre
in ferro cement,

you need:
6 days
8 bags of cement,
10 kg soft steelwire
8 m chicken mesh
a tap

CISTERN = TANK

Dear Friends and Practitioners of Rain Water Harvesting

Because many families are in urgent need of safe drinking water, my friend Bicosse Nandafa and I started the work in his village Bedanda, That was 15 years ago. Today Bedanda and many other villages in Guinea-Bissau can manage their water stress. Our work continues in Subsahara villages.

In this manual we hand over our experience to you, because thousands of families with children in many African countries suffer from water related diseases and are in need of clean water. A big need of practical training and friendship over the world can be fulfilled.

This booklet is also meant as a guide to thousands of small African farmers, working hard to survive with little help from governments. It is an ode to all supporters who believe in our work.

TRAINING: our organisation CLEAN WATER - HEALTHY VILLAGE has several years of experience in training masons and managers of projects in DR Congo, Nigeria, Ghana, Senegal, Guinea-Conakry, Tanzania, Kenya, Malawi and Zambia (see page 35) and in some countries of Latin America.

The GOAL of our project is within the Sustainable Development Goals of UN, SDG 6:
“Ensure availability and sustainable management of water and sanitation for all”

Thank you,
Paul Akkerman

More information: **www.degevuldewaterkruik.nl**
www.cleanwaterhealthyvillage.com

August 2019

2005

2018

Paul Akkerman is an independent consultant and has been working with farmers in Guinea-Bissau for 30 years. Since 2005 he has been adapting rain water harvesting as an important source of drinking water for the population. He has initiated the construction of more than 4000 domestic rainwater cisterns in the country. Now he is spreading the technology to other African countries by means of training.

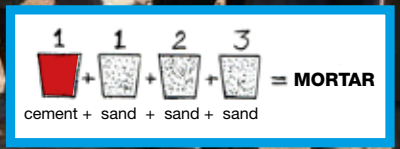
BASIC MATERIALS:
Clay blocks for the mould
Cement and sand for the cistern

Result of polluted sand

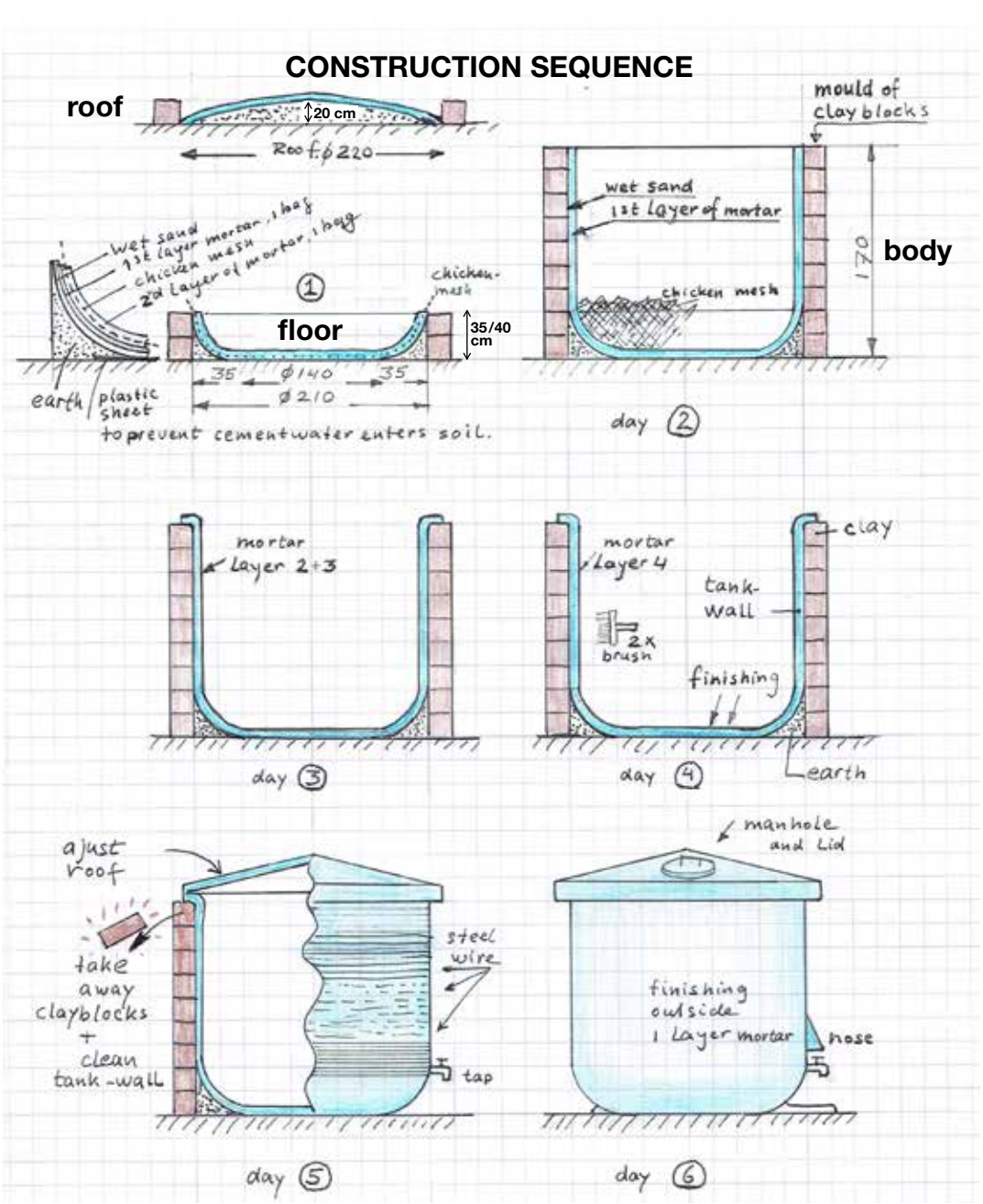
Cement blocks can be used, when clay blocks are not available.

Above: normal clay blocks (± 40 x 20 x 17 cm) can be used for the mould. They are of the same size as the blocks that are used for the construction of houses. Below: Mortar is a mixture 1 : 3 of cement with sand. A proper mix is essential in order to get a watertight cistern.

Result of bad sand and insufficient reinforcement



50 kg of cement needs 2 partly filled wheelbarrow with sand, for the right mixtrure!



The construction system of our cisterns is based on a mould of clay blocks.
The cement cistern is constructed inside this mould ① and ②. At the final stage of the construction process ⑤ the masons remove the clay blocks of the mould. The blocks can be used several times. The clay blocks are commonly used in many African countries for the construction of houses.
In other parts of the world cement blocks can be used.

INFORMATION

The Calabash Cistern is developed in West Africa. It can store rainwater that can be used as safe drinking water for families. The local name of our project is: **IAGU LIMPO – TABANKA SAN,** it means **CLEAN WATER – HEALTHY VILLAGE.**
This manual shows our practical knowledge. Together we have constructed more than 4000 water cisterns during our 14 years of existence. Every year we train masons and managers from other countries.

Materials to be bought for one cistern

8 bags (50 kg) of cement
10 kg of soft steel wire
7,5 m. of chicken mesh (1 m. wide)
8 m. of plastic sheet (2m. wide) to protect the wet cement (this sheet can be reused!)
Tap, 2 sockets, pvc tube and teflontape (see page 27)
One 50 cm steel bar D6 or D8 for the handle of the lid

Materials to be provided by the cistern owner

200 clay blocks (+/- 17 x 20 x 40 cm) for the mould
22 wheelbarrows with sand for the mortar. Take care that the sand has a good grain and it is not polluted with clay or salt.
600 l. water for the mortar

Tools

1 wheelbarrow
3 shovels, 3 trowels
3 cement plates (masonry float)
1 bucket and 1 basin ø40
1 tape measure of 3 m.
1 levelling tool / spiritlevel
1 pincer to cut the steel wire
1 hack
1 machete or chopper knife
2 brushes for the cement water
1 steal brush
1 ladder to enter the inside of the cistern and mould (can be home made)

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Partition of costs in Guinea-Bissau

Material:	€ 142	59 %
Tools:	€ 10	4 %
Transport:	€ 10	4 %
labour:	€ 60	25 %
coordination:	€ 18	8 %
	€ 240	100 %

The total cost of a 5.000 L Cistern

In many African countries the total cost is about € 250,00.
Exception: In DR Congo the total cost is about € 400,00.
€ 460,00 for a 10.000 liter cistern (Guinea-Bissau)


Hand tools only

diameter outer circle: 210 cm
diameter inner circle: 130 / 140 cm

A strong wellshaped floor is essential for the construction. Page 10 - 15

Above:
adjust the clay blocks in the upright position.

Making of the mould in wet sand in a hollow shape.
The shape is for the globe-like bottom. (See page 14).

Above: Shape by hand a regular hollow curved surface in the sand, it will give an attractive and strong body to the cistern. (See page 14). The mortar lies on the wet sand or plastic sheet to prevent drying out.The construction of the mould for the roof starts the first day.

Construction of the roof

The construction of the floor is done in **3 layers**: ① mortar (1st bag of cement) ② chicken mesh ③ mortar (2nd bag).

Extra information

Good connection between the floor and the wall is very important for the strength and the water tightness of the cistern. When the shape is like a globe, like a football, there is less peak tension in the cement and less chance of cracks. Ever seen a football with cracks?? **No cracks no leaks!!**

Extra information

Above: Always wet the surface before the new plaster of cement is applied. It creates a good bonding between the two layers of plaster.

Use plastic sheet for covering the fresh cement in order to avoid sun or dry air! Cement loves water and shadow!!!!

Moreover: it is essential that the cement should not dry out and become brittle.
Water is necessary to harden the cement, hardening is not a drying procedure. Water cisterns constructed in the moist rainy season have the best quality. No need for maintenance.

When the cistern is finished it needs to be wetted and covered with plastic for 7 days.

Fill the cistern with water the **first day** it is finished up to the level of the tap!!
“Mr. Mason, fill it yourself and do not wait for the cistern owner!”

Day 1

Applying chickenmesh: just bend the chickenmesh outside over the 2nd row of blocks, instead of bending inside. You get far better control! Idea of ir. Roger Mbumbu, DR Congo.

Bend the chickenmesh over the blocks and pile the next row of blocks upon it

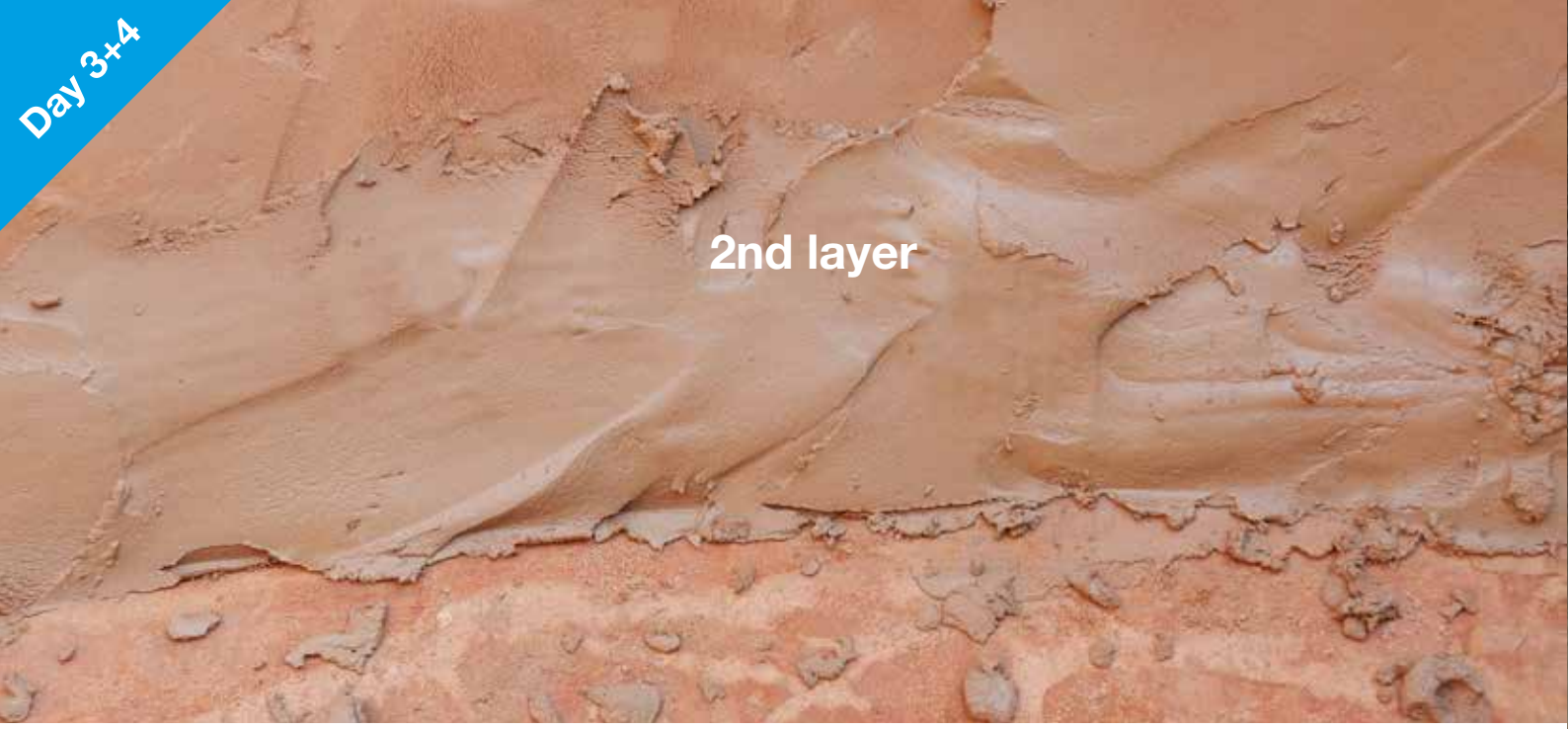
Above: construct the mould with clay blocks in + 9 rows to reach a height of 1.70 m. Below: apply 1 layer of clean wet sand for a smooth inside surface of the mould. Use a spirit level to make a vertical wall.

Construction of the wall during day 2, 3 and 4

Above: mortar on wet sand. The mortar is curved over the edge of the mould.
Below: apply a total of 4 layers of mortar during day 2, 3 and 4.

Check the thickness of the plaster with a stick.

Day 3+4



Below and right: use a mixture of water and pure cement and apply this with a brush on the 3rd and 4th layer of mortar. **This makes the wall water tight!**

Finishing the water bed

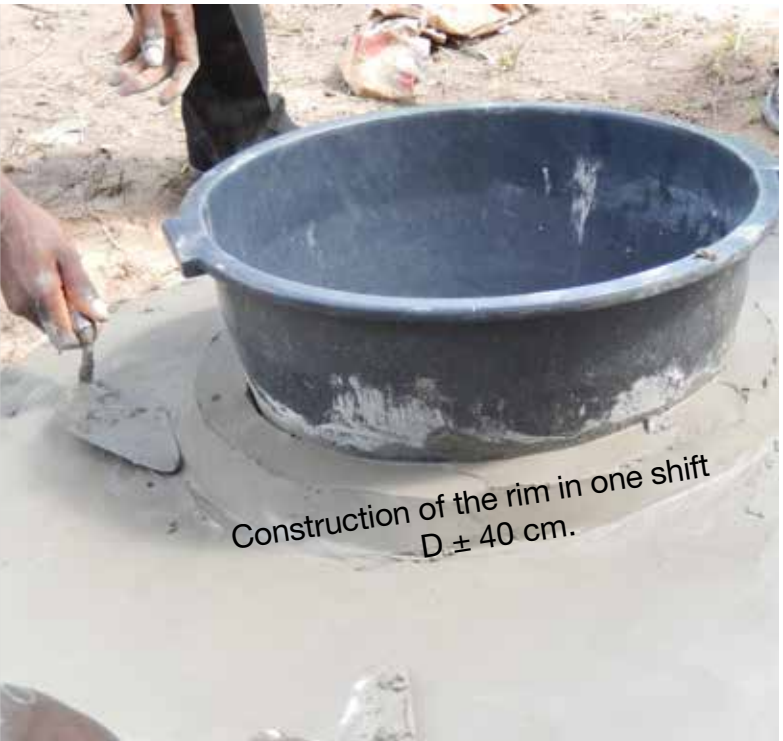
Roof
Day 2

Wet paper of cement bag

The construction of the roof. Above: the dome shaped roof is at least 20 centimetres high in the middle. Below: use a tub to shape the manhole of D ± 40 cm.

Twisting of steelwire 5x

Above: the roof is reinforced with 3 or 4 circles of twisted steel wire.
Below: the lid has to fit the manhole exactly to guarantee absolute darkness inside.



Construction of the rim in one shift
D ± 40 cm.

Day 5

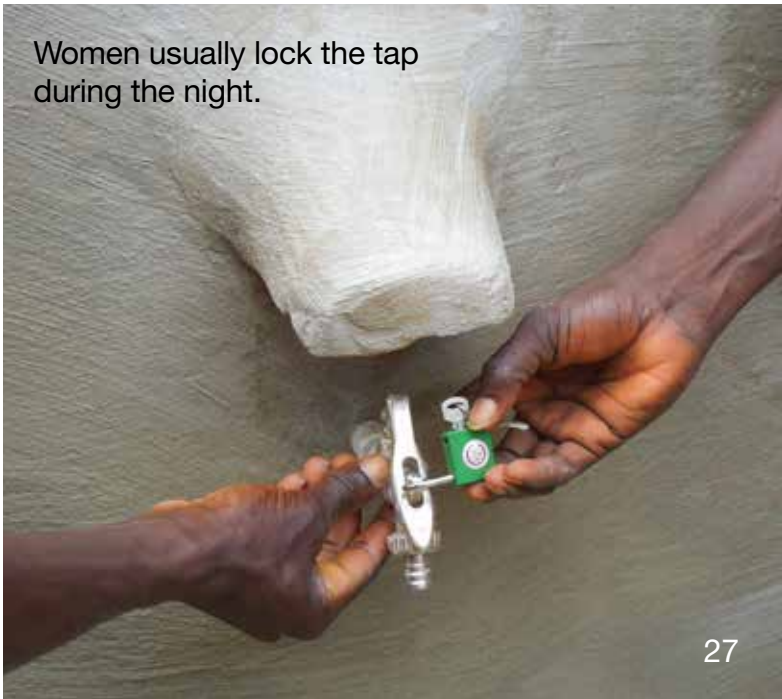
After the roof has hardened for 4 days you can lift it and carefully adjust it onto the wall of the cistern. Make sure it is hard enough. It is a heavy job and it can be dangerous. Make sure that the team is strong and coordinated. Two persons support the roof from the **inside** of the cistern while lifting it step by step over the cistern wall to make sure not to damage it!

Above: then take away the clay blocks and store them away so that they can be used once more!
Below: clean the sand from the wall with a shovel and a steel brush.

Day 5+6

We use steel wire (binding wire) for reinforcement of the cistern wall. Steel wire is good for the cylindrical wall and much cheaper than chicken mesh. Wind the steel wire around the cistern from below upwards, like a spiral. Start as low as possible to overlap the chicken mesh from the bottom. At least 10 cm overlap. In the lower half, the distance between the wires is 1 cm. More upwards, above 0,8 m the distance can be max 2 cm. The binding wire can be bought in coils of 10 kg. Plaster the wired wall with the last layer of mortar. (layer no 5)

Carefully make a hole in the cylindrical wall for the tap, just a few cm above the curved bottom. Use a piece of PVC tube and 2 unions to prevent leaking. A part of the first union has to stick out of the wall to have grip for a tube-wrench when changing the tap. Use a tap which can be locked during the night.



Women usually lock the tap during the night.

The nose over the tap is meant to prevent people from stepping on it, to reach the roof of the cistern. As the roof is often used as a safe place for laundry, solar panels and dry food.
Below: plaster the gap between the roof and the wall both outside and inside.

A small lid within the bigger lid. The small lid covers the small opening to let the rainwater in. It is easy to open and easy to close when there is no rain. The bigger and heavier lid is used for opening and closing the manhole. Only once in a few years it is used when someone enters the cistern for cleaning or repairing. Normally the manhole must be securely closed to keep sunlight, dust and insects out. See page 33.

Day 6

Finishing touch: Give the cistern our symbol, the year of construction (inscription), the name of the village and a number. This is for administration and control.


Nº1 / 2016
MPUNGDA
GUINE
BISSAU
AFRICA
OCIDENTAL
MPUNDA


More pressure

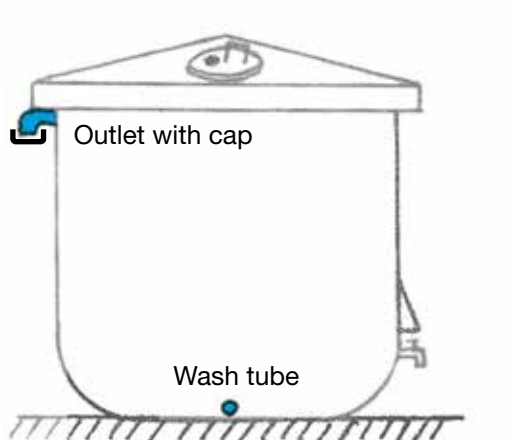

Beautiful
Deaf
mason


IAGU LIMPO
TABANKA SAN
Cistern of
10.000 L
at a school

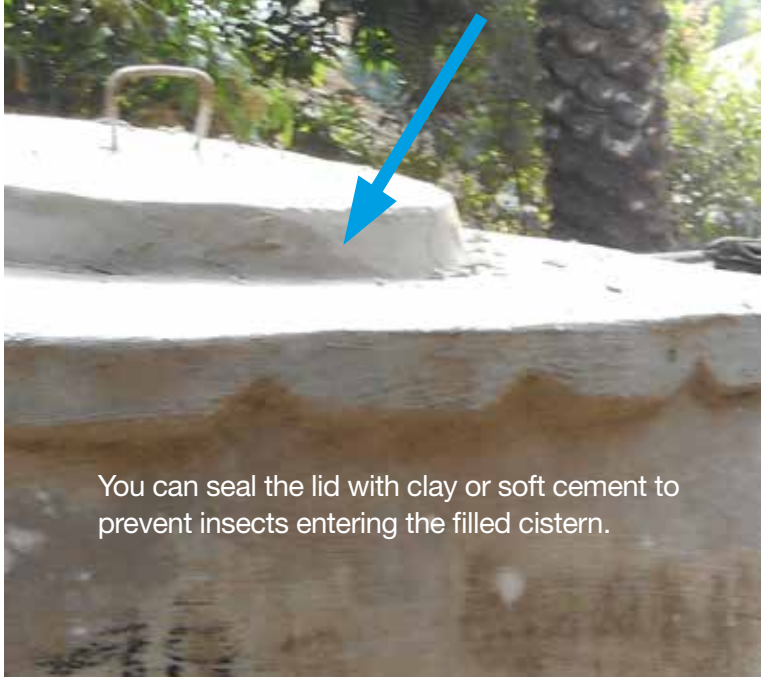

hand wash

How to catch the rain

Options



You can seal the outlet with a cap to prevent the entry of insects and light into the cistern.



You can seal the lid with clay or soft cement to prevent insects entering the filled cistern.

Repair

Always repair leaks and cracks from the inside! The cistern must be empty of water. Enter the cistern and clean the surface with a steel brush, make the surface carefully rough with a chisel and hammer and make it wet, so that the new plaster can have a good bonding to the wall. Use a cement, sand and water mixture that has a good consistency and is not too wet. Keep the repair moist for one week, using sacking or a piece of cloth that is regularly wetted.

Water Quality

Remarks by Han Heijnen

- The Guidelines for Drinking Water Quality published by the World Health Organization in 2017 (4th ed. with addendum), recognize that a well-designed rainwater harvesting system with clean catchments, covered storage cisterns and point-of-use treatment - as appropriate - can offer drinking water with very low health risks.
  http://www.who.int/water_sanitation_health/publications/gdwq4-with-add1-chapters/en/
- Domestic rainwater harvesting systems really make a difference, in dry zone areas, in places where water is saline or contaminated with fluorides or other harmful chemicals, or to enjoy a better service,
- The use of a first flush device or an inlet filter provides a way to separate dirt from good rainwater. First flush means that the first rainfall after the dry season on a dusty dirty roof, is not collected in the cistern. But it can certainly be used for watering plants
- Rainwater that is collected from a clean surface will further improve during storage. Bacterial die-off in the cistern can be substantial while bio-films developing at the cistern-water interface are also considered to have a positive effect on the water quality.
- Thus, to benefit from the bio-film effect it is better to clean the cistern only every 3-4 years.
- Point-of-use treatment of water for drinking purposes should be considered (filtration, chlorination, boiling, SODIS etc.).
- Mosquito breeding in the cistern needs to be avoided by ensuring that all entry points are closed and vents are fitted with mosquito gauze.

Observations by Hans Hartung

- The rainwater cisterns are an integral part of life in the families. People appreciate them very much as a source of clean water for drinking, whereas water for other purposes (such as cleaning, washing) is usually coming from wells (there the quality maybe a bit salty)
- Water from cisterns is especially valued at the end of the dry season (starting from February) when many wells dry up or have very little water.
- Water from the cisterns is not the only source of water but an additional source, as people use different water sources for different water needs at different times of the year. Rainwater is especially liked for its good taste, its purity and its availability at the house (in the cistern)
- Contrary to many beliefs, people collect water from (mostly) thatched roofs in a traditional way (binding the ends of the thatch together), collecting it in available vessels and then storing it in the cistern. The brown colour disappears during the storage as well as bacterial count goes down significantly (as evidenced by our own earlier tests.
- Jane Heyworth studied a sample of 1000 school children living in South Australia who were regularly drinking rainwater. They were at no greater odds of gastroenteritis than children from the capital, Adelaide, who drank treated public mains water).

Trained masons recieve their certificates in Guinea-Bissau.

Water in stock brings employment and merchandise

WOMEN OF AFRICA WANT PEACE AND CLEAN WATER

Disposition of a clean water supply contributes to the empowerment of women.

More possibilities More countries


Water for irrigation

Help for handicapped people


Water for construction of houses

Kenia

Senegal


Guinee - Conakry


Tanzania

Nigeria

Congo

Comparison of Ferrocement cistern versus PVC cistern van 5000 litre

	Indicators	Cistern van ferrocement	PVC tank
1	Costs	€ 250, 00 for a 5000 l. cistern. in e.g. Guinee, Senegal, Nigeria, Tanzania. Labour and transport included	€ 500, 00 up to € 1000, 00 for 5000 L.
2	Construction timespan	Construction on location in 6 days. When finished, the fresh cement has to be kept moist for at least one week.	Ready from the factory. Installation in a few hours when foundation has been prepaired.
3	Water quality	Water stays cool in cement cistern.	Water becomes warm in black plastic tank.
4	Impact on the health of families	Research indicates that water stored in cisterns that are dark inside, decrease the incidence of water related diseases.	Same results.
5	Repairable	Yes! Leaks can be repaired by carefully cutting away the damaged area and plastering at the inside.	Difficult or impossible to repair.
6	Lifespan	More than 25 years, as experienced in Nepal and Sri Lanka	5 to 10 years, depending of UV-erosion
7	Transport	Flexible. The transport of cement in bags and tools is possible by wheelbarrow, canoe, donkey cart, motorbike, car, etc.	With a lorry, only on proper roads.
8	Control of technology. Autonomy.	Development of local knowhow by training of local masons, craftsmen and managers. Local knowhow is essential for maintenance and repair in the long run and for independent replication.	Knowhow stays in the companies, away from the community.
9	Economical impact	Materials and tools can usually be bought at local markets. It supports the local traders.	Materials for PVC and equipment is bought by large companies. Villagers do not benefit.
10	Income generation	Local masons, technicians, trainers, small shops, etc. everyone can earn.	Incomes concentrated in the hands of a few companies.
11	Water management, autarkic self-support	Families having drinking water in stock feel responsible for the water management of their households.	Same.
12	Social impact	Empowerment of social cooperation within a village. It can reduce costs.	Less impact
13	Weight of cistern/tank	About 1600 kg	100 to 200 kg

Information Rain Water Harvesting (not complete)

- Heyworth,J., Glonek,G, Maynard E.J.,Baghurst P.S. and Finlay-Jones,J. (2006) 'Consumption of untreated cistern rainwater and gastroenteritis in young children in South Australia', International Journal of Epidemiology 35: 1051-1058 http://dx.doi.org/10.1093/ije/dy1105

- WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (2013) Progress on Sanitation and Drinking-Water: 2013 Update, {pdf} Bringing www.wssinfo.org/fileadmin/user_upload/resources/JMPreport2013 .pdf{accessed 19 March 2014}

- Hartung H., Akkerman P. (2014) 'Roofwater harvesting on the coastal islands of Guinea-Bissau: rainwater cistern construction adapted to the local context', Waterlines, international journal of water, sanitation and waste Vol. 33 No. 2: 160-167 < http://dx.doi.org/10.3362/1756-3488.2014.017>

- Heijnen, H. 2013. 'Enhancing economic resilience in North Eastern Brazil by harnessing rain'; Rainwater Harvesting Implementation Network (RAIN), Amsterdam www.rainfoundation.org

- Molenta, N. (2010) 'Bringing Low-Cost Innovations to Rainwater Harvesting Systems', Research Report,IBP 2009-2010, Saxion University of Applied Sciences, Deventer, the Netherlands

- Pathak, N., Heijnen, H. (2006) 'Health and Hygiene Aspects of Rainwater for Drinking', 32nd WEDC International Conference, Colombo, Sri Lanka 2006.

Cistern Calabash spread over Africa

Project in action

Project in preparation

www.degevuldewaterkruik.nl
www.cleanwaterhealthyvillage.com

CLEAN WATER - HEALTHY VILLAGE

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We like to meet new leaders in different African countries.
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CLEAN WATER - HEALTHY VILLAGES HEALTHY FAMILIES

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