ROOF CATCHMENT RAINWATER HARVESTING SYSTEM WITH A GEOMEMBRANE BAG

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Background

AFRHINET was a three-year project which focused on fostering the knowledge and use of rainwater harvesting technologies for off-season small-scale irrigation in rural arid and semi-arid areas of sub-Saharan Africa. As part of this project, best practices on collecting and storing rainwater for off-season small-scale irrigation have been documented and evaluated.

This case study discusses the use of an innovative and cost-efficient roof catchment rainwater harvesting system for off-season small-scale irrigation. The overall goal of this case study is to contribute to the replication and scaling up of this specific type of technology for off-season small-scale irrigation in arid and semi-arid areas.

This technical sheet has been developed in cooperation with CARE-Honduras (http://www.care.org/country/honduras) and Mexichem (http://www.mexichem.com/).

The technology

Rainfall deficits recorded in recent years are one of the main effects of climate change, causing severe droughts that affect more than 1.3 million people in 146 municipalities in the dry corridor of Honduras. As a consequence of this phenomenon, a reduction in the flow of water sources has been observed, causing a low availability of the vital liquid for both human consumption and agricultural production, further aggravating, food insecurity and threatening the health of the communities.

CARE International in Honduras through the PROSADE project, since 2013, began a research on technological options for harvesting rainwater, with the aim of providing access to safe water in excluded communities of the dry corridor. This research included the experimentation of several technologies implemented through pilot projects, with the objective of finding solutions that are economically feasible and sustainable.

Among the implemented options, it was determined that the rainwater harvest with Geomembrane bag was the one that had more acceptance at the level of the communities, for the storage capacity and cost. With the aim of replicating these options, the research was continued through an alliance between CARE and MEXICHEM Honduras, developing a commercial product that can be acquired at a national level.

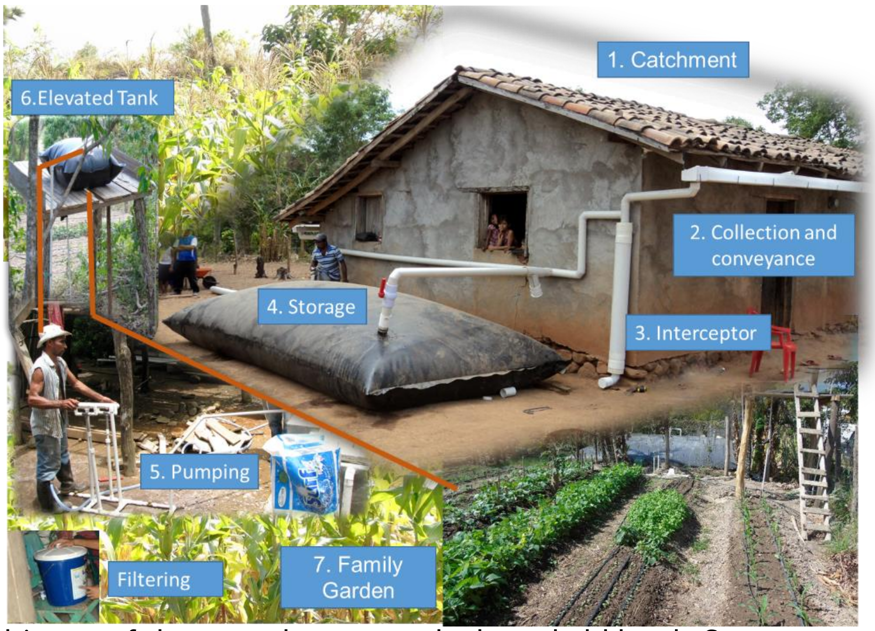


Figure 1: Visual image of the water harvest at the household level. Capture, storage, bombing, distribution and irrigation process may be observed. Photo: Eduardo Gonzalez.

During 2015, this alliance is extended, adding to the Global Water Partnership initiative and the University of Zamorano. With the aim of expanding the level of dissemination and replication of the technology, as well as initiating a research process on several important aspects related to the use and maintenance of Geomembrane tanks. Under this alliance, several research activities have been developed, such as the implementation of rainwater harvesting systems in schools, socioeconomic and water quality analysis.

Considering the climatic variability that has arisen in recent years, rainwater becomes an indispensable resource to compensate for the reduction in the availability of this valuable resource, so it must be used safely and sustainably, thus increasing the capacity for adaptation in communities affected by climate change.

The rainwater harvesting system consists of the following components:

1. **Capture:** The roofing of the houses and schools are used, which can be zinc sheets or clay tiles. The amount of water that we can collect will depend on the area of roof.

2. **Collection / Handling:** In order to conduct the collected water, PVC channels and pipes are assembled with accessories to redirect the water to the storage point.

3. **Filtration:** Before reaching the storage site, the water must be filtered to retain the solids or impurities found in the roof. The filter consists of 2 phases: The interceptor filter that is responsible for retaining the first rainwater and thus prevent ingress of accumulated dirt on the roof after a period without rain. Then passes through a second filter composed of a YEE PVC and with sieve mesh, this filter will catch any solid that can pass the first stage, such as bags and dry leaves among others.

4. **Storage:** This is the key component of the system, since the Geomembrane bag represents a considerable reduction in the cost of storage and an increase in the storage capacity, enabling the implementation on a larger scale. Considering the cost-benefit ratio of the different storage options: Thus, it can be seen that the Geomembrane bag is a viable solution. The bag is made with a Geomembrane of high density of 1 mm of thickness, it has UV protection to make it resistant to the sun rays. The bag has a boot and an outlet to extract the water, also has a valve to purge the air and thus allow it to reach its maximum capacity. The capacity of the bag is estimated at 25,000 - 30,000 litres.

5. **Pumping:** In order to extract the water inside the bag, a PVC hand pump made of materials that are easily found in a hardware store is used. The pump can be repaired and manufactured by the owner.

6. **Distribution:** The water is pumped to a raised tank which distributes it to the irrigation system or to a faucet installed inside the kitchen if the system is used for human consumption, the tank capacity helps control the daily supply for Consumption or irrigation.

7. **Irrigation System:** The system includes a drip irrigation system for a garden of 200 m^2, consisting of irrigation tapes and micro tubes.

8. **Treatment:** The water inside the bag is treated with chlorine, then to ensure the quality, a ceramic filter with colloidal silver is used.

Classification

Land Use

Vegetable crops, short cycle.

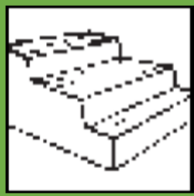
Climate

Semiarid, tropical

Degradation

Degradation and wáter shortage

Conservation measure



Structural: rain wáter storage.

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land user's initiative
- Experiments / research
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Forest fire, deforestation, erosion and drought.

Main technical functions:
- Water harvest, increase in the availability of safe water
- Ensuring the availability of safe water for irrigation during the unforeseen water shortage during rainy season. Irrigation complement

Secondary technical functions:
- Risk reduction for women during water collection.
- Economic Development

Environment

Natural Environment

Average annual rainfall (mm)

- 1000-1500
- 750-1000
- 500-750

Altitude (m a.s.l.)

- 1000-2000
- 100-1000
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- foot slopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- Steep
- Very steep

Soil depth (cm)
No data

- 0-20
- 20-50
- 50-100

Growing season(s): no data
Soil texture: no data
Soil fertility: no data
Topsoil organic matter: no data
Soil drainage/infiltration: no data

Soil water storage capacity: no data
Ground water table: no data
Availability of surface water: Rain water, temporally superficial sources, water systems distribution.
Water quality: contaminated water with coliforms, except rain water.
Biodiversity: moderate

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms, droughts / dry spells. **what modifications were made / are possible:** different sizes and capacities may be obtained to adapt to different areas.

Human Environment

Cropland per household (ha)

- <0.5 (black)
- 0.5-1
- 1-2

Land user: community, small scale land users, disadvantaged land users.
Population density: 57 persons/km2
Annual population growth: > 2 %
Land ownership: individual.
Land use rights: individual
Water use rights: no data
Relative level of wealth: very poor, which represents 80% of land users.

Importance of off-farm income: 10–30% of all Income, some migratory work in nearby towns collecting coffee.
Access to service and infrastructure: low: energy; low: health, education, technical assistance, market, roads & transport, drinking water and sanitation, financial services.
Market orientation: mixed (most is subsistence and Small portion is commercial)
Mechanization: no data
Livestock grazing on cropland: no data

Implementation activities, inputs and costs

Establishment activities

-Clearing of and ceiling alinement
-Terrain preparation.
-Installation of canals
-Installation and connection of the geomembrane.
-Installation of the water bomb and distribution tank.
- Installation of the irrigation system.
-Crop establishment

Establishment inputs and costs per house

Inputs	Costs USD$	% met by land user
Water Harvesting Kit (includes geomembrane bag, channels and PVC accesories)	700.00	20%-30%
PVC Hand Pump	50.00	
Elevated Tank and Kitchen Connection (for human consumption)	35.00	
200 m2 Micro-irrigation System	165.00	
System Instalation Labor	65.00	
TOTAL	1,015.00	

Maintenance/recurrent activities

-Drainage of the interception filter after rain
-Revision of the filter
-Washing of the geomembrane
-Cleaning of Canals and rooftops.
-Repairement activities if necessary
-Water treatment (only in the case of human use)
-Manual bombing from the bag to the elevated tank
- Operation of the irrigation system.

Maintenance/recurrent inputs and costs per year

Inputs	Costs USD$	% met by land user
Labour	-	100%
Equipment	-	
Total	-	

*All labor for regular maintenance activities is provide by the owner.
*The Water Harvesting Kit includes a reparation kit for small reparation. Special equipment is necessary only in case of mayor damage to the bag.

Impacts of the Technology

Production and socio-economic benefits
+++ increased crop yield
increased fodder production
+++ increased water availability / quality
+++ increased farm income
+ increased production area

Production and socio-economic disadvantages
none

Socio-cultural benefits
+++ community institution strengthening
+++ improved food security / self sufficiency

Socio-cultural disadvantages
none

Ecological benefits
+++ improved harvesting / collection of water
+ increased soil moisture

Ecological disadvantages
none

Off-site benefits
none

Off-site disadvantages
none

Contribution to human well-being/livelihoods
+++ Improve women and girl's security (reduce fetching water activities)
+++ Reduce labor for irrigation activities
+++ Reduction of concerns by having safe access to water.

Benefits/costs according to land user

- The availability of storage allows the use of water from other temporary sources increasing the number of production cycles per year.
- Increase in the quality of the produced crops.
- Ensure production under erratic climatic conditions. (Unforeseen dry periods) (complement irrigation)
- Increased availability of water for multiple uses, in the event of failure of the community supply system.

Benefits compared with costs	short-term:	long-term:
Establishment	no data	no data
Maintenance/recurrent	no data	no data

Acceptance/adoption: The rainwater harvesting is widely known in the region, which has facilitated its large-scale implementation. To date, more than 1,448 systems have been installed in southern and western Honduras.

Additional information

- **Range of storage capacities available:** The Geomembrane bag can be manufactured in the desired size, ranges can go from 10 - 15 - 25 - 30 - 50 thousand litres. The cost stated in this document is for the 25 - 30 thousand liters' size. The shape of the bag from square to rectangular can be adapted according to need.
- **Covered land in hectares:** To date, more than 1,448 rainwater harvesting systems have been installed (is one system per house), of which 1,260 have family gardens of approximately 200 m^2, resulting in a total of 25.20 ha.
- **Types of crops produced:** It is recommended the planting of vegetables and vegetables of short cycle and low demand of water, such as the following: Sweet potato, Alazin bean, Squash, Cucumber, Coriander, Onion, Beetroot, Cabbage, Garlic, Chile Sweet, Tomato, Peanuts, and Carrots. In some cases, also for maize (for the stage of germination and take more advantage of the winter), papaya and cassava.
- **Benefits of the system:** The low cost makes it a feasible system to be carried out on a large scale. It has great carry and installation facilities. It allows beneficiaries to tap into alternative water sources that are temporary, increasing the number of cycles that can be produced for years. Long life of the material of manufacture. Harvesting at the household level combined with water smart agricultural techniques can increase family income and improve nutrition due to possible diversification due to the availability of water. Improves women's safety by reducing water carrying activities for multiple uses. It is effective in emergency situations, to supplement periods of interruption in water supply services. Its easy operation reduces the time necessary to carry out the irrigation activities, allowing the beneficiary to have more time to carry out other activities of production or rest. It improves food security and ensures the availability of water for production when unforeseen dry periods occur. The product was designed as a kit in partnership with the private sector, making it available to all public and anywhere in the region.
- **Recommended mechanisms for financing the systems:**
  1) Return of a percentage to the rural bank in the form of compulsory savings to create a loan fund, the percentage is defined according to the poverty level.
  2) It is subsidized under a scheme of promoter producer, where the system is an incentive to disseminate in other beneficiaries the practice of sustainable agriculture.
- **Acceptance and upscaling potential:** A high acceptance of the technology has been observed due to the advantages of its large storage capacity and low cost. Dissemination processes are being developed in the Central American region in partnership with universities, local platforms and the private sector. It has also been implemented in application for health centers, schools, homes for human consumption and is planned to be used for emergency situations.

- **Lessons learned:** When the system is destined for irrigation, the ceramic filter is not provided for purification, however, in the new systems it is included, regardless of the intended use of the water, since it was observed that in situation of water shortage. The beneficiaries use it for consumption inside the home, without the ceramic filter it cannot ensured the quality of the water for consumption, because the beneficiaries can use multiple sources to fill the bag.

Concluding statements

Strengths and -> how to sustain/improve	Weaknesses and → how to overcome
- High storage capacity → can be manufactured in various sizes to suit local context any condition. - Relative low capital investment costs which are within the ranges accepted by donors, for the implementation of water supply systems, which allows their escalation. - Easy installation, no specialized personnel required → is complemented by basic training courses. - It has been thought as a complete product a "water product" developed in conjunction with the private sector, improving the economy of scale → develops alliances with the producer to support competitive prices. - High-quality manufacturing materials → periodic quality controls. - Facilities for mass hauling. - Easy system of irrigation by gravity.	- It's requires 30% more space compared to other storage solutions → research continues with other ways to reduce space. - Vulnerability to sharp objects → protections are built around the storage component. - Major damages require specialized equipment for repair → prior arrangements are made with the distributor for local repair processes, local personnel are trained.

Publisher Hamburg University of Applied Sciences, Hamburg, Germany. Financed by the ACP-EU Cooperation Programme in Science and Technology (ACP-S&T II). A programme implemented by the ACP Group of States, with the financial assistance of the European Union.

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May 2017.

Edition Josep de Trincheria.
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Partnership The AFRHINET consortium comprises of 8 organisations located in Ethiopia, Kenya, Mozambique, Zimbabwe and Germany. The contents of this technical sheet have been developed in cooperation with CARE-Honduras and Mexichem.

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Hamburg University of Applied Sciences

Implemented by the ACP Group of States

Funded by the European Union

The AFRHINET Project is funded by ACP-EU Cooperation Programme in Science and Technology (ACP-S&T II).A programme of the ACP Group of States, with the financial assistance of the European Union.