Lining geomembrane plastics for water harvesting and storage

Rwanda - Ibidamu

Lining geomembrane plastic for water harvesting and storage is a rainwater harvesting technique used by land users to collect rain water or runoff from a concave watershed to a common well-structured plastic-lined pond for agricultural, domestic and other use.

Rainwater harvesting initiatives were introduced in Rwanda in 2007, through a government-supported project on a pilot basis in three districts (Ruhango, Bugesera and Kirehe). By 2011, the technology had expanded at exponential rates such that the demand has exceeded the supply. Now the supply policy has shifted from government to private still there is a shortage of plastic lining. The typical design of each pond is trapezoidal in shape, measuring 10.5 by 9 meters top-width, 6.5 by 5 meters bottom width and 2 meters depth and a total storage volume about 120 m3. The plastic lining is factory–manufactured with standard shape and size to fit these dimensions. The ponds are made with this standard design to enable bulk purchase and supply of geo-membranes, to make use of economies of scale. The cost of the geo-membranes was subsidized by up to 100% by the government until 2010 but now only 20% are provided by the government. When this project was initiated, activities related to soil excavation was done by the government. However, with time the government pulled out and farmers are now covering the total cost of excavation and the government intervenes only for the technical compliance. The government provides technicians to train farmers on the safety and management of ponds. The volume of water harvested and stored in the ponds is on average 90 m3. However, water retention within the ponds over time differs with from farm to farm as affected by usage, evaporation and seepage losses. Treadle pumps are sometimes used to lift water by some of the farmers. Among most households, the water from the pond is used for domestic, livestock and supplemental irrigation, especially of horticultural crops. About 20% of the water is used for seedling and fruit production, 75% for livestock watering and 5% for domestic use. When the excavation of the pond is complete, the beds as well as sides of the pond have to be leveled and prepared for laying the lining plastic. Any rocks, large stones or other projections, which might damage the lining plastic, should be removed from the beds and sides of the excavated ponds.
Lining geomembrane plastic for water storage is designed to reduce seepage losses in ponds. This water is used by smallholder farmers to cope with the beginning of dry season and enhance crops to reach the maturity stage safely.
A periodical inspection is required for better life of the pond, thus timely maintenance hold the key of success for longer time. The maintenance includes inspection, repairing damages. Regular investigations are required on the pond sides, bottom, the inlet and the emergency outlet. In addition, the pond should be protected from intrusion of animals by constructing a fence around the pond. It is also important to remove aquatic vegetation, silt and sediment periodically that accumulate on the bottom of the pond.

left: A lining geomembrane plastic is used to stop infiltration of the stored water into the soil (Photo: Kagabo Desire and Ngenzi Guy)
right: A linning geomembrane plastist is used to stop infiltration of the stored water into the soil (Photo: Kagabo Desire and Ngenzi Guy)

Location: Rwanda
Region: Kayonza District (East provice)
Technology area: < 0.1 km2 (10 ha)
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed Government, recent (<10 years ago)
Land use type:
Cropland: Annual cropping
Climate: subhumid, tropics
WOCAT database reference: T_RWA006en
Related approach: Stakeholder/Participatory (A_RWA003en)
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Classification

Land use problems:

- There were poor yields of crops caused by elongation of dry season and increase of runoff soil erosion (intensive rain during rainy seasons) at the previous season. (expert's point of view)
Low crop production, soil erosion (land user's point of view)

Land use

Annual cropping

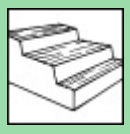
Climate

subhumid

Degradation

Soil erosion by water: gully erosion / gullying, offsite degradation effects

Conservation measure



structural: Dams / pans: store excessive water

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: recent (<10 years ago)
- Experiments / Research
- Externally introduced
- Other: Government: recent (<10 years ago)

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Direct causes - Natural: other natural causes, Steep slopes in many cases over 60%
Indirect causes: population pressure

Main technical functions:
- control of concentrated runoff: retain / trap
- water harvesting / increase water supply

Secondary technical functions:

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

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

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 150 days (September – February), 120 days (March – July)
Soil texture: medium (loam)
Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: medium

Soil water storage capacity: very high
Ground water table: 5 - 50 m
Availability of surface water: good
Water quality: for agricultural use only
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, droughts / dry spells
Sensitive to climatic extremes: heavy rainfall events (intensities and amount), floods

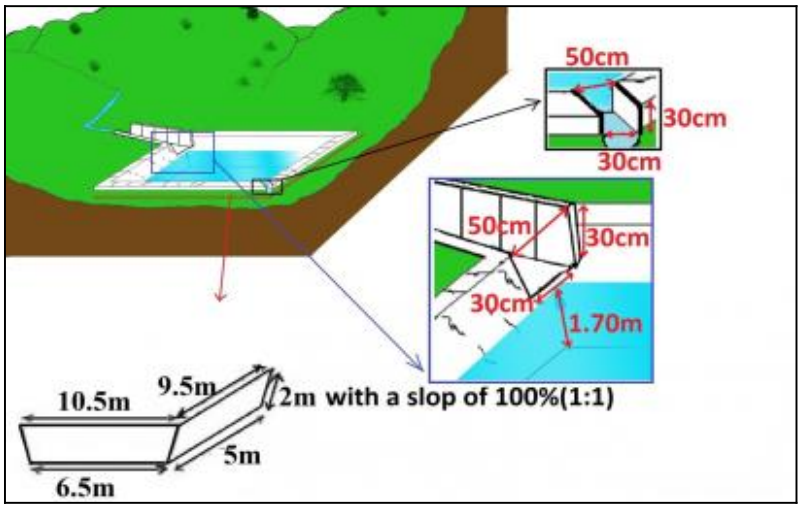
Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, men and women
Population density: 200-500 persons/km2
Annual population growth: 3% - 4%
Land ownership: individual, titled
Land use rights: individual
Water use rights: open access (unorganised)
Relative level of wealth: poor, which represents 45% of the land users; 40% of the total area is owned by poor land users

Importance of off-farm income: less than 10% of all income:
Access to service and infrastructure: low: employment (eg off-farm), energy, financial services; moderate: health, education, roads & transport, drinking water and sanitation; high: technical assistance, market
Market orientation: commercial / market
Mechanization: manual labour
Livestock grazing on cropland: yes



Technical drawing

Surface runoff water storage pond have got a reservoir of 10.5m x 9.5m at top and 6.5m x 5m at bottom and a depth of 2m with side slope of 1:1.5. The capacity of one pond is estimated about 120m3. (Kagabo Desire and Ngenzi Guy)

Implementation activities, inputs and costs

Establishment activities

- Surveying
- Buying materials
- Construction of pond

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	1600.00	70%
Equipment		
- tools	500.00	20%
Construction material		
- stone	150.00	0%
- sand	55.00	0%
- Plastic sheet	100.00	0%
TOTAL	**2405.00**	**50.73%**

Maintenance/recurrent activities

- regular maintenance of Channels and all around the pond.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	120.00	100%
TOTAL	**120.00**	**100.00%**

Remarks:
The most factors that affects the cost is the construction materials and labor.

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++ increased crop yield
+++ increased irrigation water availability quality
++ reduced risk of production failure
++ increased farm income

Production and socio-economic disadvantages

Socio-cultural benefits

++ improved food security / self sufficiency
++ improved health
+ improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

+++ improved harvesting / collection of water

Ecological disadvantages

++ increased niches for pests

Off-site benefits

++ reduced downstream siltation

Off-site disadvantages

Contribution to human well-being / livelihoods

+++ It has increased income of household hence enhance life.

Benefits /costs according to land user

	Benefits compared with costs	short-term:	long-term:
	Establishment	neutral / balanced	very positive
	Maintenance / recurrent	slightly positive	very positive

It require light labor during the maintenance activities

Acceptance / adoption:

50% of land user families (250 families; 70% of area) have implemented the technology with external material support.
4% of land user families (10 families; 20% of area) have implemented the technology voluntary.
There is little trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Income generation → More financial support and trainings	Occasional accidents → To maintain fences around the pond and increase awareness about accidents around a pond, especially for parents (high risk for small kids)
Improvement of production → To make a regular maintenance of ponds	Pond attract various insects and diseases (habitat for Mosquitoes) → Mosquito nets are needed
Soil erosion control → Divert more runoff to mitigate the soil erosion downstream and always clean the conveying channel.	
Impermeable material → Acquisition of high quality plastics that can last many years	