The three components of a roof rainwater harvesting system: a catchment roof, conveyance pipes and a ferro-cement storage jar. (K.M. Sthapit)

Rooftop rainwater harvesting system (Nepal)

Akase paani sankalan pranali - Nepali

DESCRIPTION

A water harvesting system in which rain falling on a roof is led through connecting pipes into a ferro-cement water collecting jar.

Many households in Nepal's midhills suffer from water shortages during the pronounced dry season. The technology described here - harvesting roofwater during times of heavy rainfall for later use - is a promising way of improving people's access to water for household use, especially for households with no or only limited access to spring or stream water. The technology has yet to be extensively adopted in Nepal's midhills.

Purpose of the Technology: The technology was introduced in the Jhikhu Khola watershed to demonstrate an alternative source of water for domestic use (mainly drinking water). This technology is appropriate for scattered rural households in mountaineous areas. The harvesting system consists of a catchment roof, conveyance pipes, and a storage jar. The pipes include a gutter system made from longitudinally split polythene pipe which has a flushing system that allows the system to be periodically flushed clean.
The collected water enters a 500 or 2000 litre capacity ferro-cement jar made using a mould (see photo). A preconstructed mould made from iron rods and polythene pipes is installed on a concrete base plate. Metal wires are extended from the base plate over the main mould to the top. Chicken mesh is then wrapped over the mould and tied securely with thin wire. A cement coating is applied over the metal structure. The jar is finished with three coatings of cement and the opening is covered with a fine nylon mesh to filter out undesired coarse matter. A tin lid is placed over the top.

Establishment / maintenance activities and inputs: A tap is fixed about 20 cm above the ground. This height allows for water to be collected in the typical 15 litre local water vessels (gagri) and avoids collection of too much water in bigger vessels as well as minimising the dead storage of water (Nakarmi et al. 2003). Trained masons can easily install the entire system. Provided all the materials and the mould are available, the entire system can be put together in about a week. The main maintenance task is to keep the roof clean, especially after long dry periods. This is done using the gutter pipe flushing system in which the first dirty water from the roof is diverted away from the jar.

LOCATION

Location: Kavrepalanchowk district, Kharelthok, Sathighar, Panchkhal, Hokse and Patalekhet VDCs of the Jhikhu Khola watershed, Nepal

No. of Technology sites analysed:

Geo-reference of selected sites
- 85.68449, 27.68362

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?:

Date of implementation: less than 10 years ago (recently)

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

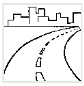
Installing the mould and wrapping it in chicken mesh to make the jar. (PARDYP)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact
- [x] Access to water

Land use



Settlements, infrastructure - Settlements, buildings
Remarks: courtyard

Water supply

- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

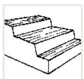
Degradation addressed

physical soil deterioration - Pw: waterlogging

SLM group

- water harvesting

SLM measures



structural measures - S5: Dams, pans, ponds

TECHNICAL DRAWING

Technical specifications

A water harvesting system with roof catchment, connecting pipes and storage tank.

Technical knowledge required for field staff / advisors: high

Technical knowledge required for land users: high

Main technical functions: water harvesting / increase water supply

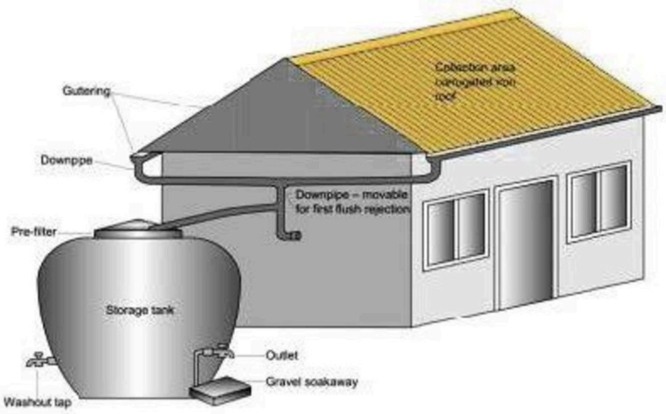
Structural measure: Dam/ pan/ pond
Material: Concrete

Structural measure: Jar

Structural measure: Gutter

Structural measure: pipes

Construction material (other): Cement



Author: A.K. Thaku

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Rooftop rainwater harvesting system**)
- Currency used for cost calculation: **USD**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: 2.10

Most important factors affecting the costs

The mould and tools were provided by the project and can be used to install many water harvesting systems. Therefore, the cost of tools are not included here. Material costs fluctuate from time to time. The transport costs will vary according to the remoteness of the site. During 1999/2000, the cost of a system varied from US$80 to US$120, of which land users contributed about US$40 by providing the unskilled labour and locally available materials like sand and fine aggregates (calculated at an exchange rate of US$1 = NRs 73).

Establishment activities

1. Construct the concrete base plate with the help of base moluld (Timing/ frequency: 1st day of a week)
2. Curing work (Timing/ frequency: 2nd to 7th days of a week)
3. Final checking and metal cap putting over the top of the jar (Timing/ frequency: 7th day of a week)
4. First coat of cement (Timing/ frequency: 2nd day of a week)
5. Gutter and pipe fitting; including flush pipe (Timing/ frequency: 4th day of a week)
6. Inner coat of cement (Timing/ frequency: 6th day of a week)
7. Main mould installation with the help of metal wires, wrapping of chicken mesh (Timing/ frequency: 2nd day of a week)
8. Removal of mould (Timing/ frequency: 6th day of a week)
9. Second coat of cement (Timing/ frequency: 3rd day of a week)

Establishment inputs and costs (per Rooftop rainwater harvesting system)

Specify input	Unit	Quantity	Costs per Unit (USD)	Total costs per input (USD)	% of costs borne by land users
Labour					
Construction of rooftop rainwater harvesting system	Persons/unit	19.5	2.1	40.95	25.0
Construction material					
Cement	unit	1.0	23.6	23.6	
Sand and aggregate	unit	1.0	1.4	1.4	100.0
Chicken wire mesh	unit	1.0	20.9	20.9	
Metal jar cover	unit	1.0	5.5	5.5	
Plastic sheet/mosquito screen	unit	1.0	1.5	1.5	
Polyethylene, pipes, reducer	unit	1.0	23.7	23.7	
Nail, clamps, pipe elbow etc.	unit	1.0	3.6	3.6	
Brass tap. socket, seal tap	unit	1.0	3.5	3.5	
Other					
Paint	unit	1.0	2.1	2.1	
Total costs for establishment of the Technology				**126.75**	
Total costs for establishment of the Technology in USD				*126.75*	

Maintenance activities

1. Cleaning the jar (Timing/ frequency: dry months/one or twice in a year)
2. Flushing contaminated water (Timing/ frequency: After a long dry spell/whenever required)

Maintenance inputs and costs (per Rooftop rainwater harvesting system)

Specify input	Unit	Quantity	Costs per Unit (USD)	Total costs per input (USD)	% of costs borne by land users
Labour					

Cleaning the system	Persons/unit	7.0	2.1	14.7	100.0
Total costs for maintenance of the Technology				**14.7**	
Total costs for maintenance of the Technology in USD				*14.7*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [x] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Thermal climate class: subtropics

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [x] ridges
- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Ja
- [ ] Nee

Occurrence of flooding
- [ ] Ja
- [ ] Nee

Species diversity
- [ ] high
- [ ] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

IMPACTS

Socio-economic impacts

production area (new land under cultivation/ use)	decreased	increased	by the house to accommodate the water jar
drinking water availability	decreased	increased	in dry seasons harvested water can be used during busy periods (field preparation, vegetable planting, rice harvesting, and festivals). Quantity before SLM: 1 hour Quantity after SLM: 5 minutes greatly reduced time needed to fetch water
workload	increased	decreased	reduced women's workload i.e. per day water fetching time reduced from about 12 hours to about 1 hour (for the households having ~10 family members).
Water is available near the house	reduced	improved	A house hold having 10 family member require about 12 gagree (1 gagree is equivalent to15 litre)

Socio-cultural impacts

community institutions	weakened	strengthened	together with adopters, other potential local adopters have started discussing options
SLM/ land degradation knowledge	reduced	improved	through training, demonstration, and knowledge sharing
livelihood and human well-being	reduced	improved	Improved heath condition due to clean water availability
Sanitation	reduced	improved	more water avilable forwashing leading to improved health
Risk of injury from carrying water along slippery and steep tracks	improved	reduced	

Ecological impacts

Off-site impacts

downstream flooding (undesired)	increased	reduced	a little portion of rainfall traped directly from the roof and collected at the courtyard
downstream siltation	increased	decreased	reduced eroded materials from the courtyard.
availability of water for neighbours during scarce period	decreased	increased	

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Although the initial investment is high, the users immediately get more water. The high cost of installing the system means that the short term benefits are slightly negative.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well

Climate-related extremes (disasters)

local rainstorm	not well at all	very well
local windstorm	not well at all	very well

drought — not well at all ☐ ✓ ☐ ☐ ☐ very well
general (river) flood — not well at all ☐ ☐ ☐ ✓ ☐ very well

Other climate-related consequences
reduced growing period — not well at all ☐ ☐ ☐ ✓ ☐ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology
- [x] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Number of households and/ or area covered
46 households in an area of 1 - 10 sq km (200 - 500 persons/sq km)

Of all those who have adopted the Technology, how many have done so without receiving material incentives?
- [ ] 0-10%
- [x] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?
- [ ] Ja
- [ ] Nee

To which changing conditions?
- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- The stored water can be kept for use in emergencies such as to prepare food for guests during busy times like rice planting and harvesting, and during festivals.

  How can they be sustained / enhanced? Share experiences to extend adoption of the technology
- Harvested water is tastier due to being cooler compared to the water collected in the polythene tank.

  How can they be sustained / enhanced? Laboratory analysis of the harvested rainwater in different time period, i.e. from 1st month of harvest to 12th month could help to know the quality status.

Strengths: compiler's or other key resource person's view
- Harvested rainwater has saved almost one workday per day per family due to reduced water fetching time in this case referring to the rainy season, however water will generally be used during the dry season.

  How can they be sustained / enhanced? Publicise the economic benefits of the technology through experience sharing programmes.
- Women are responsible for fetching water and so the technology reduces their workloads.

  How can they be sustained / enhanced? Implement a larger scale programme to promote the technology.
- The jars are more durable than plastic tanks.

  How can they be sustained / enhanced? Carry out regular maintenance to keep systems in good working order.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- The technology is expensive for poor households. External support is needed for poor households to afford this system.
- The height of the tap is very low which makes it inconvenient to collect water in the gagree. It was designed to use collected water efficiently, the tap height can be raised, which means that the dead storage is increased, i.e. more water is unavailable for use.
- There are chances of the jar's base plate subsiding due to lack of compactness of foundation. The area of base plate should be made more compact.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- 2,000 litre capacity jars barely meet the dry season needs of a household. Larger sized jars or more than one jar need to be built to meet most household's requirements.
- Microbiological contamination (total and faecal coliform bacteria) and levels of phosphate above the EC maximum were found in a number of the jars caused by bird droppings and dust particles from the roof. Regularly clean catchment roofs and treat water before drinking by boiling or chlorinating. Rainwater has a low mineral content which can be harmful for the human body, if taken in large quantities (due to reverse osmosis process).
- This technology is not suitable for temple roofs because such roofs are usually home to large numbers of pigeons, and their excreta will contaminate rainwater that falls there. Avoid badly contaminated catchments.

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Compiler
Madhav Dhakal

Editors

Reviewer
David Streiff
Deborah Niggli
Alexandra Gavilano

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Resource persons
Madhav Dhakal - SLM specialist
Sanjeev Bhuchar - SLM specialist
Isabelle Providoli - SLM specialist

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n.a.

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