Left: The three components of a roof rain-water harvesting system: a catchment roof, conveyance pipes, and a ferro-cement storage jar (K.M. Sthapit)
Right: Installing the mould and wrapping it in chicken mesh to make the jar (PARDYP)

Rooftop rainwater harvesting system

Nepal: आकाशे पानी संकलन प्रणाली

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 Nepal's midhills.

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 mountainous 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.

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.

WOCAT database reference: QT NEP18
Location: Kharelthok, Sathighar, Panchkhal, Hokse and Patalekhet VDCs of the Jhikhu Khola watershed, Kabhrepalanchok district. Nepal
Technology area: 1-10 km^2
SWC measure: Structural
Land use: Settlements
Climate: Humid subtropical
Related approach: Not described
Compiled by: Madhav Dhakal, ICIMOD
Date: November 2006

General comments: Water harvesting is an ancient practice. The system used in the Jhikhu Khola watershed comes from Thailand, so the technology is often called 'Thai jar'. In Nepal, the Rural Water Supply and Sanitation Support Programme (RWSSSP) introduced it in the water deficit districts of western Nepal.

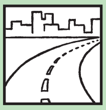
The technology was documented using the WOCAT (www.wocat.org) tool.
ICIMOD
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC
WOCAT

Classification

Water use problems

Inadequate water supply during the late winter and pre-monsoon months and sediment contamination during the wet season. The discharge from traditional water sources like dug-out ponds, springs, seepage 'holes', shallow wells, and streamlets becomes limited soon after the end of the monsoon.
Many settlements are located on ridge tops and most water sources are located below making it difficult to provide water to households through networks of pipes. Women and girls often face hardship in carrying the water uphill, especially during the monsoon when trails are slippery.

Land use

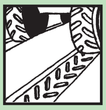


Settlement, infrastructure

Climate

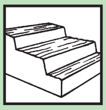
Humid subtropical

Degradation



Physical degradation: water scarcity

SWC measures



Structural: tank or jar

Technical function/impact

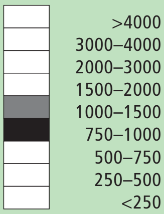
Main: - water harvesting

Secondary: - none

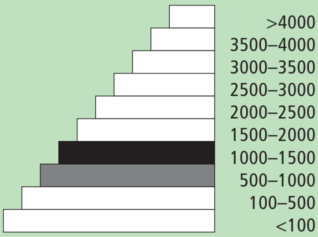
Environment

Natural environment

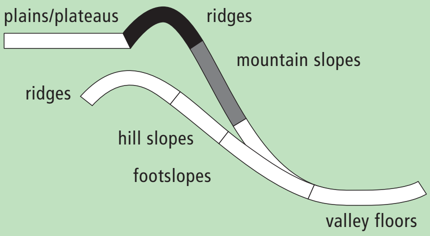
Average annual rainfall (mm)



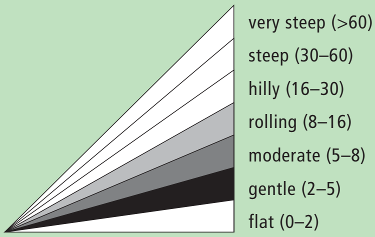
Altitude (masl)



Landform

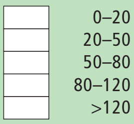


Slope (%)



Applied (large extent) Applied (medium extent) Applied (little extent)

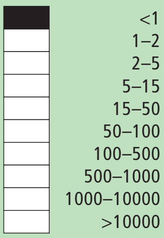
Soil depth (cm)



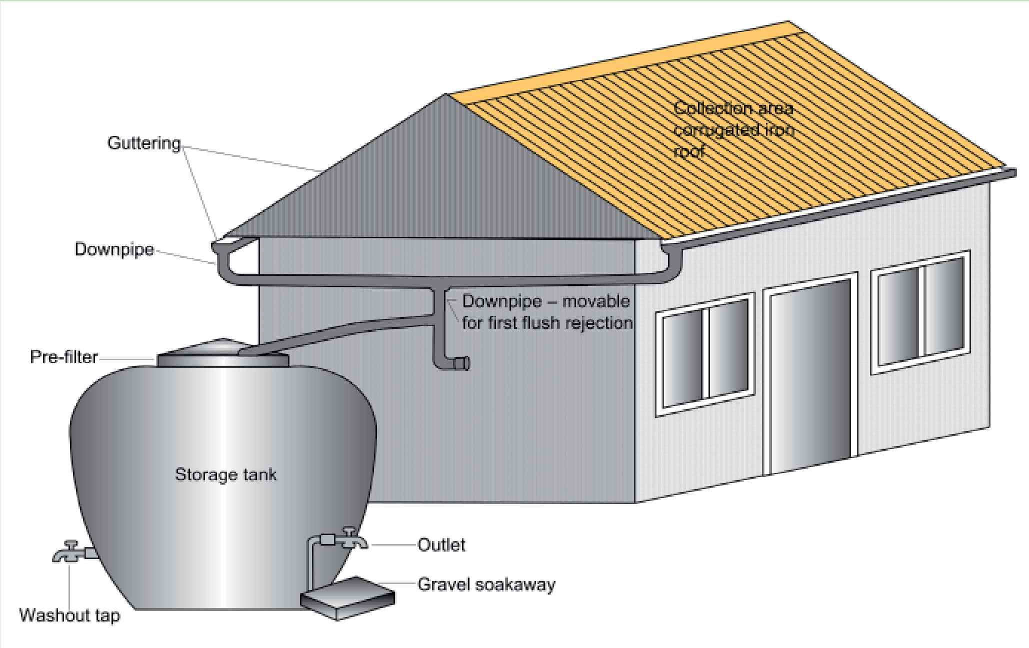
Growing season: not relevant
Soil fertility: not relevant
Soil texture: not relevant
Surface stoniness: not relevant
Topsoil organic matter: not relevant
Soil drainage: not relevant
Soil erodibility: not relevant

Human environment

Other land per household (ha)



Land use rights: individual
Land ownership: individually owned/titled
Market orientation: mostly subsistence (self-supply), mixed (subsistence and commercial: only vegetables)
Level of technical knowledge required: field staff/extension worker: high, land user: high
Number of livestock: 3.9 tropical livestock units (TLU) per household
Importance of off-farm income: In most farm households off-farm income plays at least a minor and increasingly a major role. Occasional opportunities for off-farm income present themselves in the form of daily labour wages. Some households' members receive regular salaries whilst an increasing number of Nepalis are working in India, the Middle East, Malaysia and elsewhere and sending remittance incomes home.



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

Implementation activities, inputs and costs

Establishment activities

Provided all materials and moulds are available, fabrication of the entire system is completed in about a week. The work is performed with manual labour using construction tools (hacksaw, steel scissors, hammer, pliers, wrench trowel, steel pan bucket, and jug).

1) Jar construction: The first task is to construct the concrete base plate. Then the main mould is installed on the plate. Metal wires are extended from the base plate over the main mould to the top. Chicken mesh is wrapped over the mould and tied securely with thin wire. Two coats of cement are applied following which the mould is removed. A further coat of cement is applied to the inside of the jar after which the cement is cured and final checks made. A metal cap is put over the top of the jar. The jar should always be kept covered.
2) Gutter and pipe fitting: A polyethylene pipe is cut in half longitudinally leaving 15 cm uncut at one end. This forms the gutter. A piece of pipe is attached to the uncut end of the gutter vertically. A 'T' shaped pipe is attached to divert water into the jar through a reducer pipe. Another 'T' shaped pipe' is connected with a flush pipe which is kept covered with a cap, and is opened to flush contaminated water

Establishment inputs and costs per unit system (2006)

Inputs	Cost (US$)	% met by land user
Labour (15 person days: skilled and unskilled)	41.1	25%
Materials		
- Cement (4 kg)	23.6	0%
- Sand and aggregate	1.4	100%
- Chicken wire mesh and wires	20.9	0%
- Metal jar cover	5.5	0%
- Plastic sheet and mosquito screen	1.5	0%
- Paint	2.1	0%
- High density polyethylene (HDP) pipes, reducer	23.7	0%
- Nail, clamps, pipe elbow, tee connector, end cap	3.6	0%
- Nipples, brass tap, galvanized iron (GI) socket, thread seal tap	3.5	0%
TOTAL	**127**	**9%**

Maintenance/recurrent activities

The regular flushing away of dirt from the roof, especially after long dry periods and cleaning the jar once or twice a year

Maintenance/recurrent inputs and costs per unit per year (2006)

Inputs	Cost (US$)	% met by land user
Labour (7 person days)	15	100%
TOTAL	**15**	**100%**

Remarks: 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)

Assessment

Acceptance/adoption

Among 46 land user households in the case study area, 34 (74%) households accepted the technology with incentives and 12 (26%) adopted it spontaneously paying all costs themselves.
The number of households applying the technology is increasing without further incentives being provided.

Drivers for adoption
- Need for water due to very dry years

Constraints to adoption
- Not having access to the moulds and other materials for making the jars
- Technical guidance is needed and may be not available
- Costs are high

Benefits/costs according to land users

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.

Benefits compared with costs	short-term	long-term
establishment	slightly negative	very positive
maintenance/recurrent	very positive	very positive

Impacts of the technology

Production and socioeconomic benefits
none

Production and socioeconomic disadvantages
- Loss of land by the house to accommodate the water jar

Socio-cultural benefits
+++ Strengthened community institution: together with adopters, other potential local adopters have started discussing options to overcome the scarcity of water and are searching for funds to install roofwater harvesting systems
+++ Improved knowledge of soil and water conservation and erosion through training, demonstration, and knowledge sharing

Socio-cultural disadvantages
none

Ecological benefits
++ Increased water availability in dry season
++ Better sanitation from more water available for washing leading to improved health

Ecological disadvantages
none

Other benefits
+++ Water is available near the house
+++ Greatly reduced time needed to fetch water, reducing women's workloads
++ Reduced risk of injury from carrying water along slippery and steep tracks
++ Less chance of disputes over turns to fetch water

Other disadvantages
none

Off-site benefit
++ Increased availability of water for neighbours during scarce periods
+ Reduced downstream flooding
+ Reduced downstream siltation

Off-site disadvantages
none

Concluding statements

Strengths and ➔how to sustain/improve	**Weaknesses** and ➔how to overcome
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 ➔Publicise the economic benefits of the technology through experience sharing programmes	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
Women are responsible for fetching water and so the technology reduces their workloads ➔ Implement a larger scale programme to promote the technology	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)
The jars are more durable than plastic tanks ➔Carry out regular maintenance to keep systems in good working order	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
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 ➔Share experiences to extend adoption of the technology	The technology is expensive for poor households ➔ External support is needed for poor households to afford this system

Key reference(s): ICIMOD (2000) *Water Harvesting Manual,* unpublished manual prepared for PARDYP Project, ICIMOD ■ ICIMOD (2007) *Good Practices in Watershed Management, Lessons Learned in the Mid Hills of Nepal.* Kathmandu: ICIMOD ■ Nakarmi, G.; Merz, J.; Dhakal, M. (2003) 'Harvesting Roof Water for Livelihood Improvement: A Case Study of the Yarsha Khola Watershed, Eastern Nepal'. In *News Bulletin of Nepal Geological Society,* 20: 83-87 ■ Nakarmi, G.; Merz, J. (2001) *Harvesting Rain Water for Sustainable Water Supplies to Rural Households in the Yarsha Khola Watershed,* a report submitted to Kirchgemeinde Zuoz, Switzerland and ICIMOD, Kathmandu, Nepal ■ Sharma, C. (2001) *Socioeconomic Indicative Impact Assessment and Benchmark Study on Rooftop Rainwater Harvesting, Kabhrepalanchok District, Nepal,* a report submitted to ICIMOD, Kathmandu, Nepal
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