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# Opportunities in rainwater harvesting

B. Helmreich*, H. Horn

*Institute of Water Quality Control, Technische Universität München, Am Coulombwall, 85748 Garching, Germany*
*Tel. +49-(0)89-28913719; Fax +49-(0)89-28913718; email: b.helmreich@bv.tum.de*

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**Abstract**

Water scarcity is a major problem in many developing countries. Depending on precipitation intensity rainwater constitutes a potential source of drinking water. In addition, its proper management could reduce water and food crisis in some of these regions. Rainwater harvesting (RWH) is a technology where surface runoff is effectively collected during yielding rain periods. In order to support such technologies RWH systems should be based on local skills, materials and equipment. Harvested rainwater can then be used for rainfed agriculture or water supply for households. Unfortunately, rainwater might be polluted by bacteria and hazardous chemicals requiring treatment before usage. Slow sand filtration and solar technology are methods to reduce the pollution. Membrane technology would also be a potential disinfection technique for a safe drinking water supply.

*Keywords:* Rainwater harvesting; Rainfed agriculture; Rainwater treatment; Solar energy; Membrane filtration; Sand filtration

## 1. Introduction

One of the UN Millennium Development Goals is to reduce by half the proportion of people without sustainable access to safe drinking water. Another goal is to reduce by half the proportion of people who suffer from hunger. In some countries both goals are far from being fulfilled until 2015. One billion people do not have access to safe drinking water. According to the Food and Agriculture Organization (FAO) some 840 million people still suffer from undernourishment [1].

Most of the developing countries are classified as water-scarce countries which are characterized by low erratic rainfall, which results in high risk of droughts, intra-seasonal dry spells and frequent food insecurity [2]. Most of the rainfall events are intensive, often convective storms, with very high rain intensity and extreme spatial and temporal rainfall variability [2–4]. The ratio of rainfall to evaporation is often unsatisfactory. Rainfall often varies in a range of 200–600 mm/year from arid to semi-arid areas [5]. Potential evapotranspiration varies between 1500 and 2300 mm. This results in poor crops. The relation between rainfall and the potential evapotranspiration determines the growing period lasting about 2.5–4 month in semi-arid zones. Rainfall in the semi-arid areas exceeds potential evapotranspiration during 2–4.5 months only [5].

Fig. 1 indicates the partitioning of rainfall into different water flow components [5]. Soil evaporation accounts for 30–50% of rainfall, a value that might exceed 50% in sparsely cropped farming systems in semi-arid regions. Surface runoff is often reported to

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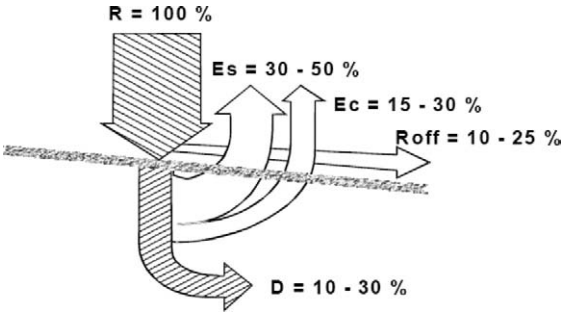


Fig. 1. General overview of rainfall partitioning in farming systems in the semi-arid tropics of sub-Saharan Africa. R, rainfall; Ec, plant transpiration; Es, evaporation from soil and loss by interception; Roff, surface runoff; D, deep percolation. Graphic from [5].

account for 10–25% of rainfall. The characteristics in dry lands of frequent, large and intensive rainfall events result in significant drainage, amounting to some 10–30% of rainfall [5].

Plant transpiration is reported to account for merely 15–30% of rainfall. The rest, between 70% and 85% of rainfall, is ''lost'' from the cropping system as soil evaporation, deep percolation and surface runoff. Fig. 1 thus indicates that there is a high risk of soil water scarcity in crop production, irrespective of spatial and temporal rainfall variability. In such a situation it is necessary to increase the amount of water available for agricultural purposes above the actual amount of direct rainfall [5]. Rainwater harvesting (RWH) may be a method to reduce water scarcity in such regions.

## 2. Rainwater harvesting techniques

Rainwater harvesting has a long tradition for thousands of years [6]. It is a technology used for collecting and storing rainwater from rooftops, land surfaces or rock catchments using simple techniques such as natural and/or artificial ponds and reservoirs. One millimeter of harvested rainwater is equivalent to one litre water per square metre. After collecting and storing the rainwater is a source in households for drinking, cooking, sanitation, etc., as well as for productive use in agriculture.

There are three major forms of RWH:

- In situ RWH, collecting the rainfall on the surface where it falls and storing in the soil.
- External water harvesting, collecting runoff originating from rainfall over a surface elsewhere and stored offside, both are used for agricultural RWH.
- Domestic RWH (DRHW), where water is collected from roofs and street and courtyard runoffs.

### 2.1. Agricultural RWH

Irrigation of rainfed crops by the use of RWH is a likely viable option to increase water productivity and therefore crop yields. Rainfed agriculture in arid and semi-arid areas contributes to up to 90% of the total cereal production of these regions [7]. However, in many countries, productivity remains low due to less than optimal rainfall characteristics, unfavourable land conditions and lack of proper management of these resources. Increasing productivity of rainfed areas could increase food security, improve livelihoods, and reduce irrigation frequency. Apart from the climate, the landscape must be suited for RWH agriculture. Following minimal requirements have to be fulfilled [1]:

- The landscape surface must be such that runoff is readily generated by rainfall.
- Differences in elevation must be present in the landscape surface. The runoff generated by rainfall must be allowed to flow and to be concentrated in the specially prepared parts of the landscape.
- The runoff receiving part must have sufficiently deep soils of suitable texture and structure to retain and store the received runoff water.

Storage can be achieved by various types of surface and sub-surface storage systems. The method of application differs according to the financial strength. Runoff collection may involve land alterations, soil compaction, etc., to increase the runoff from the catchment areas [5]. Following systems are common:

- Micro-catchment systems: They constitute specially contoured areas with slopes and berms designed to increase runoff from rain and concentrate it in a planting basin where it infiltrates the soil profile and is effectively ''stored'' therein. The water is available for plants but protected from evaporation. Micro-catchments are simple and inexpensive and can be rapidly installed using local materials and manpower. There are three types of micro-catchments: contour bench terraces, runoff strips, and micro-watersheds.