Sustainable agriculture for the future

February | Februarie 2024

No 130

Agri About

www.agriabout.com

Bioengineering

The Role of Biosystems Engineering

Bioengineering tools Improve Plant Performance and Yield

Soil Biology in Regenerative Agriculture

Passive Rainwater Harvesting

Passive Rainwater Harvesting

Fanie Vorster
ARC-Natural Resources and Engineering, Agricultural Engineering Campus

Several regions in the world, like Southern Africa experience water constraints as well as severe and prolonged droughts. The map in Figure 1 shows a global perspective on the regions that experience water scarcity.

Typically, rainfall occurs in South Africa in a 4–5-month period, with the remainder of the year dry. During the growing season frequent hot dry spells can occur. Therefore, especially in rural areas the practice of storing a sufficient volume of rainwater, could save a crop or secure a good yield. Provision could also be made for household water during the winter months when in general no rain falls in the summer rainfall areas. With municipal service delivery problems in the urban areas, harvesting rainwater for back-up purposes is a good idea. Peak run-off flood damage could also be reduced if rainwater harvesting could be implemented on a large scale in a catchment area.

Collecting rainwater from roofs and storing it in tanks (Active rainwater harvesting), is in most cases only viable for back-up household use or back-up purposes. The reason is that usually the roof area (catchment) and/or the tank (storage) are the constraints – preventing the storage of a volume of water sufficient for crop production.

Passive rainwater harvesting is when the flow of run-off water originating from rain that fell on and adjacent to a catchment area, is slowed down, spread over the area, and facilitate the infiltration thereof into the soil profile for storage. This allows for storage of a sufficient volume of water for crop production.

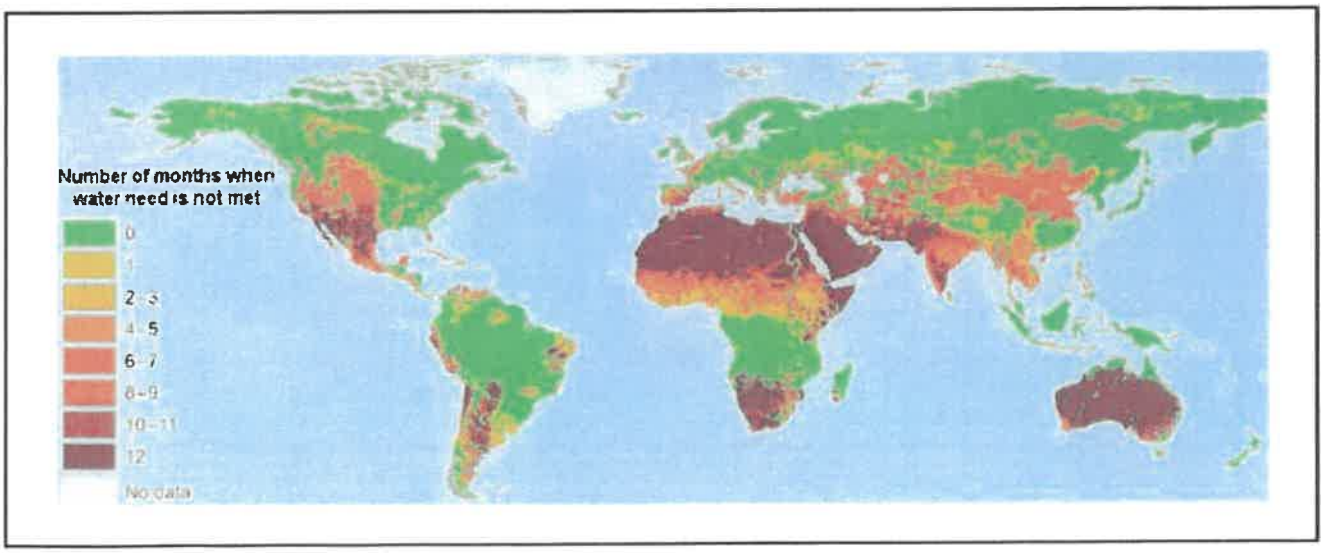

Figure 1: Drought areas of the Earth, (from M. M. Mekonnen and A. Y. Hoekstra, Four billion people facing severe water scarcity, *Science Advances, 2 (2016) e1500323)*

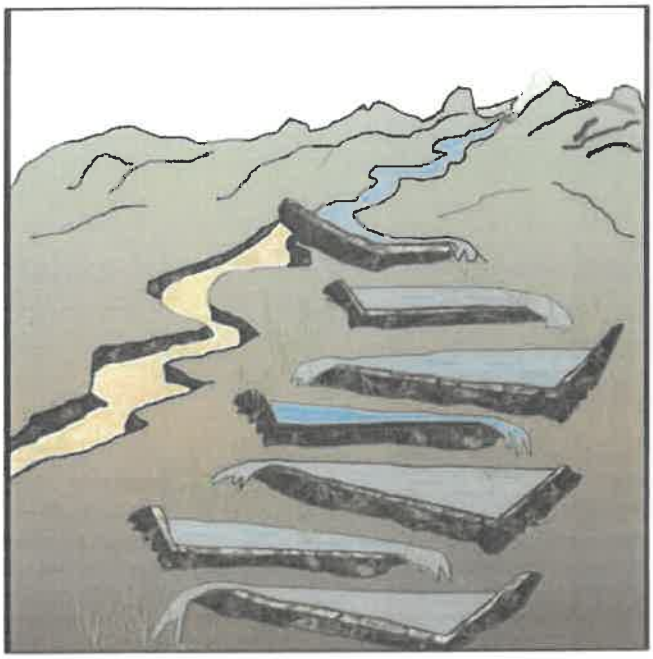

Figure 2: Typical water spreading banks

In this article, we are going to focus on passive rainwater harvesting.

What does a passive rainwater harvesting system consist of?

It consists of:

- a catchment area, which can include soil surfaces, roads, roofs, and parking lots,
- a water distribution system acting to slow down run-off water and directing it to appropriate storage areas, which could include dry trenches, small unlined ponds, berms and swales, rock walls or vegetation hedges on contour.
- an area in the landscape where the water could be stored, which could include tanks, subsurface reservoirs, small ponds or "infiltration pits", basins, French drains and in the subsurface soil profile.

What advantages does passive water harvesting have?

- The materials that are used can mostly be sourced locally, on or near the site – thereby reducing cost.
- Construction and maintenance are simple, making it achievable for anyone who only has a basic understanding of the principals involved.
- It causes runoff water to slow down and spread across the soil surface, thereby reducing the erosion potential of the water, and increasing the portion of the water that infiltrates into the soil.

What are the principals involved in creating the interventions for managing and harvesting rainwater passively?

- Start with a small intervention and then extend and improve incrementally.
  - Observe the measure of success in actual rain events and make improvements.
- Start at the top (highest elevation) of the catchment area.
  - Draw a map of the areas involved.
  - Mark the different catchment areas, as well as other sources of runoff water entering the relevant catchment area.
  - Start intervention at the top of the catchment area, proceeding down the slope to reduce the volume and eroding power of the collected water at the bottom of the catchment.
- Use several small catchment areas in combination with each other.
  - It is easier to manage water in several small

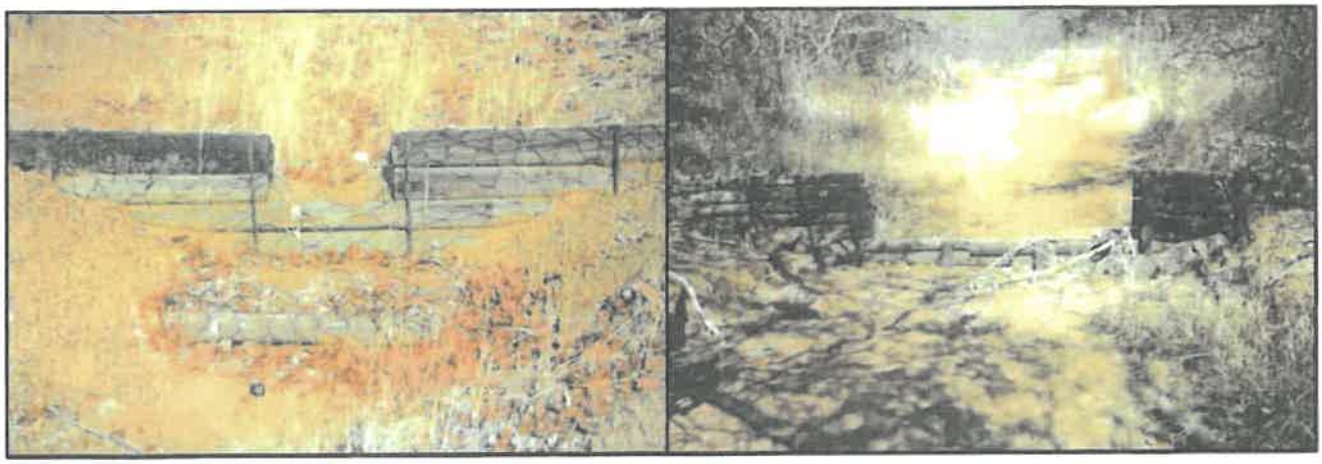

Figure 3: Typical permeable timber pole structures

Figure 4: Typical examples of mulching

catchments than in one large catchment area.
  - Therefore, utilize the natural topography of the site to subdivide the catchment in more than one sub-catchment.
  - If the natural topography is uniform and sub-divisions cannot be recognized as such, the catchment can be divided into sub-catchments artificially to facilitate easier water management.
- Facilitate slowing, spreading, and infiltration of the runoff water.
  - Infiltrating water into the soil and thereby storing it there is the most economical option.
  - Storing water in the soil has a major beneficial influence on the local climate and environment.
  - By allowing water that is concentrated in a channel to spread out over an area in intervals, slows the flow and reduces the erosion potential. This causes sediments to deposit and facilitates a larger portion of the water to infiltrate into the soil.

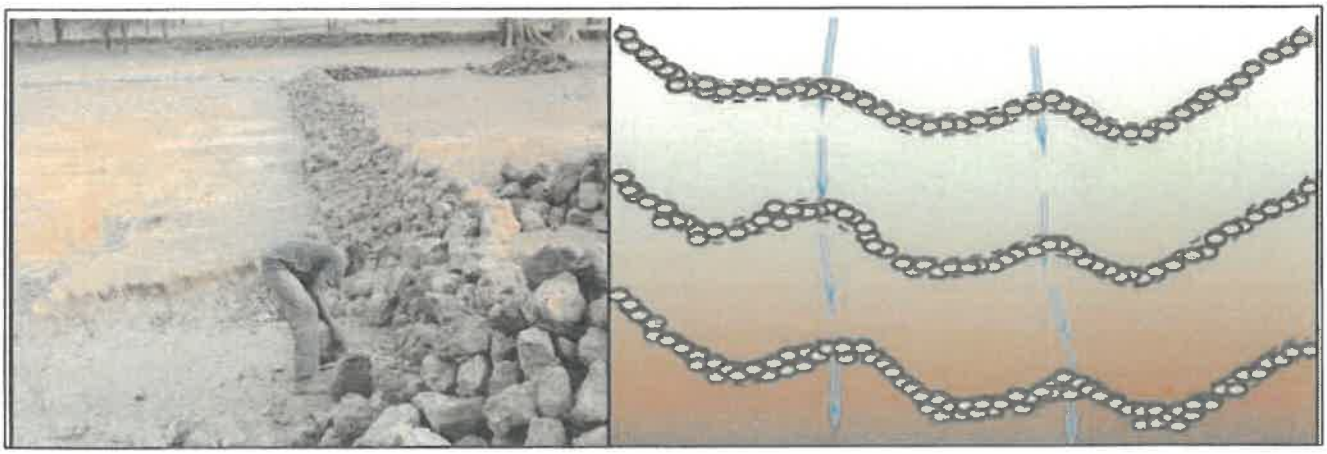

Figure 5: Typical permeable rock wall structures built on the contour

    - Surface stormwater is decreased due to more water infiltrating into the soil.
    - Vegetation should be established in the areas to utilize the water infiltrated into the soil to maximize the environmental and climatic benefits.
- Ensure overflow areas are of suitable size and lined to protect the soil from erosion.
    - Overflow areas need to be level across their width and lined with rocks for protection against erosion.
    - The overflow structures need to be sized (width and flow depth) to make provision for runoff from extreme rainfall events on the catchment – especially in the case of larger catchments.
    - Overflow structures need to be maintained regularly.
- Provide a layer of organic mulch to limit evaporation.
    - This has the effect of making water available for plants over a longer period.
    - A layer of mulch consisting of organic material could be made 75 mm-150 mm thick. In the case of rocks or other inorganic materials, the layer could be 50mm thick.
    - Over time organic mulches decompose, thereby improving soil fertility. Therefore, it needs to be replenished periodically.
- Utilize the water harvested.
- Do regular maintenance.
    - The earthworks and especially the overflow structures need regular maintenance to function optimally for an extended period.

For more detailed information on the different interventions as well as the effect that water stored in the soil has on the environment and local climate, the publication *"Changing climate: The role of water and what you can do to drought-proof your land"*, can be consulted. It can be ordered from the ARC-NRE publication office at StoltzE@arc.agric.za

References:

- Passive Water Harvesting (Rainwater Collection); Cado Daily, Cyndi Wilkins; College of Agriculture and Life Sciences – Cooperative Extension; The University of Arizona; Oct 2012.
- Changing Climate: The role of water and what you can do to drought-proof your land; SJR Vorster; ARC-NRE; Sept 2020.

Enquiries: vorsters@arc.agric.za