

# Up-scaling of rain-water harvesting for crop production in the communal lands of the Modder River basin in South Africa: Comparing upstream and downstream scenarios

YE Woyessa<sup>1\*</sup>, E Pretorius<sup>1</sup>, M Hensley<sup>2</sup>, LD van Rensburg<sup>2</sup> and PS van Heerden<sup>3</sup>

<sup>1</sup> School of Civil Engineering and Built Environment, Central University of Technology, Free State, Private Bag X20539, Bloemfontein 9300, South Africa

<sup>2</sup> Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa

<sup>3</sup> PO Box 11632, Universitas, Bloemfontein 9321, South Africa

## Abstract

The study area is the Upper and Middle Modder River basin situated in a semi-arid area of central South Africa. This is an important catchment because of the relatively large nearby towns of Bloemfontein, Botshabelo and Thaba Nchu. Crop production in the basin using conventional production techniques is currently not suitable due to marginal and erratic rainfall, and high evaporative demand, as well as low precipitation use efficiency on the clay and duplex soils caused by large runoff and evaporation losses. A labour-intensive in-field rain-water harvesting (IRWH) technique for crop production recently introduced into a part of the basin occupied by communal farmers has been shown to increase maize and sunflower yields by 30 to 50% compared to conventional tillage, making crop production utilising this technique a feasible proposition for these farmers. The area of land suitable for the IRWH in the basin is estimated to be 80 667 ha, of which 15 000 ha is located in the communal land. The two catchment management options compared in this paper are:

- Allowing the 80 667 ha to remain under grassland and utilising the runoff downstream for irrigating maize
- Utilising the 80 667 ha for maize production in the basin using the IRWH technique.

Results showed that the expected maize production from the options shown above were 23 040t and 137 134t respectively. The large unproductive water losses during storage and conveyance to downstream use points are probably the main reason for this large difference in production. An economic analysis, which enabled the grazing benefit to be included in the first option, shows that the gross margin of this option, expressed as R/m<sup>3</sup> of rain water utilized, could be expected to be between 0.0234 to 0.0254 under current conditions, of which irrigation contributed about 25% or less. The comparable value for the IRWH option was 0.0354. The second option is clearly shown to be the most preferable, with high socio-economic benefits for the communal farmers who are currently struggling to achieve sustainable livelihoods.

**Keywords:** rain-water harvesting, catchment management, river basin, small-scale farming

## Introduction

In a new paradigm shift related to integrated water resource management (IWRM) in the context of a river basin, attention is being drawn to consider the upstream 'on-site' influences on the various water use entities, as well as the downstream 'off-site' impacts arising from them. Along the path of water flowing in a river basin are many water-related human interventions, including water storage, diversion, regulation, distribution, application, pollution, purification and other associated acts to modify the natural systems. All of these have one common effect, and that is that they impact on those who live downstream (Sunaryo, 2001). This concept of river basin analysis of water would enhance the common understanding of the issues on overall productivity of water, such as in rain-fed agriculture and related strategies.

Green water productivity in rain-fed agriculture will have to increase dramatically over the next generations if food production is to keep pace with human population growth (Rockström et al., 2002). In sub-Saharan Africa, over 60% of the population

depends on rain-based rural economics, generating about 30 to 40% of the regions' GDP (World Bank, 1997). Rain-fed agriculture is practiced on approximately 95% of agricultural land, with only 5% under irrigation (Rockström et al., 2002). This shows that rain-fed agriculture will remain the dominant source of food production for the foreseeable future in sub-Saharan Africa.

In many parts of the water-scarce countries, yields from rain-fed agriculture are low, oscillating around 1 t·ha<sup>-1</sup> (Rockström, 2001). However, many researchers suggest that the low productivity in rain-fed agriculture is more due to sub-optimal performance related to management aspects than to low physical potential. For instance, Bennie et al. (1994) reported that in arid and semi-arid areas between 60 and 85% of the rainfall evaporates from the soil surface before making any contribution to production.

A reduction in runoff will result from practices that successfully increase the infiltration capacity of the soil, increase the contact time, and/or reduce surface sealing. It is commonly accepted that covering the soil with a mulch, for example, with a crop residue, will achieve these goals (Unger, 1990) and will also reduce evaporation from the soil surface. The infield rain-water harvesting technique, whereby runoff is captured in a micro-basin, is found to reduce runoff from the field to zero (Hensley et al., 2000) by converting to stored soil water, leading to increased

\* To whom all correspondence should be addressed.

☎ +27 51 507 3535; fax: +27 51 507 3254;

e-mail: [ywoyessa@cut.ac.za](mailto:ywoyessa@cut.ac.za)

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