IVM Institute for Environmental Studies

VU UNIVERSITY AMSTERDAM

Returns to water harvesting investment in semi-arid regions – A meta analysis

Jetske Bouma, Seema Hegde, Ralph Lasage

Institute for Environmental Studies, Amsterdam

Introduction

Traditionally, smallholder farmers in semi-arid regions have invested in water harvesting techniques to cope with droughts and enhance the productivity of their land. Research has found that these traditional practices can indeed increase agricultural productivity, but attempts to spread or intensify the practice of rainwater harvesting have had limited success.

There are indications that the reason for the limited uptake is the relatively low cost-benefit ratio: with increasing opportunity costs of labor the costs of investment can be substantial, whereas returns are uncertain and often limited because of market constraints. The few studies that have assessed returns to water harvesting are case studies, however, and to the authors knowledge no general assessment of the returns to water harvesting exists. Given the renewed interest in water harvesting for reasons of climate change adaptation this is a serious gap in the literature- a gap that this paper attempts to bridge.

Water harvesting technologies

Water harvesting is defined as a method of inducing, collecting, storing, and conserving local surface runoff for agriculture. It is a relatively low-cost, simple technology with a proven capacity to improve productivity in semi-arid zones.

Household ponds in the Alaba region, Ethiopia

Zaï and stonelines in Malgretenga, Burkina Faso

Investments include techniques that capture and store water *in the soil* and techniques that store water *in reservoirs.* With regard to *in soil* water harvesting technologies it is important to acknowledge that complementary investments in soil fertility help to improve the water retention capacity of the soil. We account for this in the analysis by reporting findings with and without complementary investment in soil fertility. With regard to the cost of investment, *in soil* water harvesting investments are generally more labor intensive, but reservoir storage techniques have higher material costs. Although no peer reviewed studies are available that report the costs of water harvesting we will reflect in our analysis on investment and maintenance costs.

Methods

We conducted a meta-analysis of 31 peer-reviewed studies reporting changes in crop yields due to water harvesting. Initially a much larger number of studies was consulted but most studies did not report crop yield changes systematically.

Table 1. Summary of the reviewed literature and the studies included in the meta database.

Region	Total number of publications reviewed	Publications reporting yields (no baseline)	Publication reporting yield changes
Africa	82	33	14
Asia	76	29	17
Total	158	62	31

We added information about rainfall decile classes to the 254 observations in our database in order to allow for an analysis of crop yield changes in different rainfall years. We analyze the database using different statistical techniques, including simple t-test statistics, mixed-effect models with clustered standard errors and panel data models with fixed and random effects.

Results

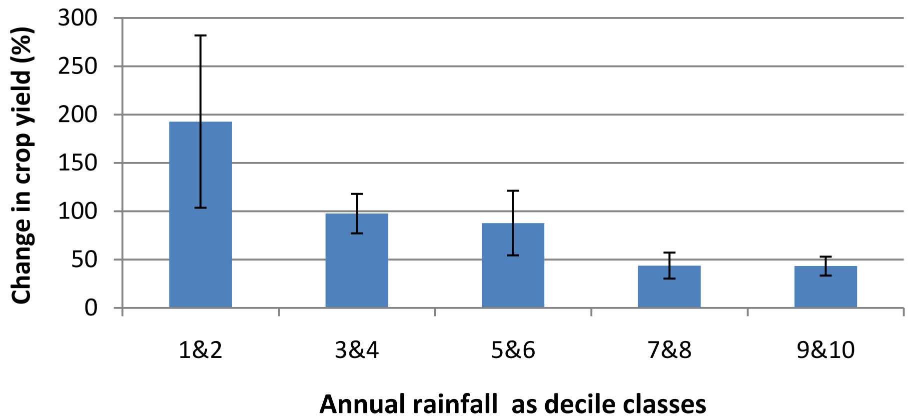

Figure 1. Crop yield changes (%) due to WHT across rainfall classes in Africa and Asia

Our analysis indicates that on average water harvesting increases crop yields with more than 80% (but with a large standard deviation). When accounting for rainfall variability the finding emerges that impacts are greatest in below rainfall years (figure 1). This finding is robust for different model specifications, the inclusion of technology and location characteristics and exclusion of mixed evidence studies reporting soil fertility effects.

In terms of returns, relative impacts may be largest in below average rainfall years but absolute returns are in those same years low (figure 2). This has implications for the impact of water harvesting on food security, but it also influences the benefit-cost ratio. Case study analysis suggests that benefits depend for a large part on market access: returns are largest when water harvesting allows farmers to shift to higher value (cash) crops. Also for food security, farmers need access to storage facilities to be able to benefit from the higher yields.

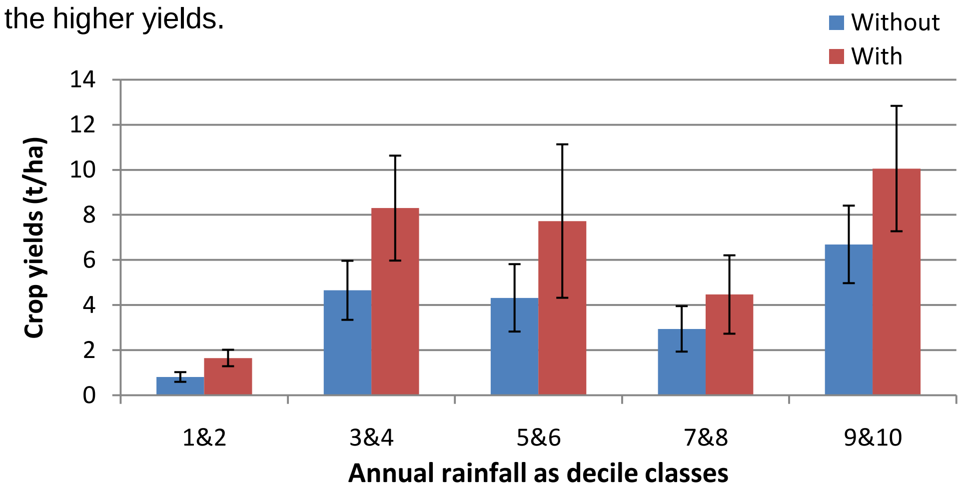

Figure 2. Crop yields (t/ha) with and without WHT across rainfall classes in Africa and Asia

Discussion and conclusions

Water harvesting is a relatively low cost technology with a proven capacity to improve agricultural productivity in semi-arid zones. Given climate change and population growth it seems a promising option to increase food security.

Farmer uptake of water harvesting technologies has been limited, the literature discussing different reasons for why this may be the case. The findings in this paper suggest that a low benefit-cost ratio may be one of the reasons: water harvesting increases crop yields significantly, but especially in below average rainfall years when the absolute gains (kg/ha) may be low.

In terms of returns, farmers with good market access and credit and storage facilities can capitalize yield improvements, but for farmers in remote regions without storage and other facilities returns may be limited, although remoteness reduces the opportunity costs of labour as well. Whether net returns are positive will thus depend on contextual factors, the analysis in this paper suggesting that water harvesting can improve food security, if the facilities for farmers to benefit from yield increases are improved.

For the full paper please contact the authors or check whater.eu

IVM INSTITUTE FOR ENVIRONMENTAL STUDIES
VU University Amsterdam
De Boelelaan 1087
1081 HV Amsterdam
t +31-20-5986 659
f +31-20-5989 553
www.ivm.vu.nl
Jetske.bouma@vu.nl

Acknowledgements: We would like to acknowledge the excellent research assistance from Sanne Muis and Daniel Fisher. The research leading to these results has received funding from the European Community's Seventh Framework Programme under grant agreement no. 266360 (WHaTeR).