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Soil hydrology and irrigation in arid environments A.203 | EGU2019-1839

Abstract

- Climate change and demography are expected to increase water scarcity in drylands. A large number of studies is calling to focus efforts to enhance water productivity (WP), and one of the most promising option is represented by water harvesting, the collection and storage of runoff water to be used for beneficial uses.
- The research aims to deepen the knowledge about WP of water harvesting systems studying a sand dam irrigation system in Tigray, north Ethiopia. We analyzed a representative maize plot irrigated during the dry season of 2017 through a shallow well drilled in the sand dam aquifer, in terms of yield, Crop Productivity (CWP), Crop Water Productivity based on Water Evapotranspiration (CWP(ET)) and Economic Water Productivity (EWP), through field data analysis and a validated Aquacrop model.

Study area (13.89° N 39.28° E)

- May Gobo Tabia (municipality), Hawzen Woreda (district), Tigray Region, Ethiopia
- Altitude of 1714 m a.s.l.
- Climate is **semi-arid** and is classified as BSk
- Mean annual temperature 17.4 °C
- Total rainfall is 611 mm
- Roughly half of it concentrated in the months of July and August

Sand dam and irrigated area

- Built in 2012
- A concrete wall built in the riverbed of sandy ephemeral rivers
- The sedimentation of the transported sand in the upstream of the wall in a few years creates an **artificial unconfined aquifer**, whose water is accessed by people through digging scoop holes or shallow wells
- Farmers were also provided with diesel pumps, fruit trees and improved seeds, to improve agriculture and livelihoods
- Furrow irrigation performed with very low efficiency
- Low soil fertility



General scheme of a sand dam. Source: Borst and de Haas (2006)

References

Borst L., de Haas, S. A., 2006. Hydrology of Sand Storage Dams - A case study in the Kiindu catchment, Kitui District, Kenya. VU University, Amsterdam, the Netherlands. Rockström J., Falkenmark M., 2015. Agriculture: Increase water harvesting in Africa. Nature. Vol. 519: 283-285.

Water productivity analysis of sand dams irrigation farming in northern Ethiopia

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ΑΙ	considering actual irrigation method	СИ
NI	calculating the net irrigation requirements at constant field capacity	ЕИ
OI	generating an optimal irrigation schedule	
NS	testing the OI irrigation schedule without soil fertility stress	CWI

Materials and methods

- 1. Field data collection
- 2. Simulation of AI conditions and validation of Aquacrop with collected data
- **3. Simulation** of Al, Nl, Ol, NS
- 4. Calculation and comparison of maize Crop Water Productivity (CWP), Crop Water Productivity based on Evapotranspiration (CWP(ET)) and Economic Water Productivity (EWP)
- for the NS simulation was estimated 5. FWP considering a proportional increase in costs of fertilizers

	Yield (t/ha)	Water stress (%)	Soil fertility stress (%)	Evaporation (mm)	Transpiration (mm)	Net irrigation requirements (mm)	Gross irrigation requirements (m ³)
ΑΙ	3.316	1%	60%	107.5	188.4	759	660
ΝΙ	3.332	0%	60%	148.9	190.5	341.5	297
ΟΙ	3.301	0%	60%	58.3	185.4	160.1	139
NS	8.491	0%	0%	40.9	245	160.1	139

	CWP (ET)	CWP	EWP	Field da
	(kg/m³)	(kg/m³)	(birr/m ³)	CMD =
ΑΙ	1.12	0.218	0.74	EWP =
ΝΙ	0.98	0.488		*1 Birr
ΟΙ	1.35	1.033	3.94	TABLE 2
NS	2.97	2.655	9.54	Water pr field date

grain yield in kg water applied to the field in m^3

net return in birr VP =water applied to the field in m^3

> grain yield in kg water evapotranspired in m³



May Gobo sand dam



Scoop hole in May Gobo



lata results

 0.23 kg/m^3 • 0.77 birr/m³ = 0,031 E

AND BOX: productivity calculation compared with ta results

CONCLUDING REMARKS

1. Technical suitability of materials and methos

- AQUACROP model show good accordance with field data
- AI to NS simulation in line with other studies analyzing maize CWP and CWP(ET) both in good and bad conditions

2. Water Harvesting and irrigation planning

- Sand dams can be successfully used for irrigation purposes
- Soil fertility is an essential co-constraint that must be seriously tackled
- To increase WP, main solutions are to increase irrigation efficiency and soil fertility
- Farmers with **irrigation water** available tend to **misuse** it

3. Recommendations

- fields)
- When planning interventions, important to have a **holistic approach**
- Farmers need time to adapt to **new technologies**: tillage method (Maresha plow) should be questioned in Ethiopia
- **Conservation agriculture** possible solution?

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Abstract: Water scarcity is the main problem to be tackled to meet regional food security in drylands. A large number of studies is calling to focus efforts to enhance Water Productivity (WP), and one of the most promising option is represented by water harvesting, the collection and storage of runoff water to be used for beneficially uses. Among the available technologies, sand dams are experiencing a renovated interest because of their relative simplicity and their potential. This research atms to deepen the knowledge about WP of water harvesting systems studying a sand dam irrigation system in Tigray, north Ethiopia, where farmers are getting used to this new technology. The research was carried out in the period March-April 2017, when farmers use sand dams water to irrigate maize, during the Ethiopian dry season. We analysed a representative plot irrigated through a shallow well drilled in the sand dam aquifer, in terms of yield, Crop Water Productivity (CWP), Crop Water Productivity based on Evapotranspiration (CWP(ET)) and Economic Water Productivity (EWP), through field data analysis and a validated Aquacrop model. CWP(ET) was found to be low (1.12 kg of grain per m ³ of water), due to both inefficient water application and low soil fertility. Aquacrop model results showed that changing the irrigation schedule can increase CWP(ET) up to 1.35 kg/m ³ and EWP up to 3.94 birr/m ³ , but yield gap is mainly due to the low soil fertility. Interventions on soil fertility can raise yields from the observed 3.3 kg/ha up to 8.5 kg/ha, and thus CWP(ET) and EWP up to 2.94 kg/m ³ and 9.54 birr/m ³ respectively. To enhance the effect of sand dams in northern Ethiopia, a set of measures, including conservation agriculture, is then proposed.	







• Sand dam planning is a crucial phase to avoid irreparable problems (residues invading

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LINK to the paper







