Water management practices and carbon sequestration for climate change mitigation in Africa

Oladimeji Oladele[1*], and Ademola Braimoh[2]

[1]Department of Agricultural Economics and Extension, North-West University, Mafikeng Campus South Africa oladele20002001@yahoo.com

[2]Agricultural and Rural Development, The World Bank, 1818 H Street, NW, Washington DC 204 abraimoh@worldbank.org

*Corresponding author

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Introduction

The majority of sub-Saharan Africa’s (SSA) population make their living from rainfed agriculture

Economic development in SSA remains particularly vulnerable to the vagaries of rainfall, which can be aggravated by the effect of climate change.

There is a correlation between poverty, hunger and water stress.

Recurrent droughts and dry spells led to food shortages and famine and continuous degradation of natural resources which reduce resilience and increased vulnerability

The single most limiting factor for crop growth in the dry lands is water available at the crop root zone for biomass production

Introduction

Yields can be significantly enhanced by improved water management,

The soil's water-holding capacity is intimately linked to its texture, structure and organic matter content.

Integrated land and water management could play a key role in achieving the Millennium Development Goals (MDGs) of reducing poverty and hunger.

Integrated rainwater harvesting and soil water conservation (RWH/SWC) is one of the appropriate technologies used in SSA

Water management system

In Zimbabwe, Kenya, Swaziland and Ethiopia RWH techniques of such as *fanya juu*, infiltration pits and tied ridges in communal areas have been introduced

In Burkina Faso the *"zai""* is a traditional technique for enhancing soil moisture through the use of stone strips, which are arranged perpendicular to the slope of the land in order to slow down water flow.

In Ethiopia, technologies developed to control soil erosion and conserve soil water include cut-off -drains locally called "*Boraatii* and drainage furrows called *"Bo'oo' or 'yaa'a".*

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Soil moisture – carbon- climate change nexus

The adoption of water management practices has several implications for climate change.

The primary goal of water management practices is the enhancement of soil moisture which consequently affects soil carbon.

Prominent among the mitigation and adaptation strategies is the improvement and increasing of soil carbon stocks

Water harvesting for crop production, if successfully implemented within a social and hydrological catchment, have many interacting implications on biophysical, economic, and ecological systems.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Objective of the study

The objective of this paper is to examine the impact of water management practices such as rain water harvesting, slope/barriers and terracing on carbon sequestration and climate change mitigation.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Materials and Methods

A review of the scientific literature using on-line scholarly and scientific databases as well as more general search engines such as Google.

The reported soil carbon concentrations in the studies were standardized

Concentration (C_c in g kg^{-1}) were converted to volumes and then areas to calculate stocks (C_s in kg $^{-1}$ ha^{-1}) and sequestration rates (kg ha^{-1} yr^{-1}) using bulk density (BD in g cm^{-3}) and sample soil depth (D, in cm): $C_s = BD \times C_c \times D \times 10000$

In a few studies where values were given in terms of % soil organic matter, concentrations of C_c (g kg^{-1}) were calculated as : $C_c = 0.58 \times OM\% \times 10$

To convert C to CO_2, the mean carbon sequestered was multiplied by 3.57 and then expressed per thousand.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Results

Rates of soil carbon sequestration by water management practices

The average carbon sequestered from 33 estimates was 839 kg C ha^{-1} yr^{-1}.

This practice is particularly important to framers in the semi-arid and arid region where there are few days of rains but rainfed agriculture is practiced.

The practices of cross slope barriers (22 estimates) and terracing (15 estimates) sequester additional carbon at the mean rate of 1193 and 421 kg C ha^{-1} yr^{-1} respectively (Table 1).

Table 1: Observed rates of soil carbon sequestration as a result of water management

	Carbon sequestration kg C ha^{-1} yr^{-1}					
Water management	Mean	Lower 95% CI of mean	Upper 95% CI of mean	Min	Max	Number of estimates
Water harvesting	839	556	1122	103	3170	33
Slope/barriers	1193	581	1805	151	4615	22
Terracing	421	276	566	60	990	15

Green house gas mitigation potential of water management practices

The amount of carbon sequestered by each water management practices covered in this study was translated into climate change mitigation benefits.

The carbon sequestered was calculated in terms of $tCO_2eha^{-1}\ yr^{-1}$.

Table 2 presents the different values for each water management practices based on the mean amount of carbon sequestered.

The use of slope and barriers has the highest Climate Change mitigation potential 5.27 $tCO_2eha^{-1}\ yr^{-1}$ respectively.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

Table 2: Climate Change mitigation benefits of land management practices

Land management practices	Mitigation potential $tCO_2eha^{-1}yr^{-1}$	Land Emissions[a] N_20 and CH_4 $t\ C0_2e\ ha^{-1}yr^{-1}$	Process Emissions[a] $t\ C0_2e\ ha^{-1}yr^{-1}$	Net Impact $t\ C0_2e\ ha^{-1}yr^{-1}$
Water harvesting	3.08	0.66	0.23	3.97
Slope/barriers	4.38	0.66	0.23	5.27
Terracing	1.55	0.66	0.23	2.44

[a] All values in this columns are from (Eagle et al., 2010). Corresponding land emission and process emission values used for land management practices not covered in Eagle et al reports include woody crops for tree cropping; alley farming for afforestation; grazing land management for grazing pasture; intensification for cropping intensity; irrigation improvements for water harvesting, slope/barriers and terracing.

Conclusion

There is high potential to sequester additional carbon through water management practices with use of slope and barriers as the most prominent

The performance of these water management practices depends on soil properties and climatic conditions, and the degree of soil degradation at the time of time of intervention.

The potential of these water management practices for climate change mitigation should not be selectively considered.

There is need to integrate these water management practices for carbon sequestration into larger sustainable development and livelihoods strategies and practices

Thank You

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS