Strengthening Capacity in Environmental Physics, Hydrogeology and Statistics for Conservation Agriculture Research

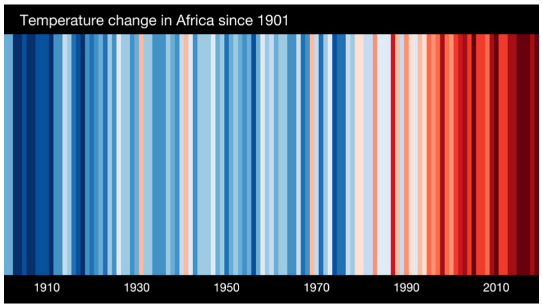
CEPHaS Project Briefing

No. 13 April 2021

FARMING UNDER CLIMATE CHANGE, IS CONSERVATION AGRICULTURE A TOOL FOR BOTH ADAPTATION AND MITIGATION?

Introduction

It is widely considered that conservation agriculture, and similar agronomic practices, can improve the sustainability of smallholder production in the face of climatic variability and climate change. This in turn can lead to improved food security and economic status of rural households. The CEPHaS project seeks to evaluate the impacts of conservation agriculture practices on the resilience of food production and how these practices impact the quantity and quality of groundwater resources. It is therefore concerned with the Sustainable Development Goals *Zero Hunger* (2) and *Clean Water* (6).



Visualization of changes in mean annual temperature across Africa from 1901 to 2019.

Image from https://showyourstripes.info/ produced by Prof Ed Hawkins, University of Reading, CC-BY 4.0 license.

Experimental plots at Chitedze with conservation agriculture treatments all with crop residues retained.

Conservation Agriculture

Conservation agriculture (CA) is a farming system that seeks to increase productivity, improve resilience to climatic variability and climate change and reduce greenhouse gas emissions. This is achieved through the three principles of CA (minimal soil disturbance, maintaining permanent soil cover, and crop rotations) described in Briefing Document 11 https://www2.bgs.ac.uk/CEPHaS/index.html. CA is regarded as a 'climate-smart' agricultural practice because of its effects on biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and improved and sustained crop production. CA is therefore regarded as an adaptation option to mitigate climate risks.

Reduction of Climate Change Impact on Agriculture

With increasingly erratic rainfall and prolonged events of drought, agricultural systems are becoming vulnerable to the effects of climate change and climatic variability. This is a challenge if the demand for food for an ever-increasing population is to be met sustainably. It is hypothesized that CA practices increase infiltration and reduce runoff and evaporation. This improves water use efficiency and buffers crops against drought. Therefore, the water- and soil-conserving effects of CA help to stabilize yields against weather extremes. Mulch cover also buffers the soil against temperature extremes. In the CEPHaS project we are making detailed measurements of properties such as the water retaining properties of soils and rates of infiltration to test this hypothesis by comparing experimental plots under CA and conventional management.

Conventionally cultivated land in ridges (foreground), with one geophysics array to monitor water movement, and conservation agriculture in the background with crop residues.

CA effects on Greenhouse Gas Emission

Conventional farming practices contribute to greenhouse gas emissions; tillage stimulates aerobic microbial respiration in soil resulting in the loss of soil organic carbon. So there is an urgent need to adopt agricultural practices which reduce these. There is evidence that CA practices reduce greenhouse gas emissions from agriculture and also improve carbon sequestration. Reduced tillage and the retention of crop residues increase the accumulation of organic carbon in the soil. For example, studies in Zimbabwe found that the rate of emission of CO_2 from plots under CA were about 40% less than those under conventional management over a three-year period (O'Dell et al., 2020). A study of agroforestry systems (trees intercropped with arable crops or grass) in semi-arid degraded lands of Western India showed that these enhanced agro ecosystem resilience to extreme weather and improved the carbon stock and sequestration potential (Kumar and Kakade, 2019). Other changes associated with practicing CA such as reduced use of fuel for agricultural machinery may also represent mitigation opportunities. Therefore, despite challenges associated with adoption of CA such as labour, multi-usage of crop residues in mixed farming system and poor markets, CA contributes to climate change mitigation through carbon sequestration and reduced greenhouse gas emissions.

Monitoring borehole at the conventionally tilled site at Domboshava, Zimbabwe.

The author of this briefing, Mr Pathias Lubinga, CEPHaS Research Fellow.

References

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WHO ARE WE?

We are soil scientists, agronomists, hydrogeologists, geo-physicists, statisticians and agricultural economists from the University of Zimbabwe, the University of Zambia, Lilongwe University of Agriculture and Natural Resources, the University of Nottingham, Rothamsted Research, Liverpool School of Tropical Medicine and the British Geological Survey. We are working with the Kasisi Agricultural Training Centre, Zambian Agriculture Research Institute, the Department for Agricultural Research Services (Malawi), and our commercial partner, Delta-T Devices (UK).

To find out more, visit our webpages at https://www2.bgs.ac.uk/CEPHaS and follow us on twitter @CEPHaS_Soil

CEPHaS is funded by UK Research and Innovation through its Global Challenges Research Fund programme.