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

CEPHaS Project Briefing

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CA INFLUENCES ON SOIL ORGANIC CARBON AND AGGREGATE STABILITY

Soil organic carbon and its role on soil moisture in soils

Conservation agriculture (CA) is defined by three key principles: minimum or no tillage, retention of residues on the soil surface and crop diversification. It is widely promoted across sub-Saharan Africa as a sustainable farming practice which is resilient to climate variability and change. The practice offers important benefits and ecosystem services which help with climate adaptation such as increased water infiltration, reduced soil moisture loss through evaporation, reduced soil erosion and run-off. One of the reported benefits of CA is increased soil organic carbon (SOC). SOC is very important in promoting the cohesion between soil particles which results in stable soil aggregates (see Figure 1). Aggregates are a basic unit of soil structure. Increases in infiltration arising from CA are commonly credited to improved aggregate stability especially in the surface soil, where improvements in SOC are largest, and the increase in continuous macroporosity allows faster water movement into the soil profile in the absence of tillage.

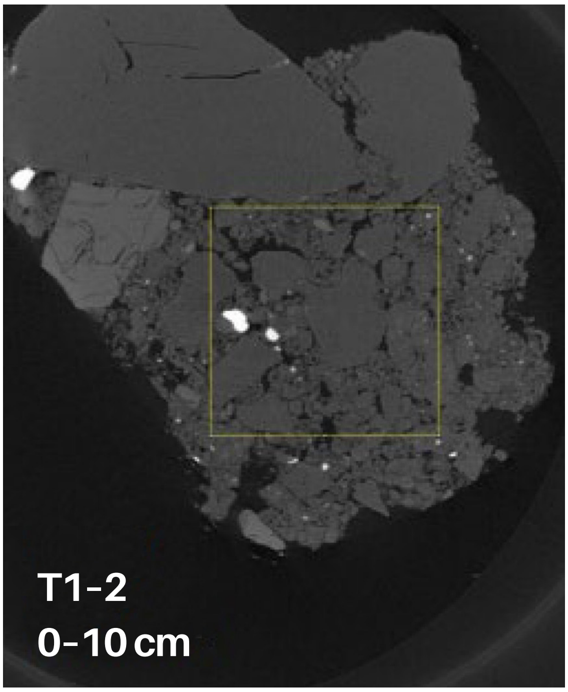
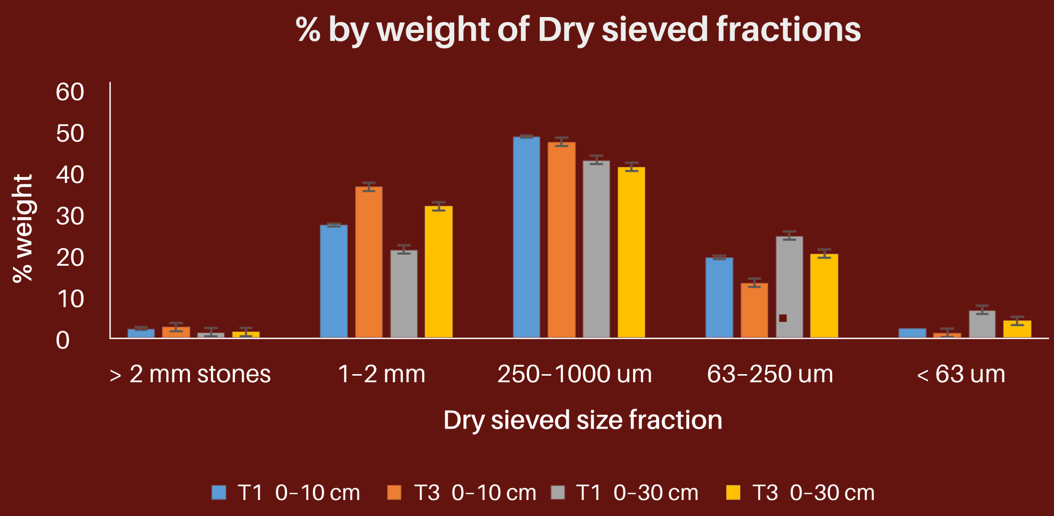


Figure 1 *The composition of a microaggregate, a mixture of mineral components of different size held together by organic material, is shown by this micro-CT scan. The yellow box is approximately 1 mm x 1 mm.*

Soil aggregate stability

Once aggregates are formed in the soil they are exposed to disruptive forces such as tillage, impact of rain, swelling and shrinking, water movement and wind abrasion which may cause disintegration. Therefore, good soil management ensures the stability of the aggregates. Aggregate stability is the ability of the soil aggregates to resist disruptive forces. The wet aggregate stability indicates how well a soil can resist rain drop impact and water erosion. On the other hand, the size distribution of dry aggregates can be used to predict resistance to abrasion and wind erosion. Therefore, aggregate stability is a very important property in the soil as it regulates the movement and storage of water, nutrients and air throughout the soil profile, thereby influencing root growth and controlling erosion. Soil aggregate stability also leads to the protection of soil organic matter and is key to its sequestration.

Figure 2 Effect of farming practice on aggregation. T1 represents conventional tillage (CT) without residue retention and T3 represents CA (residue retention). There appears to be an increase in 1–2 mm fraction after CA.



Experimental work on aggregate stability and CA practice

Dr Andy Tye – CEPHaS Co-Investigator.

CA field experimental plots at Chitedze research station in Malawi have existed for 14 years and at Domboshava research station in Zimbabwe for 12 years. We are examining the extent of changes in SOC, soil aggregation and macro-aggregate (1–2 mm) stability on two selected treatments, a continuous maize in conventionally managed systems (without residue retention) (CT) and the other minimum tillage (direct seeding) with residue retention (CA) or application. At Chitedze, an assessment of aggregation indicated over 20% higher percent of soil aggregates (1–2 mm) for the top (0–10 cm) in CA plots than in CT plots (**Figure 2**). Tests using a laser-granulometer particle size analyser based methodology with consistent energy inputs imparted with a sonicator will be used to assess whether CA practices increase aggregate stability. Humic substances (HS) are an important component of SOC and in the stabilization of soil aggregates. The nature of HS in aggregates is being examined using a range of techniques (Rock-Eval, $\delta^{13}C$ and laser fluorescence) to assess whether CA changes its nature within aggregates.

Dr Keston Njira – CEPHaS Research Fellow.

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

Mr Vengai Mbanyele – CEPHaS Research Assistant.

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