

# Impact of conservation tillage on soil quality under smallholder farming systems in eastern Uganda and western Kenya



Okeyo<sup>1</sup> M. Jeremiah, Norton<sup>1,\*</sup> Jay, Omondi<sup>1</sup> Emmanuel, Norton<sup>2</sup> Urszula, Ngosia<sup>3</sup> Dominic, Odhiambo<sup>2</sup> Judith, Ashilenje<sup>4</sup> Dennis



<sup>1</sup>Department of Ecosystem Science and Management, <sup>2</sup>Department of Plant Science, University of Wyoming, Laramie, USA;

<sup>3</sup>Sustainable Ecological Agricultural Training and Extension Centre, Kitale, Kenya; <sup>4</sup>Manor House Agricultural Center, Kitale, Kenya

## Introduction

Sustainable land management practices are required to improve soil quality and crop productivity under smallholder farming systems in the tropical highlands of East Africa.

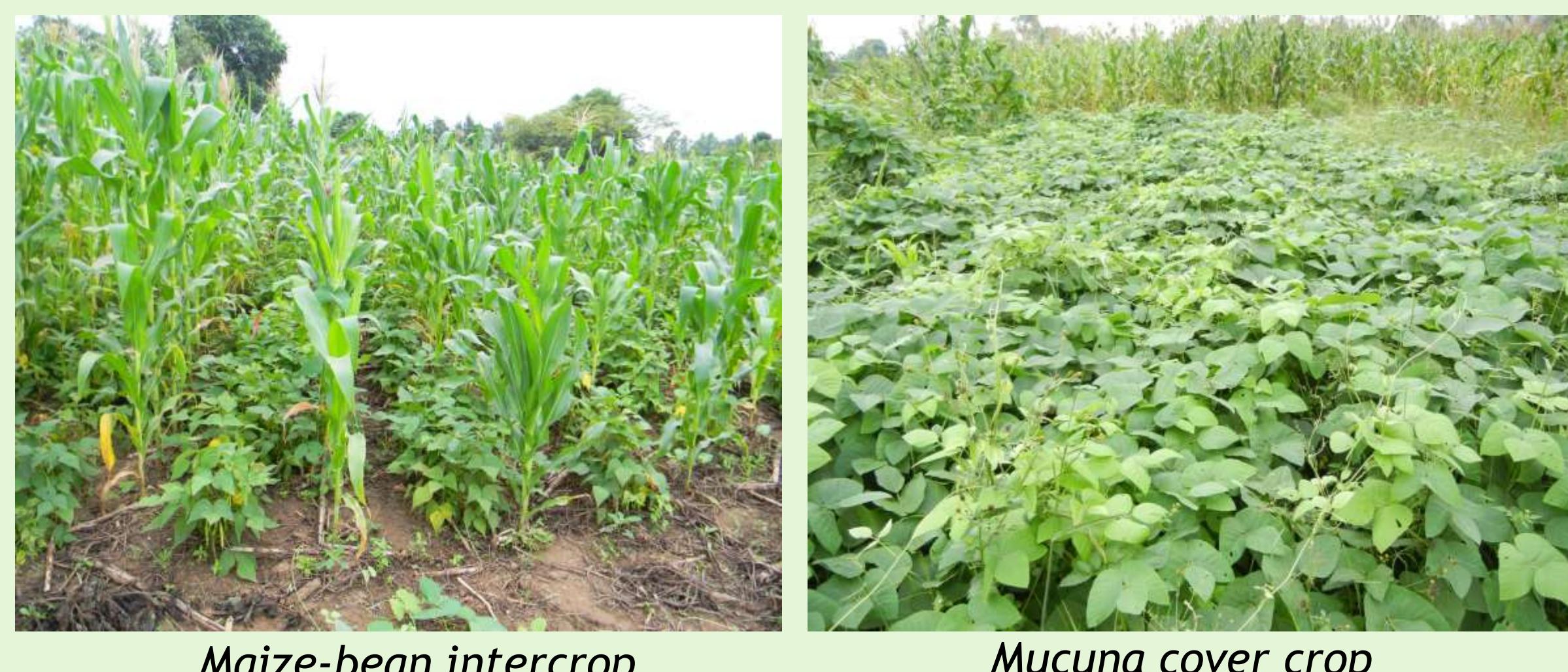
Conservation agriculture (CA) has shown potential as such an approach.

CA is based on 3-interlinked practices:

- Minimum tillage or no-till;
- Soil cover (crop residue or cover crops);
- Crop rotations/associations.

A synergistic effect created by simultaneous application of all the 3 practices.

Widespread adoption and impact of CA under smallholder farming systems is still limited.



## Objectives

The main objective of the study was to evaluate the impact of tillage: conventional tillage (CT), minimum tillage (MT) and no-till (NT) combined with 3 cropping systems: intercrop, relay and strip system on:

- i. Total and labile SOC and N pools;
- ii. Bulk density (BD), penetration resistance (PR) and water infiltration.

## Materials and Methods

Study sites were in eastern Uganda and western Kenya (Fig. 1).

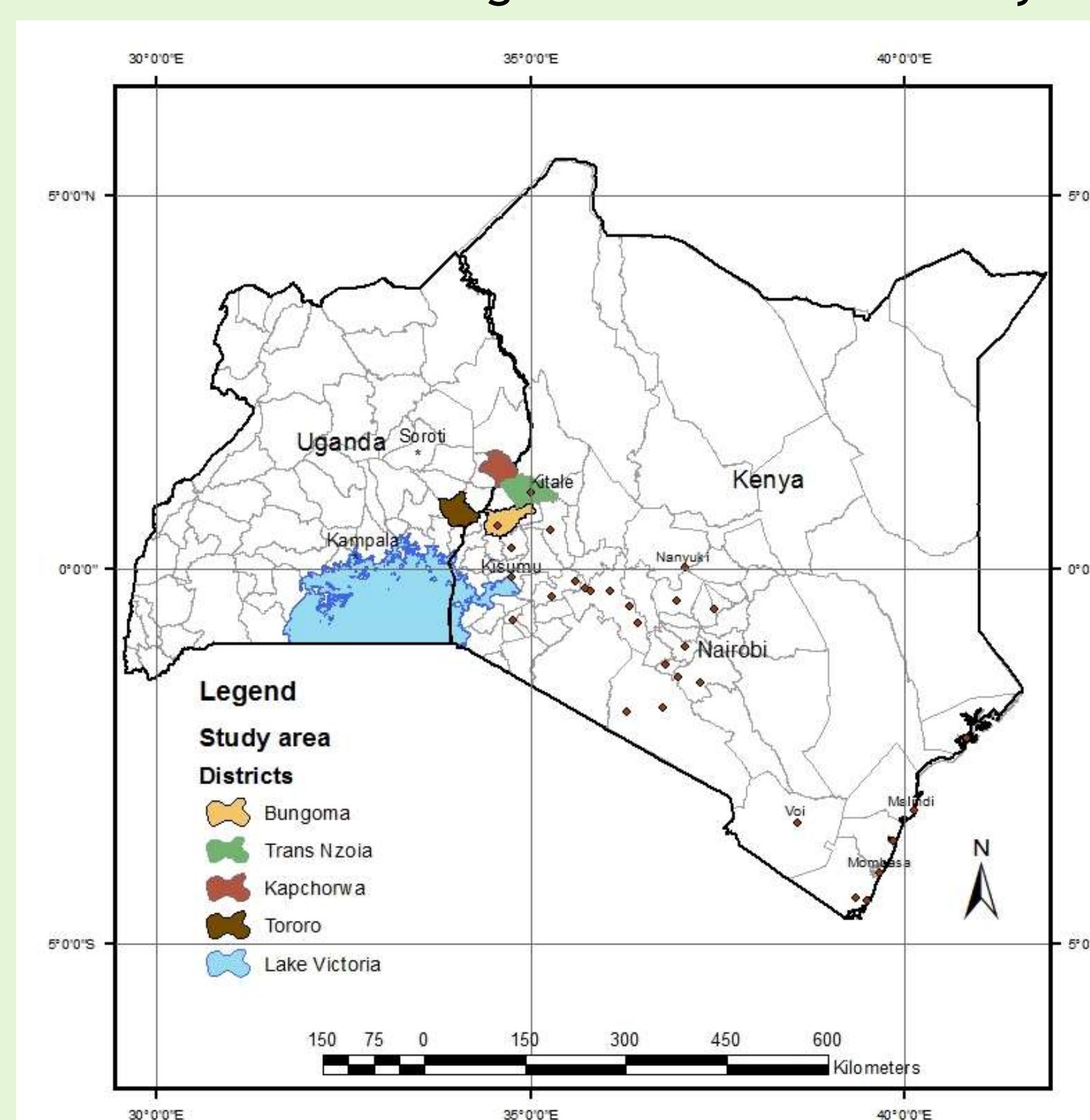


Fig. 1

Experimental layout in a RCBD with split plots in space:

- Tillage: CT, MT & NT (whole plot factor);
- Cropping system: intercrop, relay & strip (sub-plot factor).

Total SOC/N determined by dry combustion, mineralizable C by aerobic incubation, microbial biomass by fumigation-extraction, mineral N - calorimetrically, BD by core method, PR by cone index and infiltration by mini-disk infiltrometer.

## Results

- MT and NT treatments are trending towards more SOC accumulation in 3 of the 4 study sites (Fig. 2).
- Use of mucuna, a leguminous cover crop, enhanced N fixation in Tororo (Fig. 3).
- Labile C & N pools were not significantly influenced by treatment effects (data not shown).
- Reduced tillage tended to increase soil compaction as indicated by higher BD and PR (Fig. 4 & 5).
- No till promoted formation of macropores in the soil (Fig. 6).

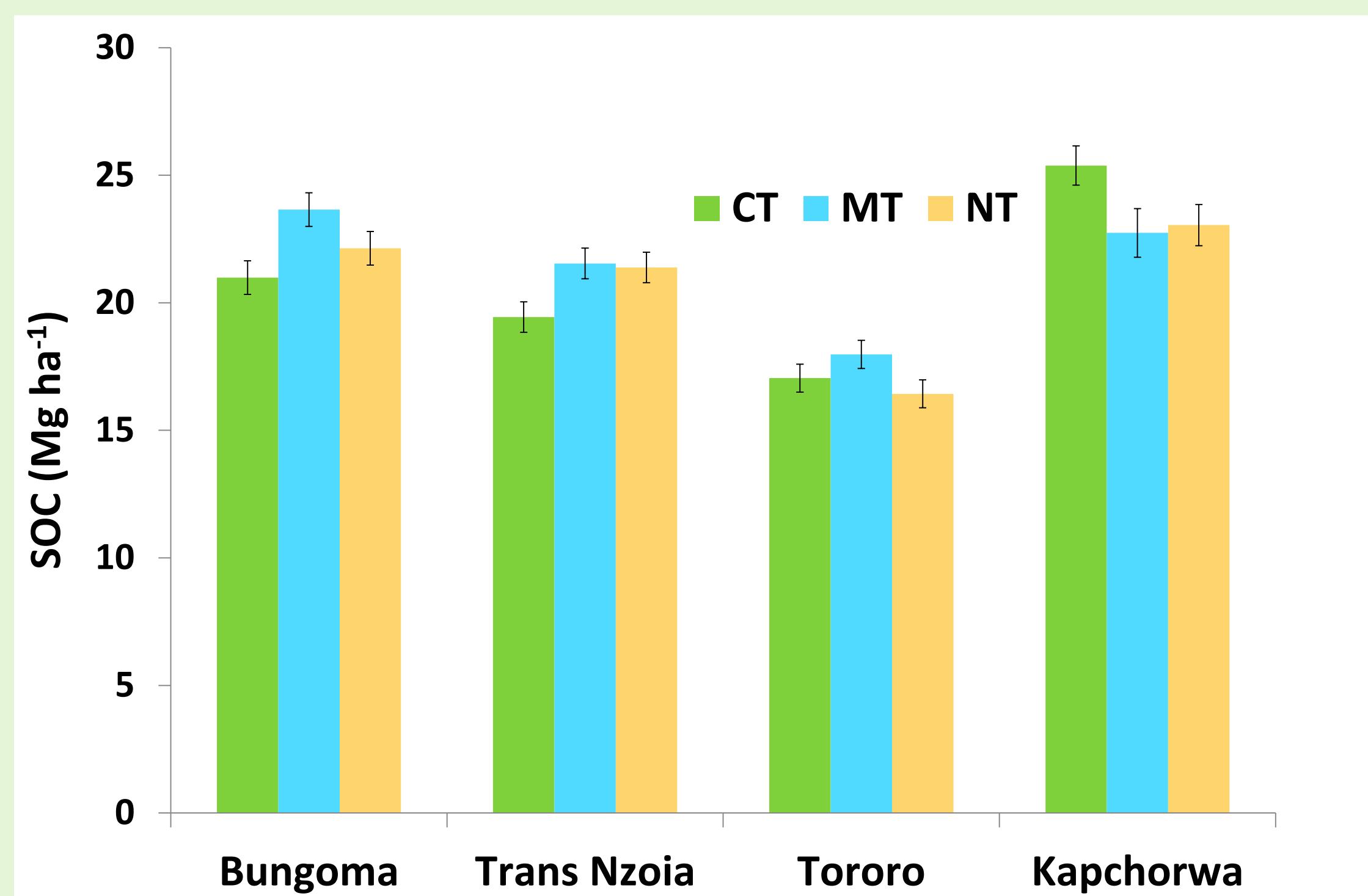


Fig. 2: Soil organic carbon (SOC) as influenced by tillage system

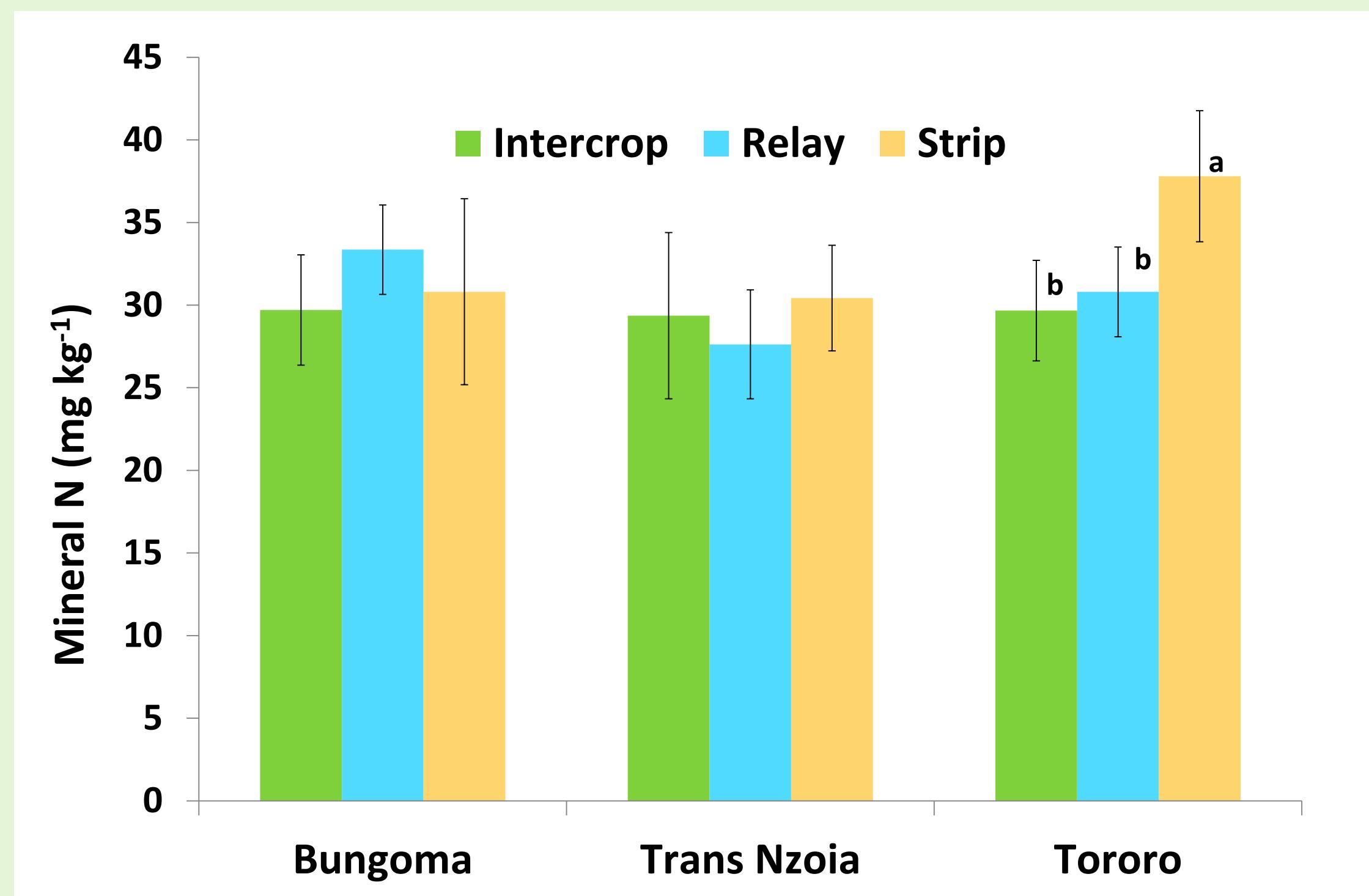


Fig. 3: Mineral N under different cropping systems

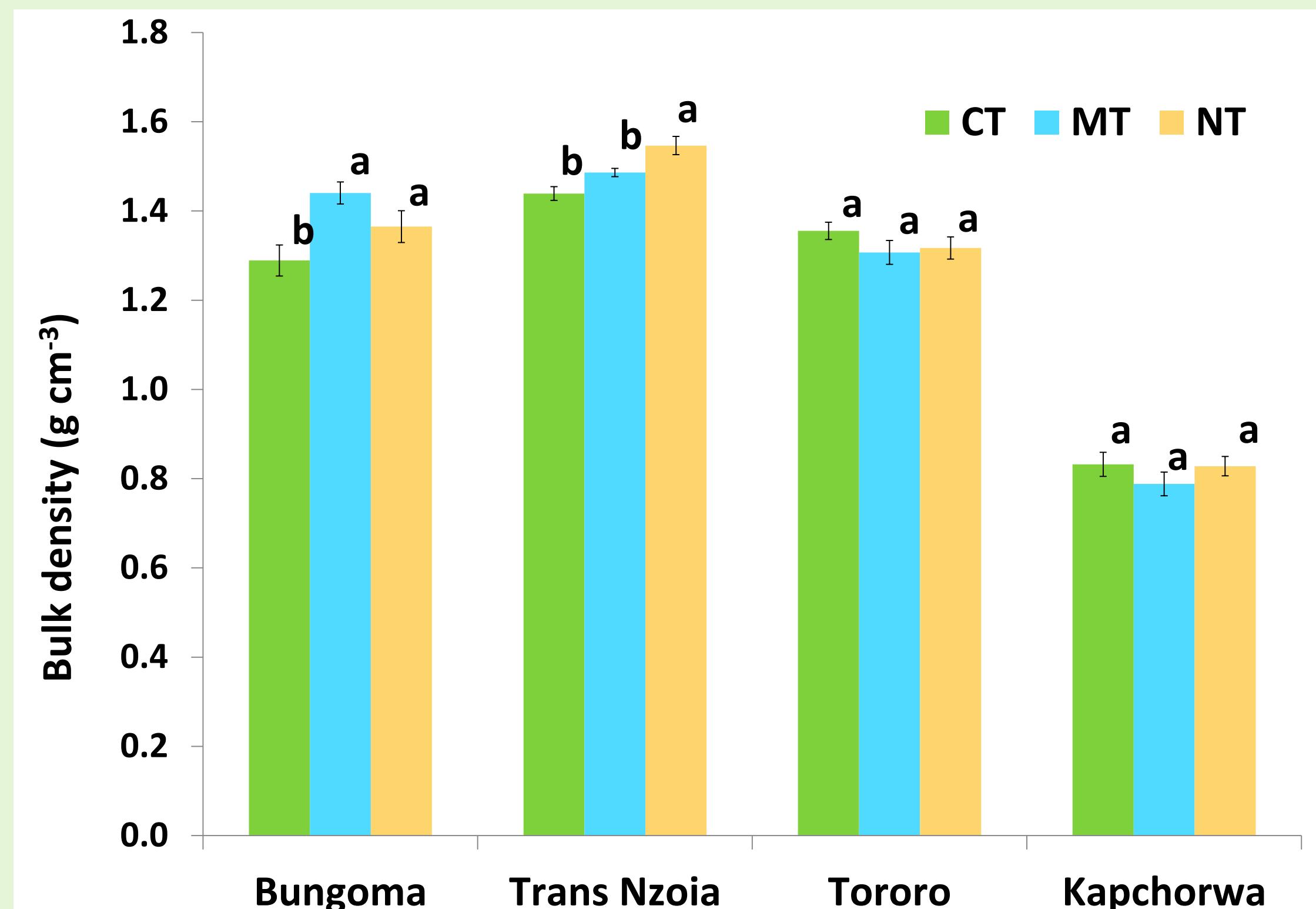


Fig. 4: Bulk density as influenced by tillage system

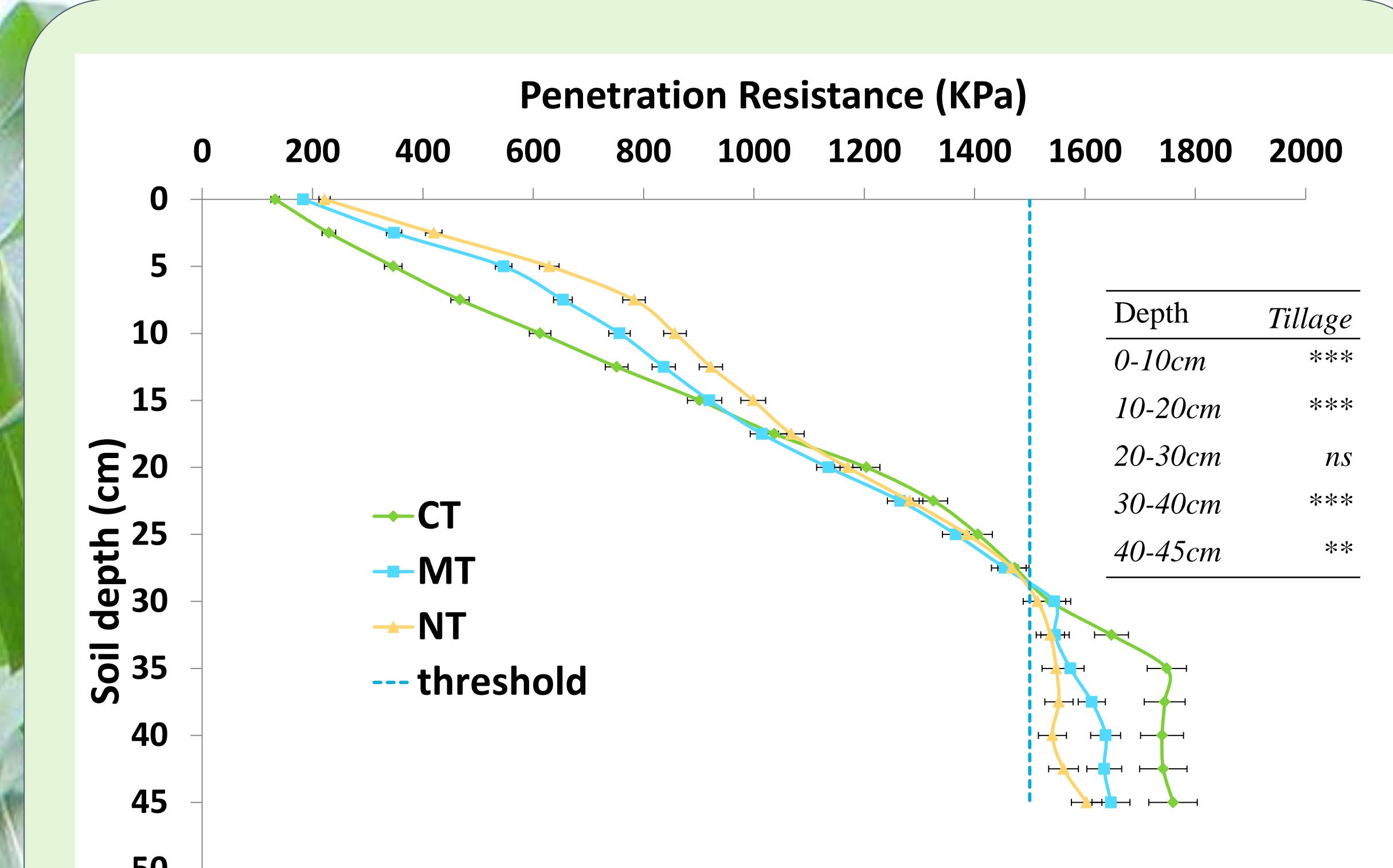


Fig. 5: Penetration resistance as impacted by tillage system (averaged across all sites)

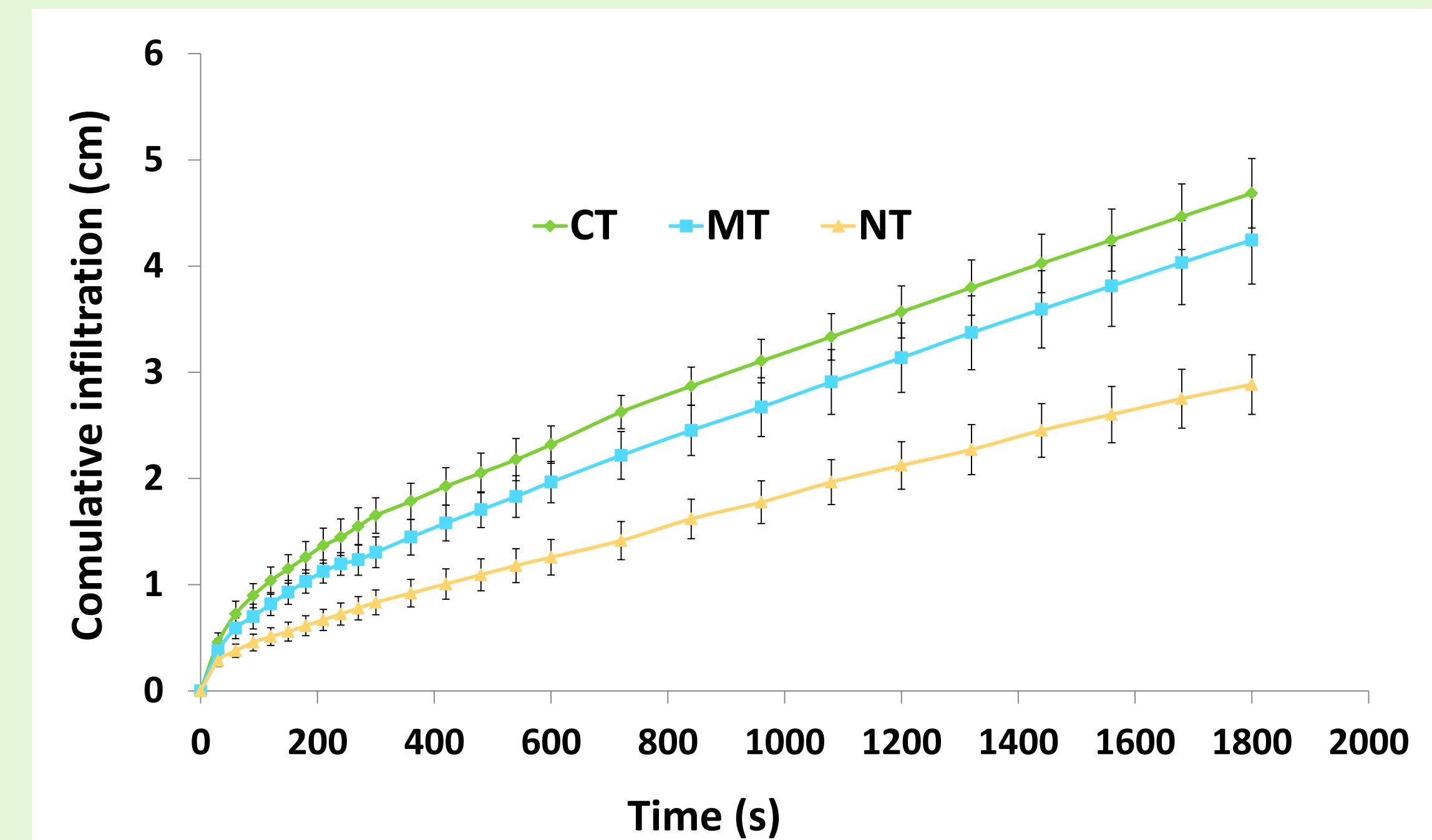


Fig. 6: Cumulative water infiltration under different tillage systems in Trans Nzoia

## Conclusion

- Reduced tillage is showing positive trends in SOC accumulation.
- Leguminous cover crops such as mucuna can be used to enhance N fixation.
- Near surface soil tends to compact under MT & NT, hence we recommend:
  - Ripping to break the hardpan, and
  - Retention of sufficient crop residue/cover crop biomass.
- Below the plough depth, MT & NT are showing lower PR perhaps due to better soil structure.

## References

- Govaerts, B., Verhulst, N., Castellanos-Navarrete, A., Sayre, K.D., Dixon, J., Dendooven, L., 2009. Conservation Agriculture and Soil Carbon Sequestration: Between Myth and Farmer Reality. *Critical Reviews in Plant Sciences* 28(3), 97-122.
- Okeyo, J.M., 2014. The effect of conservation agriculture practices on soil quality and crop productivity under smallholder farming systems in western Kenya and eastern Uganda, PhD thesis, University of Wyoming, 178 pp.
- Strudley, M.W., Green, T.R., Ascough, J., 2008. Tillage effects on soil hydraulic properties in space and time: State of the science. *Soil and Tillage Research* 99(1), 4-48.
- Thierfelder, C., Cheesman, S., Rusinamhodzi, L., 2012. A comparative analysis of conservation agriculture systems: Benefits and challenges of rotations and intercropping in Zimbabwe. *Field Crops Research* 137, 237-250

## Acknowledgement

This work was funded by USAID through the SANREM Innovation Lab, Conservation Agriculture Production Systems Project