Traffic and Tillage effects on soil carbon dynamics and crop yield

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1. Background and objectives

Different traffic and tillage management systems can have significant effects on soil organic carbon (SOC) and crop yield. While the impacts of traffic or tillage on soil are well documented, their combined effects are less understood. Our work was conducted to gain an in-depth understanding of the interacting effects of traffic and tillage systems on SOC dynamics and crop yield.

A unique long-term experimental site was established at Harper Adams University (Shropshire, UK) in 2011 to help investigate these effects and be able to inform soil and mechanisation management practices.

2. Materials and Methods

A randomised block design field-scale experiment was established in 2011 at Harper Adams University (U.K.). The site has 36 plots (4 m × 80 m) where three tillage (Deep, Shallow, Zero) and three traffic (STP: Standard tyre pressure, LTP: Low tyre pressure, and CTF: Controlled Traffic Farming) treatments are compared (Fig.1). Winter barley *var.* Belfry was established in the autumn of 2020 and harvested in the summer of 2021.

Soil samples were collected after harvest at the 0-100, 100-200 and 200-300 mm depth intervals for estimation of soil organic carbon (SOC).

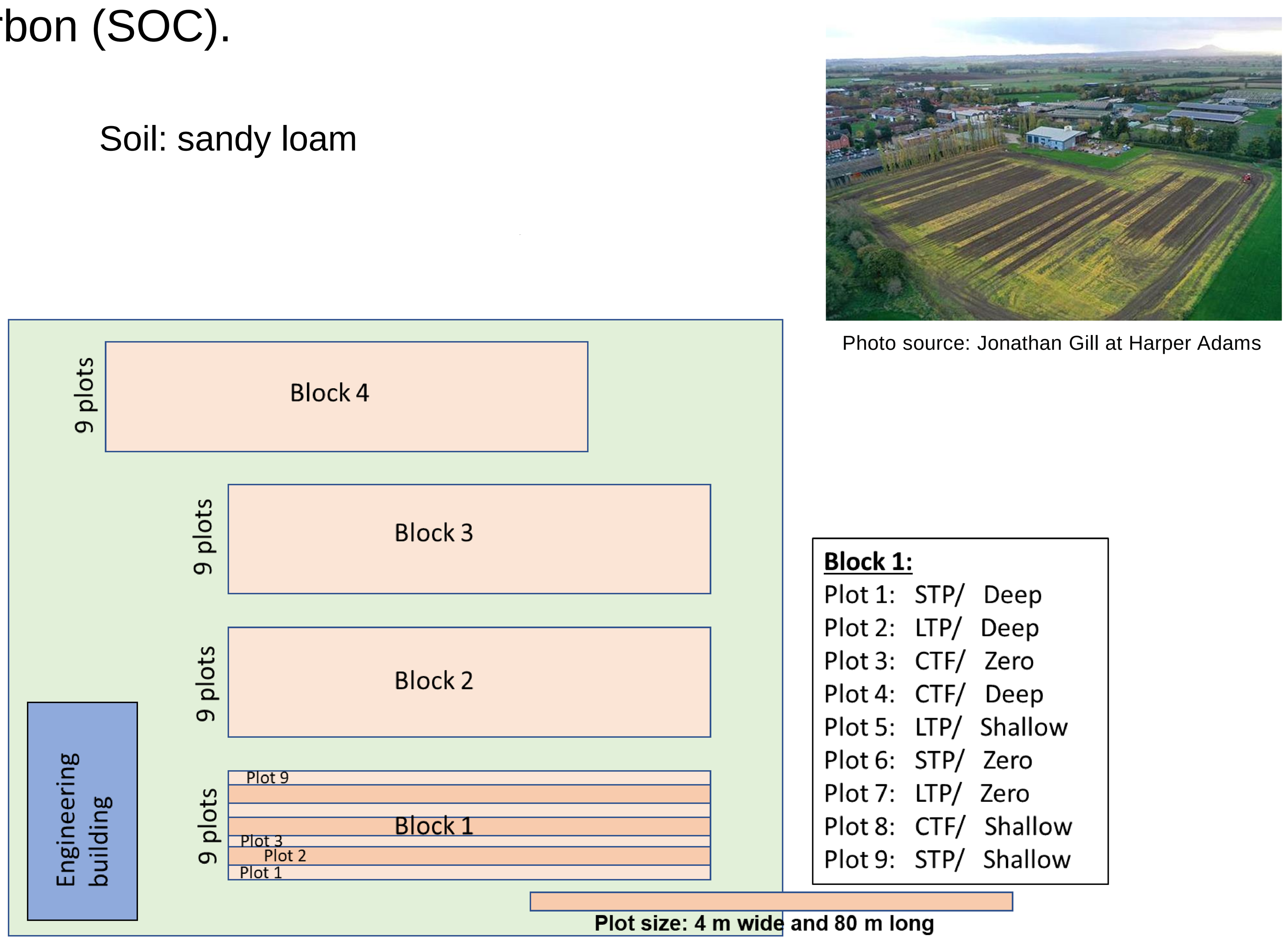

Figure 1. Experimental site and treatments.

3. Results

- SOC stocks were higher in zero-tillage (CTF and LTP) compared to deep and shallow tillage both on (CTF) at 0-300 mm (Fig.2) (P<0.05).
- Tillage had a significant effect on SOC stocks, with soils under zero tillage storing 5 Mg ha^{-1} more than shallow and deep tillage.
- SOC stocks were distributed differently across the soil profile but generally decreased with an increase in soil depth: the average SOC stocks were marginally higher at 0-100 mm (28.84 ±1.23 Mg ha^{-1}) than at 100-200 mm (27.63 ±1.05 Mg ha^{-1}). Both soil layers exhibited higher (P<0.01) SOC compared to the 200-300 mm depth interval (22.82 ±1.06 Mg ha^{-1}) as shown in Fig. 3.
- There were no significant differences in grain yield between traffic and tillage treatments in the 2021 harvest season (Fig. 4).

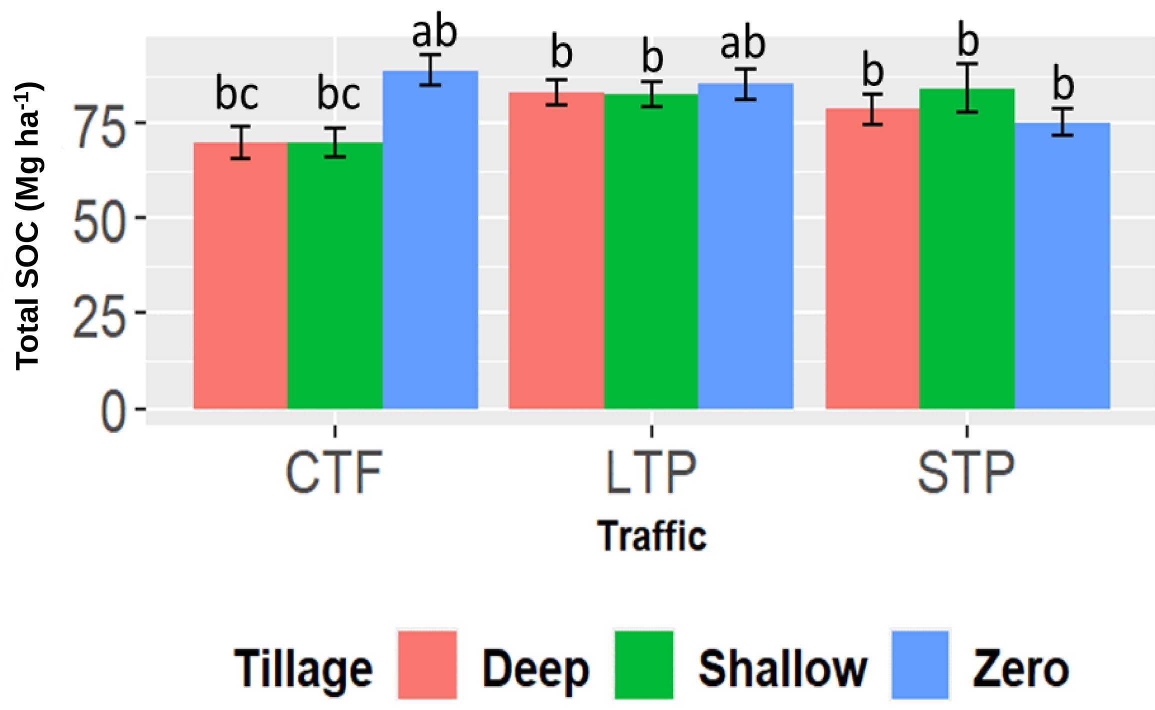

Figure 2. Soil organic C stocks at equivalent soil mass (EMS) on 0-300 mm.

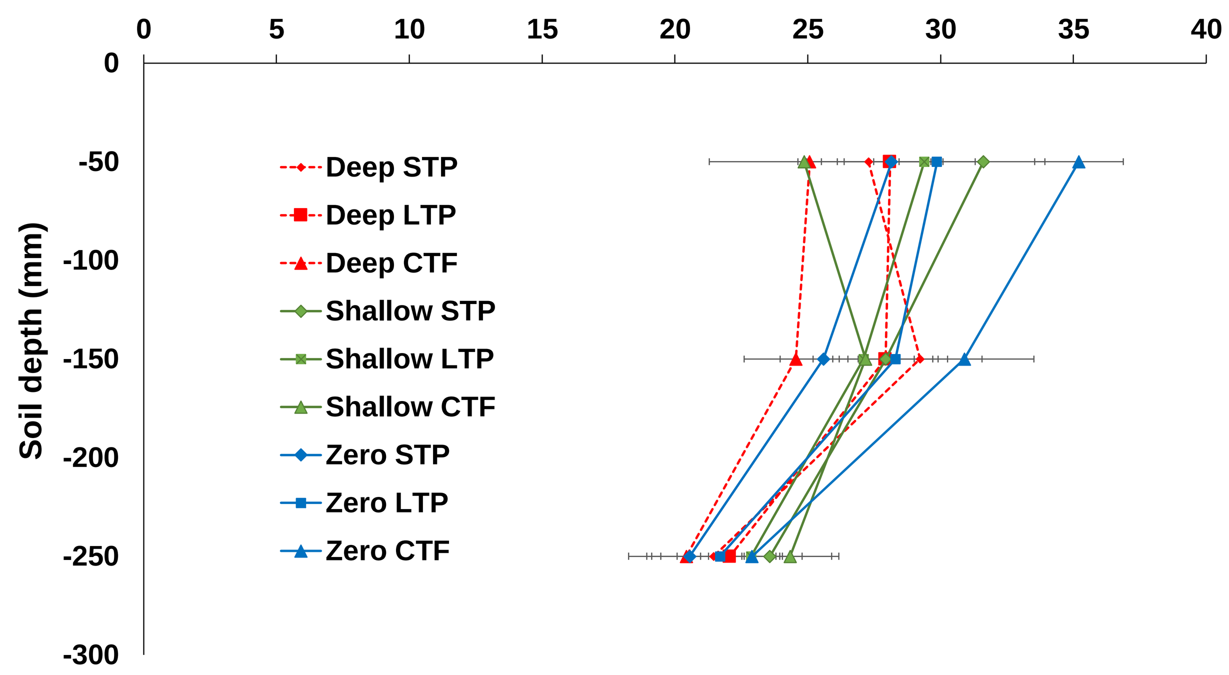

Figure 3. Soil organic C stocks at equivalent soil mass (EMS) on 0-300 mm.

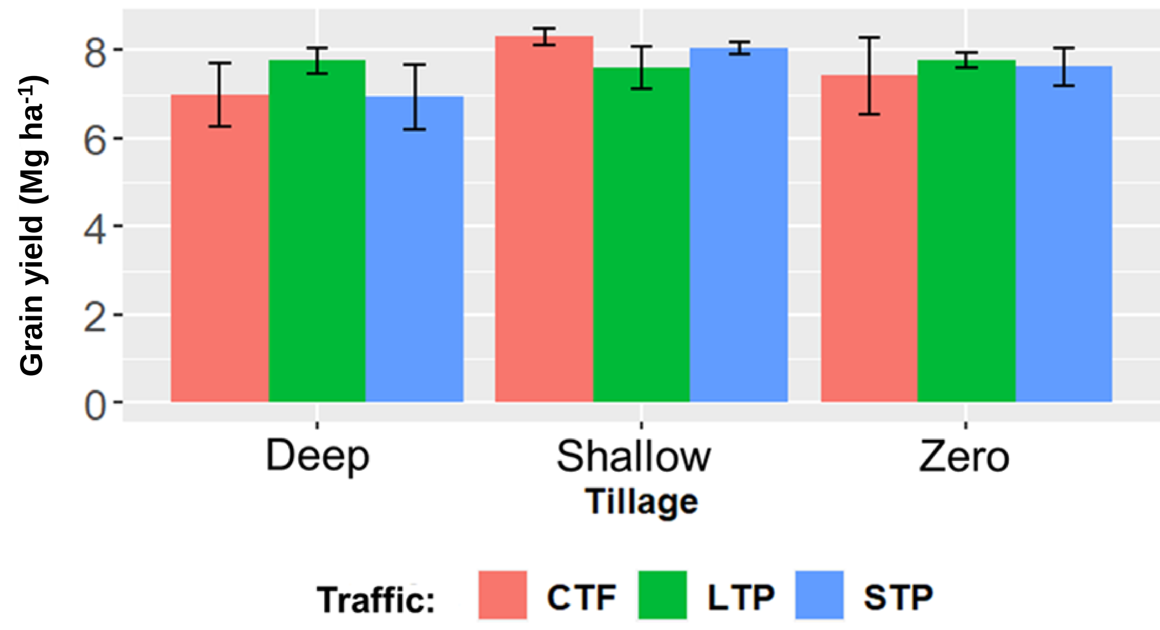

Figure 4. The effect of tillage on grain yield of winter barley.

4. Key Conclusions

- Reduced tillage and traffic (zero-tillage combined with CTF or LTP) has potential to increase SOC under the U.K. climatic conditions, particularly in the topsoil.
- Zero-tillage soil stored about 5 Mg ha^{-1} [SOC] more than either the shallow or deep tillage treatments.
- There were no apparent effects of tillage or traffic on grain yield (single season results).
- Additional C savings may be possible with the adoption of zero-tillage coupled with CTF through reduced fuel use (i.e., increased energy-use efficiency).

5. Future Work

Soil carbon dynamics will be further investigated by looking at natural ^{13}C abundance.

Millet crop (June '22 – Sept. '22). C4 plants will be established in spring where only C3 plants have grown.

Methodology:

- SOM and SOC stocks will be measured as before.
- δ13C isotope ratios will be applied to different depths and different SOM fractions to investigate soil carbon dynamics.

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