Trade-offs between yield, soil organic matter and greenhouse gases in a paired reduced-tillage and reduced-rain field trail

Antonios Apostolakis[1], Paulina Englert[1,2], Stefan Siebert[1] and Ana Meijide[1,2]

Project website

Antonios' X/Twitter

1. Introduction

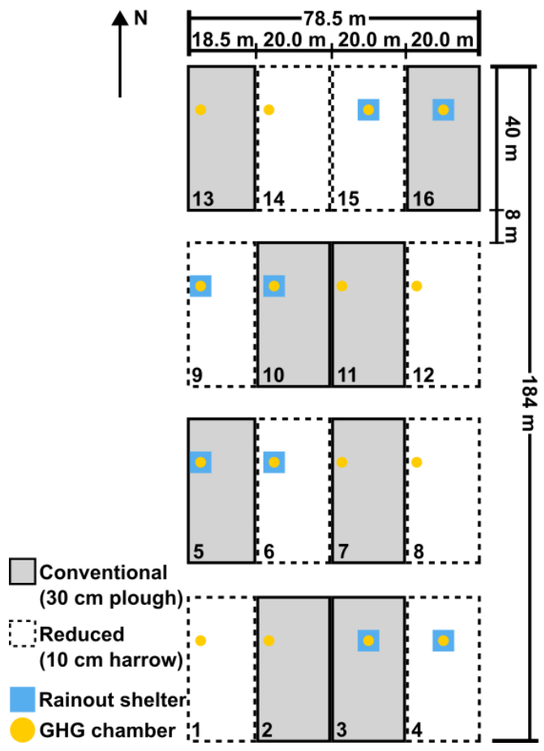
Reduced tillage (RT) is a widely applied practice often found to increase **organic carbon (OC) sequestration** in the topsoil compared to **conventional tillage (CT)**. However, it is unclear how **long-term** applications of reduced tillage will affect yield, soil OC and **greenhouse gas (GHG)** emissions especially under drier (future) conditions.

2. Design

Garte-Süd is a **field trial** comparing CT and RT in a Luvisol (silt =73%, clay =15%, pH =6.6) in central Germany (MAP =618 mm, MAT =9.5°C) running since **1970**.

In 2023, we installed **rainout shelters** (2 m × 2 m) designed to **intercept 50%** of precipitation.

We measure **soil CO_2 efflux** & **N_2O fluxes** with static chambers and portable gas analyzers.



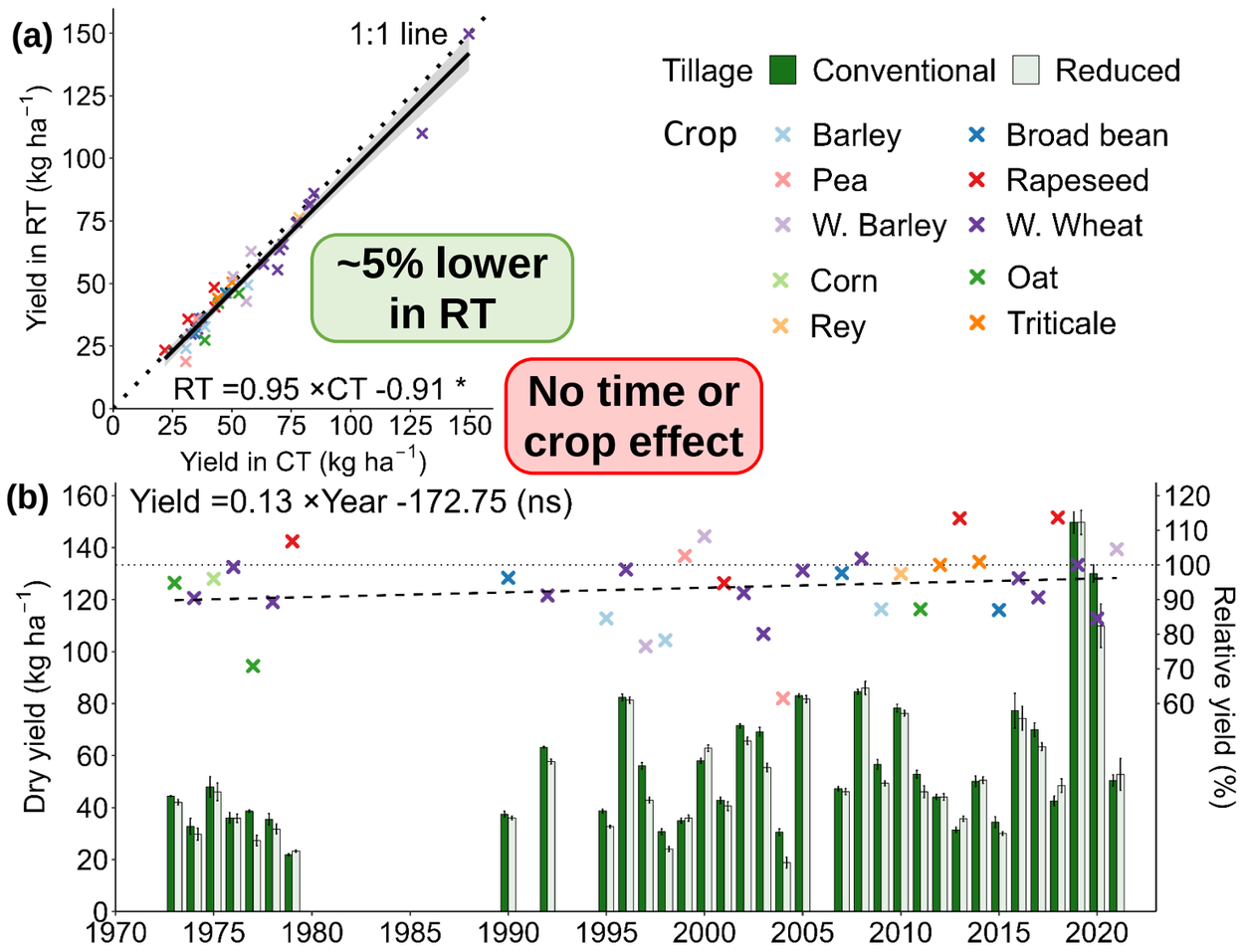


Fig 1. Crop yield in Garte-Süd. (a) Correlation between dry yield under Conventional (CT) and Reduced (RT) tillage. (b) Dry yield under CT and RT, and relative yield under RT over time.

Conclusions

Reduced tillage increased **soil OC** without increasing **soil C losses** as CO_2. However, it decreased **crop yield** and, under reduced rainfall, it increased **soil N_2O** emissions.

If no **agricultural land leakage** occurs and if **precipitation patterns** stay as usual, reduced tillage has a **climate change mitigation potential** in temperate fine-textured soils.

3. Preliminary results

- **Crop yield** was 5% lower under RT than CT (Fig 1b)
- **Soil OC** was higher under RT than CT at 0-10 cm (Fig 2c)
- Long-term **soil water** was not affected by tillage (Fig 3a)
- **Soil CO_2 efflux** was 22% lower under RT than CT under 100% rainfall (Fig 3b)
- **Soil N_2O flux** was 133% higher under RT than CT under 50% rainfall (Fig 3c)

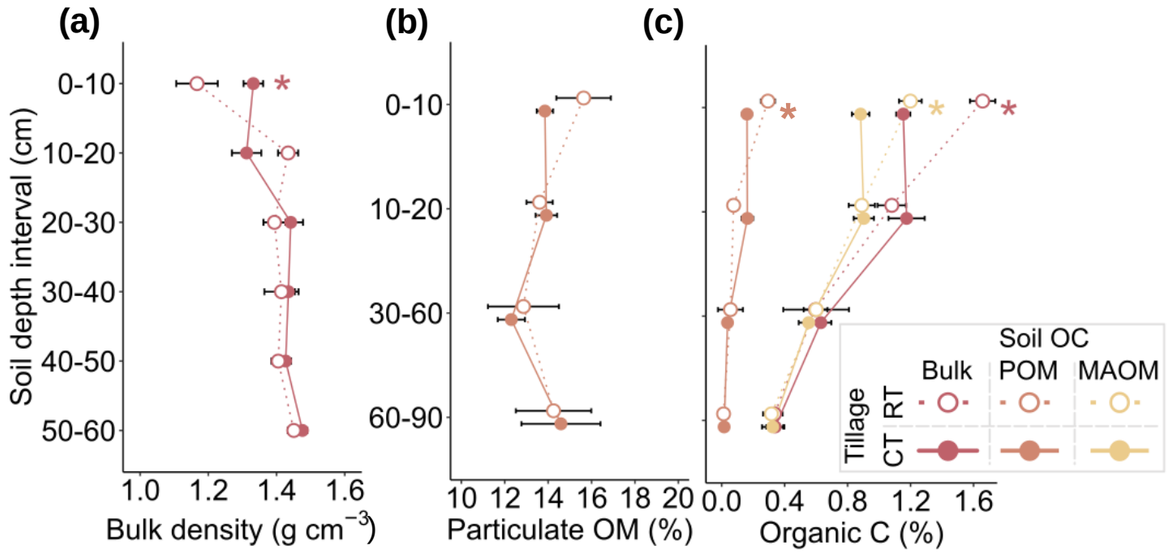
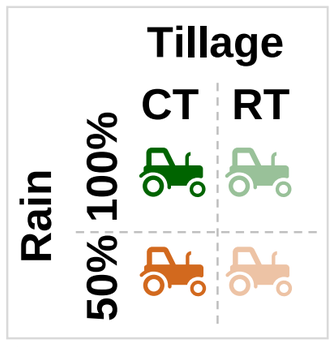


Fig 2. (a) Soil bulk density (n =6), (b) particulate organic matter (POM) content (n=8) and (c) soil organic carbon content of bulk soil, POM and mineral-associated organic matter (MAOM) (n=8). Asterisks (*) indicate significant differences between Reduced and Conventional tillage based on linear models.



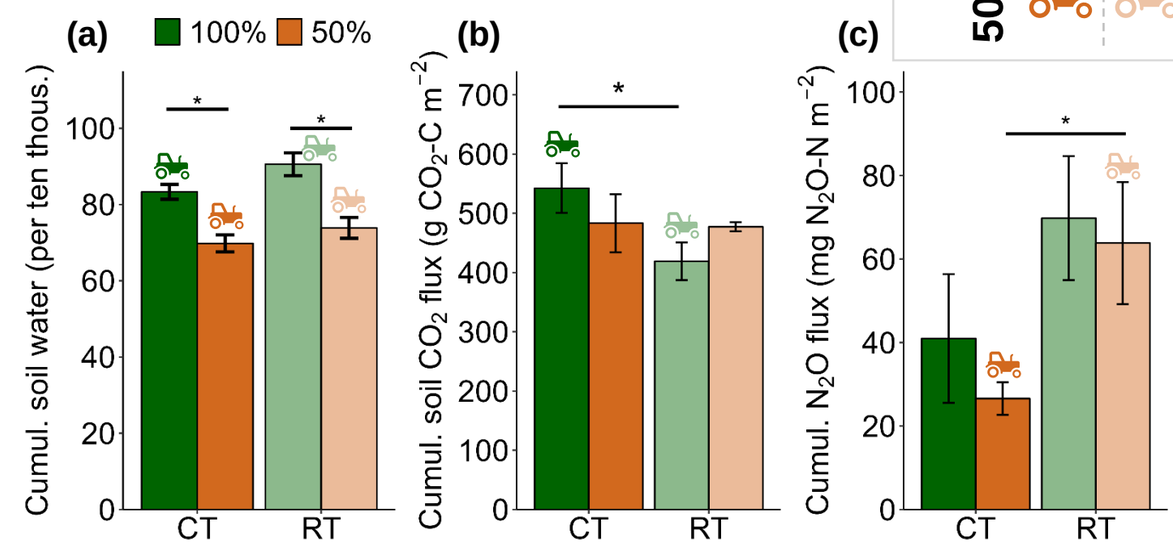


Fig 3. Cumulative soil water content (a), soil CO_2 efflux (b) and soil N_2O flux (c) for Conventional (CT) and Reduced (RT) tillage and Ambient (100%) and Reduced (50%) rain. Sample size n =4.

Affiliation: [1]Department of Crop Science, Division Agronomy, University of Göttingen, [2]Environment Modeling, Institute of Crop Science and Resource Conservation, University of Bonn.

Acknowledgements: We thank Gabi Kolle and Christiane Münter for their support with lab and field work.