

# Inconsistent Methods Compromise the Estimation of Soil Carbon Stock Changes under Perennial Cropping Systems

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## Perennial cropping systems for climate mitigation







### Inconsistent methods for estimating soil C stock changes

• Fixed depth (FD)

Soil depth-based C stock

Soil C stock = C content  $\times$  Bulk density  $\times$  Depth

• Equivalent soil mass (ESM)

FD soil C stock corrected by soil mass



They draw the same conclusion only when considering the entire soil prefile





### Inconsistent methods for estimating soil C stock changes

Absolute change ("change over time")



Soil C stock change = C stock<sub>i</sub> - C stock<sub>0</sub>



Relative change ("space-for-time")





### Differences methods may lead to different conclusions







EGU25 | YIWEI SHANG 29 APRIL 2025 | PHD STUDENT (Shang et al., in prep.)

## **Meta-analysis**

#### Hypothesis:

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The fixed-depth (FD) method and the relative change approach introduce biases in estimating soil C

stock changes under perennial cropping systems.





## **Methodological differences**



- Perennial cropping systems significantly enhanced topsoil and cumulative soil C stocks
- FD-relative change approach showed significant differences with other methods







## **Differences between cropping systems**



- Four types of perennial cropping systems significantly enhanced topsoil C stocks;
- Integrated rotation showed soil C loss in subsoil, and had no effects on cumulative soil C stocks







## **Differences between cropping systems**



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(estimated by ESM-absolute change)





## **Previous land use**

• The effect of perennial cropping system on soil C stock changes also depends on previous land use, which determines the initial soil C content.









## **Conclusion and perspectives**



To improve the accuracy and comparability of future research, we strongly recommend the adoption of standardized methods for estimating and reporting soil C stock changes.

- Improve method: missing initial soil C stock may lead to bias, and soil C stock changes need to be corrected for bulk density. ESM-based absolute change could be the most robust approach, but further validation in independent studies is needed.
- Improve cropping systems: integrating perennial crops into rotations did not enhance soil C stocks.
- Consider subsoil: enhancing subsoil C stocks remains a challenge in perennial cropping systems.
- Consider previous land use.

(Shang et al., in prep.)





#### Thank you for your attention!

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