



HAL
open science

Carbon stabilization in soil after organic amendment application -A comparison of two biomass use scenarios

Tobias Bölscher, Valérie Pouteau, Cédric Plessis, Claire Chenu, Cyril Girardin, Oliver Azam, Camille Launay, Sabine Houot

► To cite this version:

Tobias Bölscher, Valérie Pouteau, Cédric Plessis, Claire Chenu, Cyril Girardin, et al.. Carbon stabilization in soil after organic amendment application -A comparison of two biomass use scenarios. 9th International Symposium on Soil Organic Matter SOM 2024, May 2024, Ben Guerir, Morocco. hal-04611923

HAL Id: hal-04611923

<https://hal.science/hal-04611923v1>

Submitted on 14 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Carbon stabilization in soil after organic amendment application – A comparison of two biomass use scenarios



Tobias BÖLSCHER¹, Valérie POUTEAU¹, Cédric PLESSIS¹, Claire CHENU¹,
Cyril GIRARDIN¹, Olivier AZAM², Camille LAUNAY^{1,3}, Sabine HOUOT¹

¹ UMR ECOSYS, Université Paris-Saclay, INRAE, AgroParisTech, Palaiseau, France

² INRAE Transfert Environment, Narbonne, France

³ UMR AGIR, Université de Toulouse, INRAE, Castanet Tolosan, France

Context and Objectives

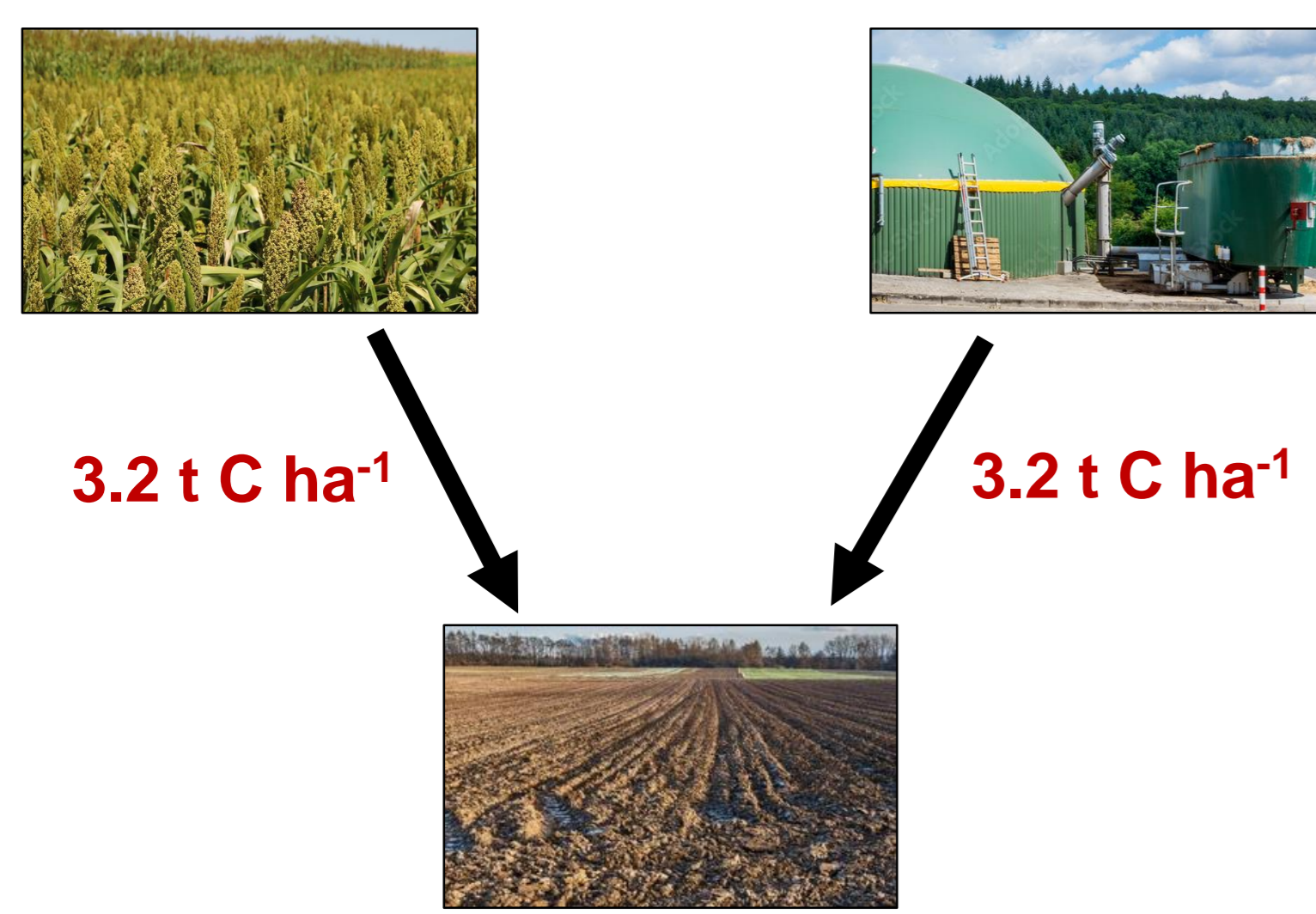
Organic amendments are used to maintain or increase soil organic carbon (C) in arable soil. Plant biomass can be directly applied to soil or processed prior its application, e.g. through anaerobic digestion.

Two scenarios:

Scenario A – Exogenous organic matter

Application of organic amendments according to fertilizer recommendations using exogenous organic matter

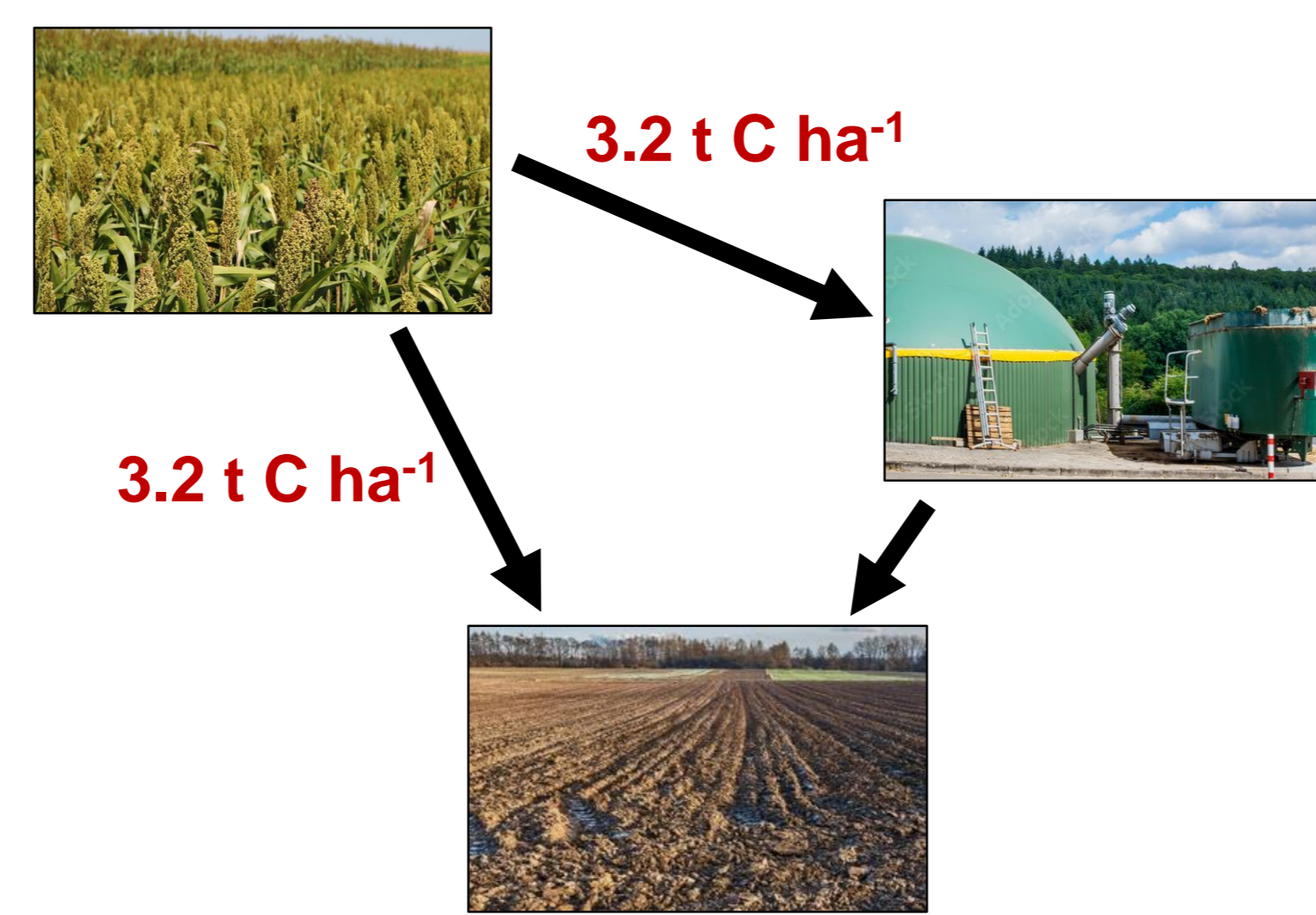
→ Equal application rates of C to soil



Scenario B – Farm internal recycling

Two possibilities: i) direct application of plant residues to soil, ii) prior use in anaerobic digester (biogas production)

→ Different application rates of C to soil



Soil organic C balance?

Overall C balance?

Materials and Methods

Plant residue and Digestate

- *Sorghum bicolor* (C4 plant)
- Experimental anaerobic digester



→ C balance during digestion

Incubation experiment

- *Luvisol* with C3 plant history (Closeaux, Versailles France)
- 85 days, 20 °C, 64 % water holding capacity
- Four treatments:

- Plant residue plus nitrogen (scenario A + B) (nitrogen addition to reach C:N ratio of digestate) } 1.03 mg C g⁻¹ soil = 3.25 t C ha⁻¹
- Plant residue (scenario A + B)
- Digestate scenario A
- Digestate scenario B } 0.37 mg C g⁻¹ soil = 1.17 t C ha⁻¹

Analysis of soil respiration

- Mineralization of organic amendments
- Priming of SOC
- Fitting one compartment, first-order model:

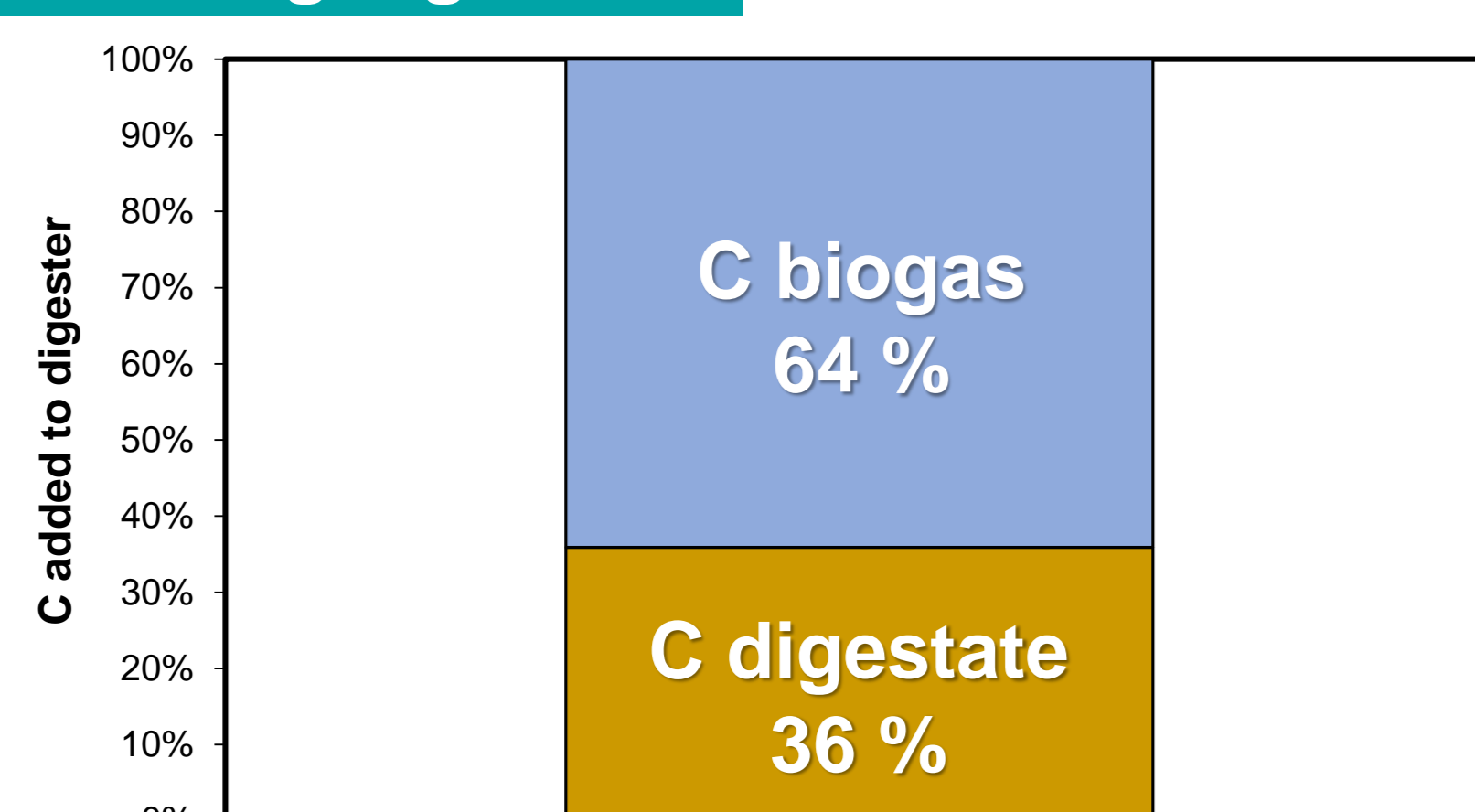
$$CO_2 - C_{amendment} = C_{fast} * (1 - e^{-\alpha * t})$$

Assumption: Model compartment (C_{fast}) represents fast decomposing C
→ remaining C considered 'stabilized C'

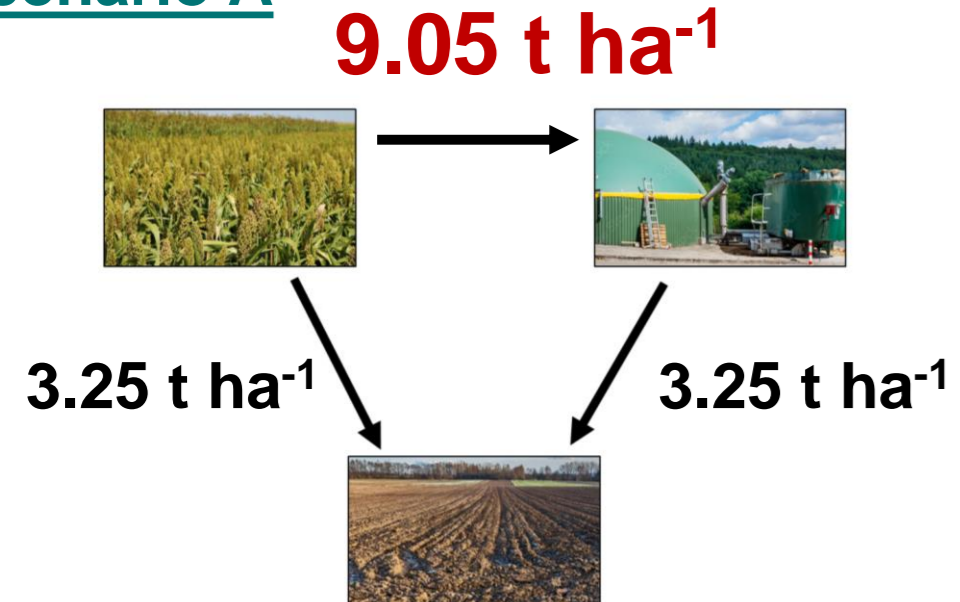
→ Soil C balance

Results

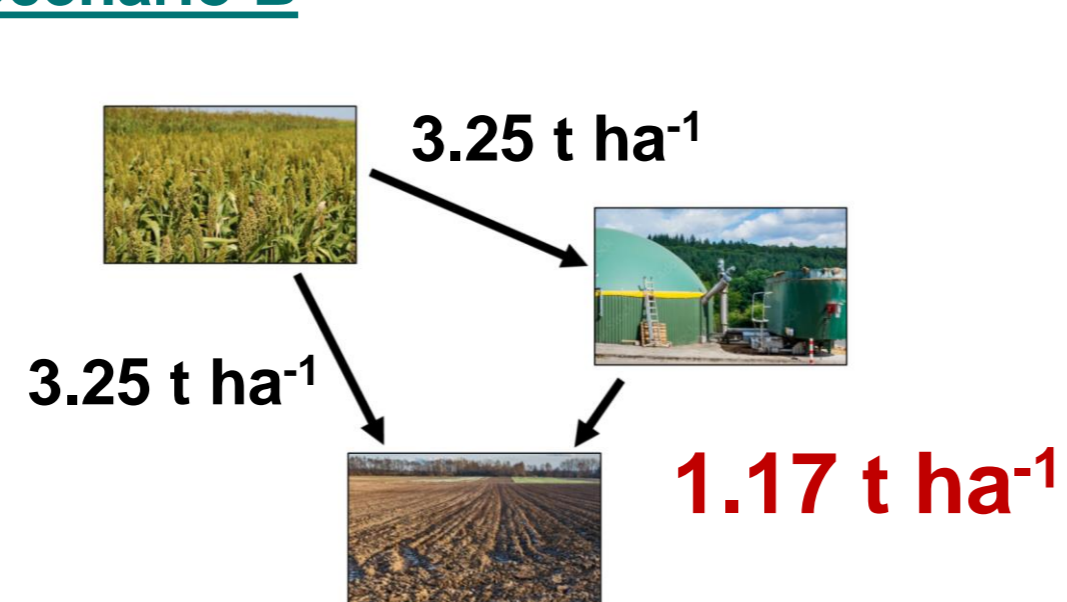
C balance during digestion



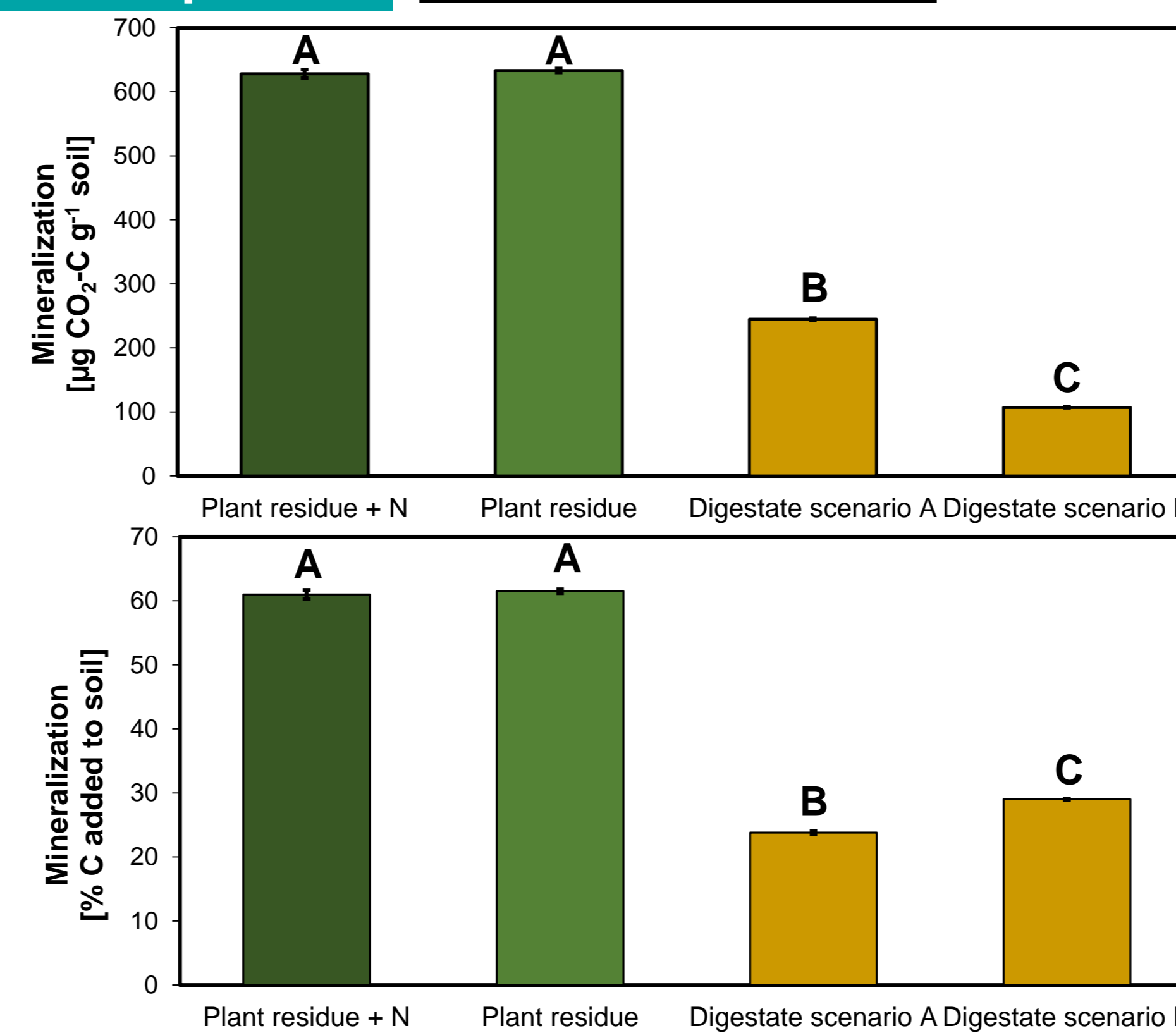
Scenario A



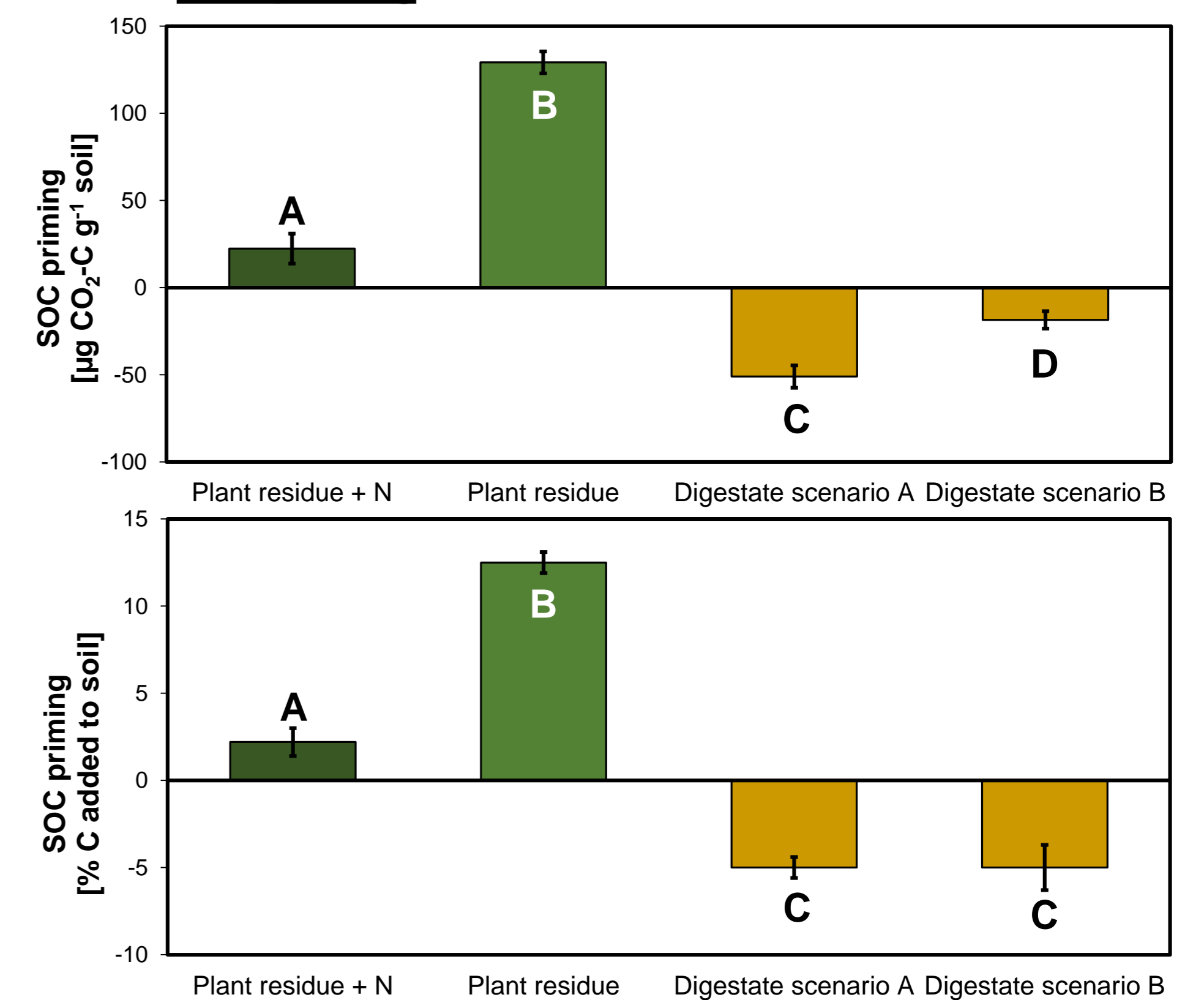
Scenario B



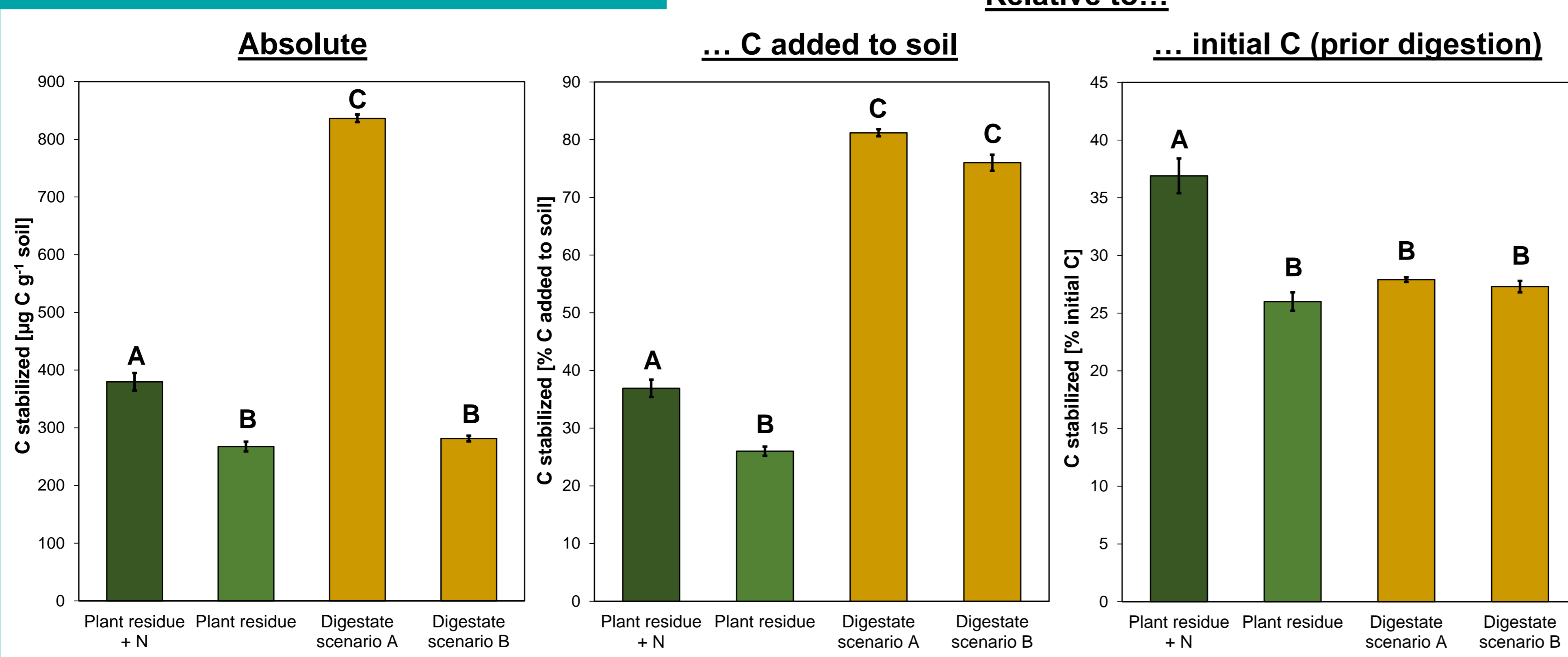
Soil respiration Amendment mineralization



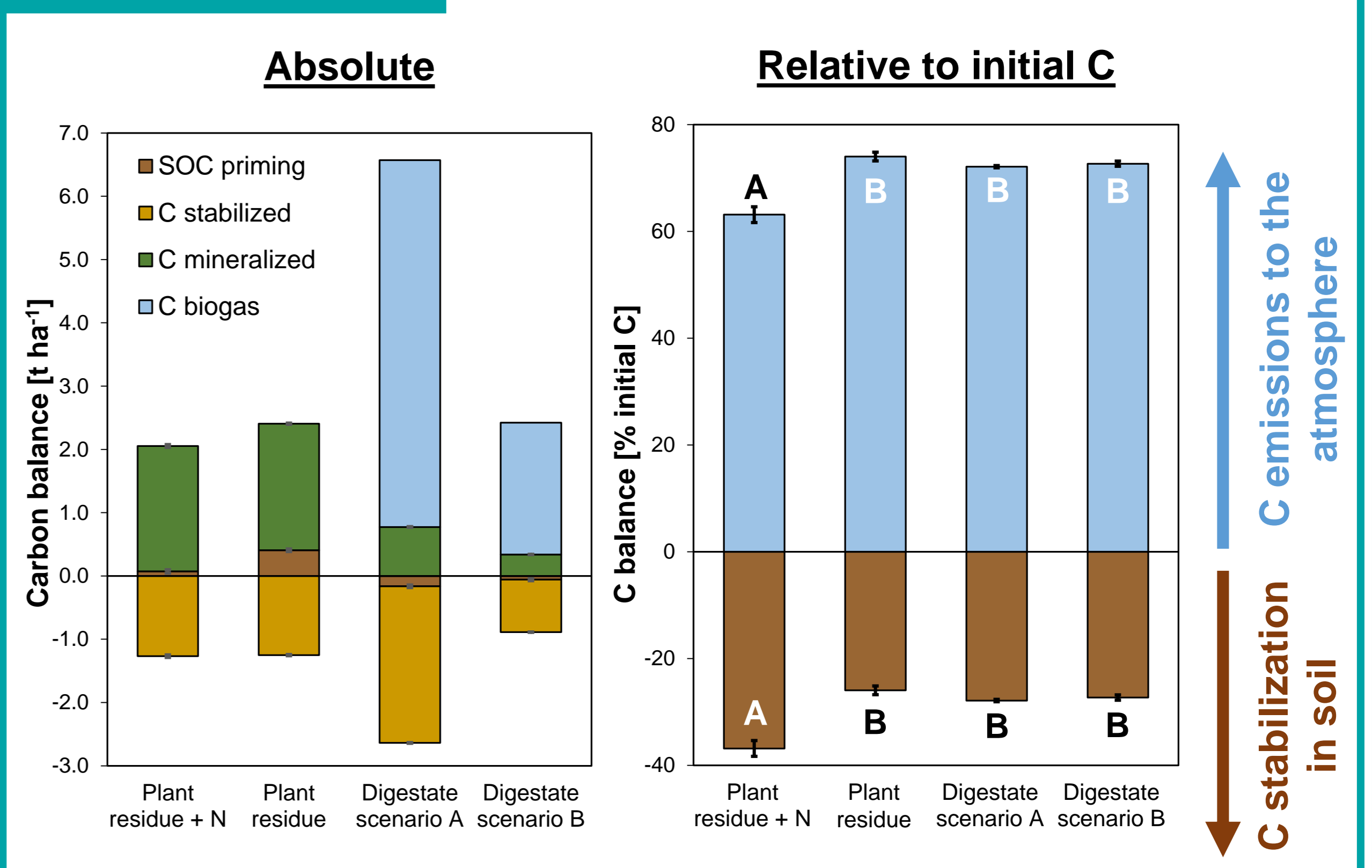
SOC priming



C stabilization in soil after 3 months



Overall C balance



Conclusions

Scenario A

Initially, more plant material required for digestion.

→ Largest C stabilization with digestate.

→ Largest C emission with digestate.

But, similar C stabilization relative to the initially utilized plant C.

Scenario B

Less C applied to soil for digestate, but...

→ ...similar C stabilization for plant residue and digestate,

→ Because relatively more digestate C is stabilized in soil than plant C.

Yet, similar C stabilization relative to the initially utilized plant C

Overall: Largest C stabilization when plant residue is applied together with N to soils and no differences between other treatments/scenarios