Federal Ministry of Food and Agriculture

GLOBAL FORUM FOR FOOD AND AGRICULTURE

Soil organic carbon sequestration potential of European agricultural

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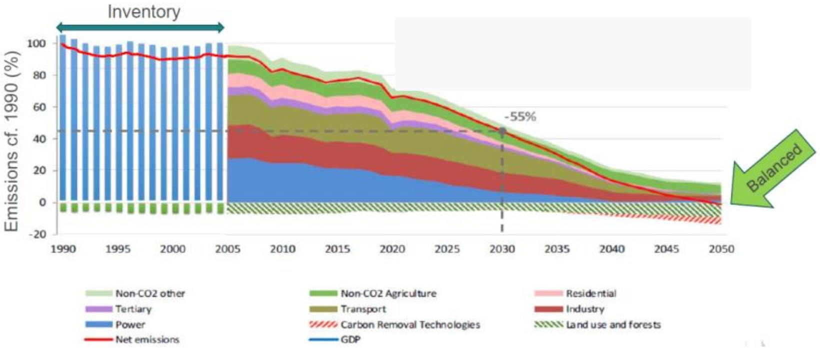
Carbon farming in the European Union



- Sink of 310 Mio. t CO_2 in LULUCF in 2030
- That is doubling of the current sink
- C sequestration in soils forstering via the voluntary CO_2 certificates market (CRCF)

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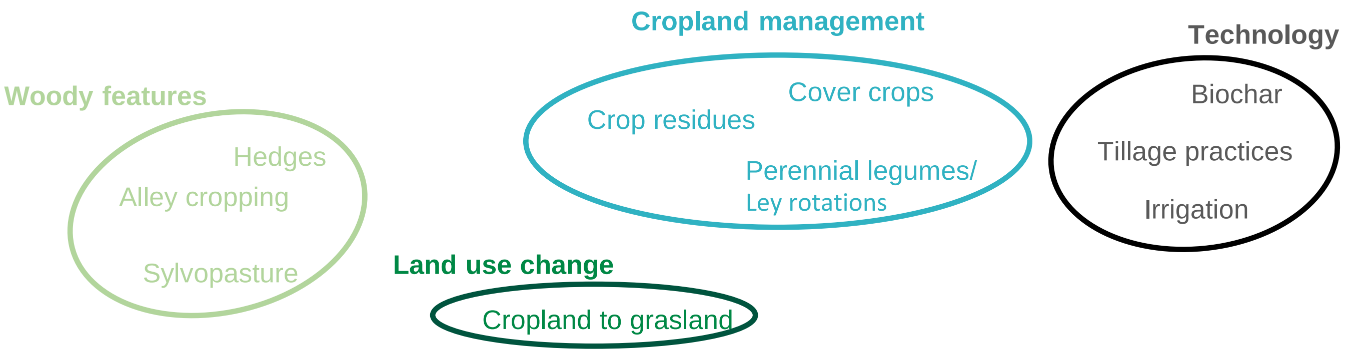
Which measures can increase SOC in Europe?

→ **Identification of tested and validated measures for increasing soil carbon in mineral soils under agricultural use in Europe**

- **Creation of an EU-wide database with European (LTE) data (1394 publications)**
- **Identification of agricultural measures that increasing SOC based on the database**



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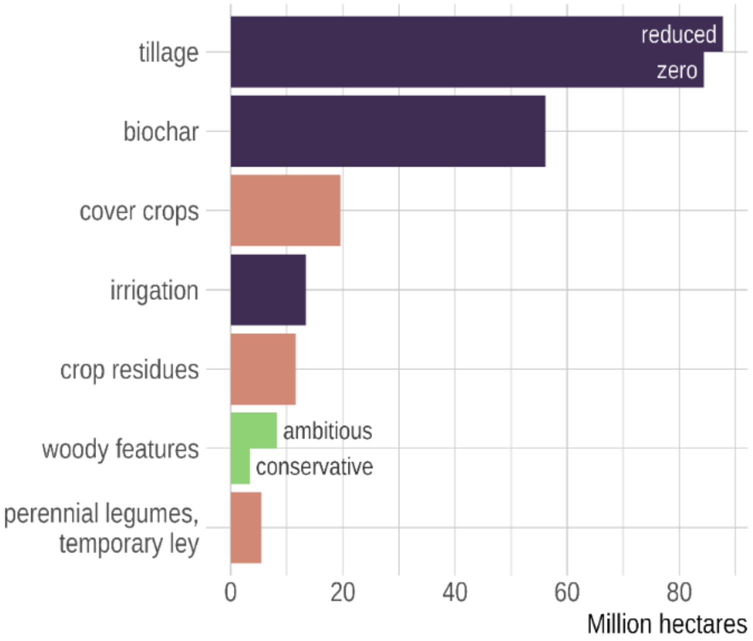
Potential area of implementation of measures



$$C\ seq\ pot = A_{measure} * (\text{SOC stocks} * \text{EF})$$

Seidel et al. In prep

→ **The potential area for implementation C sequestration measures strongly depend on the measure**

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Total C sequestration potential

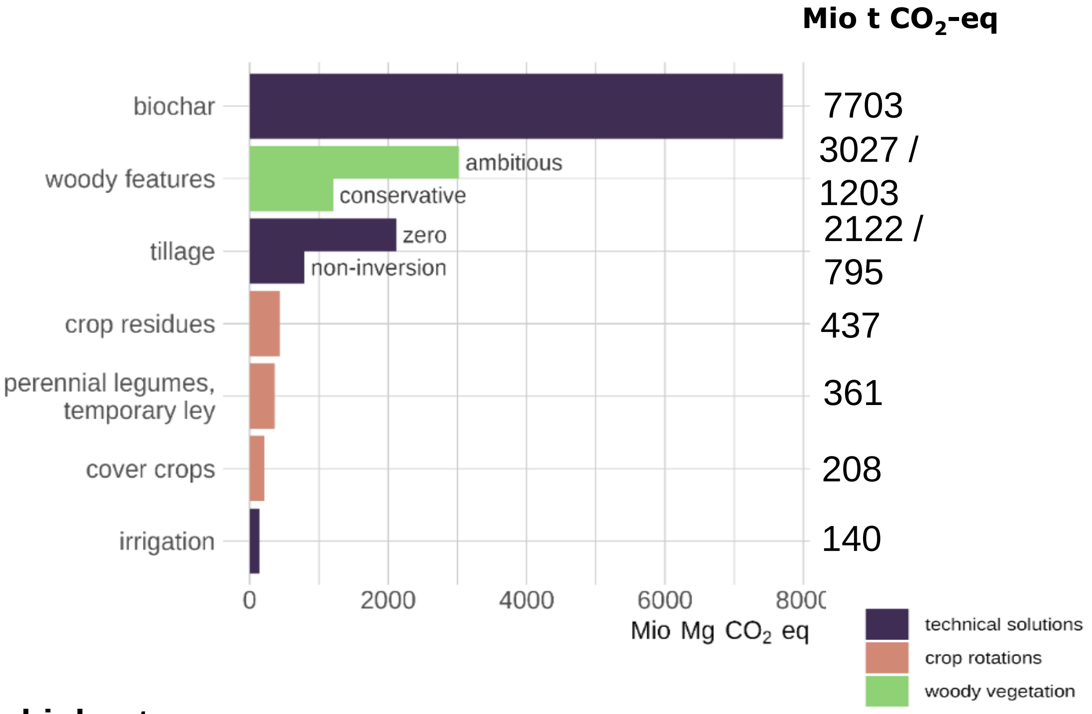
Baseline: Total EU+ agricultural area

= 218 Mio hectare

⇒ For each measure an

area of implementation

was determined



→ **Biochar and agroforestry have the highest C sequestration potential**

Seidel et al. in prep

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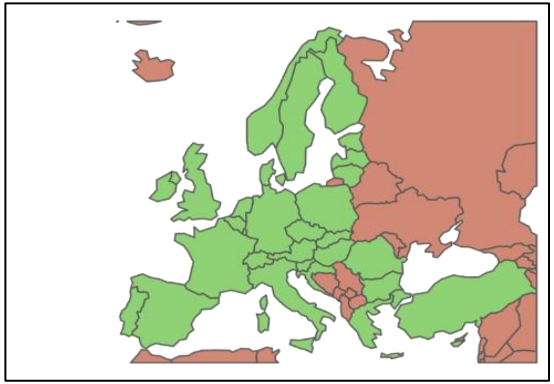
How much C can each measure potentially sequester on European scale annually?

Measure	C sequestration potential [Mio t CO_2-eq yr^{-1}]
Cover crops	4.2
Crop residues	8.7
Perennial legumes and ley management	7.2
Biochar	77.0
Zero tillage	42.4
Reduced tillage	15.9
Irrigation	2.8
Woody vegetation ambitious	95.8
Woody vegetation conservative	38.8
Conservative estimate without biochar	77.6
Conservative estimate including biochar	**154.7**



- Agricultural GHG emissions in 2020 (EU+ including LULUCF emissions): 467 Mio t CO_2-eq
- Total GHG emissions in 2022 (EU+): 3798 Mio t CO_2-eq

Measures increasing soil C accrual (excl. biochar) equal up to 12 % of annual agricultural GHG emissions or up to 1.5 % of total EU+ GHG emissions

Measures increasing soil C accrual and biochar equal up to 20 % of annual agricultural GHG emissions or up to 3 % of total EU+ GHG emissions

Measures increase soil C for a limited time period of a few decades

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Feasibility to implement biochar

How feasible is the implementation of the biochar measure?

- *Needed*: 2.8 billion t of biochar from 12.6 billion t of biomass (dry weight)
- *Current EBC certified production*: 0.064 **Mio** t biochar = 0.26 **Mio** t biomass

(Hagemann et al., 2024)

43,750 years needed to produce the needed biochar

Where to get additional biomass from?

From hedge prunings:

EU estimate (Dyjakon et al. 2019):

13.7 Mio t of woody biomass

= 3.1 Mio t biochar per year

Woody vegetation measure implemented:

Up to 36.7 Mio t of woody biomass

= 8.2 Mio t biochar per year

From straw available for energy production:

EU estimate (Monforti et al. 2015):

146.1 Mio t of straw biomass

= 32.4 Mio t biochar per year

68 years needed to produce the needed biochar

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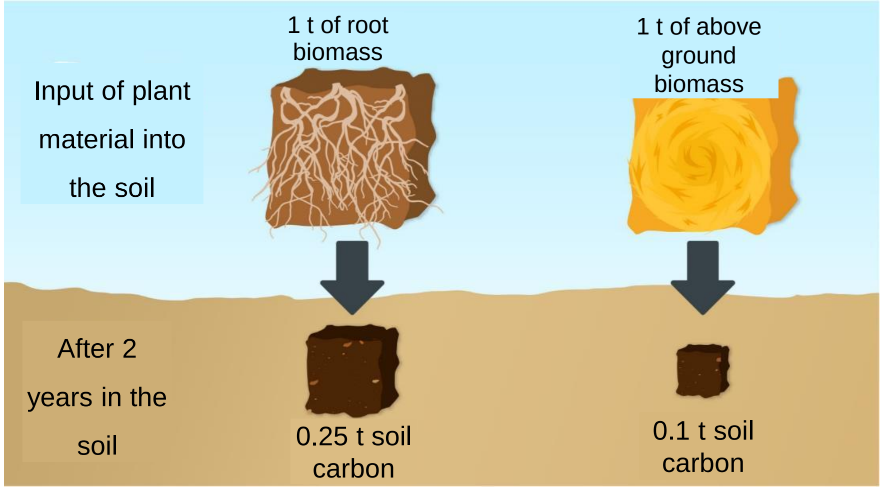
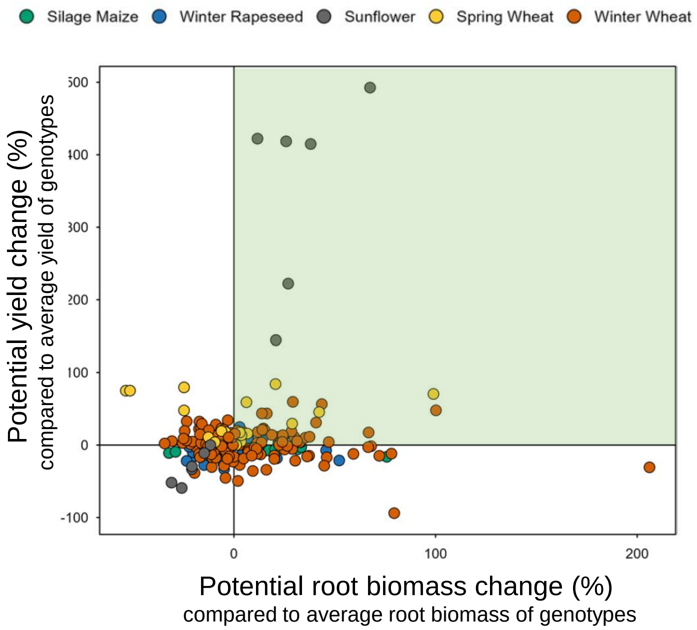
Roots to built up soil carbon



nach Kätterer et al. 2011

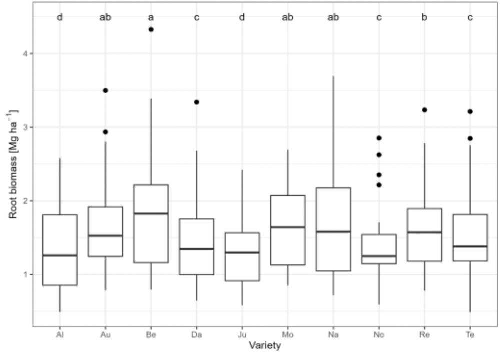
- ❑ Roots are more effective to build up soil carbon than above ground biomass

Variety selection for increased yields and roots



Heinemann *et al.* 2023 Plant and Soil

Root biomass wheat varieties



Heinemann et al. in prep.

- ❑ Many genotypes enhance roots and yield at the same time compared to average genotypes
- ❑ Breeders hardly know root traits

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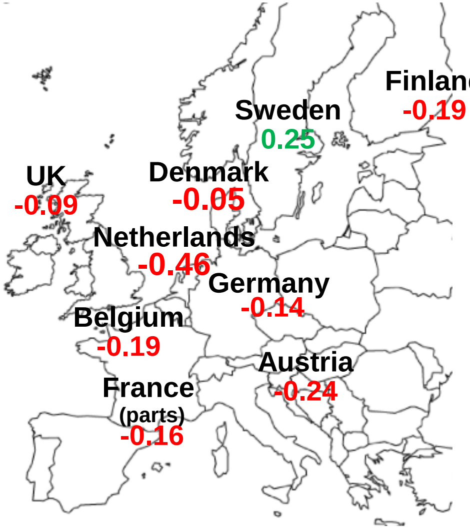
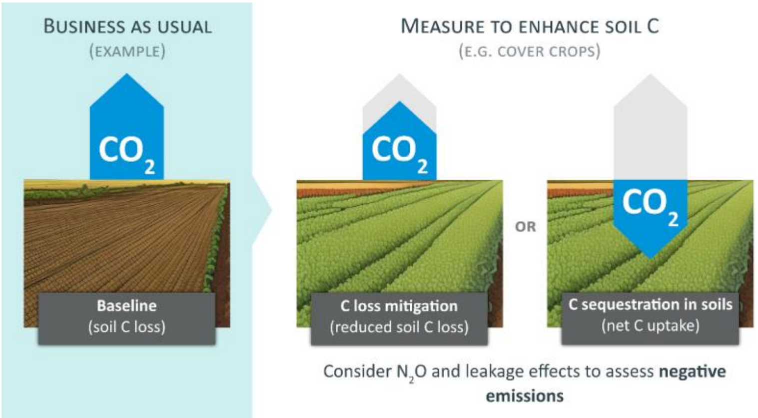
C Sequestration or C loss mitigation?

Recent soil carbon stock changes in croplands



In t C/ha/yr and based on repeated soil inventories

Sources: Heikkinen et al. 2013, Poeplau et al. 2015, Taghizadeh-Toosi et al. 2014, Lettens et al. 2005, Knotters et al. 2022, Dersch and Böhm 1997, Höper 2021, Antoni et al., 2008



Don et al. 2023, GCB

What is the baseline trend in soil carbon?

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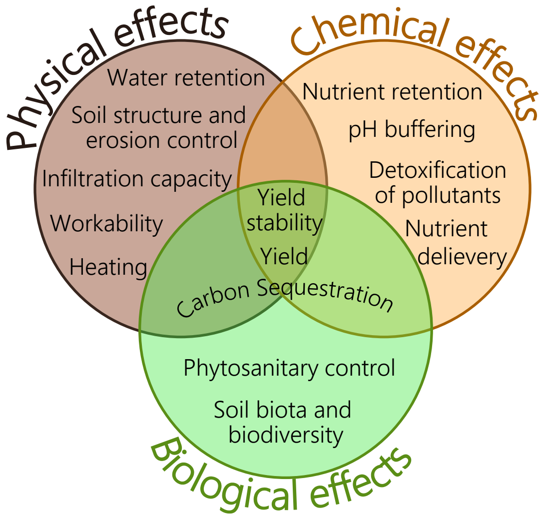
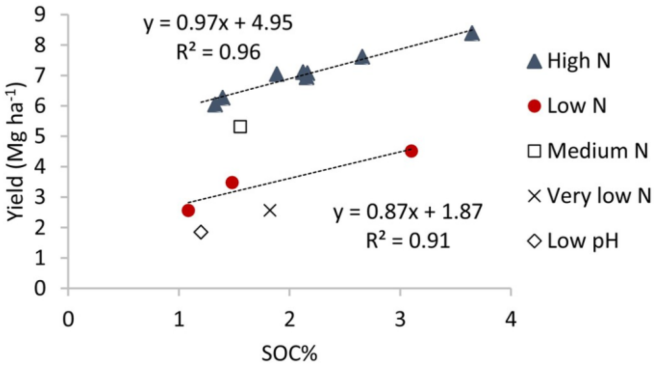
Soil carbon sustaining yield stability

→ **Higher yields due to higher SOC mostly due to improved soil physical properties**

→ (Kätterer & Bolinder, EJSS 2024)





Swedish long-term field experiment with maize

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Conclusions

- There is a **significant potential** to contribute to climate change mitigation through C accrual in soils and agricultural biomass, in the magnitude of 20% of the actual GHG emissions from agriculture.

- **C loss mitigation is the precondition for C sequestration**. Measures for C sequestration in soils can only compensate GHGs (negative emissions) if there is no C loss from soils anymore.

- Multiple **synergies with C sequestration** measures exist and should be explored
  - More roots for main crops (climate adapation)
  - More hedges and agroforestry (biodiversity and soil protection)
  - Biochar (water retention, less N_2O emissions)

- Investments into soils and soil carbon will pay of on long-term due to improved soil fertility and yields.

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→ Thank you for your attention!

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