# Organic Carbon Farming?

# Can we sequester more $CO_2$-C in organic farmed soils?

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# What needs to be considered in all farming systems:

**Soil C-sequestration for climate**

mind

- additionality
- reversibility
- leakage ($N_2O$, $CH_4$, $CO_2$)
- capacity

**General duties of agriculture**

- Reduce livestock (ruminant) numbers
- Peatland restoration and protection
- Grassland protection
- Forests
- Be sufficiently productive

# Potential of organic farming in mitigating climate change

## Advantages of organic farming systems:

- $CO_2$: Low energy input (mineral fertilizer, pesticides), regional feedstuff and concentrates, SOC friendly crop rotations, close area-animal-manure relationship
- $CH_4$: Low stocking densities
- $N_2O$: Low N surplus

## Overall effect for climate:

- Area related CO2(eq) emissions: Low
- Product related CO2(eq) emissions: Medium, variable

## Important for future introduction and acceptance are:

- Food security and consumption habits
- Yield level in developing and industrialised regions
- Sustainability goals
- Policy



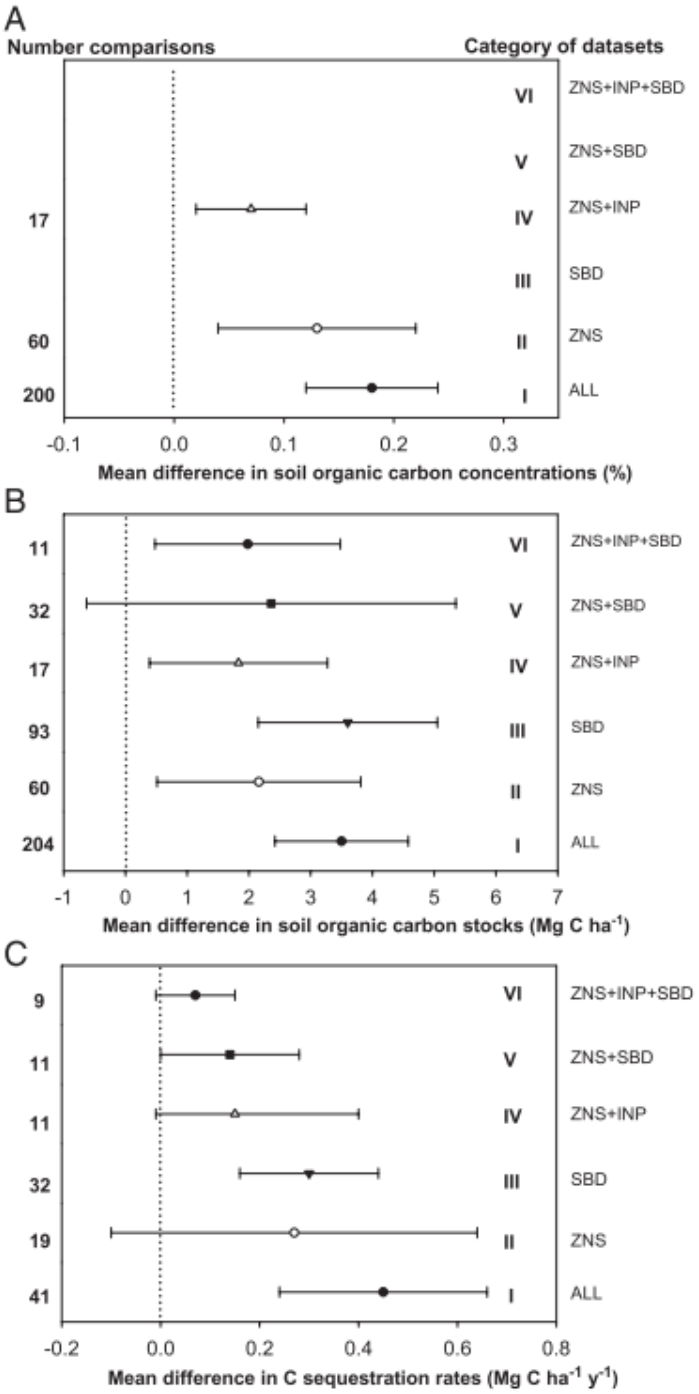
Summarized current knowledge by the author, read, e.g., Goh KM (2011) Greater Mitigation of Climate Change by Organic than Conventional Agriculture: A Review. Biological Agriculture & Horticulture 27(2):205-229

# GHG balances in plant production (Schmid et al., 2019)

| | | Organic farms (n=32) | | | Conventional farms (n=33) | | |
|---|---|---|---|---|---|---|---|
| | | mean | milk | cash crop | mean | milk | cash crop |
| **Emissions cropping** | kg $CO_{2\ eq}$ $ha^{-1}$ | **556** | **560** | **550** | **1129** | **1133** | **1122** |
| seeds | | 65 | 40 | 102 | 55 | 41 | 76 |
| organic fert. | | 182 | 253 | 78 | 273 | 410 | 61 |
| mineral fert. | | 5 | 2 | 10 | 372 | 280 | 513 |
| pesticides | | 3 | 0 | 7 | 83 | 45 | 140 |
| equipment | | 33 | 27 | 41 | 32 | 35 | 26 |
| diesel | | 268 | 238 | 313 | 315 | 320 | 306 |
| **C-sequestration** | | **-342** | **-495** | **-118** | **324** | **185** | **538** |
| **$N_2O$ emissions** | | **865** | **911** | **796** | **1429** | **1468** | **1370** |
| **GHG emissions** | **kg $CO_{2\ eq}$ $ha^{-1}$** | **1078** | **976** | **1228** | **2882** | **2785** | **3031** |
| | **kg $CO_{2\ eq}$ $GE^{-1}$** | **27** | **23** | **33** | **37** | **39** | **34** |
| | **kg $CO_{2\ eq}$ $GJ^{-1}$** | **12** | **8** | **17** | **17** | **15** | **20** |

# What do studies show?

SOC in fields under organic farming compared to conventional (**arable land, topsoil**)
(Gattinger et al. 2012, data from 74 studies worldwide)




**SOC-concentration: + 0.5-0.18 % points**

**SOC-stock: + 0.9-3.5 Mg C $ha^{-1}$ SOC**

**SOC-seq. rates: + 0.1-0.4 Mg C $ha^{-1}$ $yr^{-1}$**

Gattinger 2012, Enhanced top soil carbon stocks under organic farming. www.pnas.org/cgi/doi/10.1073/pnas.1209429109, mostly from temperate zones.

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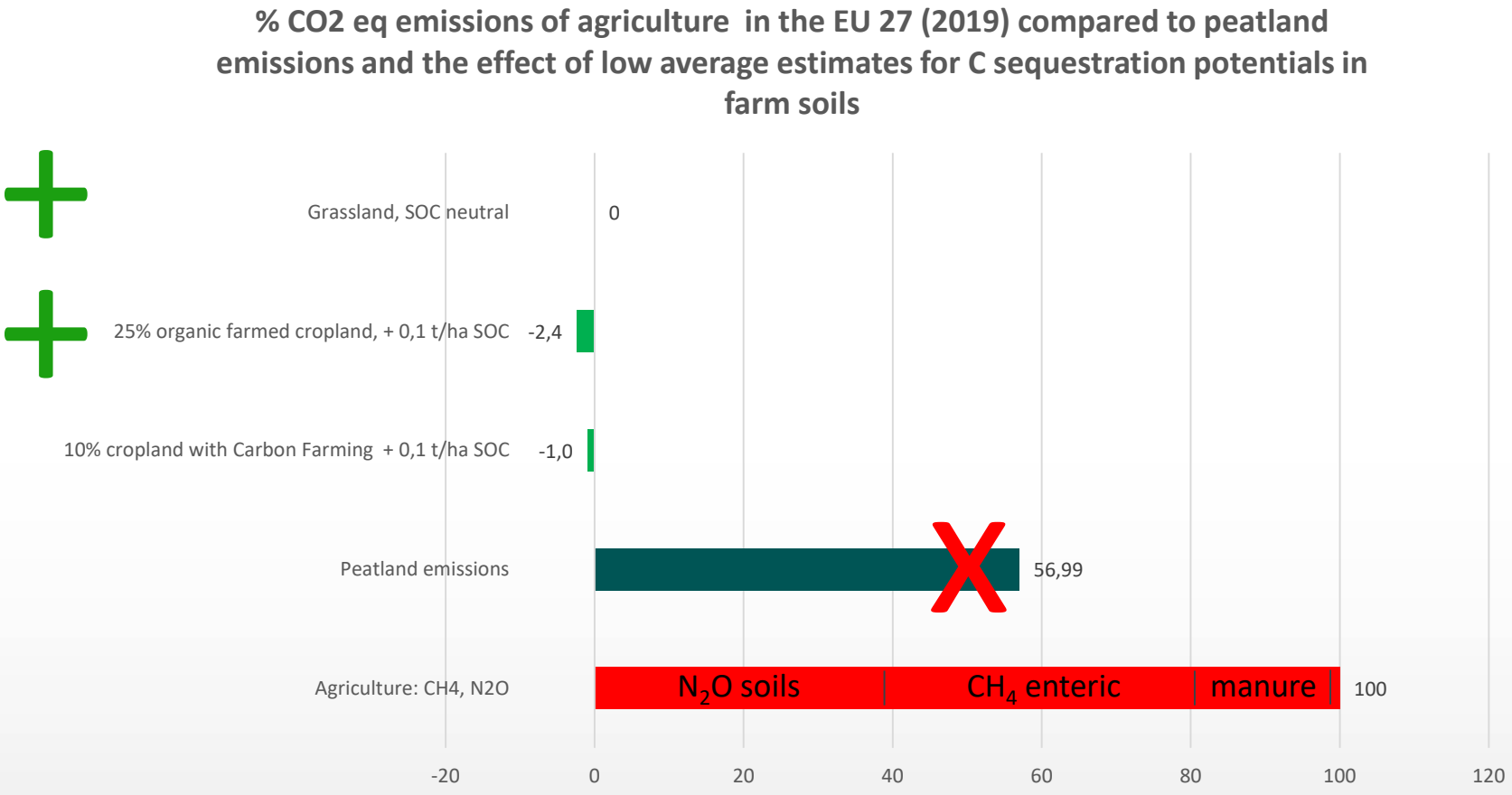
# Dimensions






EEA Report, No 13/2021, Trends and projections in Europe 2021, https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2021/at_download/file
Eurostat 2021; Land cover statistics https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics#Land_cover_in_the_EU
Greifswald Mire Centre 2019: https://greifswaldmoor.de/files/dokumente/Infopapiere_Briefings/GMC-briefing%20paper_CAP_final.pdf

# What can be done additionally?

**Improve biomass turnover and root mass directly on farm by, e.g.:**

- undersown crops, cover crops
- avoidance of unnecessary soil cultivation
- increasing multiannual crop rotation elements (also in combination with biogas/livestock)
- increasing phyto-biodiversity and share of legumes in grassland
- establishment of hedges and trees
- protection and rewetting of peatland

**and combinations**



Organic salad fields

Photo: Bildarchiv Oekolandbau.de, Stephan 2002, Thünen: Paulsen 2021

# Additional organic matter - how to produce?



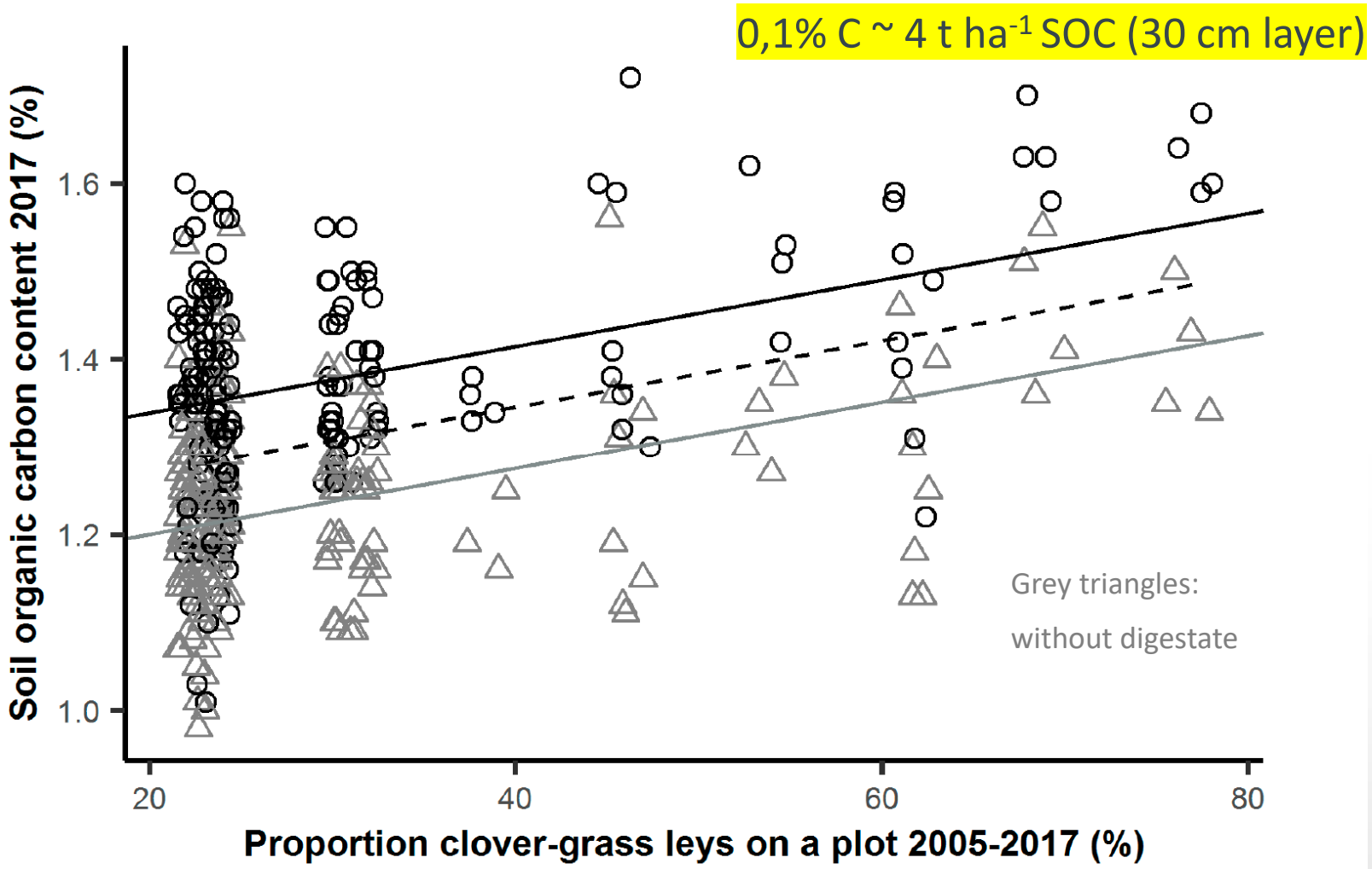






(Fotos: Thünen: Jumshudzade, Paulsen; BLE:Stephan)

# Effect of clover grass proportions in crop rotations on SOC content with and without digestate backflow (Levin et al. 2021)






Levin et al. (2021) Effects of Organic Energy Crop Rotations and Fertilisation with the Liquid Digestate Phase on Organic Carbon in the Topsoil. Agronomy 2021, 11, 1393. https://doi.org/10.3390/agronomy11071393, Technical University Munich

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# SOC enrichment and net effect for climate protection
# Role of Organic Farming

- **Dynamic equilibrium** : SOC development is dependent from biomass-input
- **Site history**: starting point is important for possible development
- **Initial effects**: probably high effects by conversion to organic management on (degraded) land
- **Additional**: Biomass-transfer is only effective with additional biomass
- **Reversible** : Unclear development, during climate change, maintaining SOC important
- **Subsoil** : high potential, under used, unknown
- **Roots** : highly important

**Evaluate your system:**

**Rise and keep SOC in organic farmed soils by**

**more biomass growth and recycling directly on farm,**

**soil cover, soil rest, diverse deep root systems and careful tillage**