



Biochar in agriculture

Nikolas Hagemann, et al.

Professional Exchange

Verein zur Dekarbonisierung der Industrie (VzDI), June 28, 2023



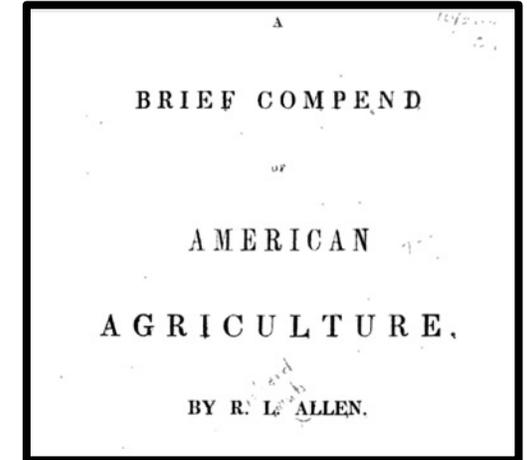
Why biochar in agriculture?

- Charcoal is the oldest chemical of mankind



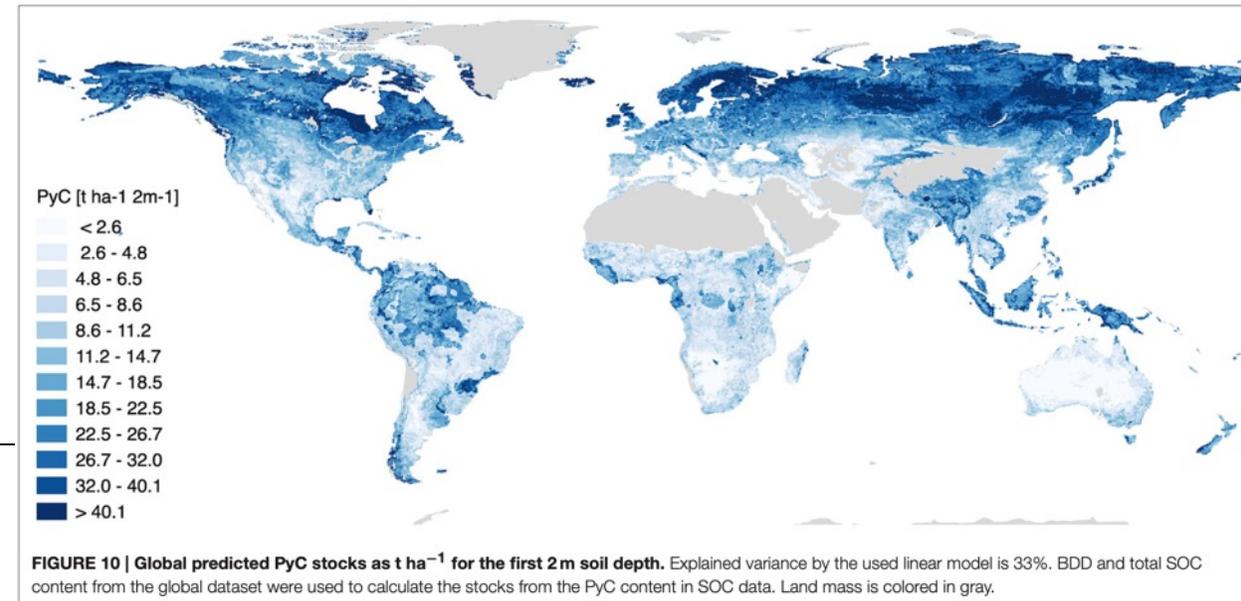
Ötzi's tatoos

- Charcoal is traditionally used agriculturally in virtually all parts of the world



Agricultural textbook, USA, 1847

- Pyrogenic carbon is more natural Component of the soil carbon



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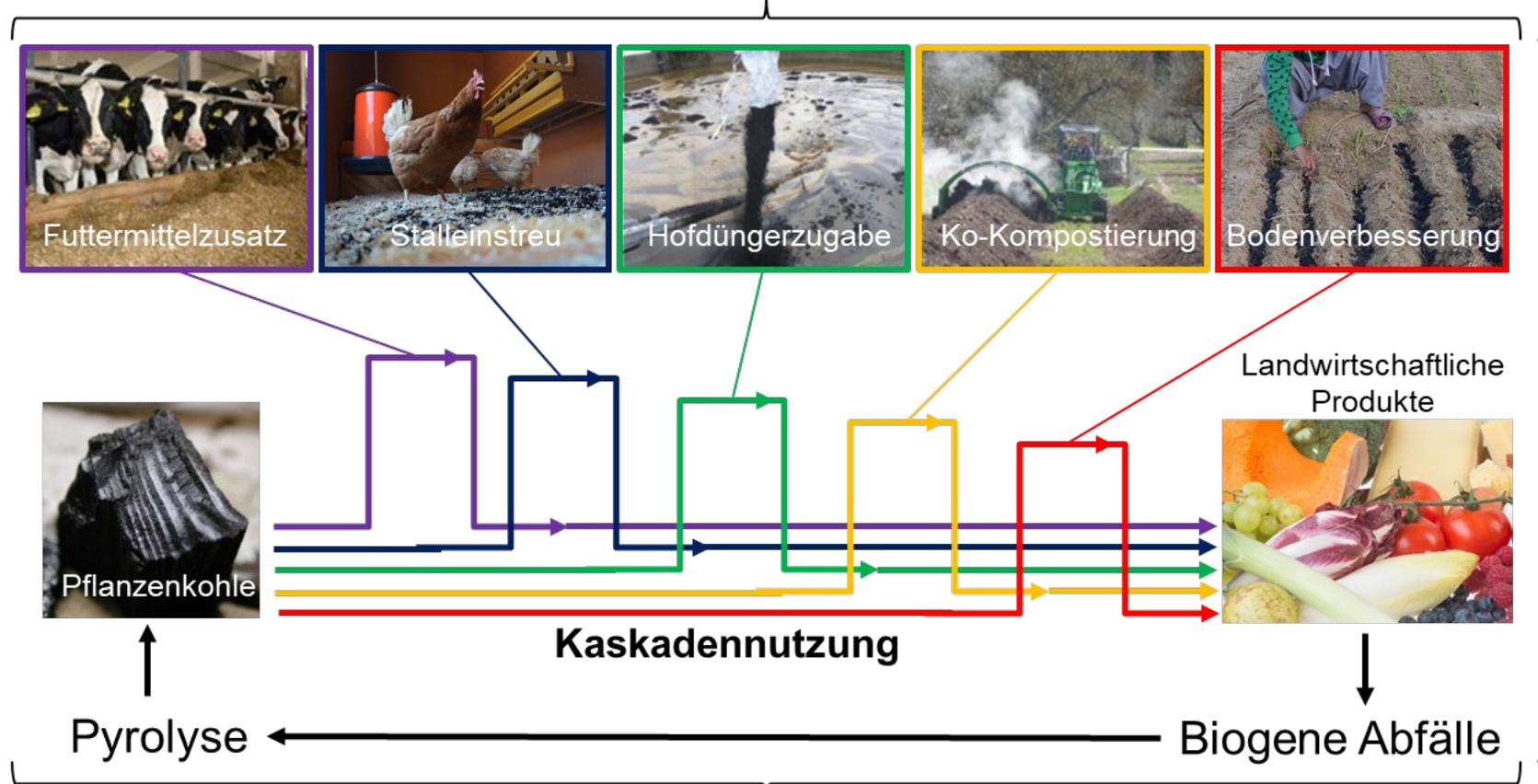
Ötzi: Eurac/ Marco Samadelli;

Map: Reisser 2016, doi: 10.3389/feart.2016.00080



Integration and cascade use of biochar

Chancen & Risiken: Tierernährung, Emissionsreduktion, Nährstoffeffizienz, Humusaufbau, Klimabilanz, Resilienz, etc.



Rahmenbedingungen: Massenbilanzierung, Life Cycle Assessment, Ökonomie, Ökobilanz, etc.

Pflanzenkohle-Charakterisierung: Stabilität, Alterung, Funktionalität, Schadstoff-Sequestrierung, etc.



Animal husbandry

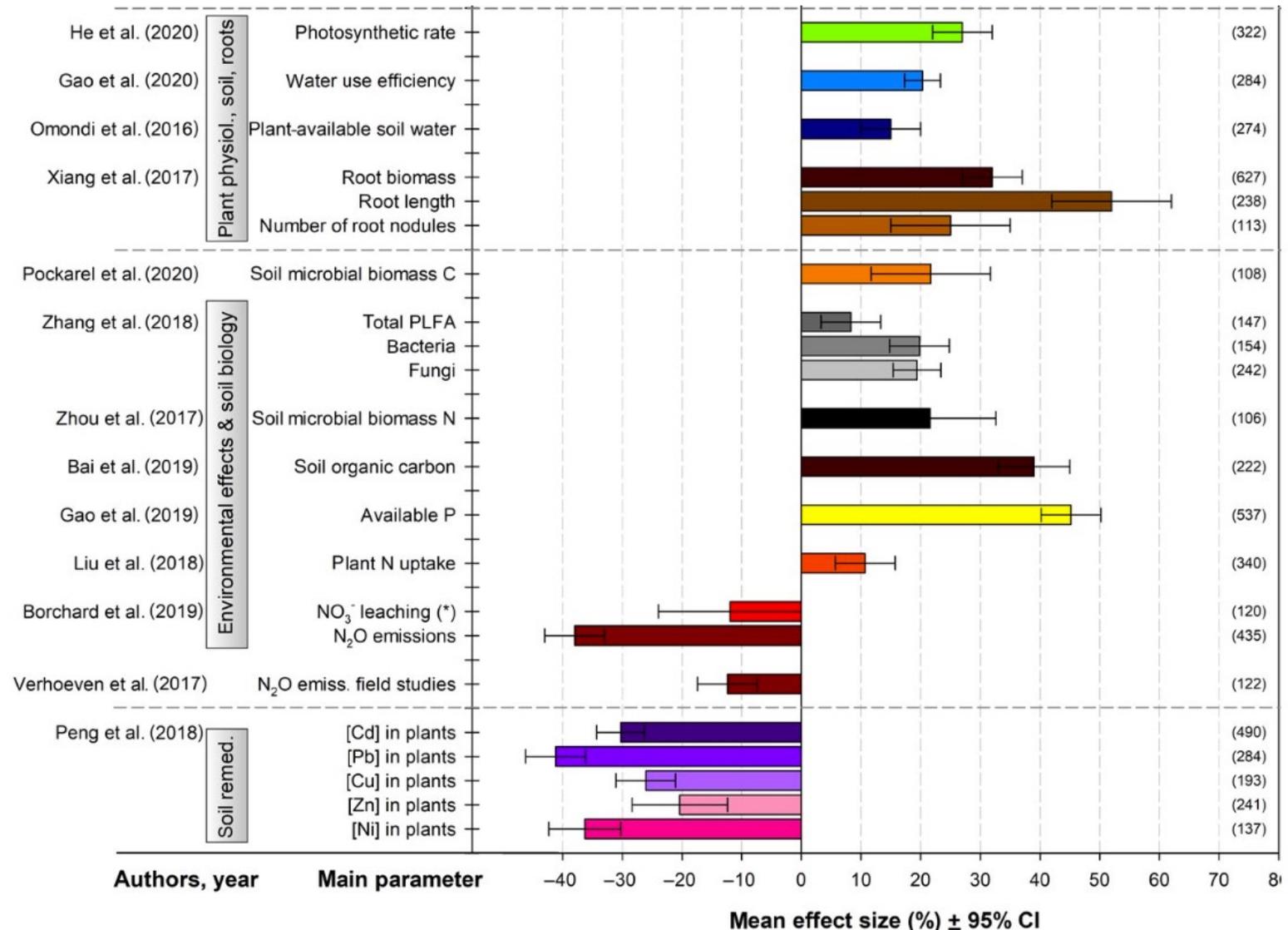
- Frequent practice reports regarding feeding:
 - fewer diseases (infectious diseases, weaning diarrhea, etc.)
 - low cell counts in the milk
 - rather no effects in "perfect" stables/herds
- Bedding:
 - less odor
 - less bale/claw sickness
 - positive effects on nutrient recycling
- Manure additive:
 - no odor, but without further no positive effect on nutrients / emissions



Biochar application has potential

Biochar in agriculture can:

- Stimulate plant growth
- Improve water and nutrient supply
- Stimulate soil biology
- Reduce environmental impact

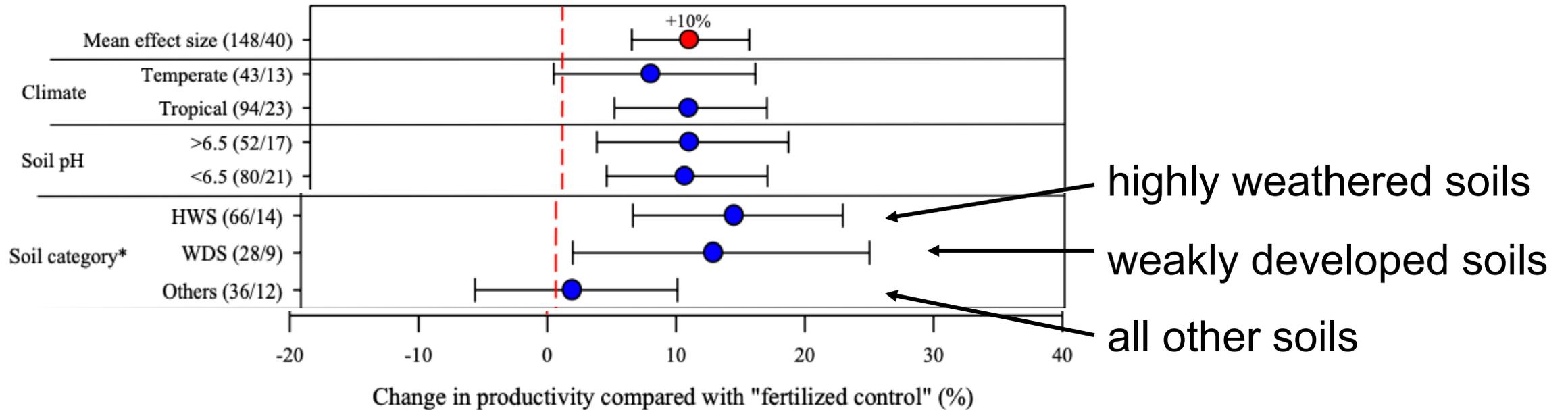


Overview of meta-analyses:
(1 bar = 106 - 627 pairwise comparisons)



Economical use of biochar: Not a "no-brainer"

Biochar based fertilization
vs. fertilized control (meta-analysis):





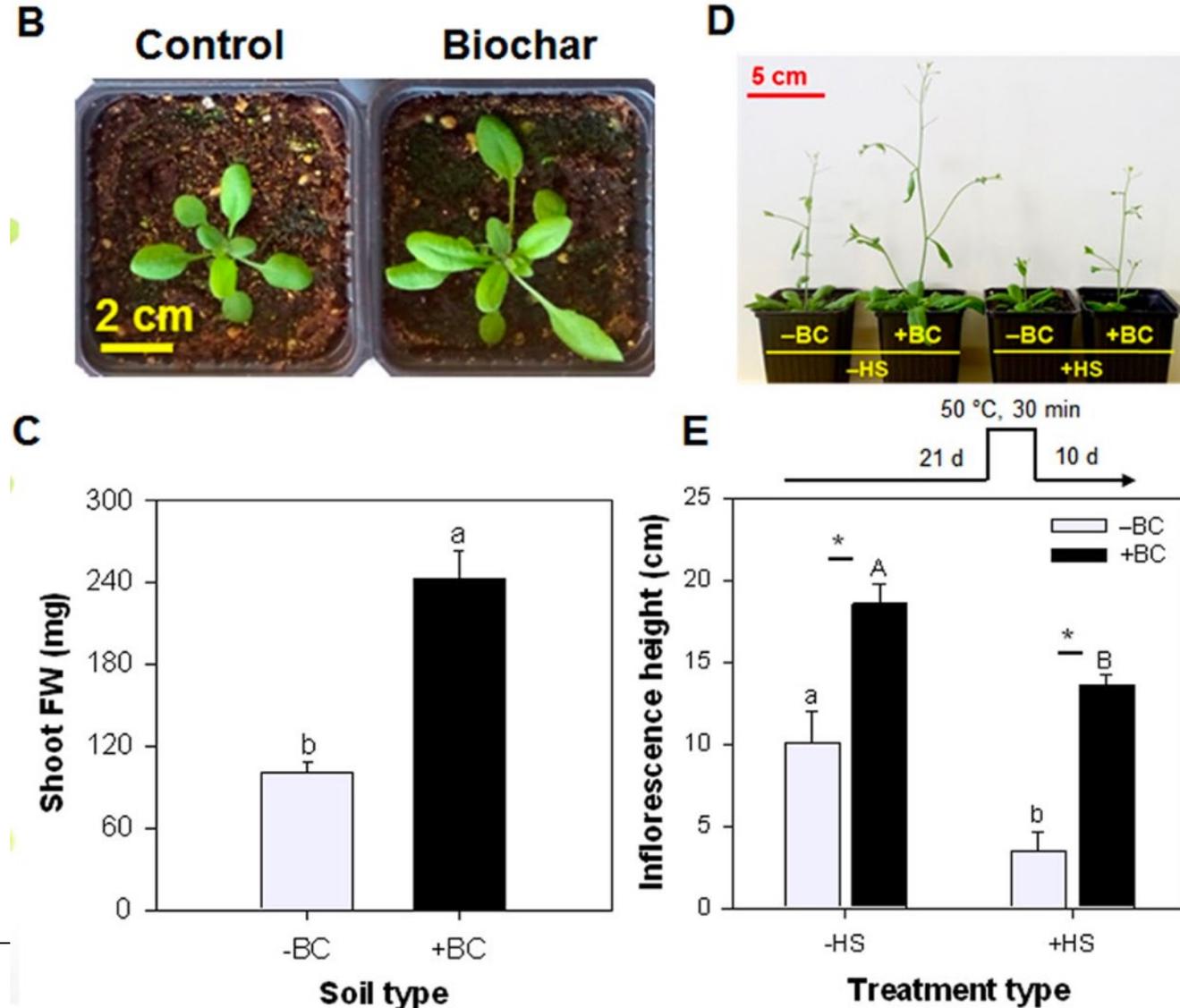
Why use biochar?

- Adaptation to climate change => stabilization of yields
 - existing toolbox for adaptation is still very small!
 - Effects of vegetable carbon:
 - medium-term build-up of soil organic matter
 - Tolerance / resistance of plants to heat and diseases can be strengthened
 - Synergies with other methods (mulching systems, agroforestry, etc.)
- Reduction of nutrient losses



Biochar can reduce effects of heat stress

- Biochar influences the biochemistry of plants (here: pyrolyzed farmyard manure in *Arabidopsis thaliana*).
- Targeted trials with heat-sensitive cultures necessary



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Kumar et al. 2021, doi:10.1038/s41598-021-88856-7.



Biochar and Water storage

Water holding capacity of biochar: 200-500%.

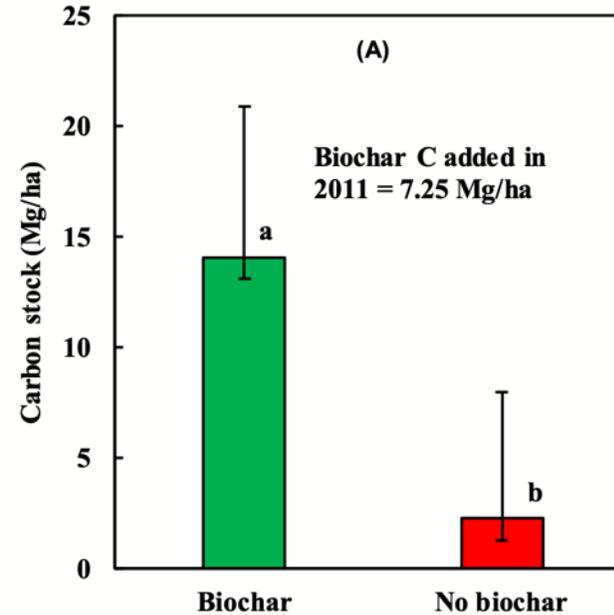
- $1 \text{ t ha}^{-1} \approx 4'000 \text{ L ha}^{-1}$
- $10 \text{ t ha}^{-1} \approx 40,000 \text{ L ha}^{-1}$
- Root Zone Application
- Long-term effects due to improved soil structure





Biochar and soil organic matter

in the **field**: growth in 6 years:



- biochar promotes humus build-up



Climate change adaptation with biochar: combining measures

- Deep loosening /
- Area reddening after winter greening or grass fallow
- Mulching systems
- Agroforestry
- Irrigation in permanent crops



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Deep loosening: Lucas Kohl, surface rotting: Hermann Metzinger

Mulch vegetable production: Johannes Storch, agroforestry: Matthias Huber,



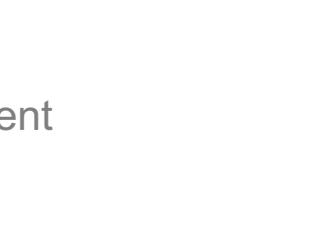
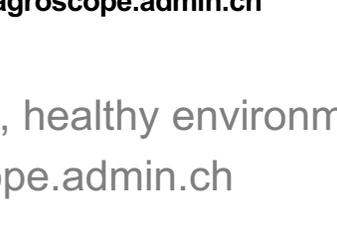
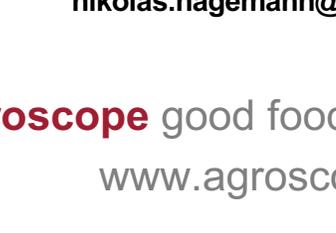
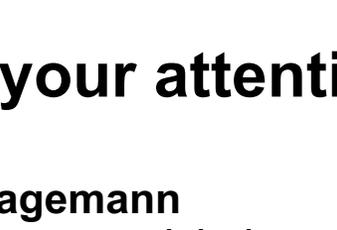
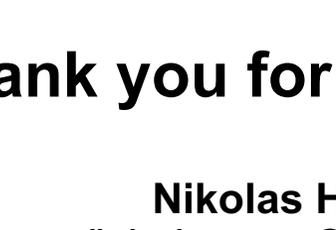
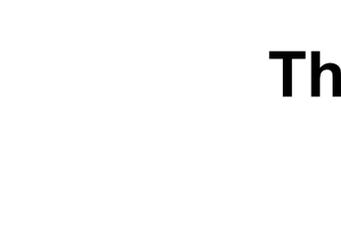
Quality and excellence

- Quality:
 - EBC certification
 - Sustainability Biomass procurement and production, occupational safety
 - Contaminant levels and basic properties (do no harm)
 - Conformity with fertilizer regulation
 - <https://www.european-biochar.org/en/ct/1>
 - <https://www.carbon-standards.com/en/standards-and-services>
- Excellence:
 - Still little secured knowledge on which biochar is “better” for a specific purpose
 - Trend: biochar from ash-rich biomasses achieve stronger effects in the soil



Final word: Biochar...

- ... is not a panacea
- ... an important, multifunctional tool in our (quite limited) climate change adaptation toolbox, that should be used in combination with other tools
- ... is a raw material, but we need products and solutions
- Biochar is not biochar: understanding and recognizing differences



Thank you for your attention

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