JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN | DFG Deutsche Forschungsgemeinschaft | FORSCHUNG FÜR PRAXIS | Hochschule Geisenheim University

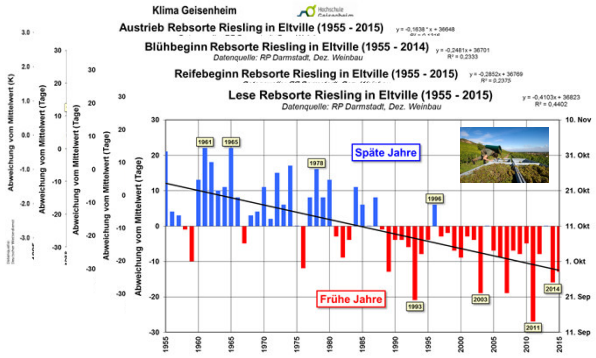
Pflanzenkohle für das N-Management im Weinbau?

Neue Erkenntnisse aus Forschung und Entwicklung

Claudia Kammann, Andreas Haller und Otmar Löhnertz

KLIMAWANDEL IM RHEINGAU

Hochschule Geisenheim University



KLIMAWANDEL: STEIGENDE CO_2-KONZENTRATIONEN

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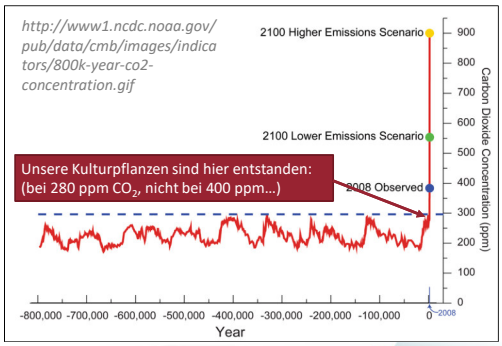

Unsere Kulturpflanzen sind hier entstanden: (bei 280 ppm CO_2, nicht bei 400 ppm…)

ERHÖHTES CO_2: WIRKUNG AUF REBEN

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….u.a. Rebholz-Zuwachs

….Bodenkohlenstoff…??

URSPRUNG DER IDEE „PFLANZENKOHLE“: ANTHROPOGENE SCHWARZERDEN IM AMAZONASGEBIET (ADE)

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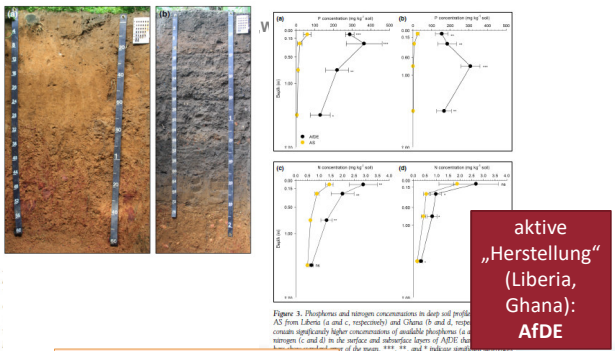


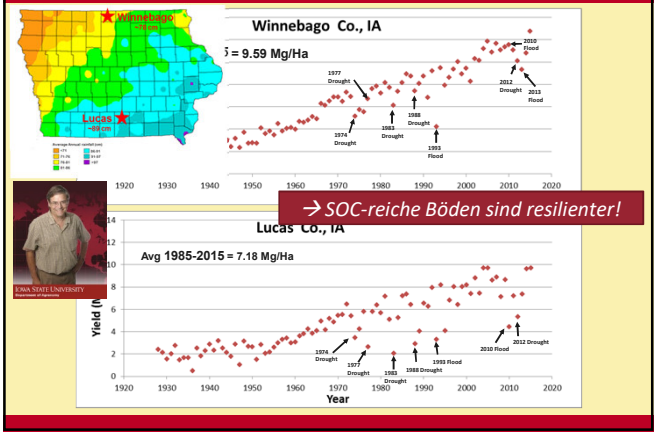
aktive „Herstellung“ (Liberia, Ghana): **AfDE**

Solomon et al. 2016, Frontiers in Ecology

IOWA STATE UNIVERSITY Bioeconomy Initiative

Maize yields

i'm an agronomist



→ *SOC-reiche Böden sind resilienter!*

PFLANZENKOHLE FÜR NÄHRSTOFF-MANAGEMENT & KOMPOSTIERUNG

(NICHT „PUR“ VERWENDEN)

Hochschule Geisenheim University

ithaka institute







3 mm < BC particles < 5mm

3 Faktoren

1. Kompost-Addition (± 2% w/w)
2. N-Düngung (28 vs 140 kg N/ha)
3. **Kontrolle**, BC_{pure} **BC_{comp}** (± 2% w/w)

→ Gewächshaus, Gefäßversuch (*Quinoa*)

UNTERSCHIED WIE TAG UND NACHT: PFLANZENKOHLE „PUR“ VS. KOMPOSTIERT

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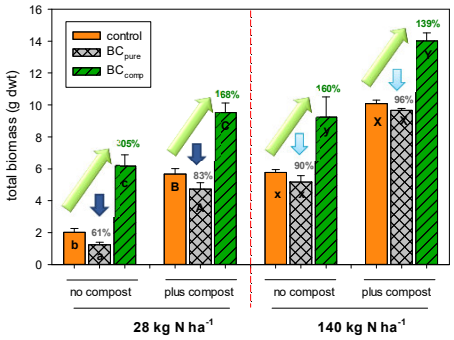

Different letters = significant biochar effects within bar group; 3-way ANOVA, p<0.05

Kammann et al. 2015, Scientific Reports

„ÜBERRASCHUNG“: BIOCHAR „LIEBT“ NITRAT!

WIE GELANGT ES IN DIE KOHLE…?

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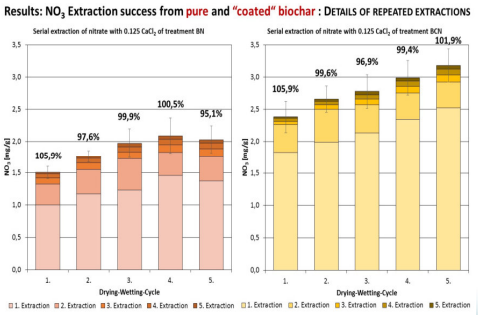
FORSCHUNG



- Trocknen - Befeuchten
- Schütteln > Still
- Organic > keine
- K^+ besser als Na^+
- > steigender Produktionstemp
- + Restwasser > trockene PK
- (Kon-Tiki)

„ÜBERRASCHUNG“: BIOCHAR „LIEBT“ NITRAT!

EINFLUSS PK-EIGENSCHAFTEN…?

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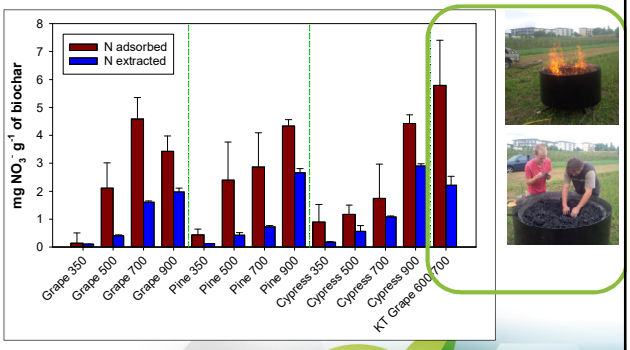
FORSCHUNG



PFLANZENKOHLE, NITRAT & BODENFAUNA

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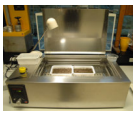
FORSCHUNG

Name:	**Regenwurm-Reproduktionstest**
Richtlinie:	ISO 11268-2 (1998)
Spezies:	*Eisenia fetida*
Substrate:	Kunsterde oder Feldböden, z.B. LUFA
Dauer:	56 Tage
Parameter:	Mortalität, Biomasse, Anzahl Juveniler
Design:	Limittest


PFLANZENKOHLE, NITRAT & BODENFAUNA

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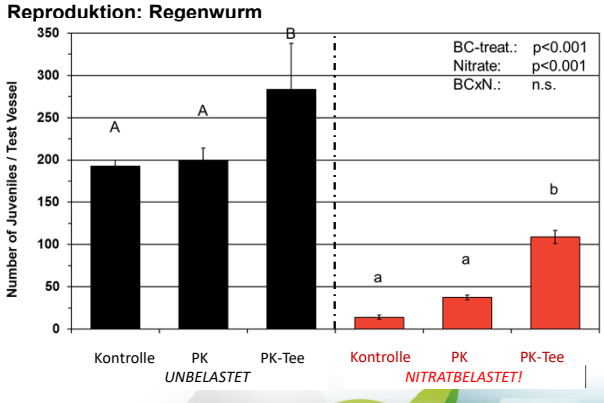
Reproduktion: Regenwurm



PFLANZENKOHLE, NITRAT & BODENFAUNA

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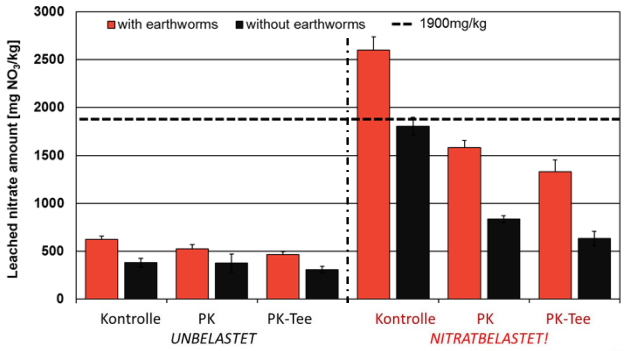
Nitrat-Auswaschung (“Starkregen”)



PFLANZENKOHLE, NITRAT & BODENFAUNA

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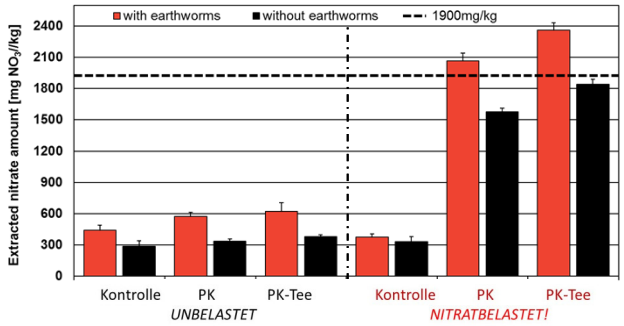
“Nitrat aus Kohlepartikeln” - Extraktion



FAZIT: PFLANZENKOHLE-KOMPOSTE + BEGRÜNUNGSMANAGEMENT

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→ *Humusaufbau: C:N:P:S….*

FAZIT: PFLANZENKOHLE-KOMPOSTE + BEGRÜNUNGSMANAGEMENT

Hochschule Geisenheim University

FORSCHUNG FÜR DIE PRAXIS


nature climate change — ARTICLES

PUBLISHED ONLINE: 24 APRIL 2017 | DOI: 10.1038/NCLIMATE3276

Biochar built soil carbon over a decade by stabilizing rhizodeposits

Zhe (Han) Weng[1,2], Lukas Van Zwieten[1,3,4]*, Bhupinder Pal Singh[1], Stephen Joseph[7,8,9], Lynne M. Macdonald[10], Terry J. Rose[4], […] Stephen Morris[3], Daniel Cozzolino[11], Joyce R. Araujo[12], Brau[…]

Biochar can increase the stable C content of soil. However, studies on the […] and the consequent changes to native soil organic carbon (SOC) are lacking. […] to monitor belowground C allocation, SOC priming, and stabilization of root-[…] 8.2 years after biochar (Eucalyptus saligna, 550 °C) was amended into a sub[…] biochar enhanced the belowground recovery of new root-derived C (¹⁴C) by 20%[…] (it slowed SOC mineralization by 5.5%, that is, 46 g CO_2-C m^{-2} yr^{-1}). Retention[…] fraction (<53 μm) was also increased (6%, $P < 0.05$). Through synchrot[…] aged biochar and microaggregates (<250 μm), we demonstrate that b[…] via organo-mineral interactions, resulting in the stabilization and accu[…] of SOC in a rhodic ferralsol.

Vielen Dank! – FRAGEN?

→ *Humusaufbau: C:N:P:S….*

PURE BIOCHAR: TOO EXPENSIVE TO RETURN INVESTMENTS BY YIELD INCREASES

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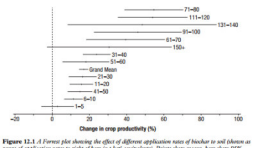
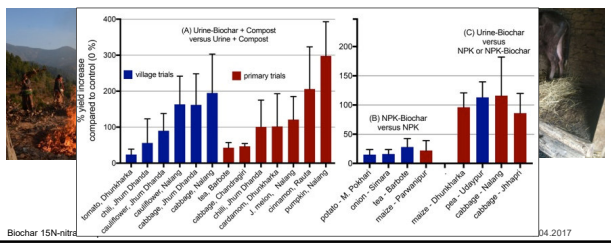
DFG Deutsche Forschungsgemeinschaft

Meta-study on crop yields:
Jeffery et al. 2015
(and other meta-studies)



VERSUS low amounts

e.g. biochar as organic root-zone fertilizer *(Schmidt et al. 2015; in review)*



…THE DIFFERENCE…? NUTRIENTS CAPTURED IN BIOCHAR

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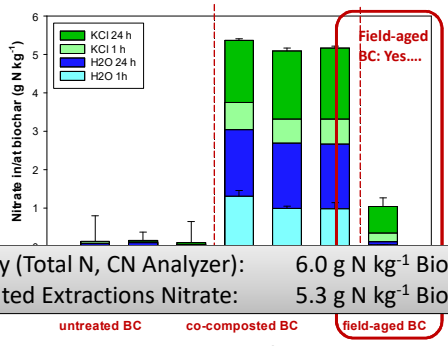


Theory (Total N, CN Analyzer): 6.0 g N kg^{-1} Biochar
Repeated Extractions Nitrate: 5.3 g N kg^{-1} Biochar

Kammann et al. 2015, Scientific Reports

DOES IT ALSO HAPPEN IN SOILS? – YES IT DOES….

But standard methods likely underestimate nitrate in BC-amended soils

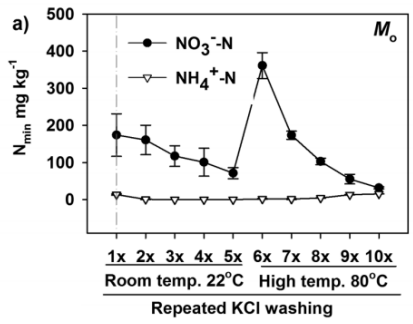
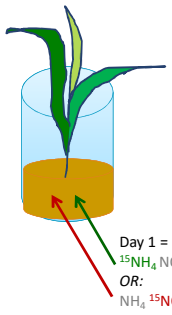


Fig. 2a, Haider et al. 2016
Repeated 2M KCl extractions (1 h)

1st extraction: 13% of total

IS NITRATE JUST SORBED OR EXCHANGED? CAN BC BECOME „FILLED“? …N_2O…?



METHODS

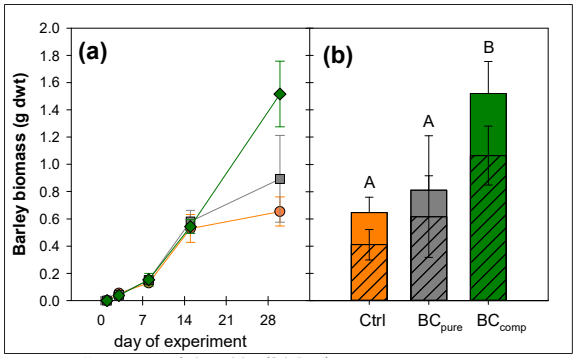
- *200g sandy soil (mixture)*
- *WHC 65%, daily adjustment*
- *+ 3 barley seedlings/jar*
- *Jar sampling days 1, 3, 8, 15, 30*
- *N concentrations and ^{15}N: KCl-extr.; plants; BC particles; N_2O fluxes*

Day 1 = N appl.
$^{15}NH_4NO_3$
OR:
$NH_4{}^{15}NO_3$

TREATMENTS

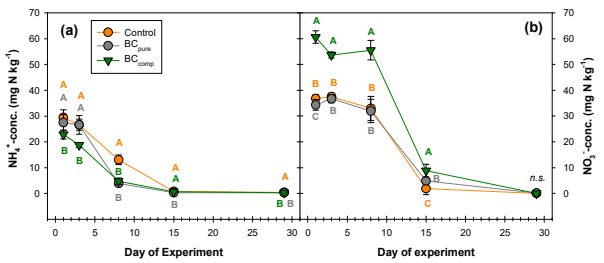
Control, **BC_{pure}** and **BC_{comp}** (± 2% w/w)

BARLEY BIOMASS GROWTH – BC_{COMP} DOES IT WHEN NMIN IS NEARLY GONE!

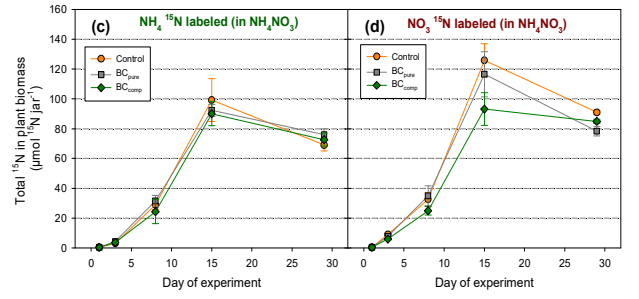


Kammann et al., in revision (Sci. Rep.)

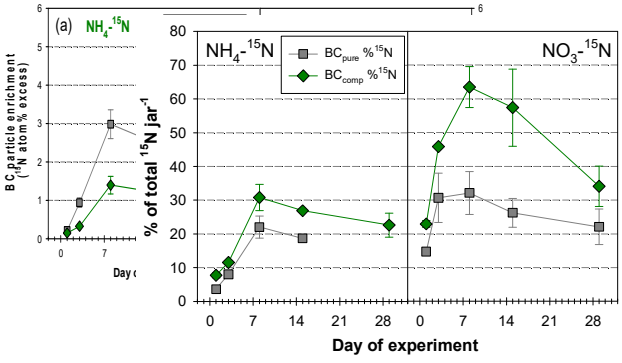
N DYNAMICS SOIL



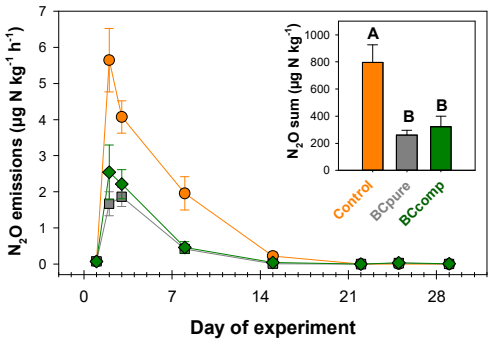
^{15}N DYNAMICS BIOMASS



^{15}N DYNAMICS BIOCHAR PARTICLES



N_2O EMISSIONS STILL REDUCD WITH BC_{COMP}



SUMMARY, OPEN QUESTIONS, PROSPECTS

- *Biochar captures and exchanges NO_3^-….*
- *…even better with age / „organics“ contact*
- *Plants profited from biochar-nitrate feeding*
- *N_2O emissions were still reduced*

→ *„hidden“ N (nitrate): part of „Terra preta“ story…?*

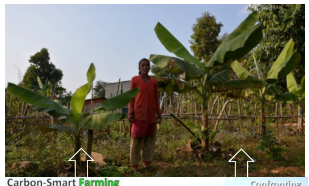
→ *Can we design slow-release nitrate fertilizers, is there*

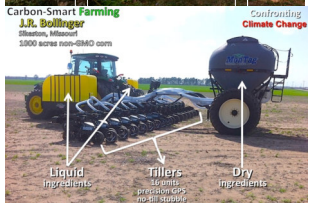
→ *a balance between N leaching protection and plant N availability?*

→ *Is nitrate capture part ot a) the „Nepal-success“ story and b) a N_2O emission reduction mechanism…?*

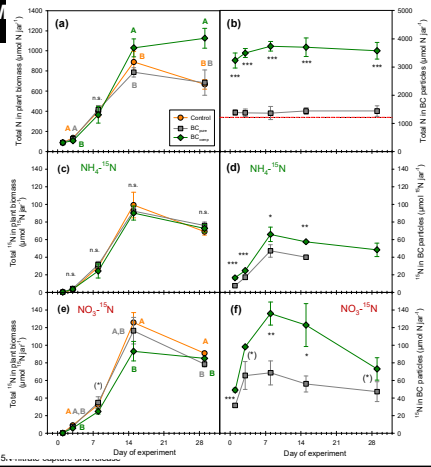
TAKE HOME, THANKS & QUESTIONS?

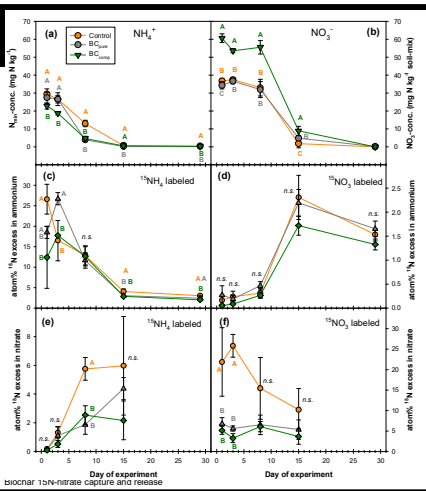
Check: repeated nitrate extractions!





SUM





GHG EMISSIONS AND ^{15}N IN N_2O