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Agroscope

ithaka institute for carbon intelligence

Pyrogenic Carbon Capture and Storage

Negative Emissions made by Plants and Fire

Nikolas Hagemann, et al.

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www.agroscope.ch | gutes Essen, gesunde Umwelt



Fire

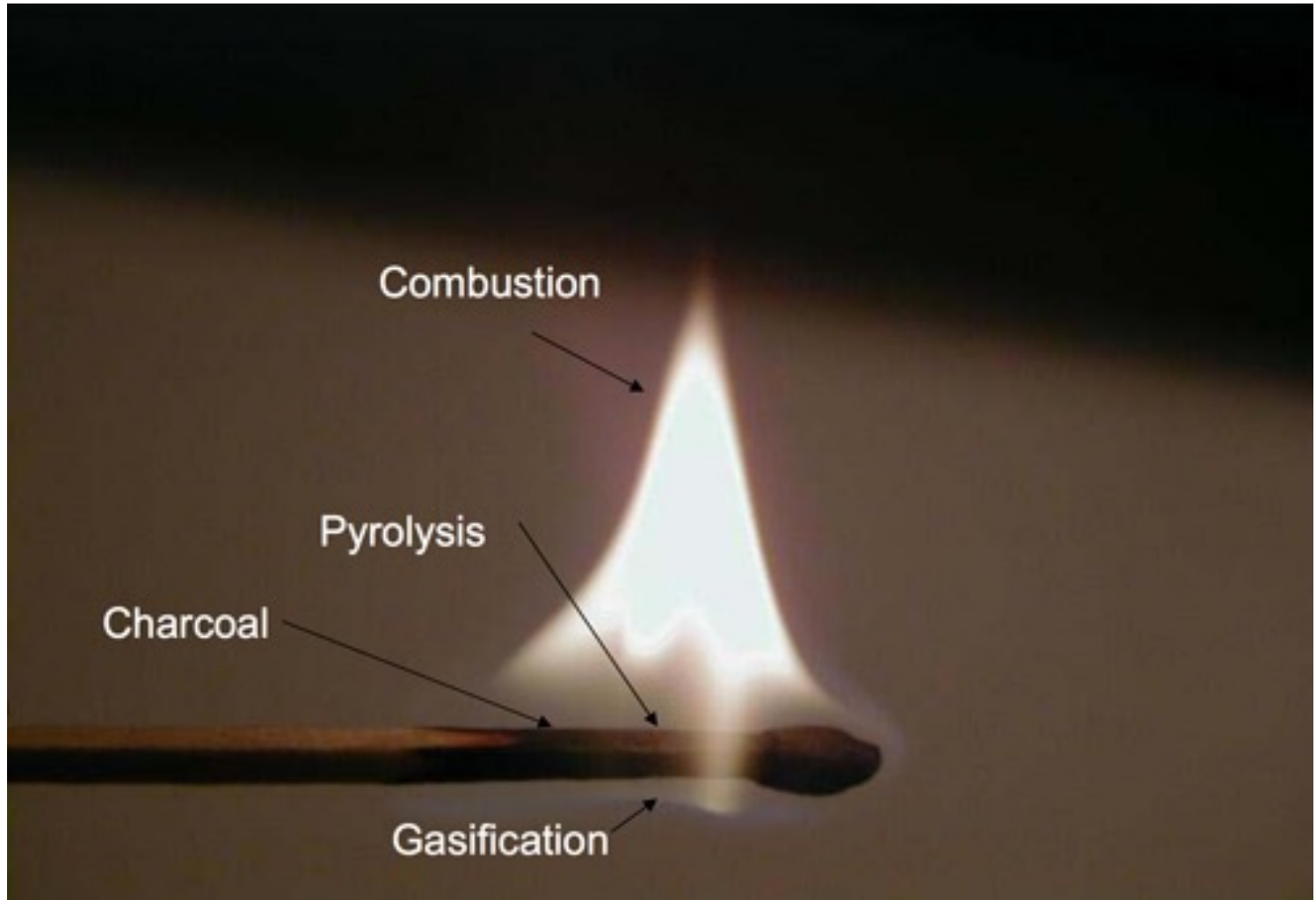


Bild: Thomas Reed

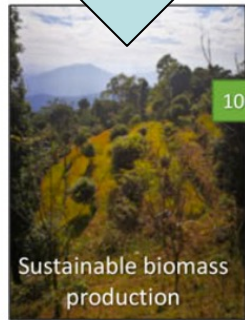
Pyrogenic Carbon Capture & Storage

SCHMIDT ET AL.

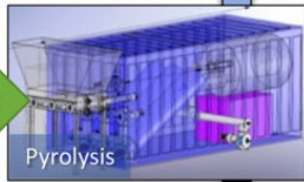
GLOBAL CHANGE BIOLOGY
BIOENERGY

WILEY 9

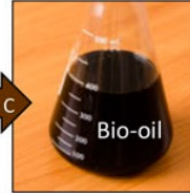
Carbon Removal from atmosphere



100% C



25%-50% C



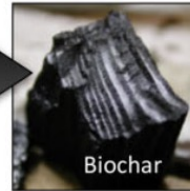
>10,000 y MRT; 2% C-leakage

>100 y MRT; > 15% C-leak.

Bio-C based materials:
a) Recycling/re-use
b) Landfill sequestration

Geological bio-oil storage

or use



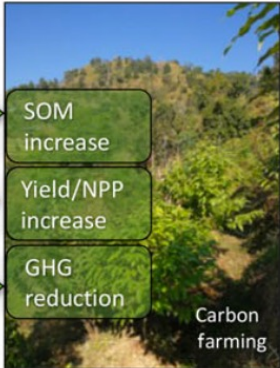
30%-50% C

>500 y MRT, 10-20% C-leak.

>500 y MRT, 15% C-leak.

Soil & animal farming amendment

Building materials:
a) Recycling/re-use
b) Landfill sequestration



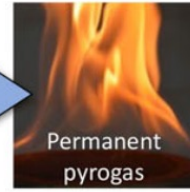
SOM increase
Yield/NPP increase
GHG reduction

or use

Geological CO₂ storage

Fuel or Energy

500 y MRT, 5% C-leakage



15%-45% C

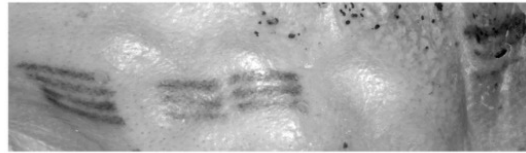
Enhanced soil fertility, co-benefits for ecosystem-services

FIGURE 1 General pyrolytic carbon capture and storage scheme for pyrolytic treatment of biomass, the pathways of solid, liquid, and gaseous products, their use and sequestration scenarios, the respective C-leakage rates, and the circular effect on carbon farming systems and sustainable biomass production



Why looking at biochar?

- It's the oldest chemical of humanity



Tatoos of Ötzi /
Icemen

- Pyrogenic carbon is a natural component of soil carbon

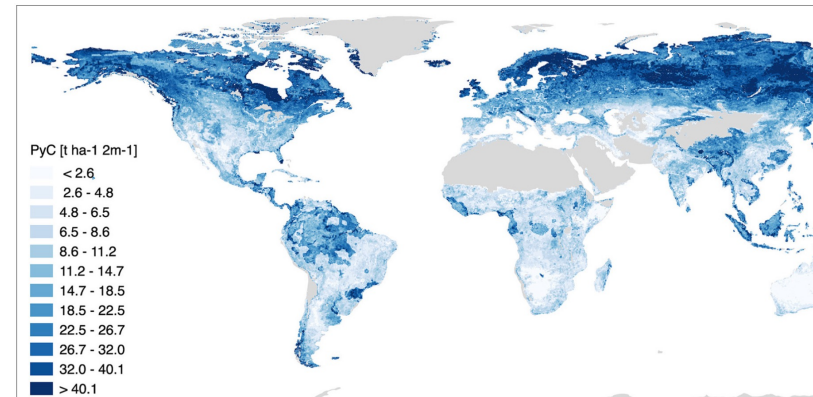
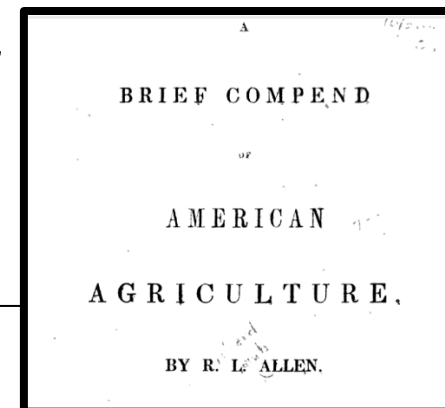


FIGURE 10 | Global predicted PyC stocks as $t\ ha^{-1}$ for the first 2m soil depth. Explained variance by the used linear model is 33%. BD content from the global dataset were used to calculate the stocks from the PyC content in SOC data. Land mass is colored in gray.

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

Ötzi: Eurac/ Marco Samadelli;
Karte: Reisser 2016, doi: 10.3389/feart.2016.00080



Agronomic
textbook
USA, 1847

Anthropogenic Dark Earths

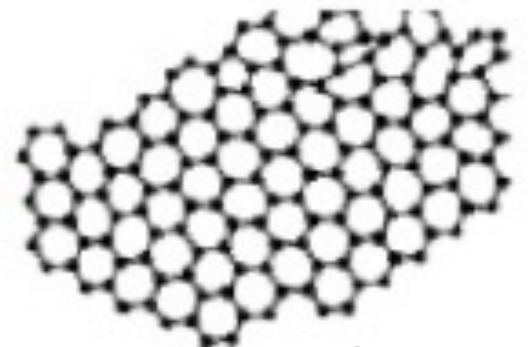
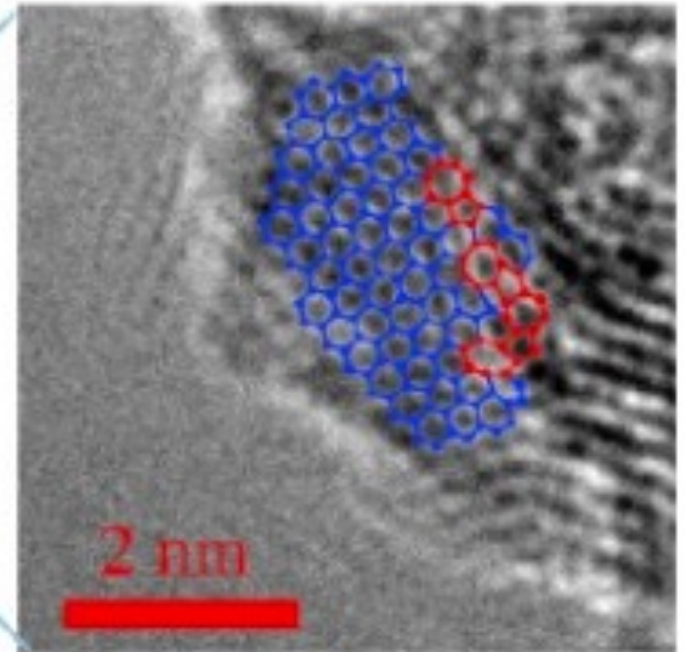
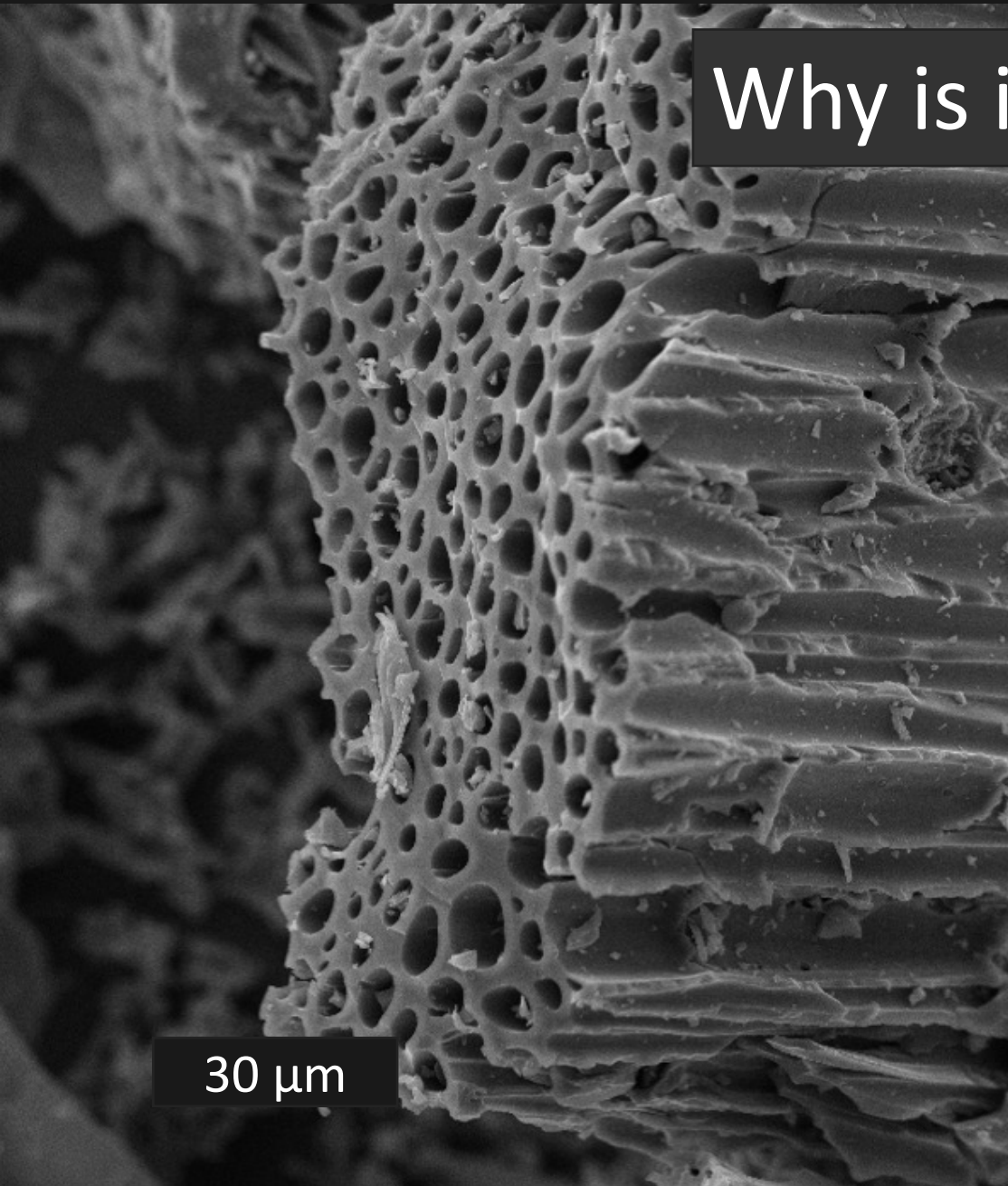


Nordic Terra Preta

Terra Preta do Indio

Terra Preta Australis

Why is it so cool?



Xiao and Chen 2017

**How does biochar
work?**

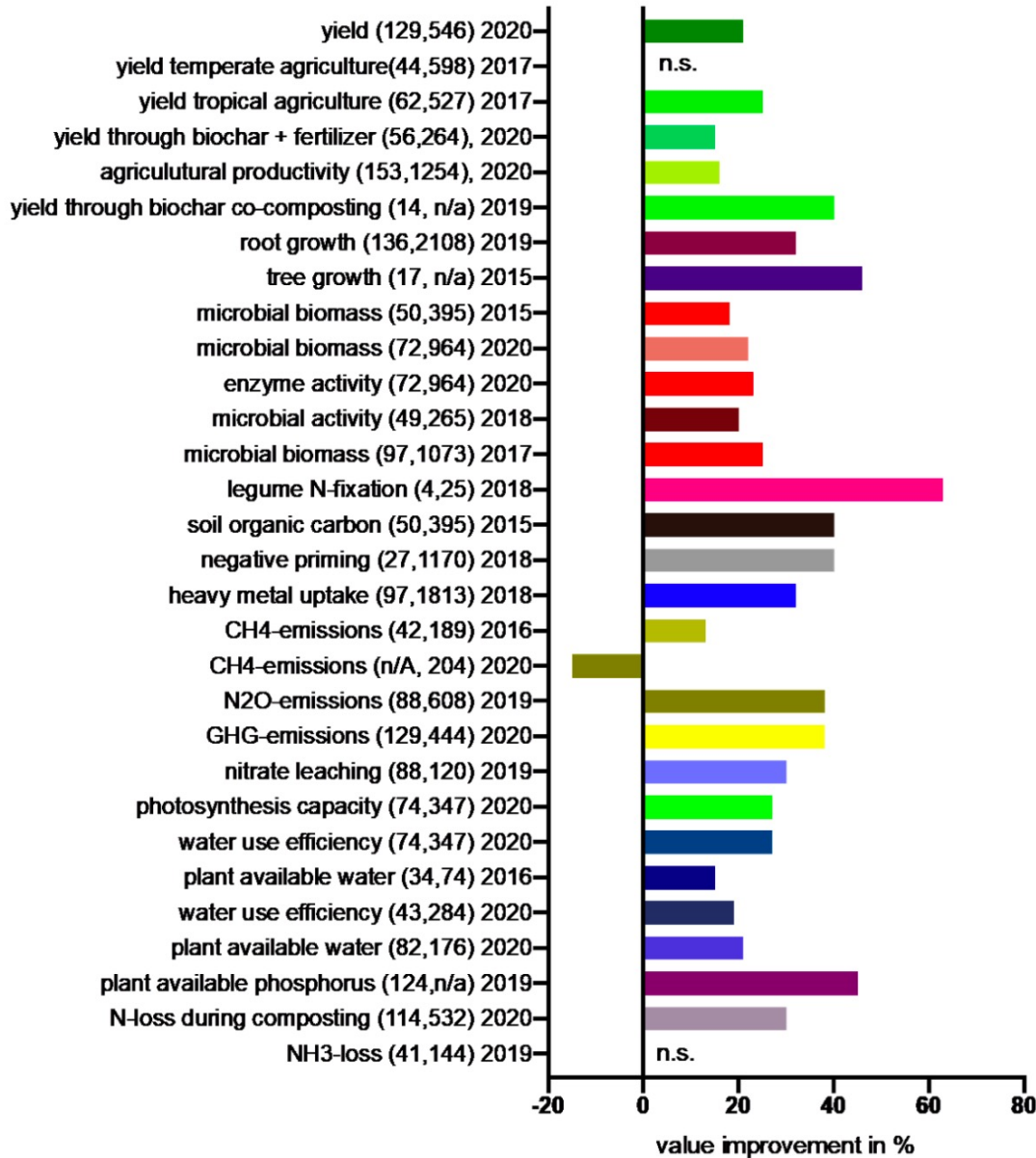


large surface area + aromatic carbon + mineral substances

- low bulk density: loosens heavy soils
- stores water
- binds soil organic matter / humic substances
- binds nutrients (after aging) and also pollutants

- changes pH and redox - especially locally
- releases nutrients if necessary (depending on feedstock)

- supports microorganisms in digestion
 - stores electrons
 - conducts electrons
 - transfers electrons



- fast durchgehend positive Effekte von Pflanzenkohle auf Umweltwirkungen und agronomische Parameter,
- u.a. Reduktion Lachgas
- noch kein agronomischer Nutzen im gemäßigten Klima ($< 10\text{ }^{\circ}\text{C}$)

umfassender Artikel zur Wirkung von Pflanzenkohle (auf Deutsch):
<https://www.agrarforschungschweiz.ch/2021/06/mit-pflanzenkohle-das-klima-schuetzen/>

Abb. 2: Übersicht der in 30 PK-Metastudien untersuchten Parameter und der jeweilige Effekt durch die Applikation der PK. Die Zahlen in Klammern geben die Anzahl der untersuchten wissenschaftlichen Studien, gefolgt von der Anzahl der untersuchten Datensätze an. Dies wird gefolgt von der Jahreszahl der Veröffentlichung der ausgewerteten Metastudien. Die Angabe n.s. anstatt eines Wertbalkens indiziert, dass die Resultate nicht statistisch signifikant waren.

**How to use it in
agriculture?**



Applikationsformen



concentrated
root-zone
application



root-zone
application e.g.
in maize



spreading
before tillage of
winter greening



biochar
fertigation

Cascading use on farms

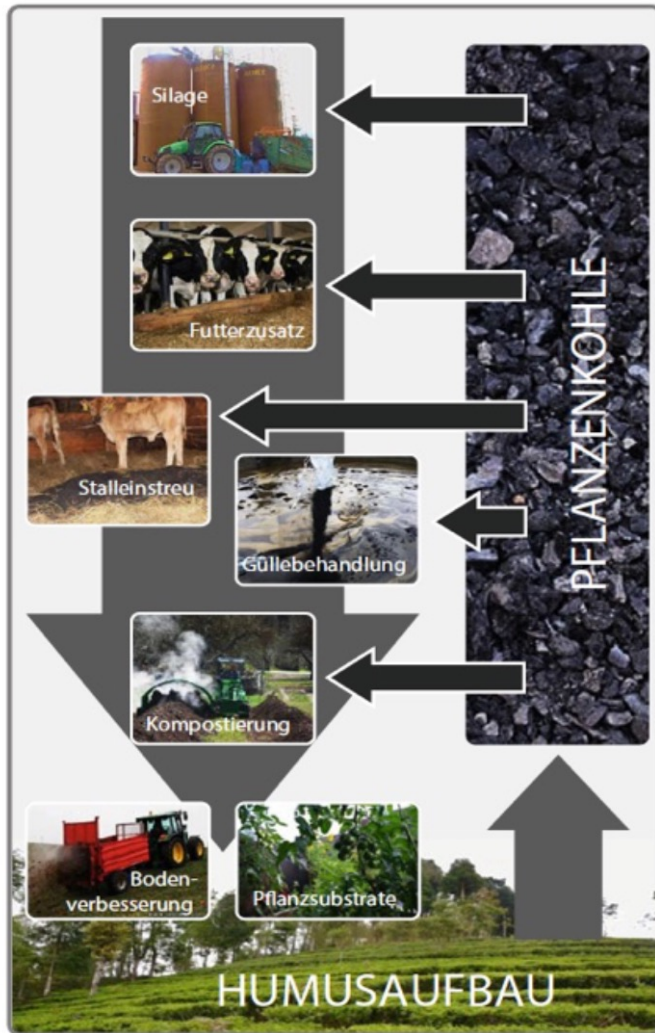


Abb. 12: Kaskadennutzung von Pflanzenkohle in der Tierhaltung und in der Hofdüngerzubereitung (nach Quicker und Weber, 2016).



Aging of biochar improves properties

pristine biochar

after composting



Biochar in materials



Biochar in materials



Foto: Embren

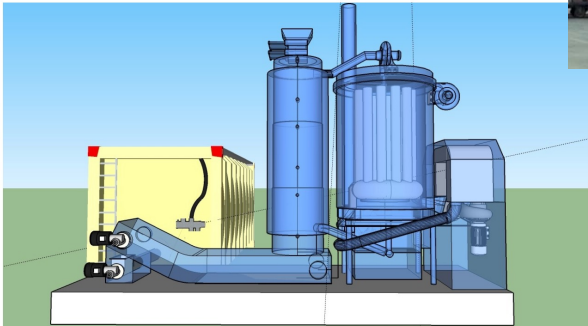
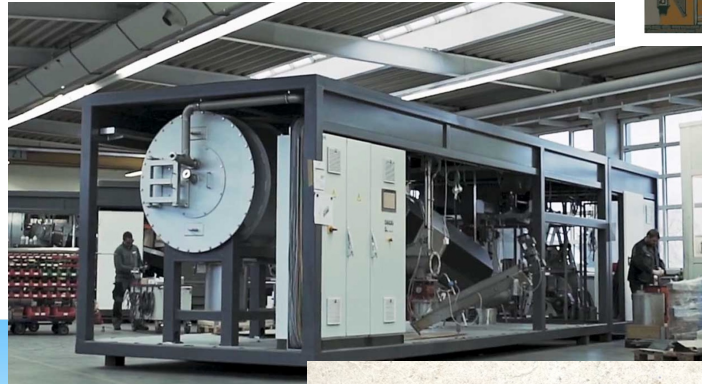
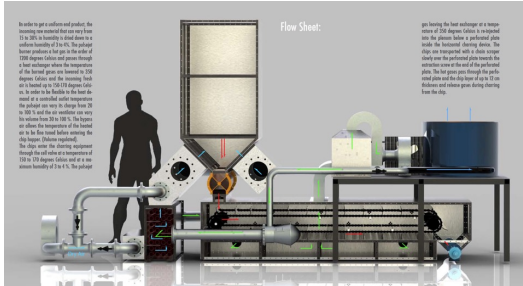
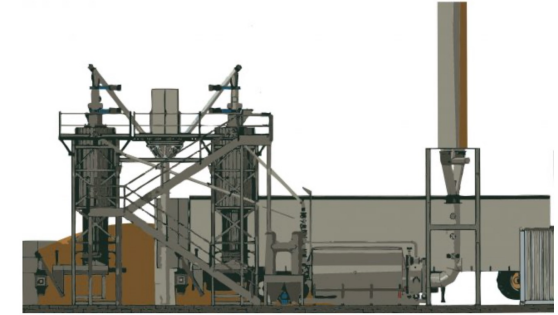
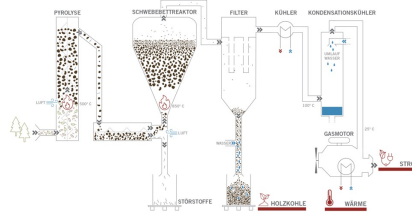


Nevin Galmarini, 2022
(Olympia Gold 2018)

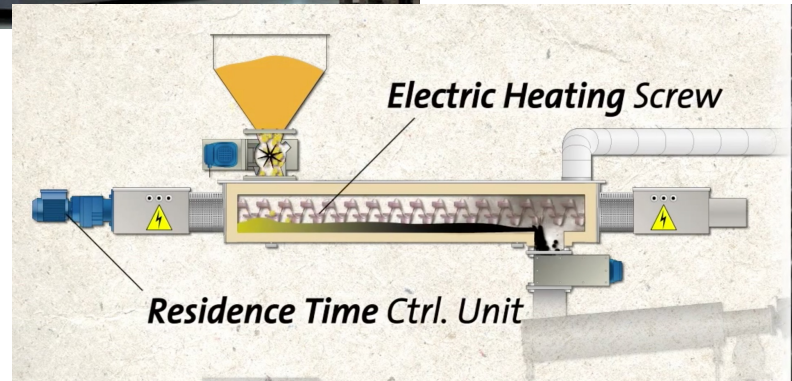
Production of biochar



Industrial Production



Pyrolyseanlage zur thermischen Verwertung von Biomasse CPP800



Energiewerke Ilg, Snycraft, Carbon Technik Schuster, Pyreg, Compaq/Ökozentrum, VT Green, uva.

Nikolas Hagemann, et a. – Agroscope und Ithaka Institut



herb extraction

ETIA - Ecotechnologies [+ Folgen](#) ...
 1.710 Follower:innen
 8 Monate ·

Very excited to see the **Circular Carbon** project moving forward! After the machine's validation in the factory, our Biogreen process is being prepared for shipping to Germany where it will soon convert cocoa shells into biochar and heat. A big thank you to ETIA and the Circular Carbon team for your participation!

[Übersetzung anzeigen](#)



Barry Callebaut:
Cocoa

ETIA - Ecotechnologies [+ Folgen](#) ...
 1.710 Follower:innen
 2 Monate ·

Here's the latest photo from our plant implementation - big thank you to the facility of Philip Morris Products S.A. for your trust and commitment to go green! We are proud to see more and more Biogreen processes comn ... [mehr anzeigen](#)

[Übersetzung anzeigen](#)



Phillip Morris:
tabacco, paper





Kon-Tiki – low (no?) tech biochar production





Standards and certification



ÖNORM

S 2211

Ausgabe: 2016-11-01

Pflanzkohle

Ausgangsmaterialien, Qualitätsanforderungen und
Untersuchungsmethoden

Plant biochar — Source material, quality requirements and test methods

Biochar à partir de plantes — Matières premières, exigences de qualité et méthodes d'essai

European Biochar Certificate
EBC-Agro / EBC-AgroBio

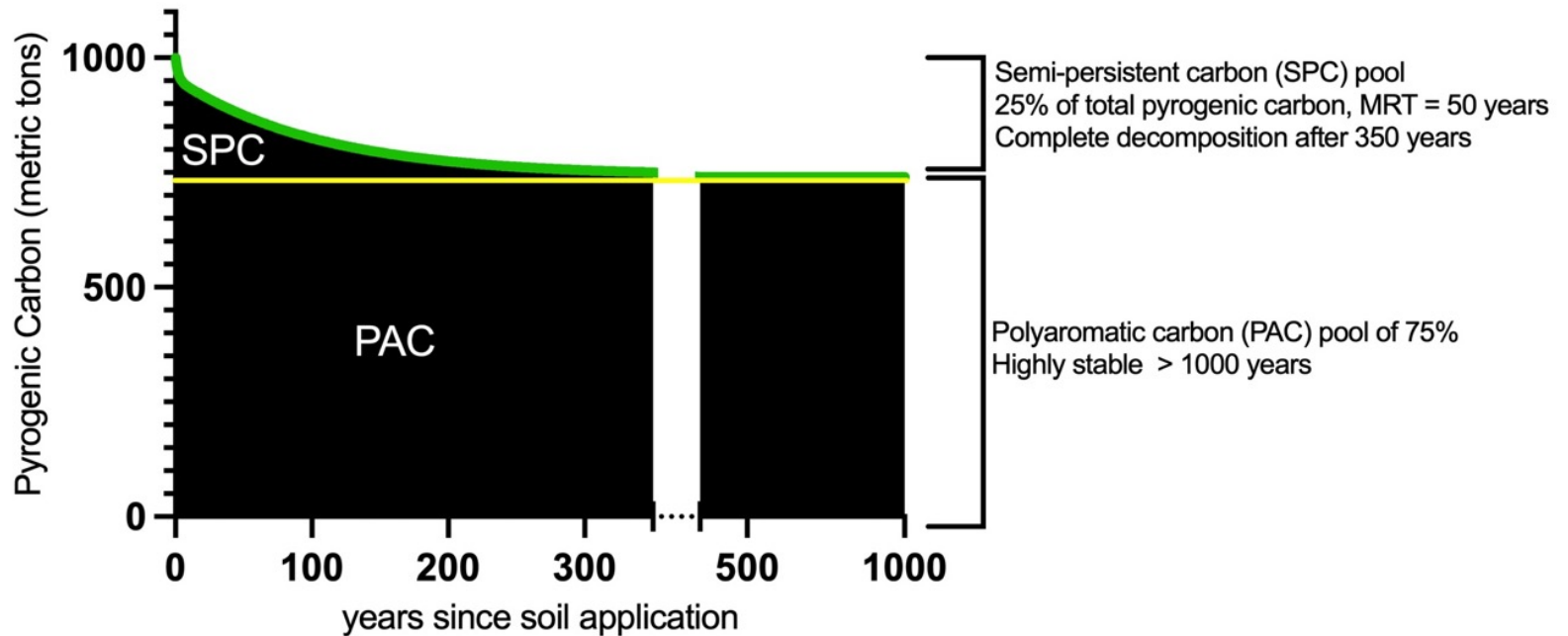
www.european-biochar.org





Certification of negative emissions

- The key: biochar stability





Principle of biochar-based C-Sink certification

- sustainable biomass sourcing
- clean biochar production: tracking and offsetting emissions
- tracking biochar from pyrolysis to the farmer
- confirmation of application => accounting for biochar decay



Danke für Ihre Aufmerksamkeit!

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Agroscope gutes Essen, gesunde Umwelt

www.agroscope.admin.ch

