What Is Biochar?

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Stantec

MNBI
EST. 2023

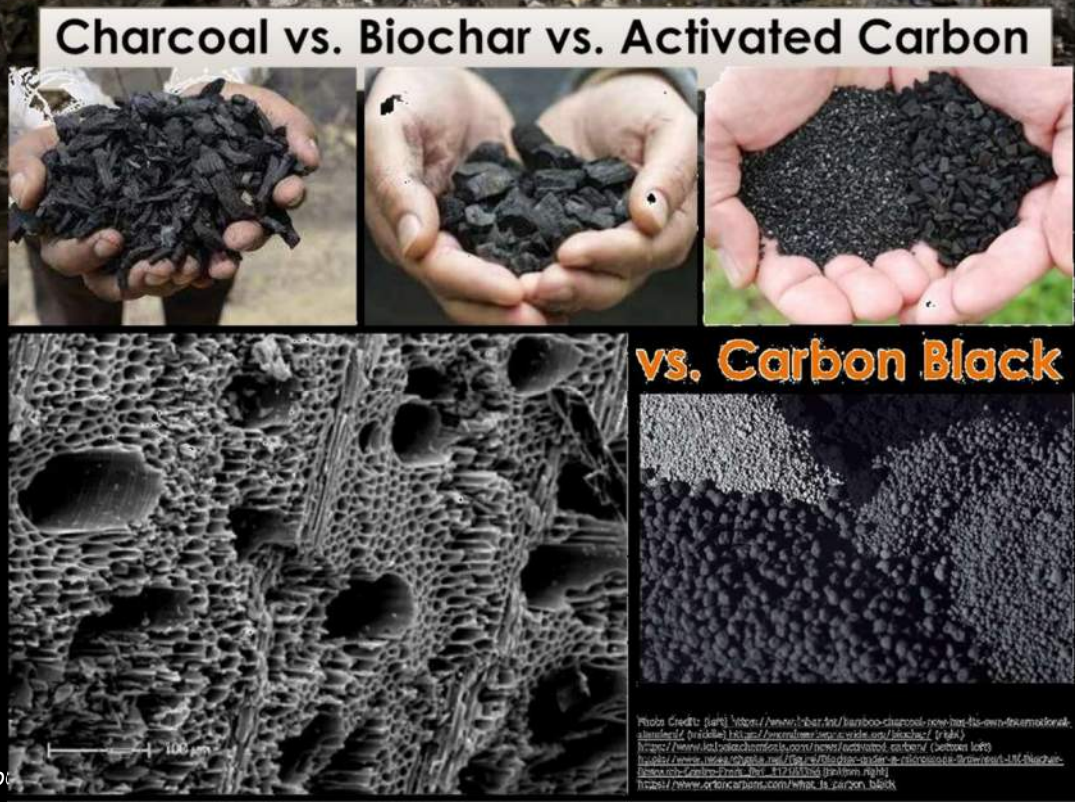
MN Composting Council

*"What we today call **biochar is** in fact a recently-invented term for a very old material – **charcoal.** …*

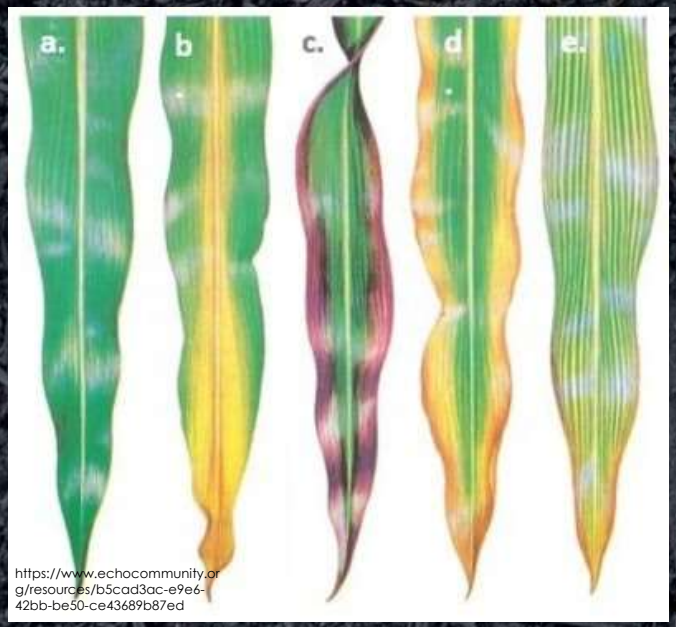
the new name has perhaps caused researchers to overlook previous research into the properties of charcoal.

Are we in danger of reinventing the wheel?"

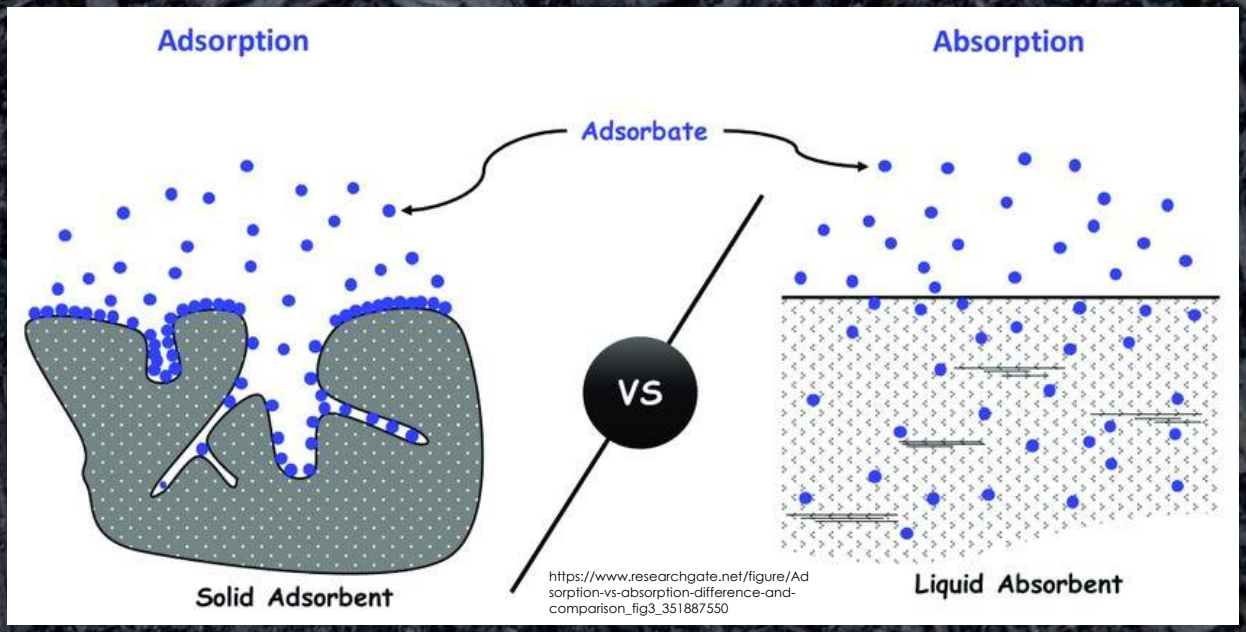
Unearthing the Past:
The Forgotten History of Biochar
Guy Shrubsole, November 2010
https://guyshrubsole.files.wordpress.com/2010/11/unearthing-the-past-gshrubsole-nov-2010.p



Biochar is a filter, not a fertilizer – when the filter is "filled" or "charged" with sorbed nutrients, it then becomes a slow-release fertility amendment.



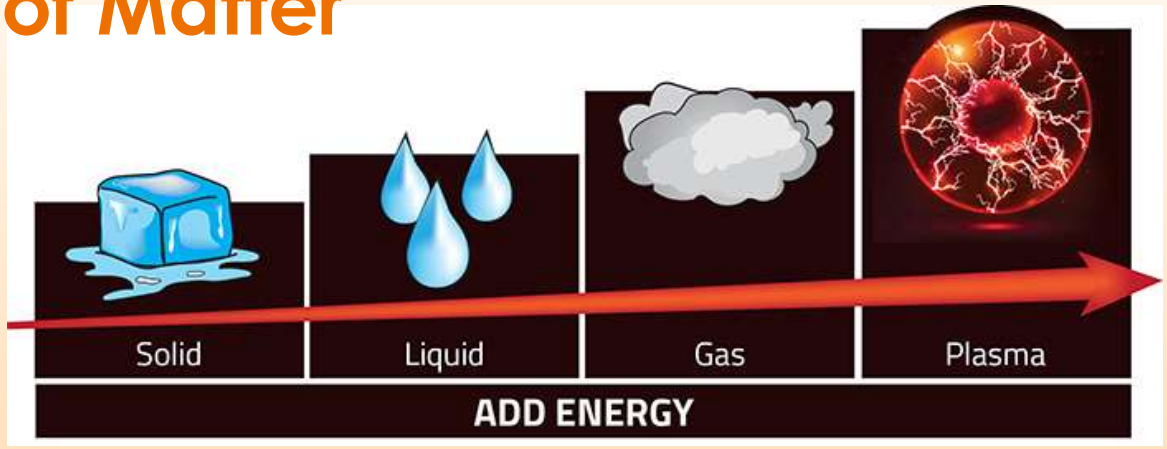
https://www.echocommunity.org/resources/b5cad3ac-e9e6-42bb-be50-ce43689b87ed



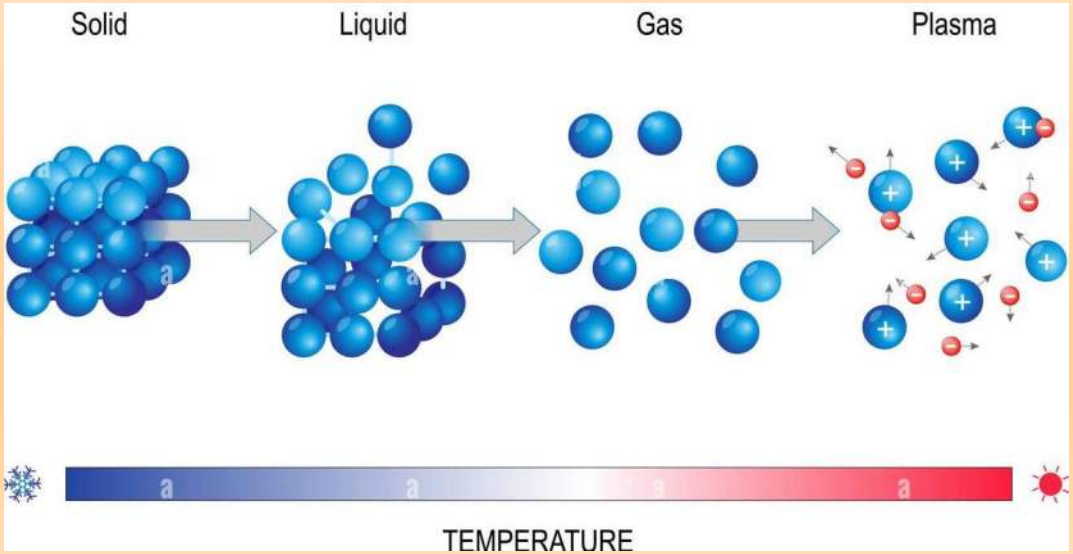
https://www.researchgate.net/figure/Adsorption-vs-absorption-difference-and-comparison_fig3_351887550


How is making Biochar
different than burning?

States of Matter

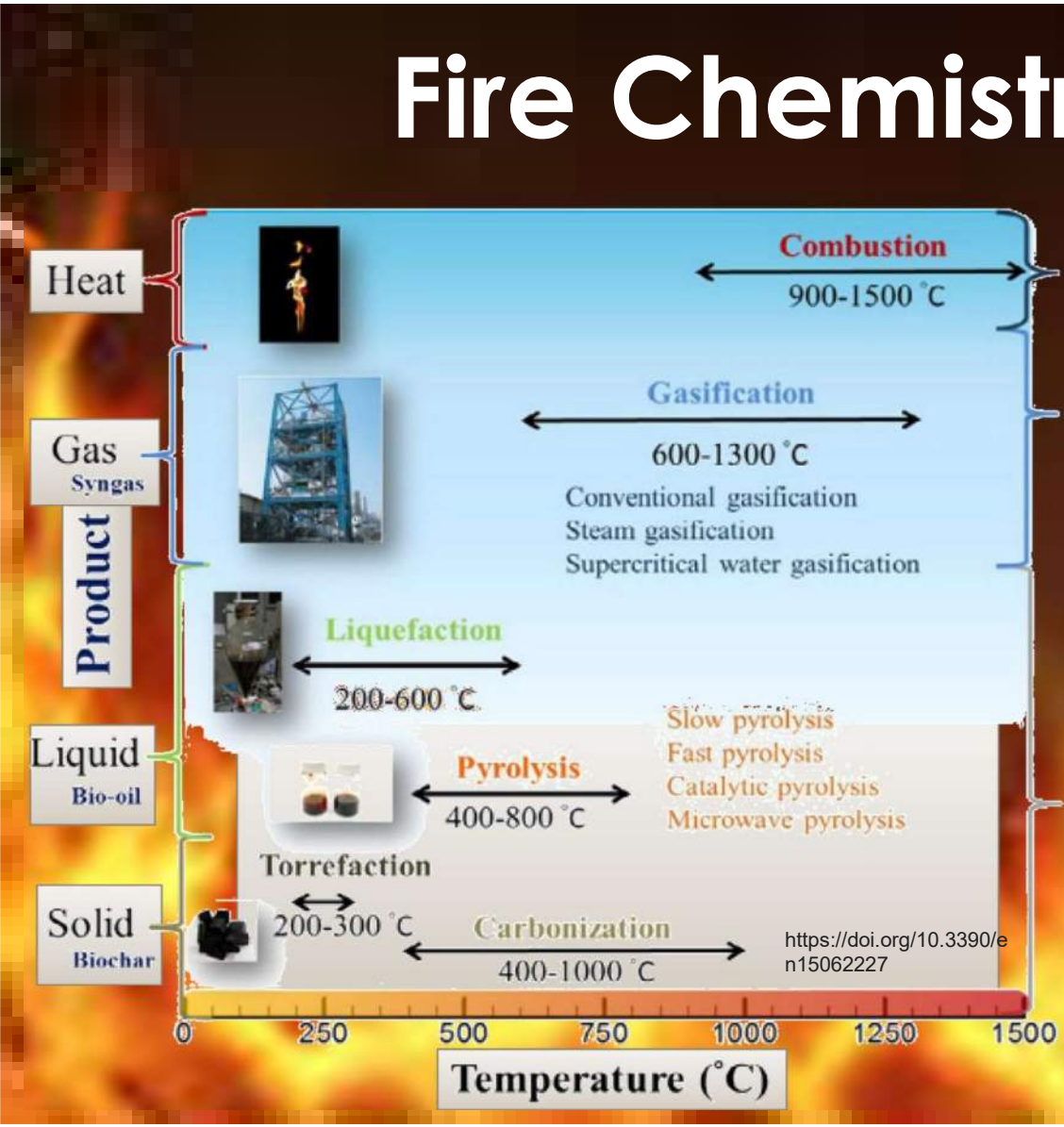


https://www.lincolnelectric.com/en/welding-and-cutting-resource-center/plasma-cutting-resource-center/process-and-theory/what-is-plasma



https://www.alamy.com/stock-photo/solid-liquid-gas-plasma.html?sortBy=relevant

Fire Chemistry



https://doi.org/10.3390/en15062227

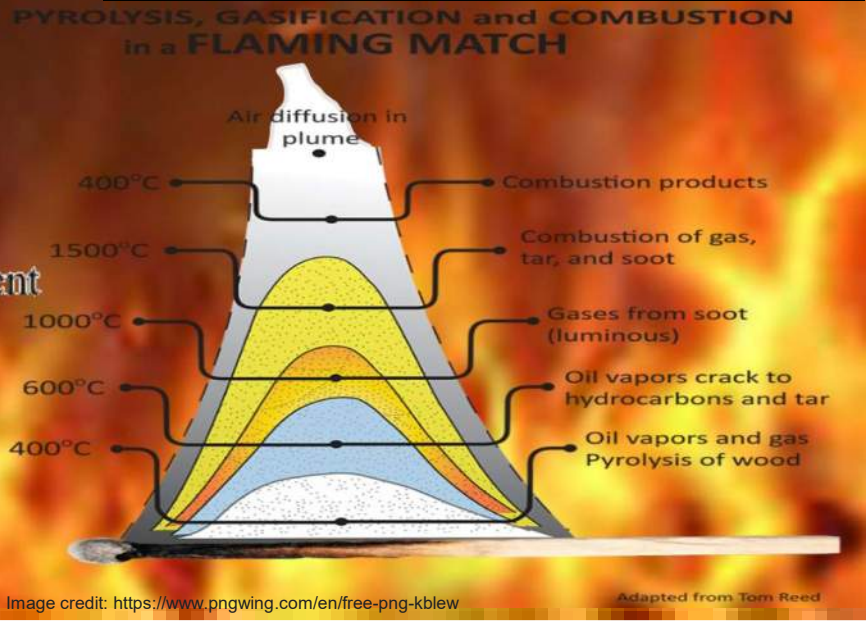
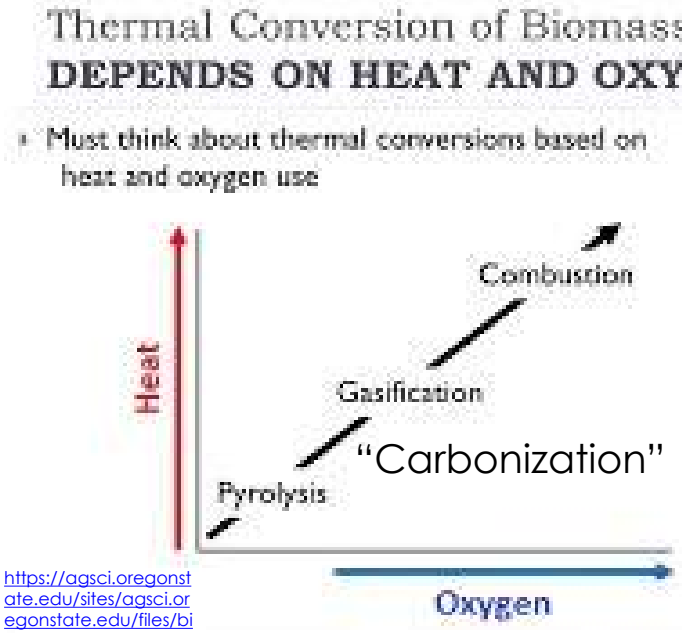


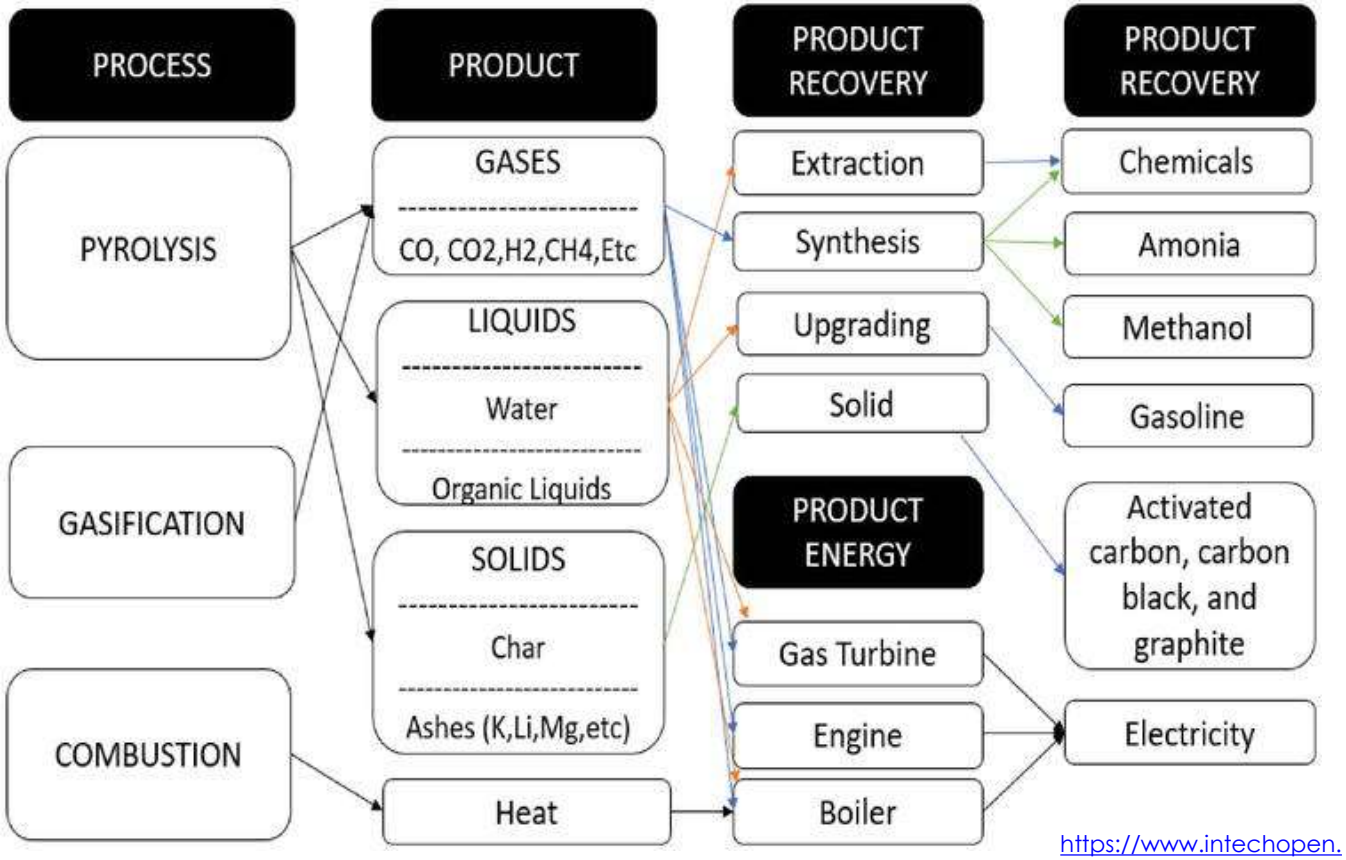
Image credit: https://www.pngwing.com/en/free-png-kblew

Gasification vs Pyrolysis



https://agsci.oregonstate.edu/sites/agsci.oregonstate.edu/files/bioenergy/education/lecture_12_-_combustion_gasification_notes.pdf

Pyrolysis is a prerequisite for gasification. Gasification does not directly produce biochar; it creates gases that can be independently recovered or combusted to drive heat for direct and indirect pyrolysis.



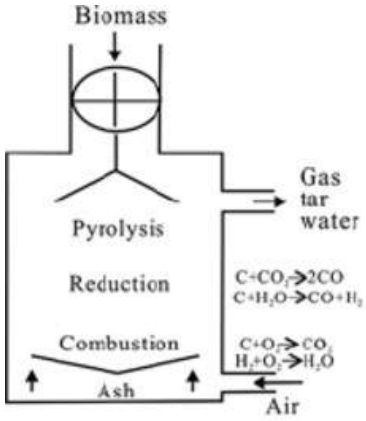
https://www.intechopen.com/chapters/77109

Types of Gasifiers

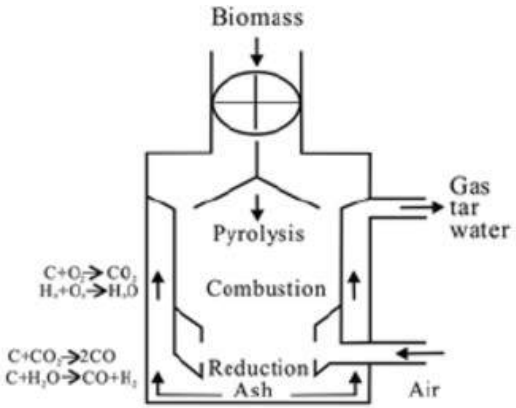
https://www.researchgate.net/figure/Illustrative-structures-of-different-types-of-gasifiers-modified-from-Dr-R-L-Bains_fig3_226602184

PP30 Power Pallet

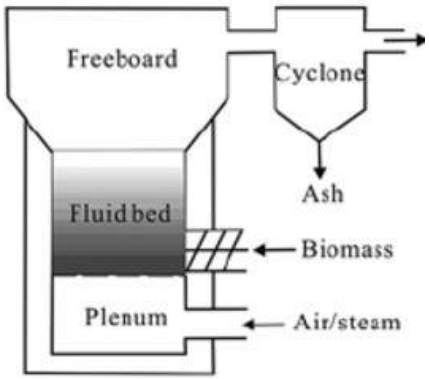
https://www.allpowerlabs.com/pp30-power-pallet



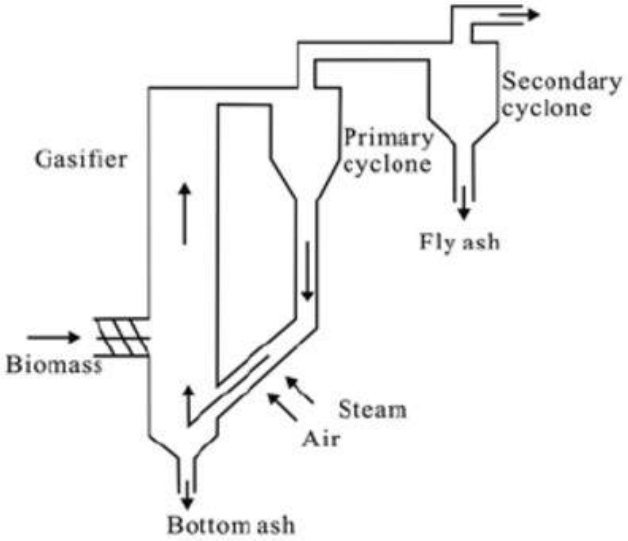
Updraft gasifier



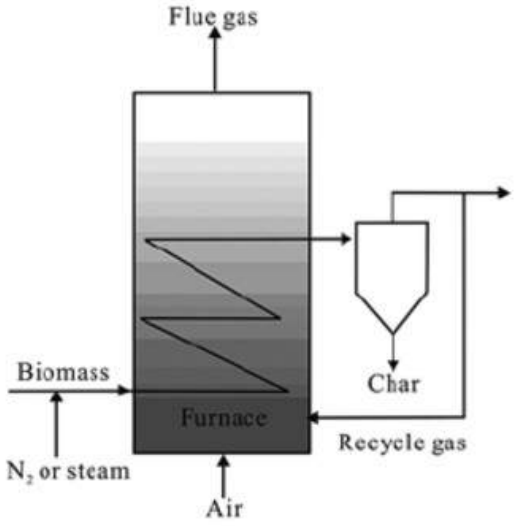
Downdraft gasifier



Fluid bed gasifier



Circulating fluid-bed gasifier



Entrained flow gasifier

How to make Biochar?

Production Methodologies

Oregon Kiln – Flame Cap Principle

Oregon kiln, loaded and ready to light.

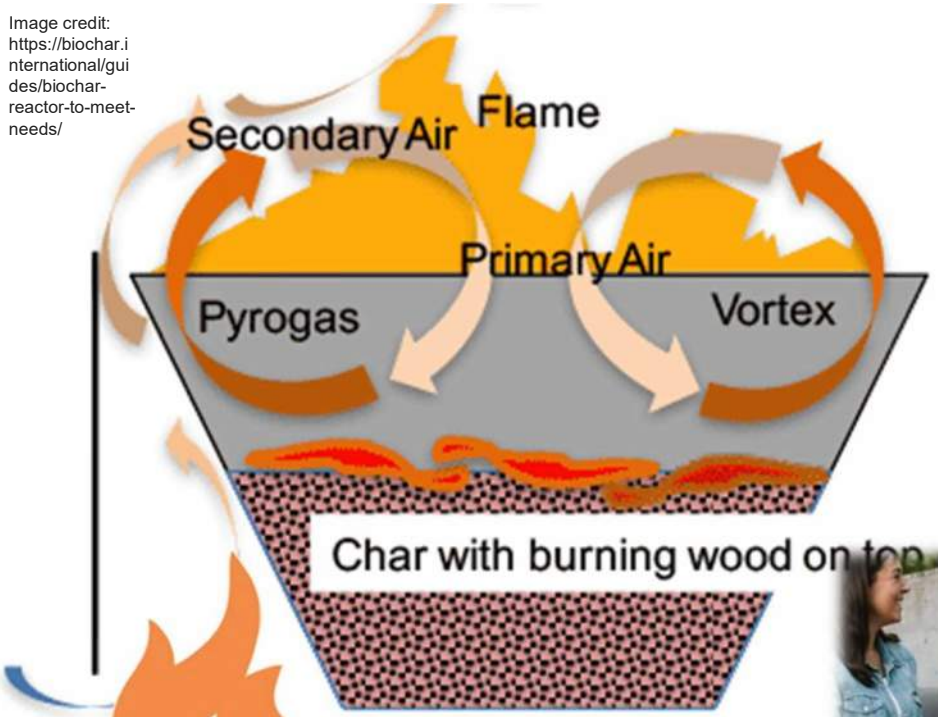
Oregon kiln, mid burn.

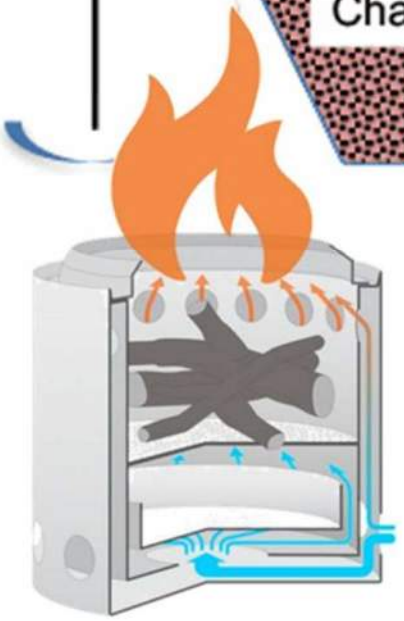
Making good BioChar at 600°F.

Open-Source Design Plans - wilsonbiochar.com/shop/ols/products/open-source-kiln-designs-oregon-kiln-and-ring-of-fire-kiln

Air Vortex Kiln – Flame Cap Principle

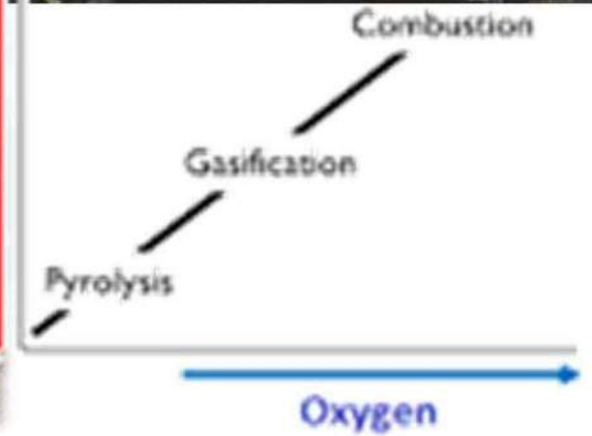
Image credit: https://biochar.international/guides/biochar-reactor-to-meet-needs/

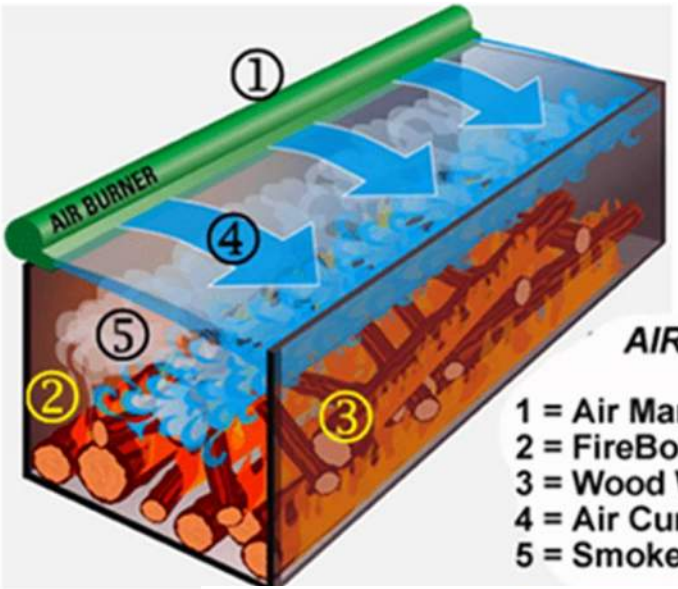




solo stove
BONFIRE
HOW IT WORKS

Image credit: https://www.researchgate.net/figure/Kon-Tiki-kiln-schematics-1-courtesy-the-democratization-of-biochar-and-in-operation_fig4_345338772

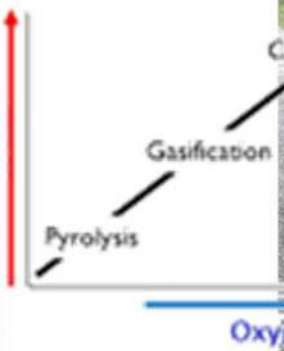




AirBurners

AIR BURNERS, INC.
THE PRINCIPLE OF AIR CURTAIN BURNING

1 = Air Manifold
2 = FireBox Refractory Wall
3 = Wood Waste or Wood Fuel
4 = Air Curtain (left to right)
5 = Smoke (PM or Black Carbon)



https://www.kleensite.com/kleenbox-burnboxservice-method

Air Curtain Burners– Forced Air Flame Cap

https://www.eglin.af.mil/News/Article-Display/Article/391840/burn-baby-burnincinerator-clears-range-debris/

Image credit: https://www.customcarbonizing.com/

Coming 2024: Phoenix Biochar

ECOVERSE

Doppstadt — Shredders

BACKHUS — Windrow Turners

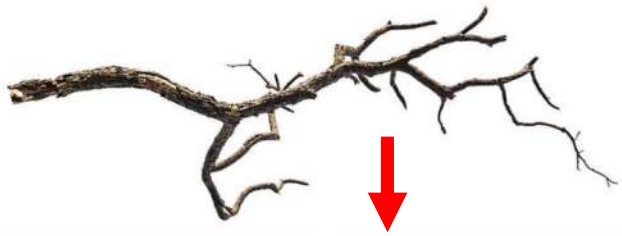
BACKERS — Star Screens

TIGER DEPACK — Depackagers

ECOSTACK — Conveyors

MENART — Towed Windrow Turners

CK — Balers



Whole brush goes in the top, no chipper needed.

A conveyor and cooling auger system deposit nutrient capturing biochar.

The machine follows fuel/invasives clearing crews, leaving behind sequestered carbon.

A diesel-electric power system allows crews to power/charge other equipment while idle, diesel engines are also adaptable to future use of hydrogen or renewable natural gas.

Komptech Americas Is Now Viably

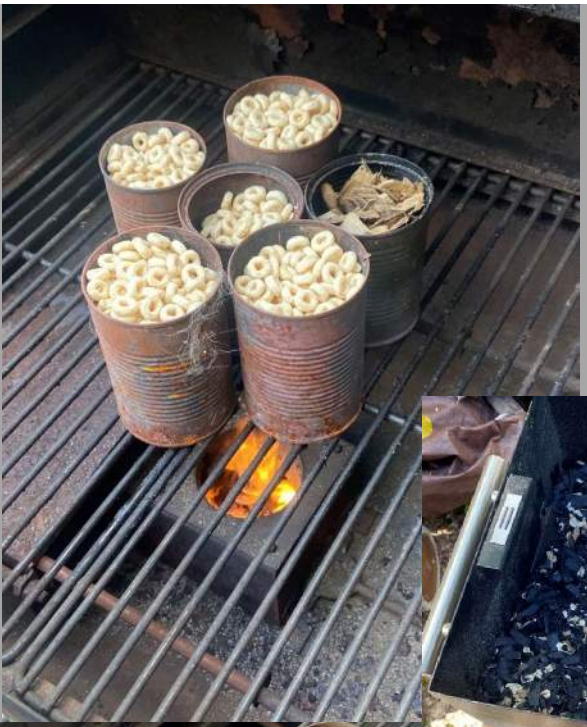
Viably

See what new
can do for you.

Indirect Pyrolysis

Temperature (°C)
550
630
680
740
770
800
850
900
950
1000
1100
1200
1300

https://commons.wikimedia.org/wiki/File:Example_incandescence_colors_%28temperature_range_550_-_1300_C%29.svg

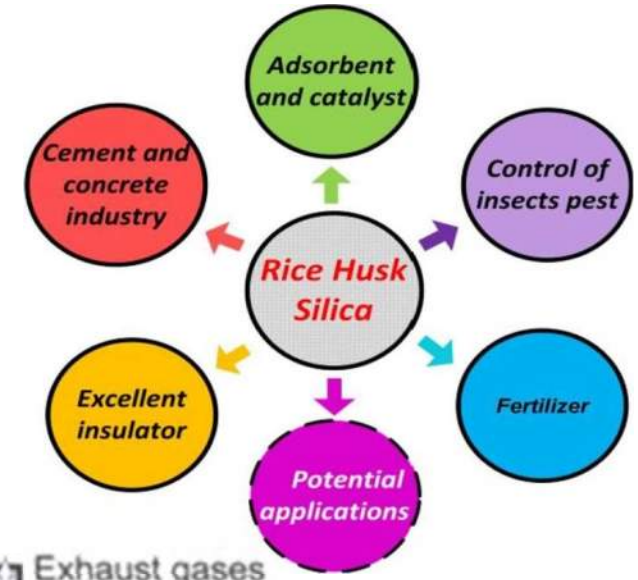


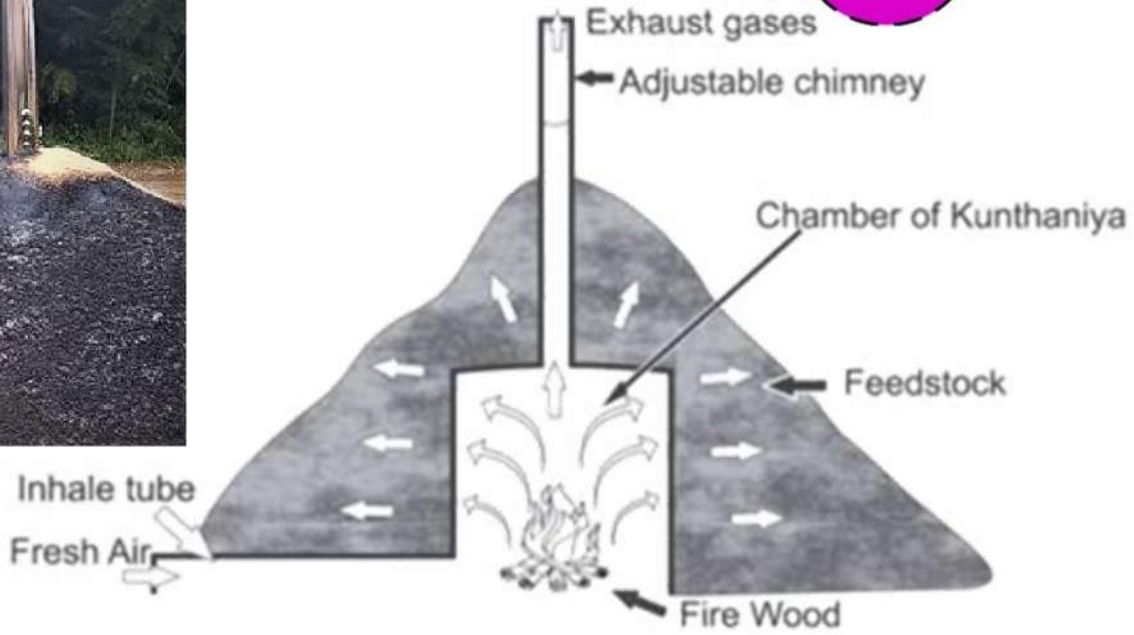

PREMIUM
HARDWOOD
PELLETS

TLUD –
Top Lit Up-Draft, Gasifier?

Image credit:
https://biochar-in
ar-reactor-to-meet-needs/
https://warmheartworldwide.org/suc
ful-biochar-program/

Rice Husk





https://onlinelibrary.wiley.com/doi/abs/10.1002/ldr.4006
https://www.researchgate.net/figure/6-Applications-of-rice-husk-silica-22_fig6_332290653
https://www.facebook.com/BiocharIntl/photos/sri-lanka-preparation-of-biochar-as-a-soil-amendment-from-rice-husk-and-corn-cob/2369588863057756/

Boulder Biochar Barrel - The Brewmaster

$2,999 + shipping

2 Barrel kit for running a generator motor $1,999 + Shipping

https://www.hpbiochar.com/boulder-biochar-barrel

HIGH PLAINS BIOCHAR

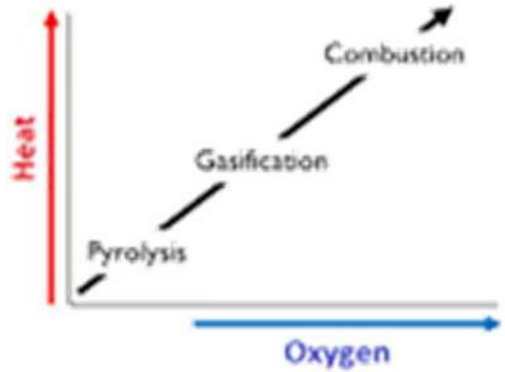
BIOCHAR CO-OP

RocketChar 301 Biochar Furnace

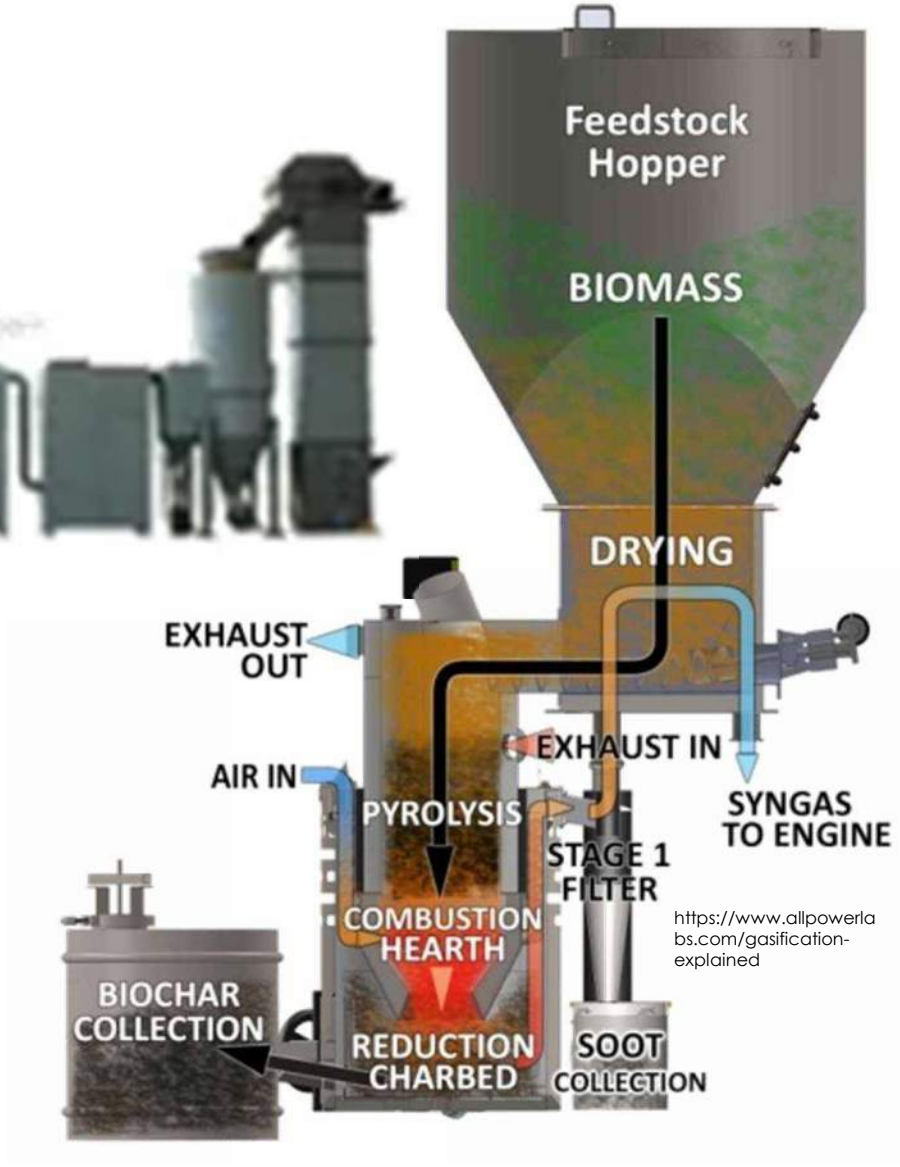
$40,000 USD

https://www.hpbiochar.com/rocketchar

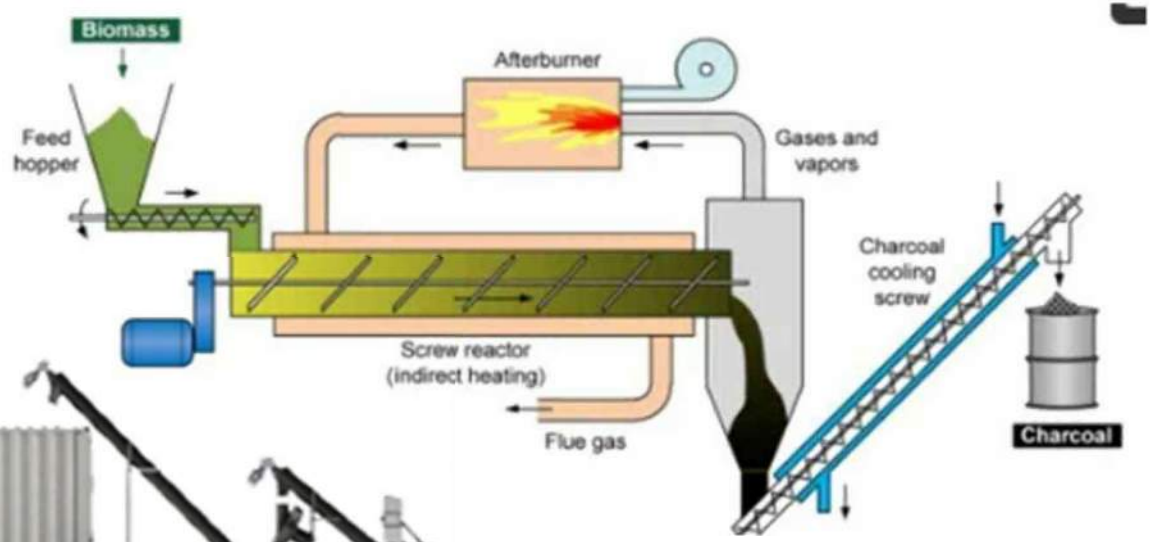
KXNY



HIGH PLAINS BIOCHAR

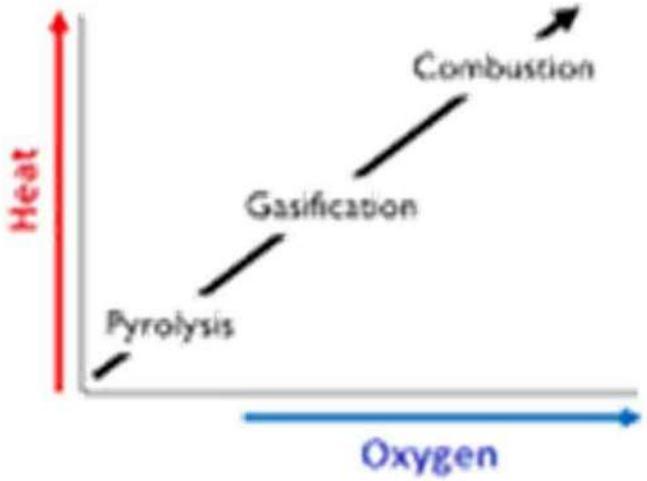


https://www.allpowerlabs.com/gasification-explained



https://doi.org/10.3390/en15062227

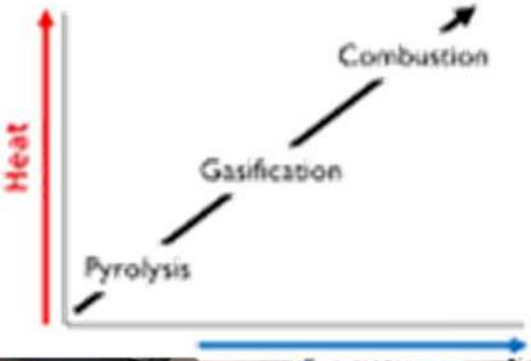
Image credit: https://www.arti.com/reactors/

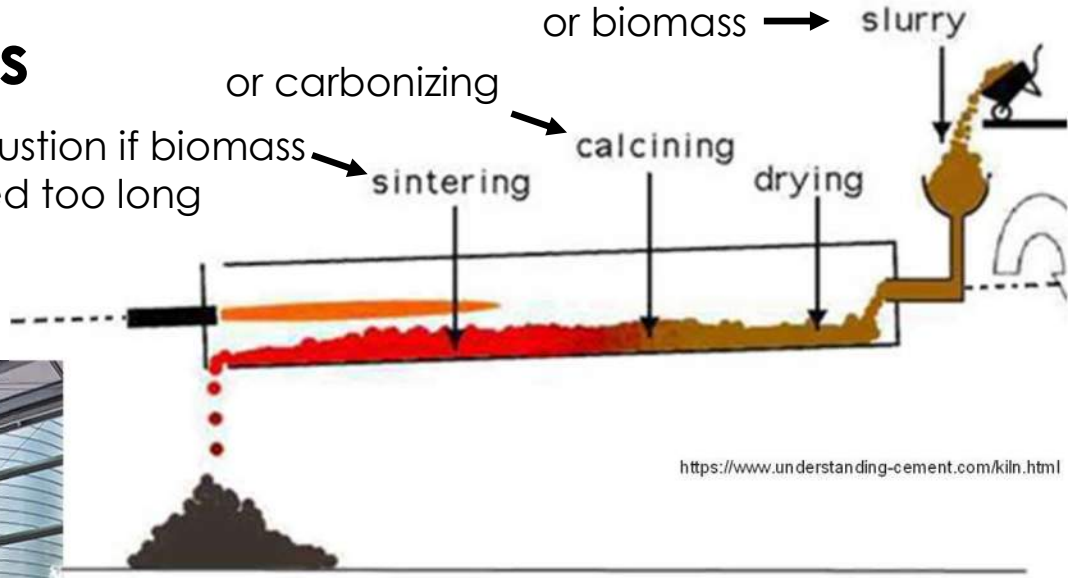


Biochar Now

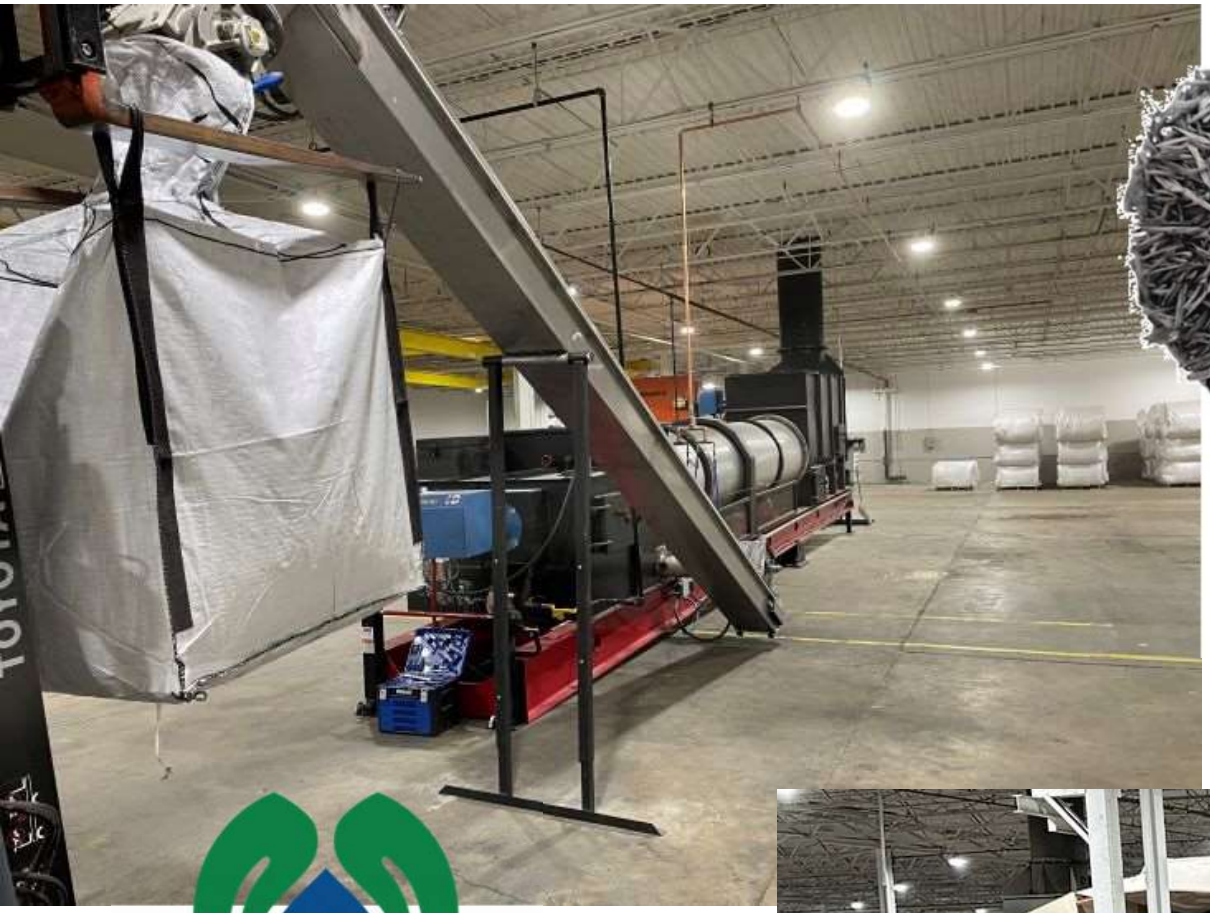
https://www.denverpost.com/wp-content/uploads/2017/06/media-reporternerald-com-0617-biz-biochar3-js-xl.jpg?w=620
https://biocharnow.com/wp-content/uploads/2019/12/15-transport-steps.jpg
https://biocharnow.com/wp-content/uploads/2019/12/15-site-kilns-1.jpg

Rotary Kilns





- Already commonplace for producing activated carbon from biomass (coconut shells, nut shells, bamboo, etc.) and making quick lime for cement.
- Biochar does not include steam activation or other energy-intensive “activation” steps
- Biochar implies energy is recovered from the process and an overall carbon-negative proces, as simple as heating the building around the kiln.
- Minimizing or recovering emissions is also typically a differentiator of biochar.



BIOMASS ENERGY
TECHNIQUES INC

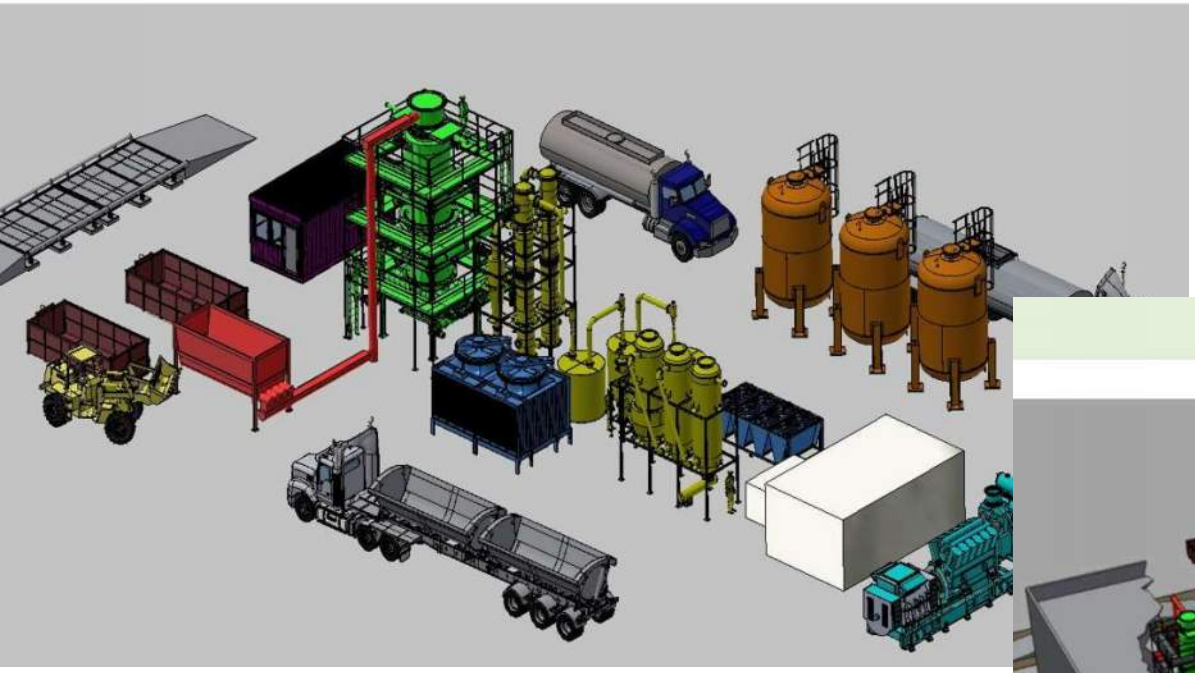
biomassenergytechniques.com

Glanris

HAIQI ENVIRON

https://www.haiqi-energyfromwaste.com/

25 ton/day Regenerator



Sage Green N.R.G.
Problem solving for a cleaner, greener, & healthier world.

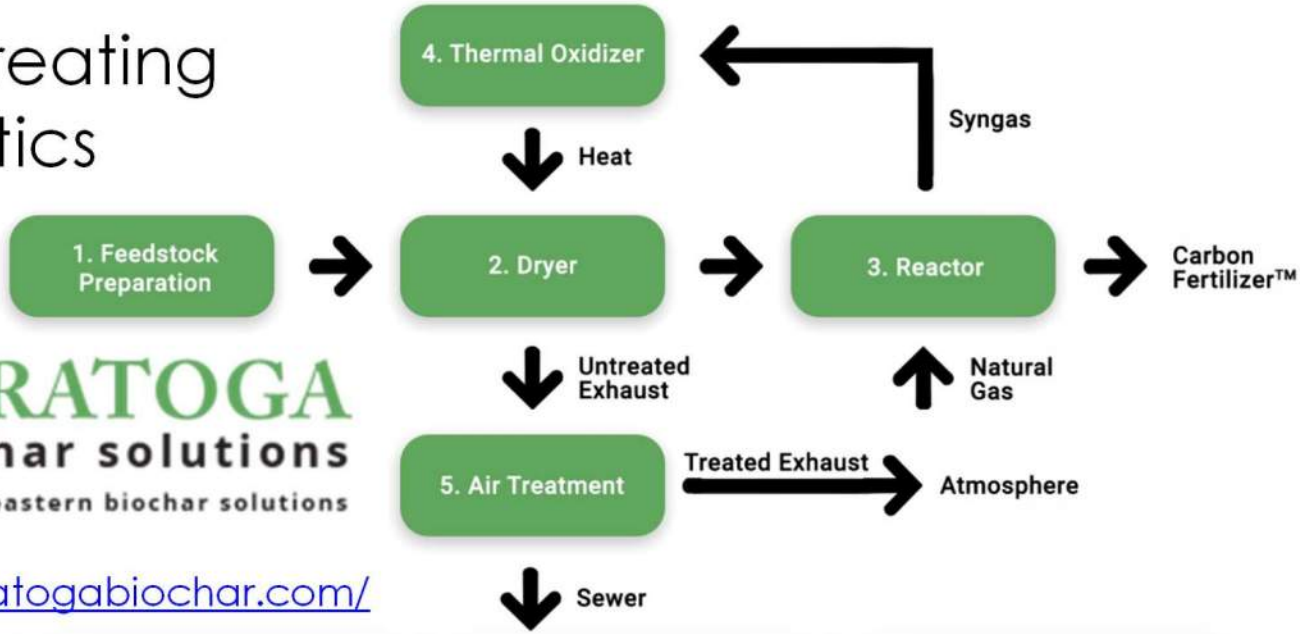
SET SINGULARITY ENERGY TECHNOLOGIES, LLC
WASTE TO ENERGY

Five 25 ton/day Regenerators

Biosolids Gasification - treating PFAS and microplastics

SARATOGA biochar solutions
a project of northeastern biochar solutions

https://saratogabiochar.com/



Feedstock Prep

Mixing biosolids, waste wood, and dried biosolids prior to processing.

Pre-Drying

Biosolids are dried utilizing the heat that is generated in the process.

Reactor

Bakes dried biosolids without oxygen to separate PFAS, VOCs, and other contaminants (syngas) from solids (Carbon Fertilizer™).

Thermal Oxidizer

Remediates PFAS, VOCs, and other contaminants and generates heat for the dryer.

Air Treatment

Employs benchmark air treatment to remove particulates and odors to protect human health and our reputation.

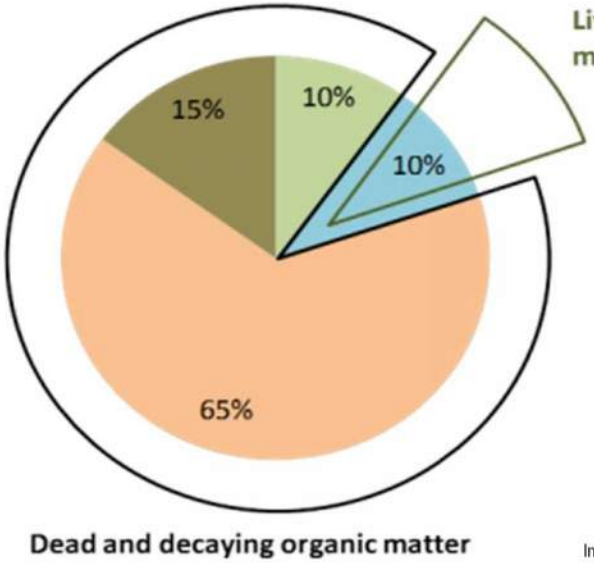
Transport, Transfer, & Storage Considerations

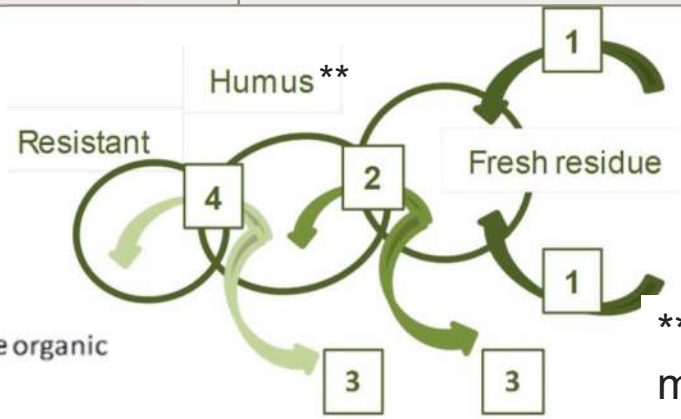
How does Biochar sequester carbon?

Labile Soil Organic Matter (SOM) vs Recalcitrant Soil Organic Carbon (SOC)

Fraction	Size	Turn-over time	Composition
Dissolved organic matter	<45 µm (in sol'n)	Minutes to days	Soluble root exudates, simple sugars and decomposition by-products. It generally makes up less than 5% of total soil organic matter.
Particulate organic matter	53 µm – 2 mm	2–50 years	Fresh or decomposing plant and animal matter with identifiable cell structure. Makes up 2–25% of total soil organic matter.
Humus**	<53 µm	10s to 100s of years	Older, decayed organic compounds that have resisted decomposition. Can make up more than 50% of total soil organic matter.
Resistant organic matter	<53 µm – 2 mm	100s to 1000s of years	Relatively inert material, such as chemically resistant materials or organic remnants (e.g. charcoal). Can be up to 10% of soil organic matter.

compost PEAT biochar





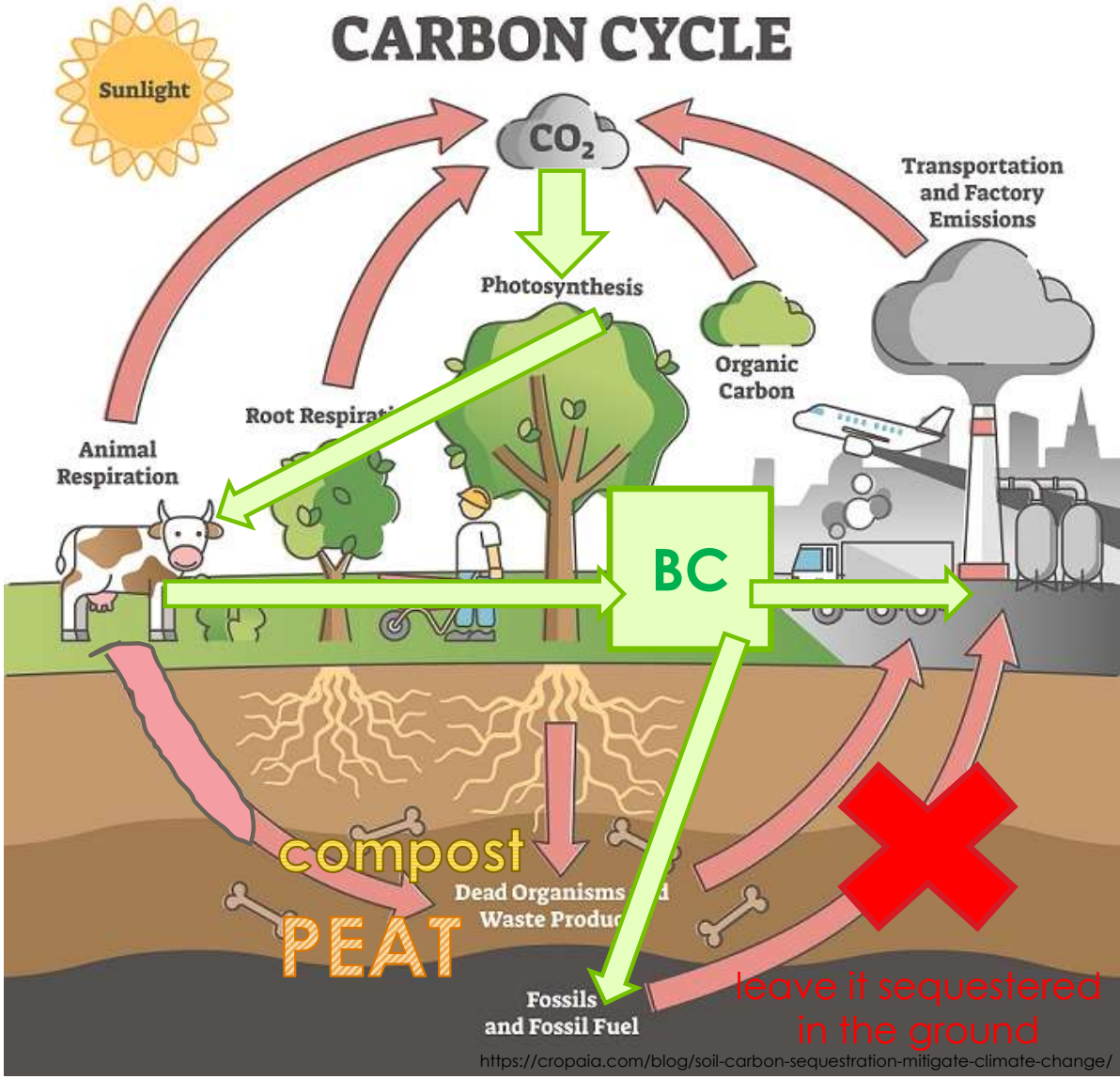
Fresh residues
Living organisms
} Particulate organic matter
Humus **
Resistant organic matter

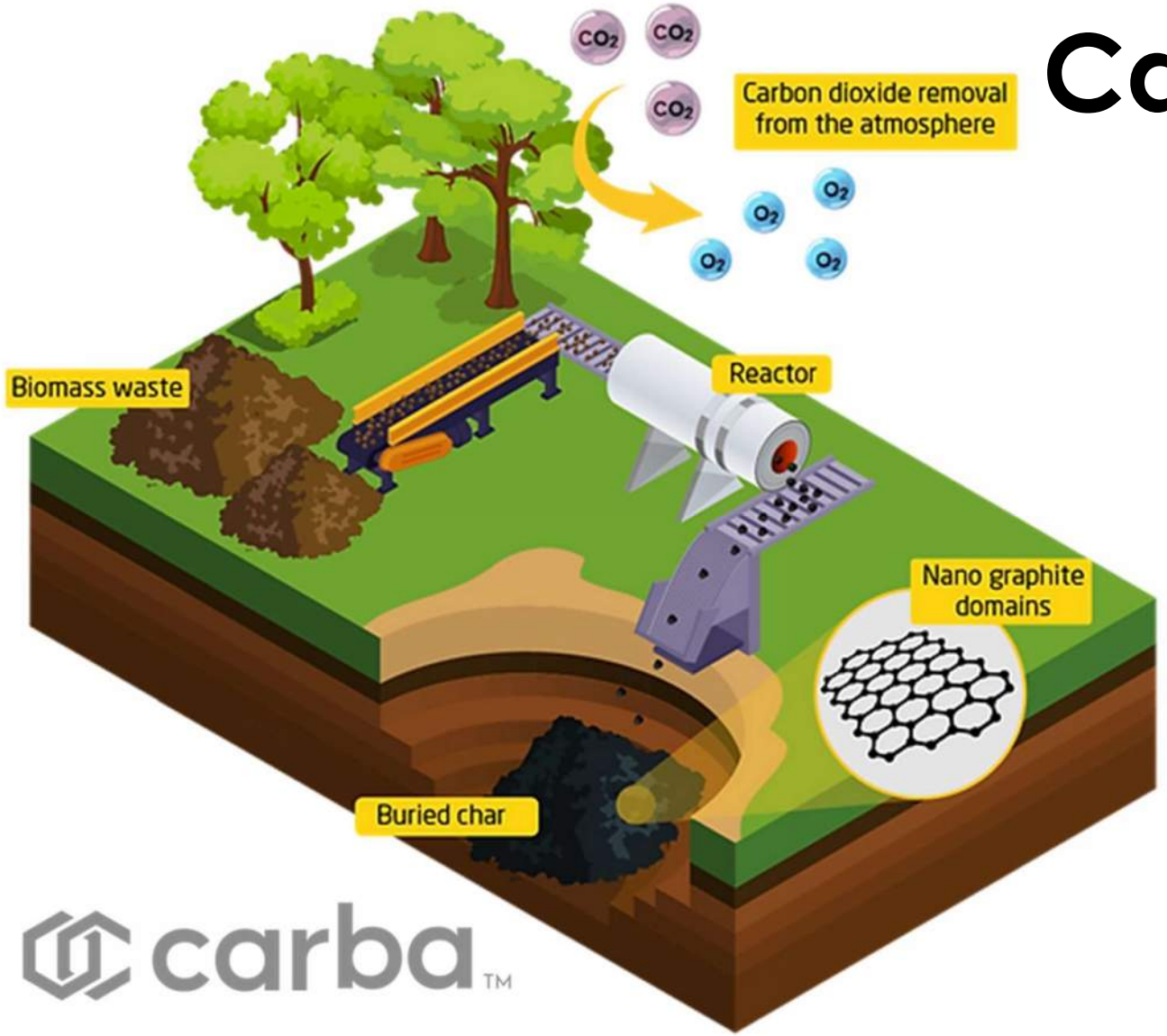
Image credit: https://www.agric.wa.gov.au/measuring-and-assessing-soils/what-soil-organic-carbon

** a.k.a. the soil matter formerly known as "humus"

(https://www.mofga.org/resources/soil/humus-is-dead-long-live-humus/)

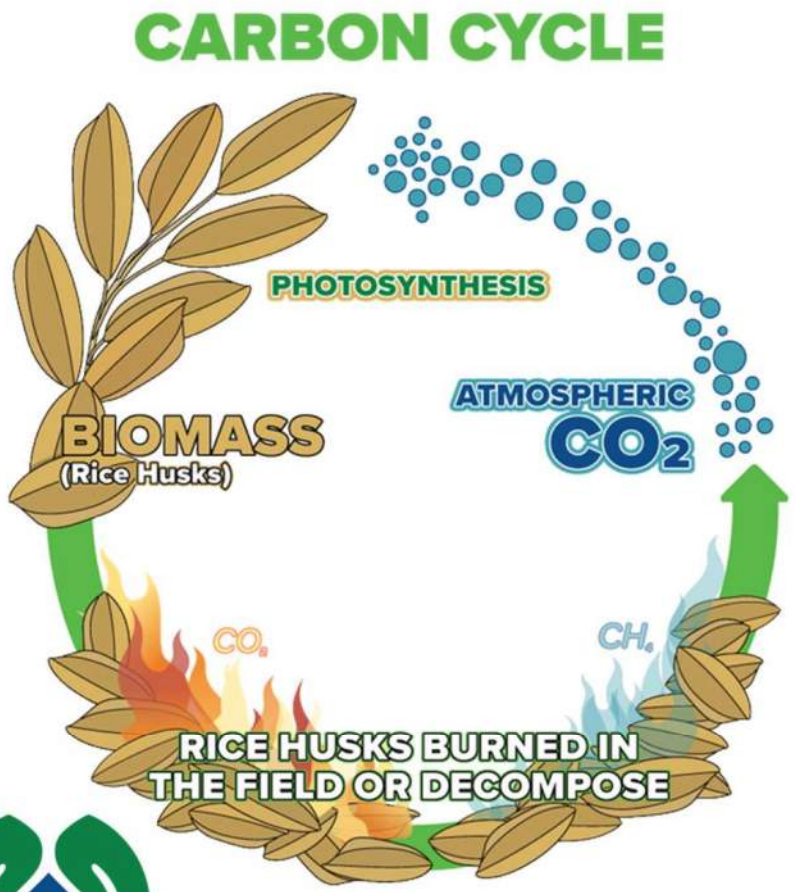
Image credit: https://www.canr.msu.edu/news/the_biochar_boon



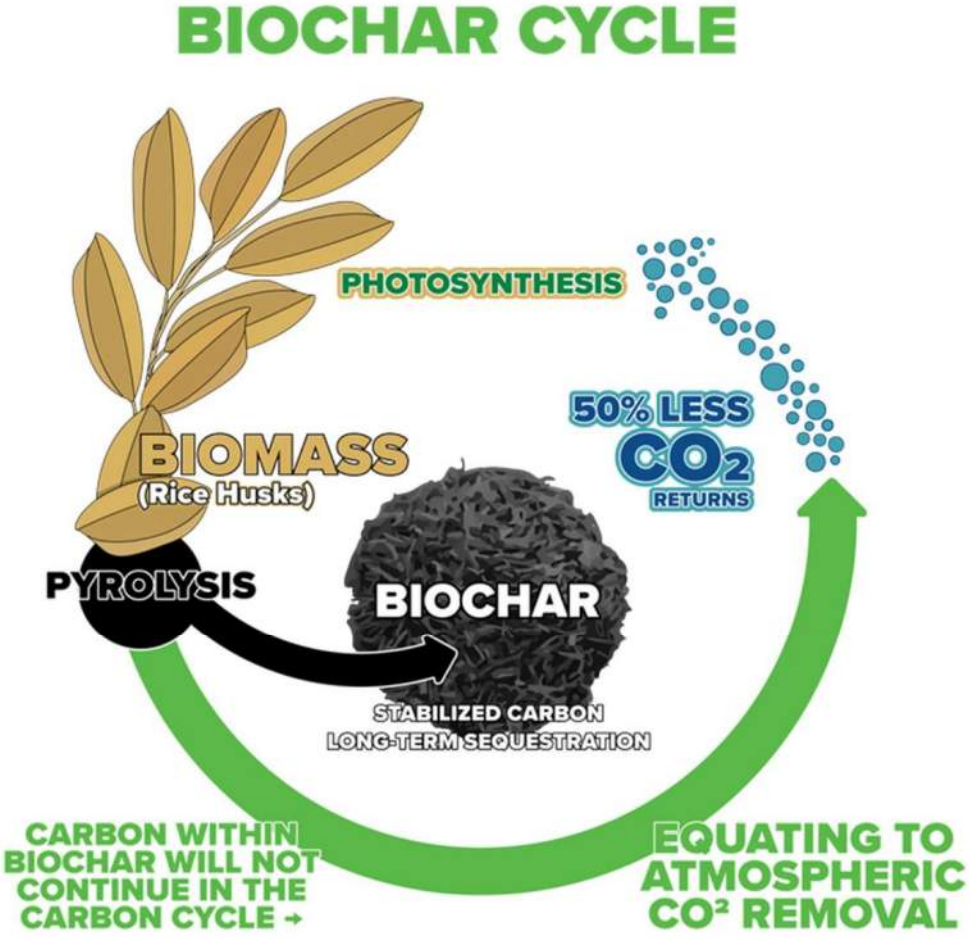


Carbon Credits

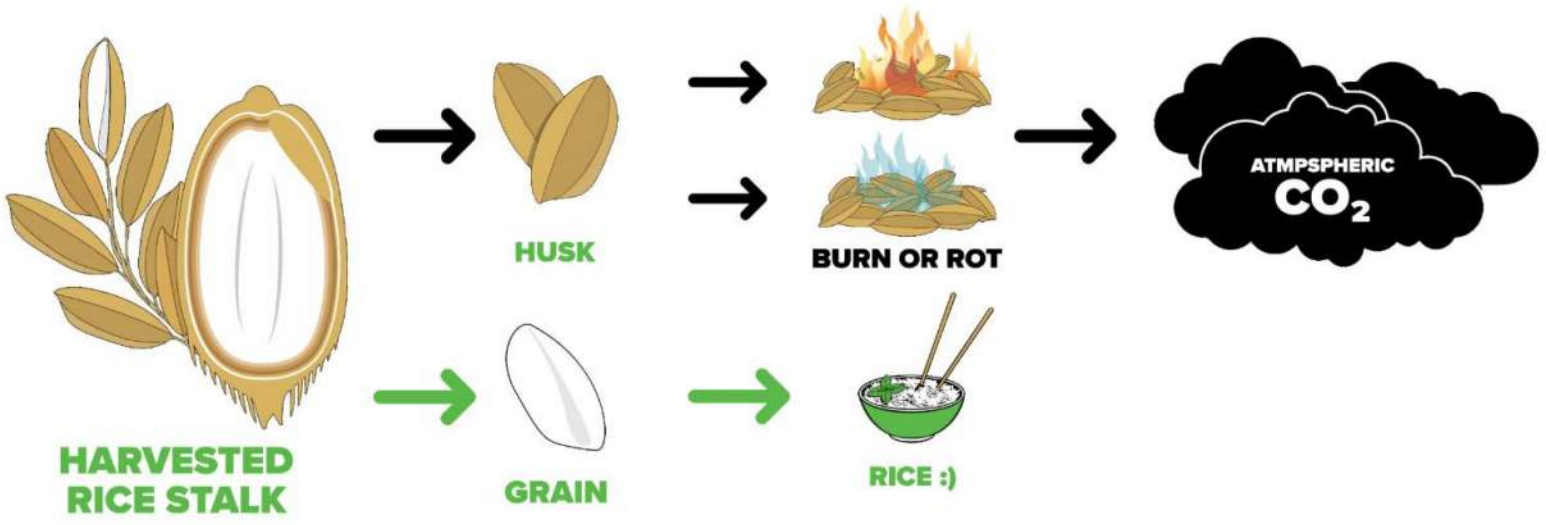
- (existing) If a tree falls in the woods, how much carbon is released when it burns in a forest fire? -98%-
- (proposed) With the right reactor, -50%- of that carbon could be locked in biochar for 100s to1000s of years.
- (credit) = (existing) – (proposed)
- It's easier to prove that carbon is unavailable to decomposition and fire deep underground than it is to prove it in complex soil biology.

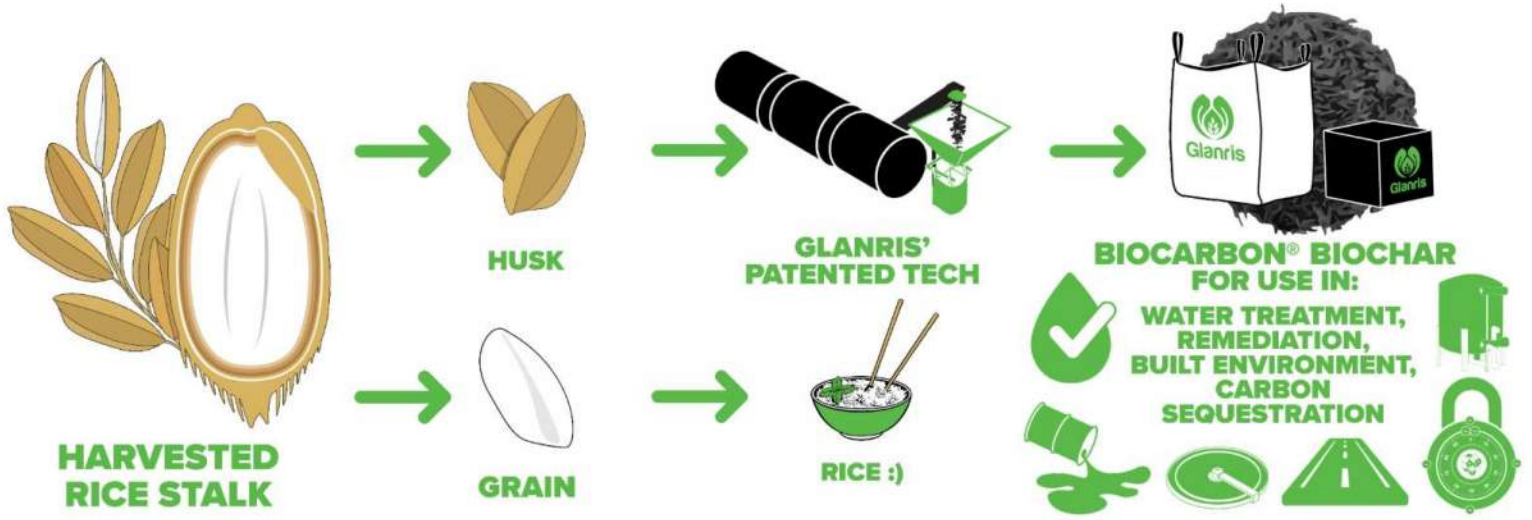

CARBON CYCLE
PHOTOSYNTHESIS
ATMOSPHERIC
CO_2
BIOMASS
(Rice Husks)
CO_2
CH_4
RICE HUSKS BURNED IN
THE FIELD OR DECOMPOSE

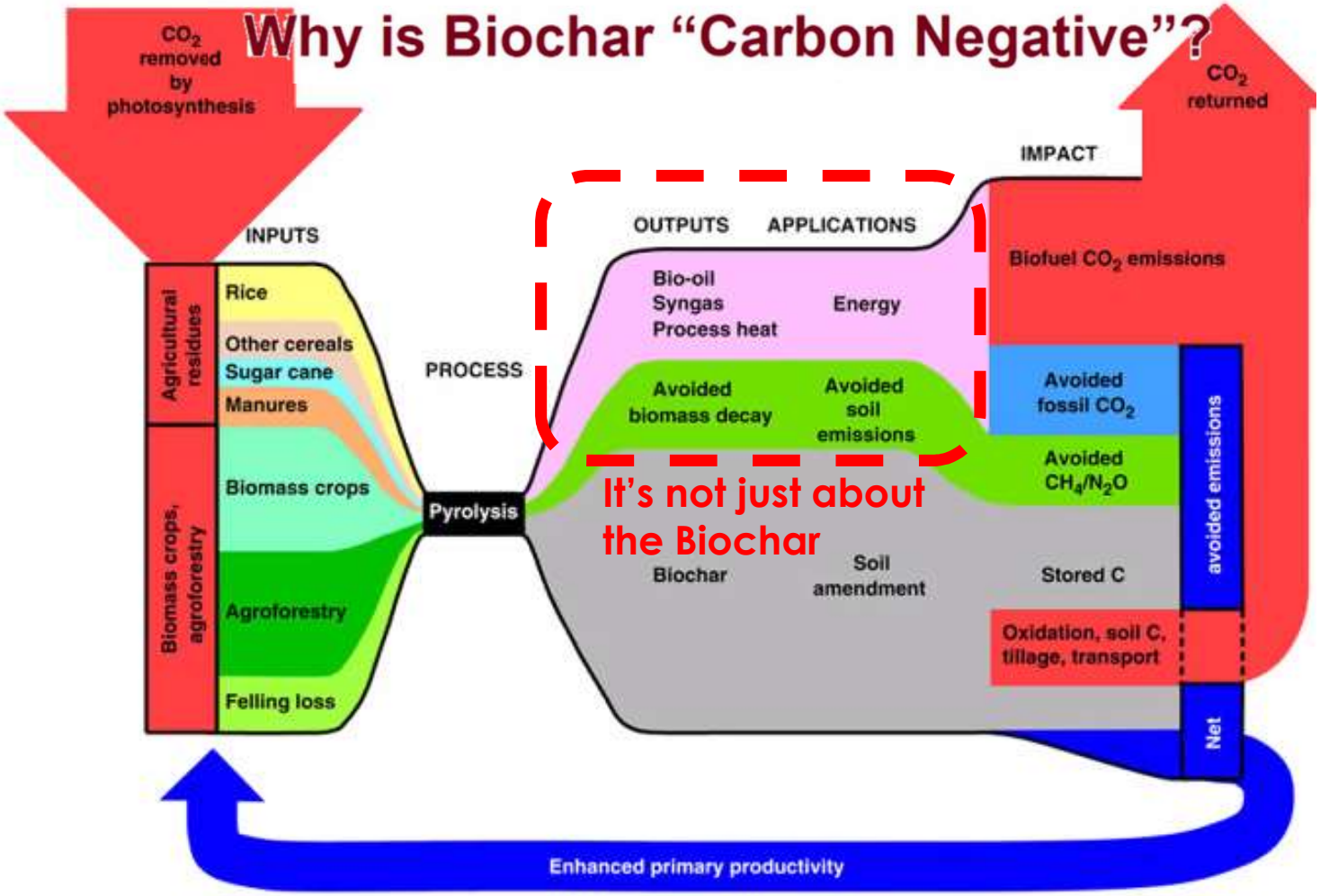
Glanris


BIOCHAR CYCLE
PHOTOSYNTHESIS
50% LESS
CO_2
RETURNS
BIOMASS
(Rice Husks)
PYROLYSIS
BIOCHAR
STABILIZED CARBON
LONG-TERM SEQUESTRATION
CARBON WITHIN
BIOCHAR WILL NOT
CONTINUE IN THE
CARBON CYCLE →
EQUATING TO
ATMOSPHERIC
CO^2 REMOVAL

Glanris


HARVESTED RICE STALK
HUSK
GRAIN
BURN OR ROT
ATMPSPHERIC CO_2
RICE :)


HARVESTED RICE STALK
HUSK
GRAIN
GLANRIS' PATENTED TECH
RICE :)
Glanris
Glanris
BIOCARBON® BIOCHAR FOR USE IN:
WATER TREATMENT, REMEDIATION, BUILT ENVIRONMENT, CARBON SEQUESTRATION



Sustainable biochar to mitigate global climate change

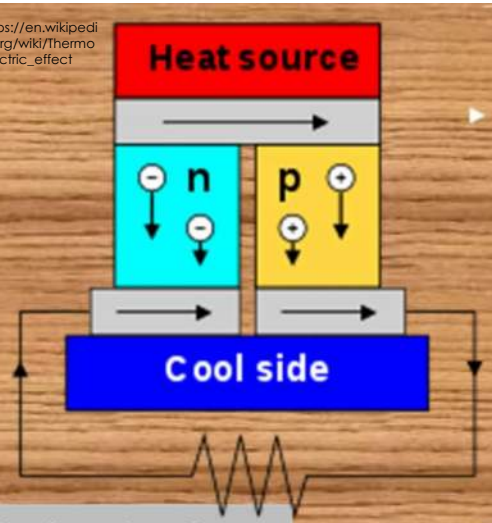
Dominic Woolf[1], James E. Amonette[2], F. Alayne Street-Perrott[1], Johannes Lehmann[3] & Stephen Joseph[4]

Slide by Bridget Ulrich, NRRI, presented March 16, 2023

Energy Recovery

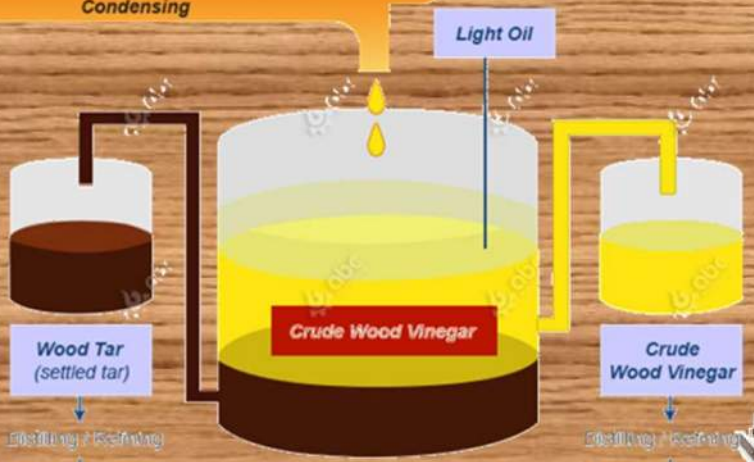
https://i5.walmartimages.com/asr/f4f942b8-fe60-4230-9d83-999f78173fee.09d50934cd6305a007ee4ace35e56e14.jpeg

https://en.wikipedia.org/wiki/Thermoelectric_effect



http://www.forgreenheat.org/technology/outdoor_wood_boilers.html

https://www.tegmart.com/wood-stove-thermoelectric-generators/



https://www.briquette-machine.com/wood-vinegar-from-charcoal-briquette-making-process.html

https://cdn.shopify.com/s/files/1/0666/9741/products/CampStove2_1_d6669270-700b-4685-b756-be3b42ef0f98.jpg?v=1612737235

Values

1. No poverty

Farmers are well paid for the production of biochar with money derived from carbon credit sales. This is a second source of income besides regular farming. The produced biochar is applied on the fields of the farmer. Therefore, farmers also become less dependent on the use of chemical fertilizers and pesticides, of which the price is increasing steeply.

2. Zero hunger

In the Odisha region, farmers deal with depleted grounds and long periods of drought. Most of them are rice farmers and have a little garden for their own food supply. Biochar is proven to increase crop yield, nutritional value and resistance to insects and drought.

3. Good health & well-being

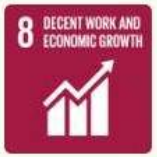
Biomass is not always valued in the Odisha region. Therefore, to get rid of it, farmers light the residues on fire on their fields. This leads to misty smoke clouds which are detrimental for the health of the farmers.Also, biochar captures and holds heavy metals and other toxic elements, which thus do not end up in the edible parts of the plant, but are kept isolated in the ground.

5. Gender equality

By employing women as artisanal farmers as well as (head) supervisors, a position of equality is created. Women will be directing and working besides men in an equal way. Women will also be paid an equal amount of money for an equal amount of work. In giving women key roles in the system, we empower them.

8. Decent work & economic growth

The biochar will increase yields for their own production, leading to actual growth of their income. Dutch Carboneers is supporting an extra source of income for the whole region. This evokes not only extra jobs directly but also economic growth in the whole region for work that is better paid than rice production.



10. Reduced inequalities

Artisanal biochar production by farmers in India includes a financial movement from large wealthy corporations to the hard working, generally poor farmers. With the financial influx from wealthy to poor, Dutch Carboneers aim is to reduce the financial inequalities between the Global North and the Global South.

12. Responsible consumption & production

Rice farmers often burn the rice straw residues in the field. Besides being detrimental for the climate, it is foremost a waste of natural goods. With production of biochar the earlier regarded waste is transformed into a soil enhancer for the farm.

13. Climate action

With biochar production, carbon stored in biomass is brought from the short term and active carbon cycle towards the long term and inactive carbon cycle. Depending on the quality of biochar, carbon is stabilized in the soil for at least a hundred and up to a thousand years. Besides the direct carbon sink, biochar also has a measurable positive influence on microbial life in the soil and thus the organic carbon content.

14. Life below water

Because of the porous internal structure of biochar, nutrients are attracted and stored in biochar, this prevents leaching out of nutrients into surrounding surface water and thus eutrophication. Eutrophication of waterways lead to uncontrollable algal blooms and the suffocation of life below water.

15. Life on land

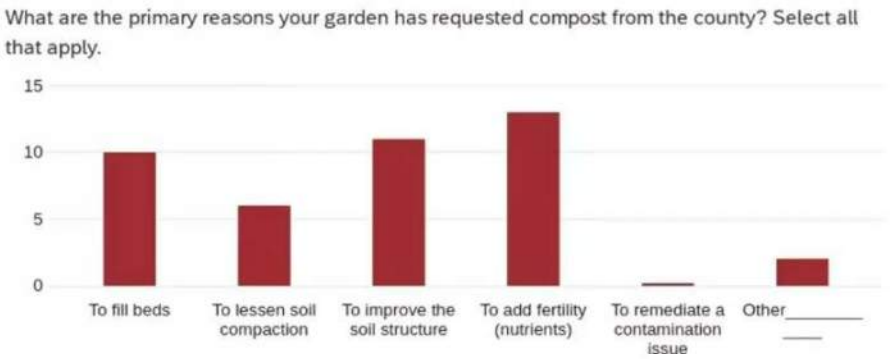
Besides biochar production, a variety of trees are planted throughout the project area. In the project area there is a huge monoculture of rice. The planting of various trees at the borders of each farm creates a more biodiverse ecosystem instead of the present rice monoculture. Biochar also is applied in farming soils, where it helps fight desertification, makes arid areas fertile again and increases micro-biological life in the soil.

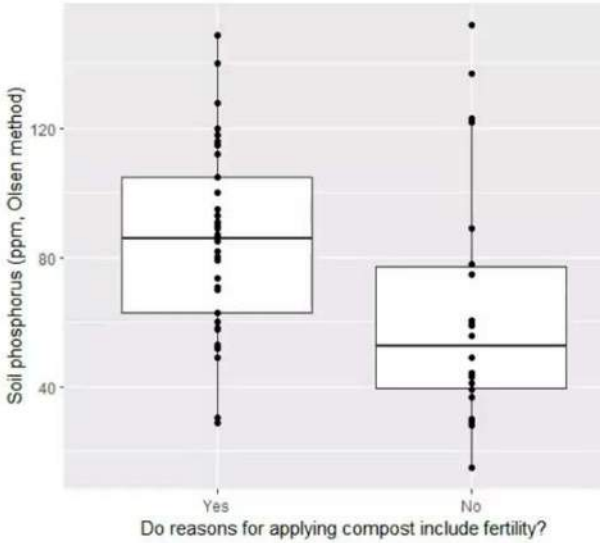
What opportunitie$ are there in Biochar for $oil amendment producer$, vendor$, applicator$, and uer/benefactor$?

- Processing – Carbon Credits
- Blending
- Vending
  - Biochar
  - Byproducts
- Application
- User Benefits
  - Nutrient Retention – Slow Release – Sell More Compost
  - Nutrient Capture – Clean Water
  - Carbon Sequestration
  - Sustainable Replacement for Coal, Peat, or Activated Carbon

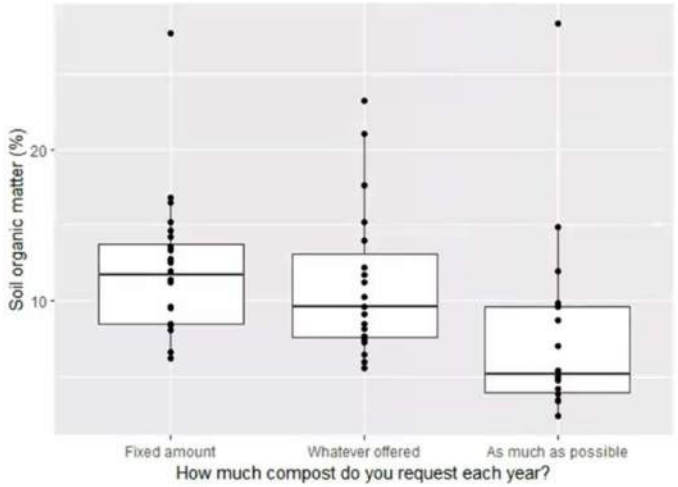
https://medium.com/the-coffeelicious/swimming-in-my-money-like-scrooge-mcduck-fc2140e78ee

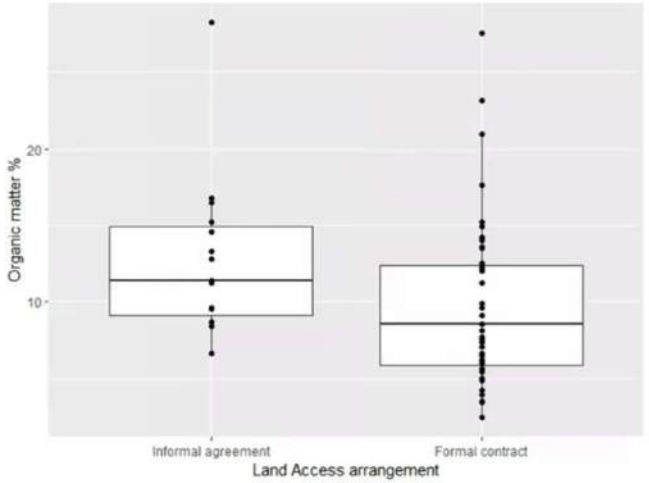
Compost for fertility





Other reasons for requesting high compost volumes





Slides by
Natalie Hoidal,
UMN Extension,
presented
10/5/2023

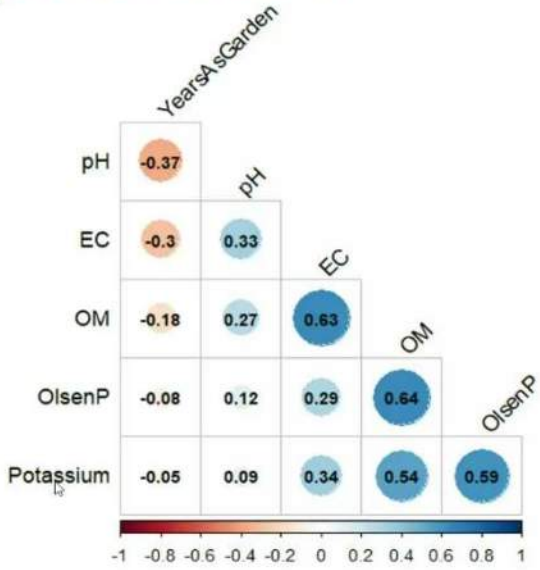
MN Composting Council white paper

- Composting process reduces N availability but has a limited impact on P – P has the potential to leach from compost
- BUT – compost improves the water holding capacity of soil and may reduce runoff and leaching overall
- Conclusion: compost users should try to prevent erosion and improve water holding capacity in the soil. Compost can help do this, as long as it's not applied in excess, particularly in sandy soils.

http://www.mncompostingcouncil.org/uploads/1/5/6/0/15602762/mncc_p_white_paper_3-19_final.pdf.pdf

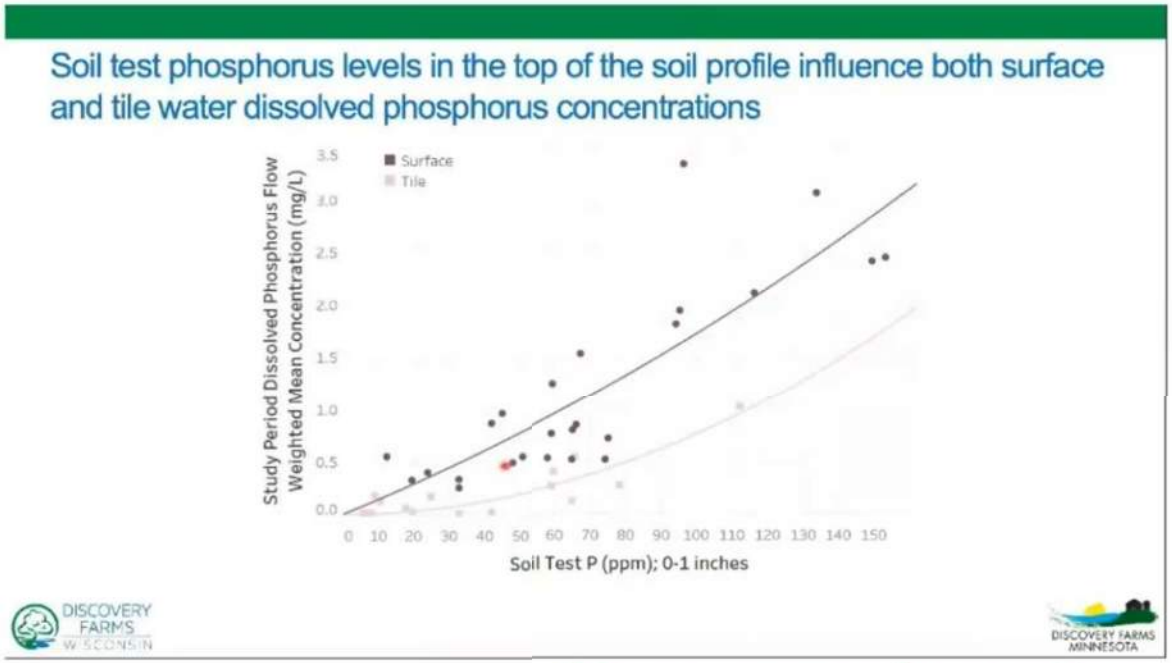
Relationships between soil parameters

- Strongest predictors of P:
  - Organic matter
  - Potassium
  - Weak relationship with electrical conductivity

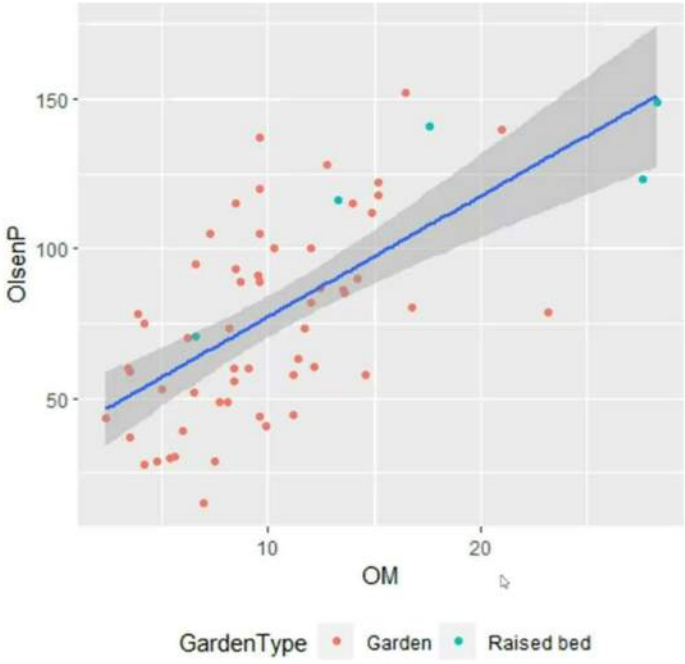


Slides by Natalie Hoidal, UMN Extension, presented 10/5/2023

Evidence for P thresholds



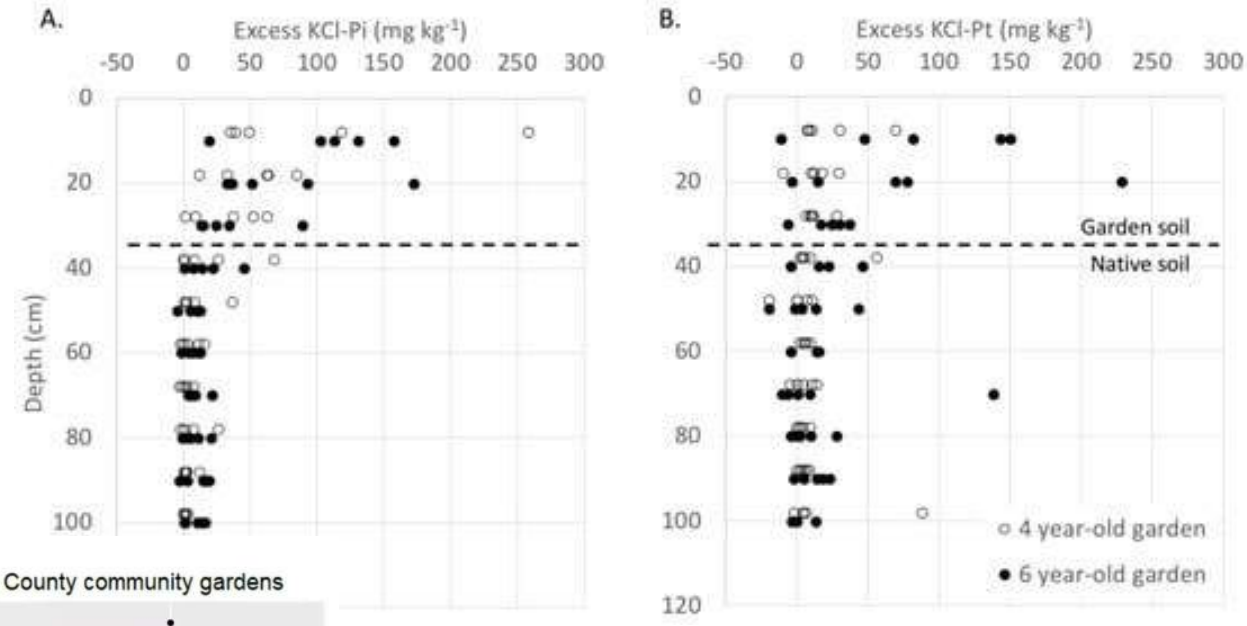
More organic matter → more soil P



Slides by Natalie Hoidal, UMN Extension, presented 10/5/2023

Measuring the Fate of Compost-Derived Phosphorus in Native Soil below Urban Gardens

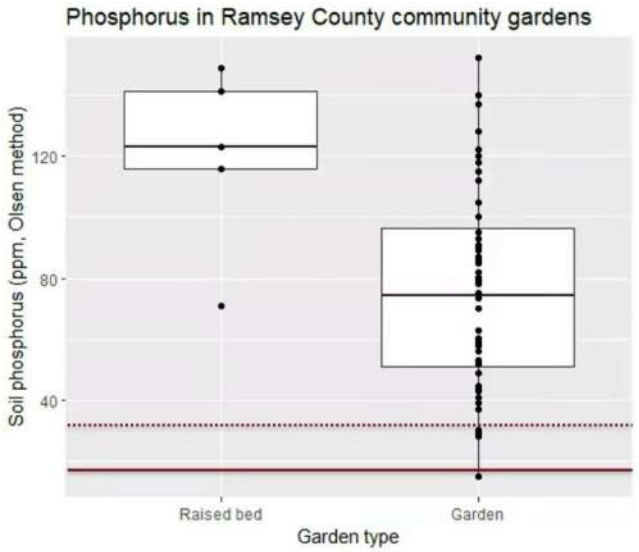
https://www.mdpi.com/1660-4601/16/20/3998



The bad news

- "Very high" for commercial growers: 34 ppm
- "Very high" for gardeners: 18 ppm

- Median values
  - Bare ground: 86
  - Raised beds: 123



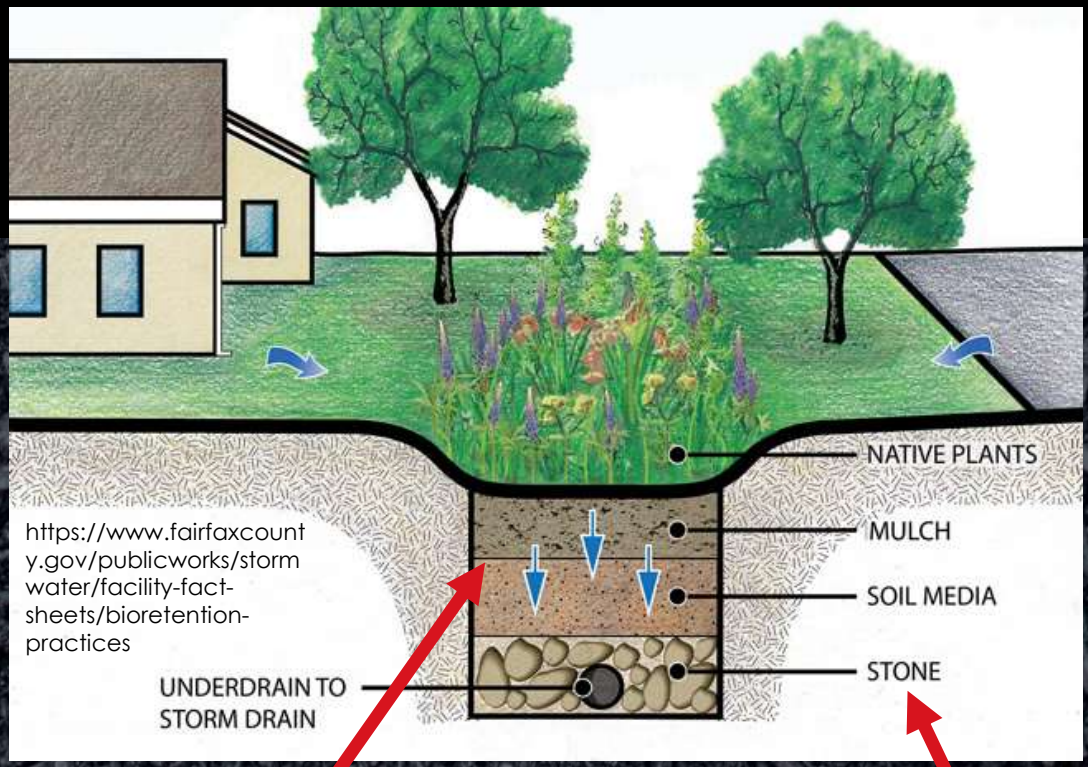
Is the conclusion that phosphorus is leaving garden beds, or that *the right subsoils* are doing their job to sorb the phosphorus?

What other amendments or other garden practices can mitigate phosphorus leaching and allow gardeners to maintain fertile growing environments?

Slides by Natalie Hoidal, UMN Extension, presented 10/5/2023

Leaching and Stormwater Filter

Plants need available N, P, K, and micronutrients. You cannot have a vegetated system without available (leachable) nutrients. Biochar is the perfect solution to concerns of nutrient leaching and can be used to contain nutrients as they move from rooting zones to export.

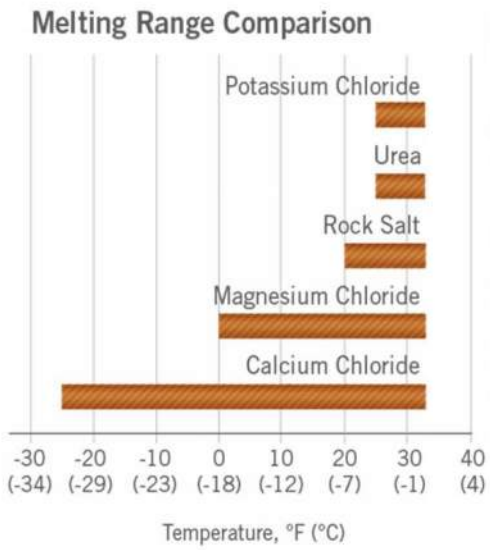


biochar mixes to improve pollutant removal

coarse biochar pipe bedding to capture anything leached from above

Multi-functional Surface Mulch

https://ozturners.com.au/product/ct-compost-turners/



Water / Snow

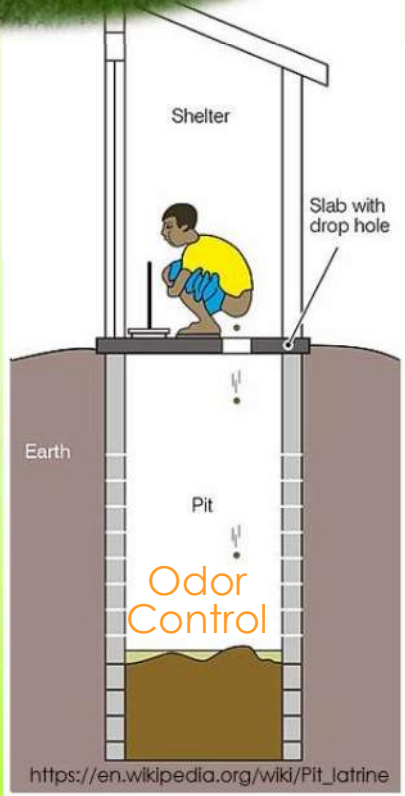
Quenching / Charging

Urine / Liquid Manure

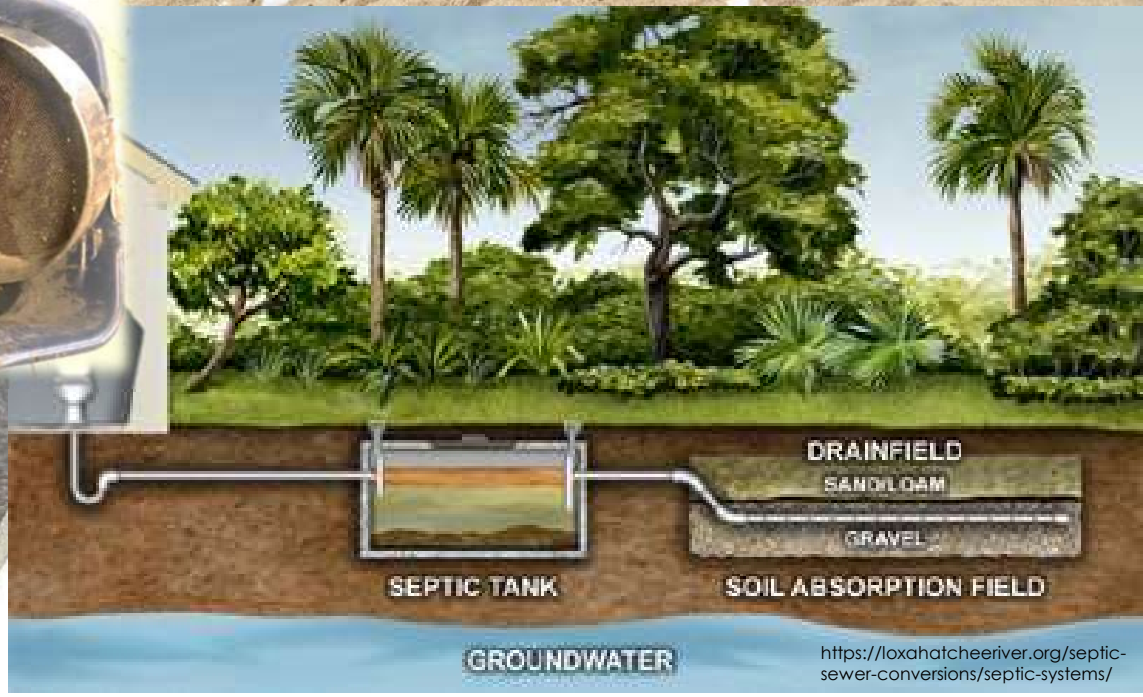
Litter / Bedding

https://www.dairydesign.com/projects/manure-management-flush-systems/#iLightbox[gallery_image_1]/3

https://www.amazon.com/Natures-Head-Contained-Composting-Quarters/dp/B009Z7EKIC



https://en.wikipedia.org/wiki/Pit_latrine



https://loxahatcheeriver.org/septic-sewer-conversions/septic-systems/

A

B

https://hal.science/hal-01665385/document

C

D

Cold Climate Peat Soils

A - Fibric
B - Hemic
C - Hemic
D - Sapric
nominal sand, silt, or caly content

Press release Published 27 August 2022

GOV.UK

Sale of horticultural peat to be banned in move to protect England's precious peatlands

The sale of peat for use in the amateur gardening sector will be banned by 2024 to protect peatlands and the natural environment.

https://www.gov.uk/government/news/sale-of-horticultural-peat-to-be-banned-in-move-to-protect-englands-precious-peatlands#:~:text=All%20sales%20of%20peat%20to,in%20a%20near%2Dnatural%20state.

Peatlands are unique ecosystems and massive carbon sinks. Some excavations of peat soils for construction or remediation are necessary; mining peat for use in horticulture releases the stored carbon as the peat decomposes in plantings.

https://www.nurserymag.com/article/biochar-peat-moss-alternative-illinois-research/

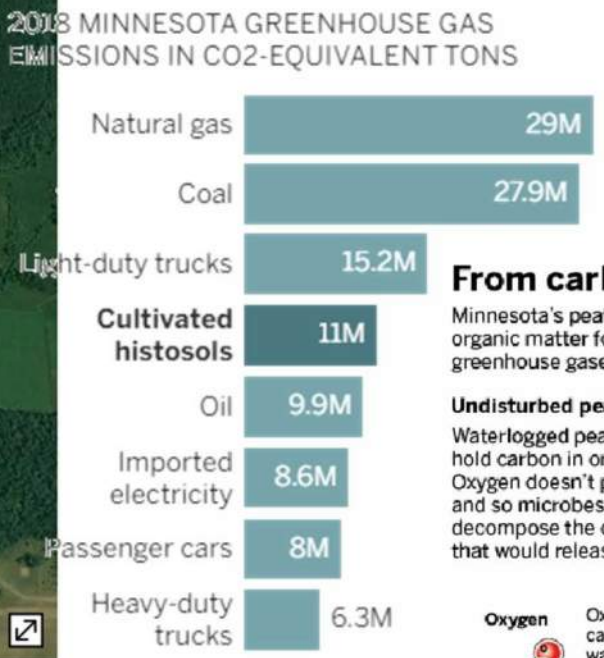
Biochar could replace peat moss in the nursery industry

New potting mix research from the University of Illinois investigates biochar as a peat alternative.

StarTribune

DENNIS RODACKER, BWSR

Shown here is a 200-acre plot of peaty cropland in Stearns County as the Minnesota Board of Water and Soil Resources began restoring it to native wetland in 2013.



Total emissions across all industries and all greenhouse gases.

C.J. Sinner, Star Tribune • Source: Minnesota Pollution Control Agency

Researchers have identified a key source of greenhouse gases in Minnesota, and now they have to figure out where it is — and what to do about it.

The culprit? The state's soggy, carbon-packed peat soil, drained and farmed in places for decades.

https://www.startribune.com/a-climate-conundrum-beneath-our-feet-minnesotas-farmed-peat-soil-releases-greenhouse-gases/600146107/

When peat is no longer saturated, it starts decaying, "composting in place," change in practice = carbon credit$

From carbon trap to carbon source

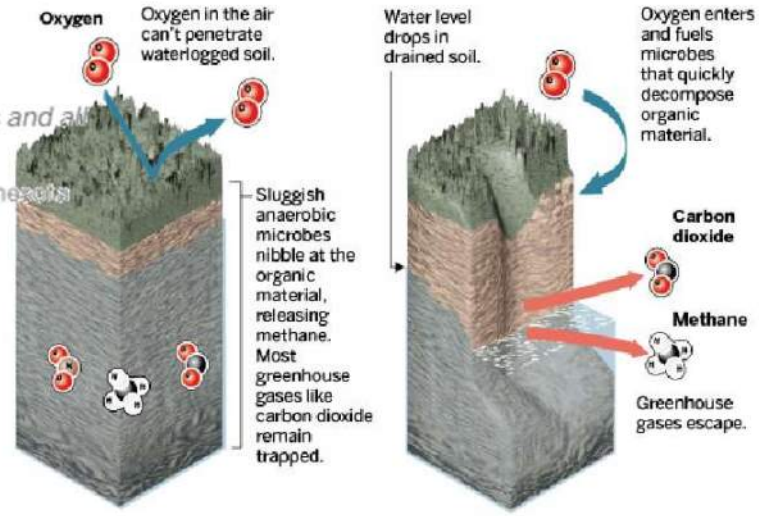
Minnesota's peat soils, known as histosols, have trapped dead plants and other organic matter for thousands of years. When they are farmed, they release greenhouse gases.

Undisturbed peat soil

Waterlogged peat soils trap and hold carbon in organic matter. Oxygen doesn't penetrate the soil and so microbes can't quickly decompose the organic material that would release the gases.

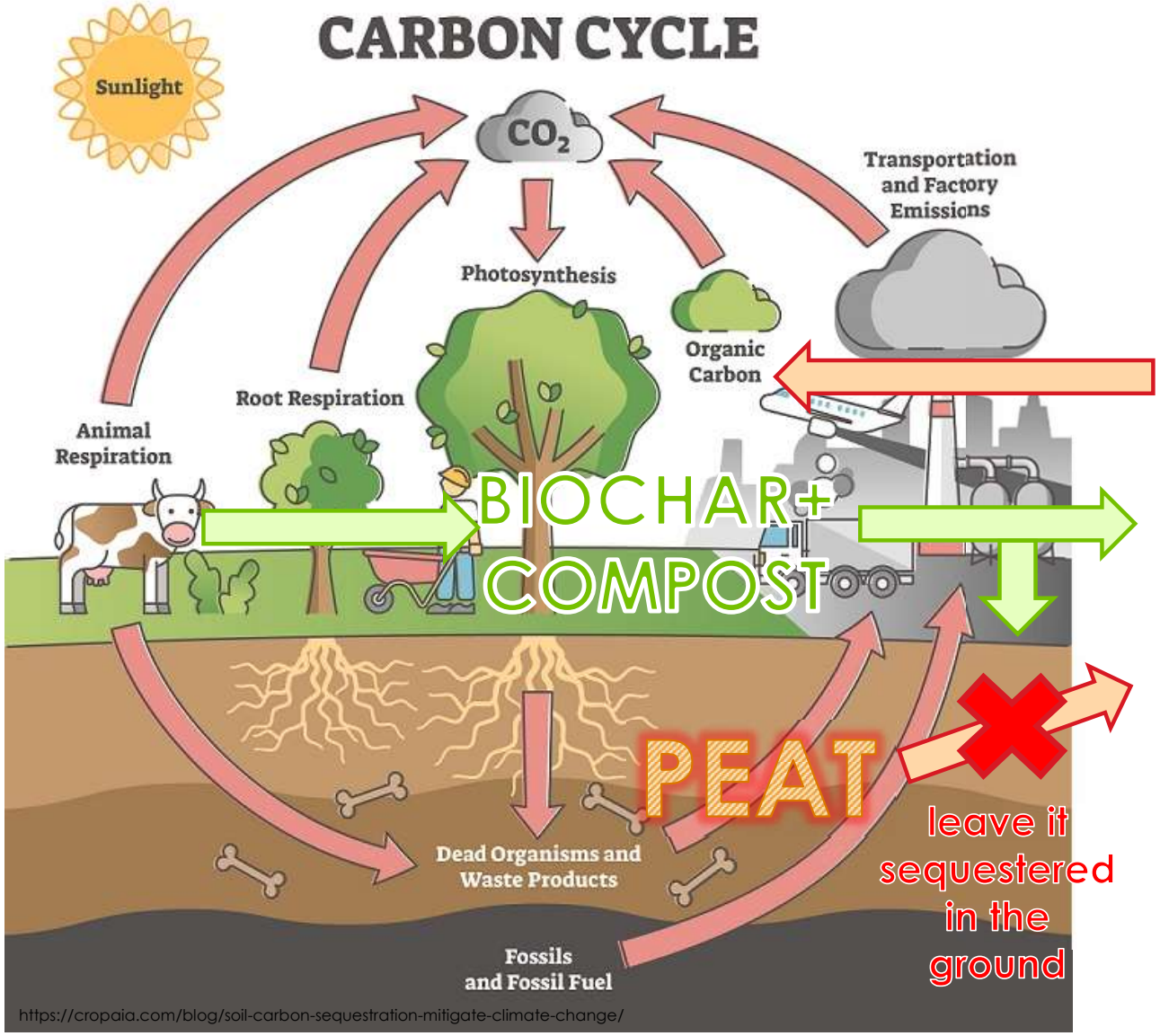
Disturbed peat soil

Peat soils that are farmed or developed are usually drained, allowing oxygen to enter. Organic material decomposes quickly, releasing large amounts of greenhouse gases such as carbon dioxide, methane and nitrogen dioxide.



Source: University of Minnesota

MARK BOSWELL • Star Tribune

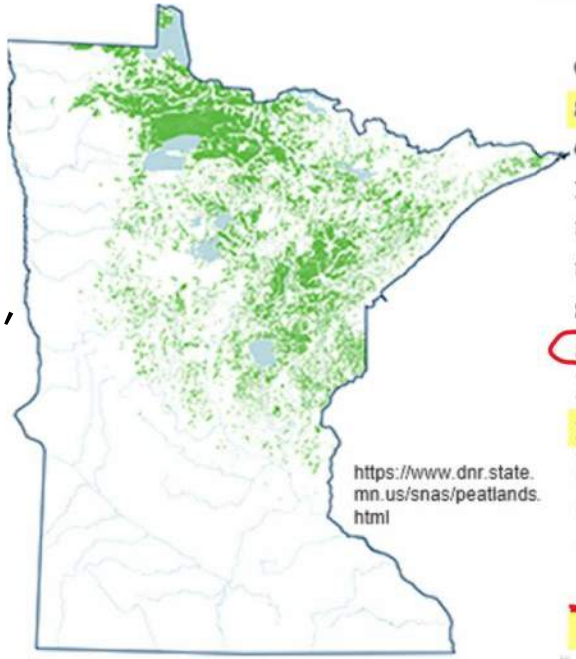


https://www.istockphoto.com/photos/tree-sapling-in-pot

≠

Peat Replacement

Biochar, Charcoal, et al., **meet official definitions of Peat**



THE OCCURRENCE AND USES OF PEAT IN THE UNITED STATES

E. K. SOPER AND C. C. OSBON 1922

https://pubs.usgs.gov/bul/0728/report.pdf

DEFINITIONS.

The terms "peat" and "muck" are often used interchangeably to designate either of those materials—a practice that is confusing and that should be discouraged. Peat is the partly carbonized organic residuum produced by an arrest in the decomposition of roots, trunks of trees, twigs, seeds, shrubs, mosses, and other vegetation covered or saturated with water. It contains a large proportion of the carbon of the original vegetable matter, and its vegetal structure is generally visible without the microscope. It is usually acidic, and it contains much less inorganic than organic matter. In fact, some pure peats contain less than 4 per cent of inorganic material. Muck is soil that contains a high percentage of uncarbonized organic matter; but, as the name is commonly applied to drained and oxidized areas of peat under cultivation, it is difficult to draw the line between peat and muck; peat may grade into muck and muck into peat. If the material will ignite and burn freely when dry it is usually considered peat.

What is Compost?

Per USCC/AAPFCO: Compost is the product manufactured through the controlled aerobic, biological decomposition of biodegradable materials. The product has undergone mesophilic and thermophilic temperatures, which significantly reduces the viability of pathogens and weed seeds (in accordance with EPA 40 CFR 503 standards) and stabilizes the carbon such that it is beneficial to plant growth.

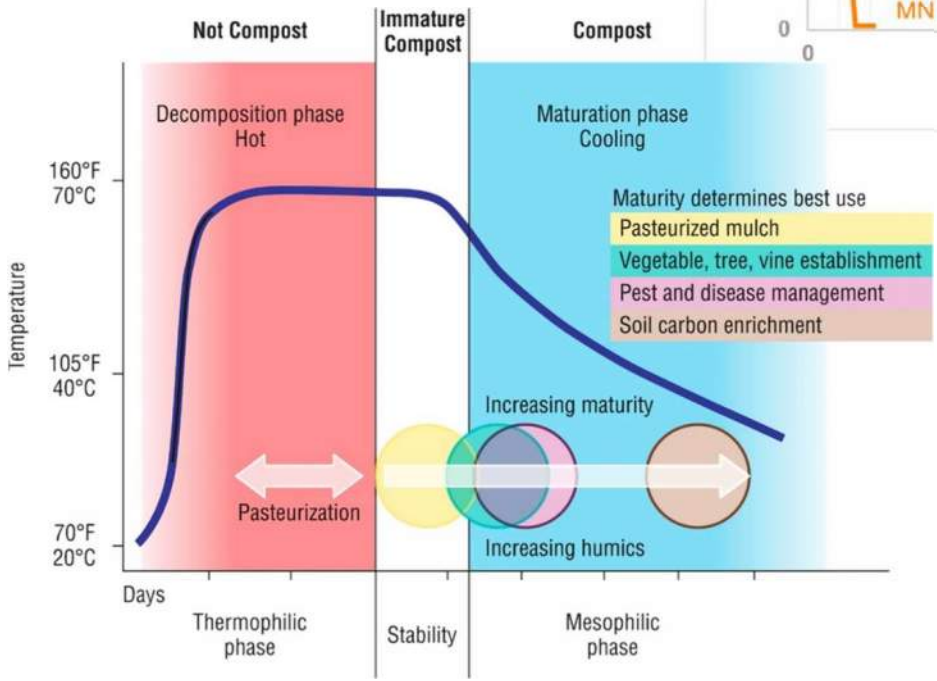
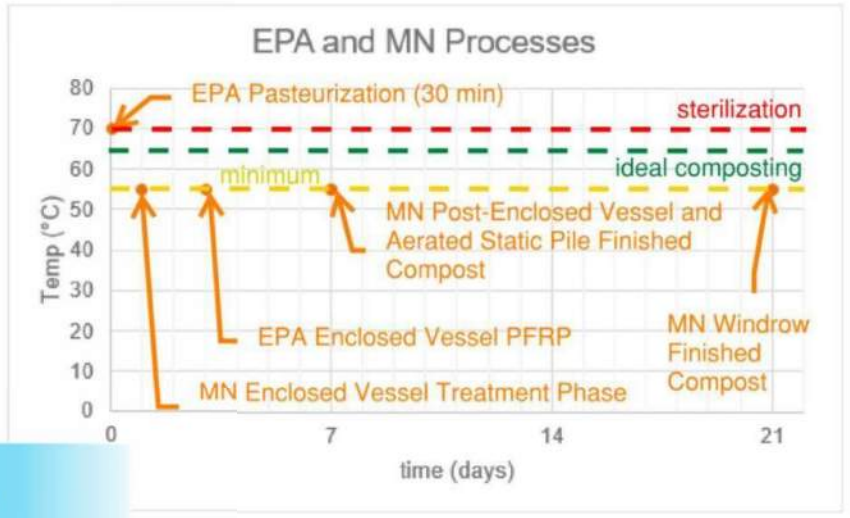


Figure from *The Composting Handbook*, 2021

Figure 6: EPA and MN Processes Compared to Temperature Benchmarks



Types of Compost: Not All Created Equal

C:N	>30:1 (mulch)	30:1 – 20:1 (compost)	<20:1 (manure)
Fertility	Consumes Nutrients	Balanced	Fertilizes
Microbes	Low	Moderate	High
Risk to Plants	Moderate	Low	Moderate / High
Uses	Stormwater Treatment / Erosion Control	Carbon Amendment / Erosion Control	Fertility Amendment
Feedstocks	Yard Waste or Wood	Food Scraps or Yard Waste	Manure or Biosolids

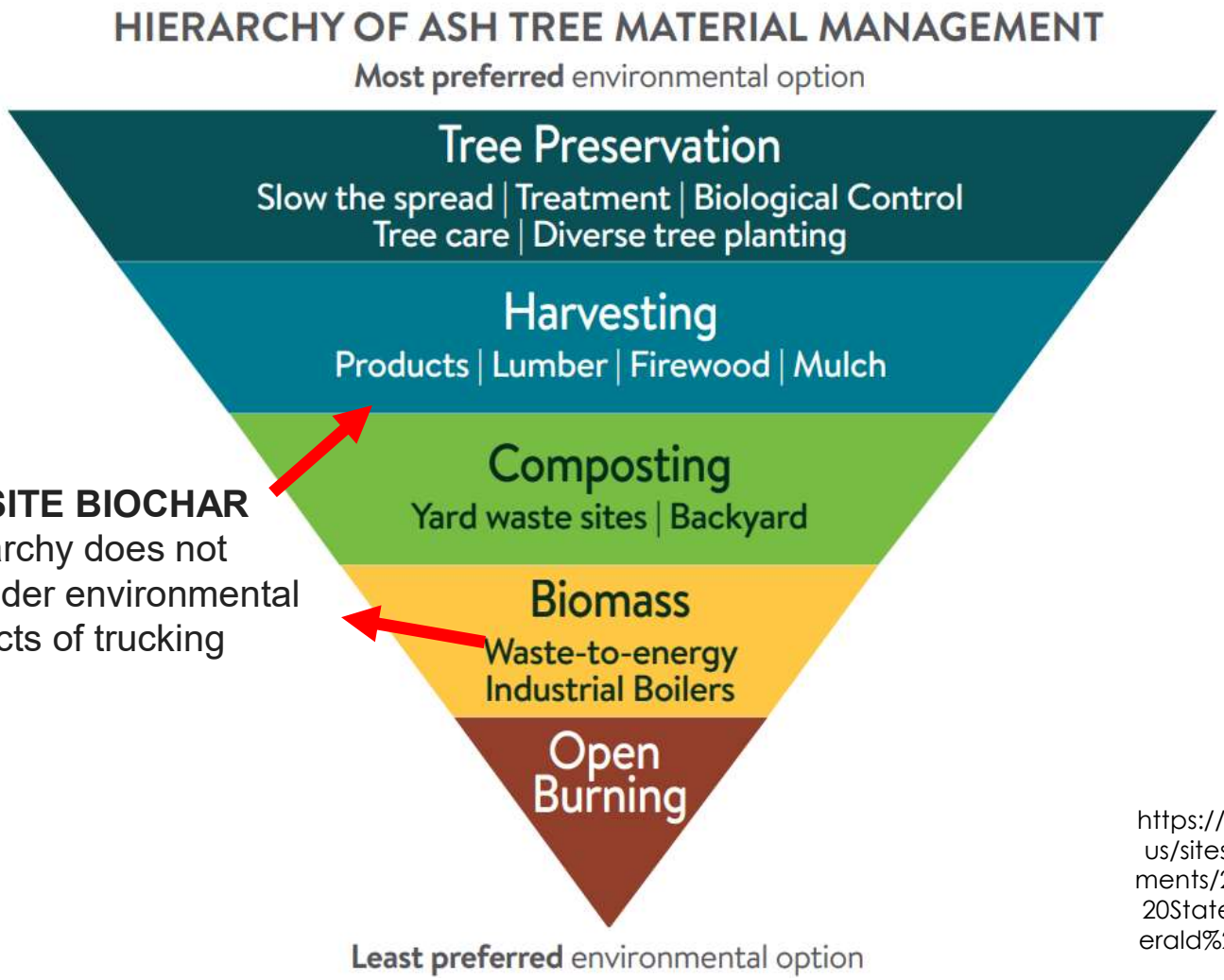
>> more aging = more balanced = less *risk* to plants <<

Adding biochar as a composting feedstock can that would otherwise be lost to contact water ponds and causing odor issues.

How to support development of the emerging Biochar industry?

What's Happening in MN

- Inaugural MN Biochar Summit – June 2023 – 101 attendees
- MN Biochar Initiative – incorporated September 2023
- City of Minneapolis – rotary kiln coming early 2024
- Biochar as a Soil Amendment in Minnesota: Findings from Literature and Interviews
  - Samantha Hunt and Sustainable Farming Association (SFA), May 2023
  - https://conservancy.umn.edu/handle/11299/254647
- Carlton SWCD – Oregon Kilns https://carltonswcd.org/biochar-kilns
  - Dovetail Partners https://www.dovetailinc.org/portfolio.php?Tag=Biochar
- Great River Greening – Oregon Kilns
- Northstar Lime, Crookston – FPEP grant
- Northeast Clean Energy Resource Team (CERT) – multiple projects
- UMD – agricultural usage
- NRRI – biochar properties and coal replacement in steelmaking
- UMN St. Anthony Falls Laboratory – stormwater treatment
- UMN CEGE / BBE – lifecycle impact and business case
- UMN CBS – surface water quality
- Carba / UMN – carbon sequestration banking
- USDA NRCS – soil application projects



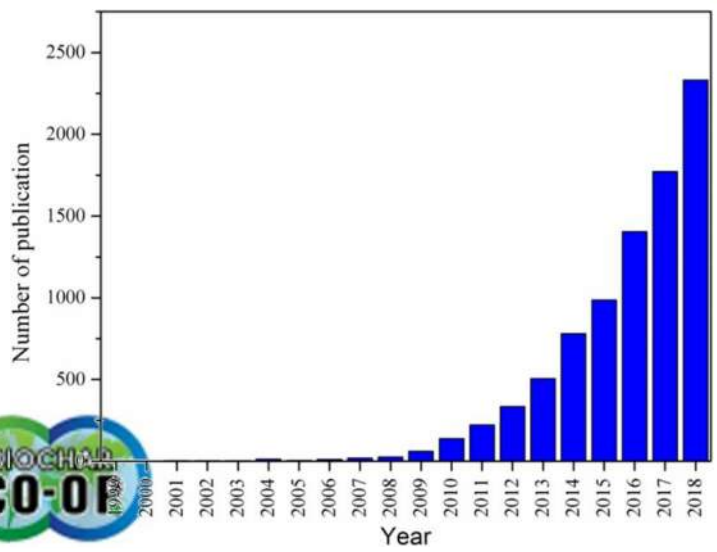
ON-SITE BIOCHAR
Hierarchy does not consider environmental impacts of trucking

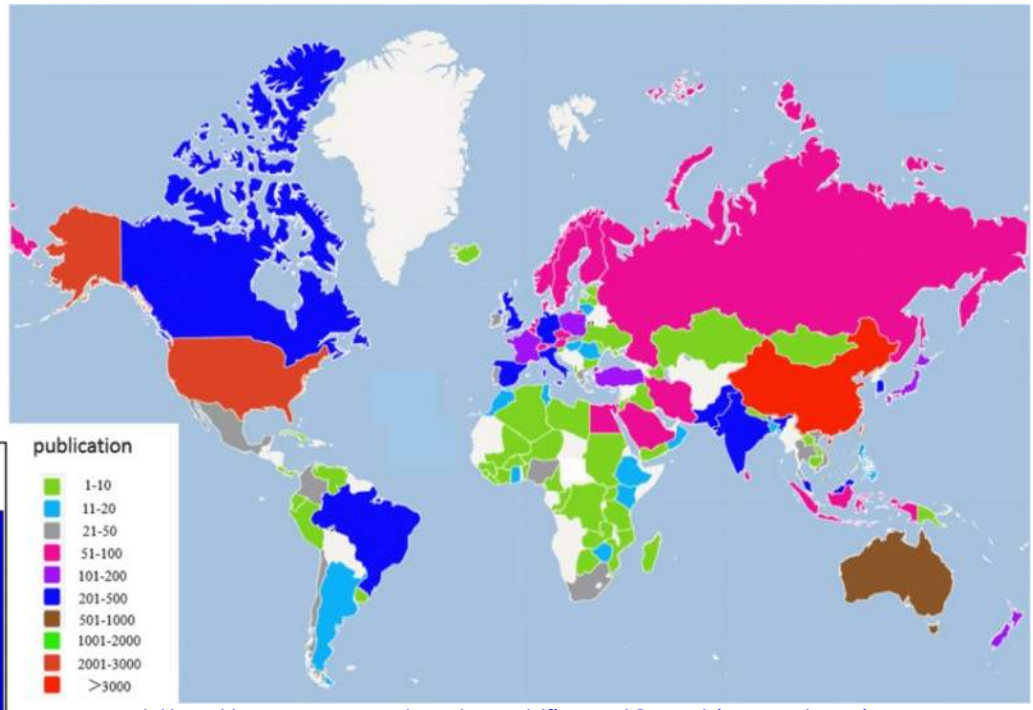
https://www.eqb.state.mn.us/sites/default/files/documents/2019%20Minnesota%20State%20Agency%20Emerald%20Ash%20Borer%20Report.pdf

Research and Knowledge Sharing

Ikhala Impact Char App

- Use app while producing biochar
- Automated process reporting
- Carbon credit certification
- Grant reporting
- Help to keep from missing data points
- https://www.africandata.tech/





https://www.researchgate.net/figure/Countries-and-regions-contributed-to-biochar-research-during-1999-2018_fig4_337949471

Biochar-related studies from 1999 to 2018: a bibliometrics-based review

USBI North American Chapters
https://biochar-us.org/regional-groups

https://www.biocharco-op.com/

pnwbiochar.org

PACIFIC NORTHWEST BIOCHAR ATLAS

International Biochar Initiative

USBI

Building the future from the ground up.™

US BIOCHAR COALITION

MNBI

EST. 2023

MN Composting Council

STATE CHAPTER OF THE U.S. COMPOSTING COUNCIL

IBI biochar-international.org

USBI biochar-us.org

USBC usbiocharcoalition.org

MNCC/MNBI mncompostingcouncil.org/biochar

?

Q&A

?

Nicholas.Vetsch@Stantec.com