BIOCHAR

AN ELEGANT SOLUTION FOR COMPLEX PROBLEMS

THE COMPLEX PROBLEM

Climate change from too much CO_2 and other GHG's in the atmosphere

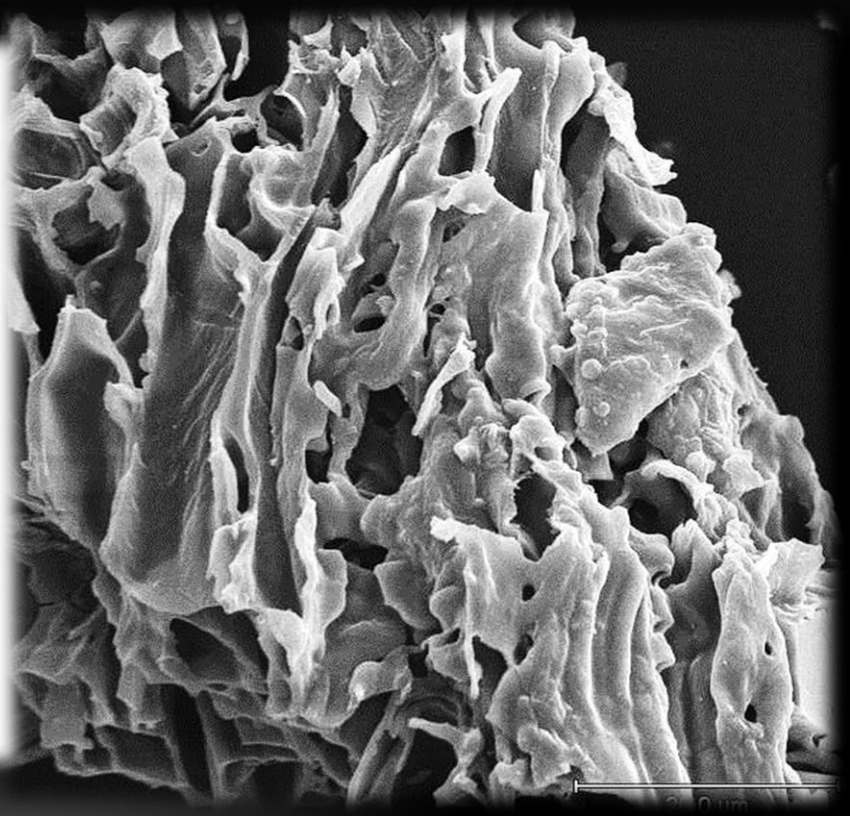
1. Excess CO_2 from burning fossil fuels
2. Methane (CH_4) from livestock, landfills & decomposition
3. Nitrogen/phosphorous run-off and N_2O off-gassing from fossil fuels converted to fertilizer
4. Temperature and moisture regime change deleterious to plant health, benefitting disease & insect life-cycles
5. Concentrations of biomass "waste" in agriculture and forestry
6. High forest density & increasing wildfire risk

Climate Benefits: Carbon and More

FOCUS ON BIOCHAR

CHARCOAL WITH A PURPOSE

Support soil biology & nutrients



Protect biology from heavy metals & toxins

BIOCHAR is CARBON

Lasts
100's–1000's years

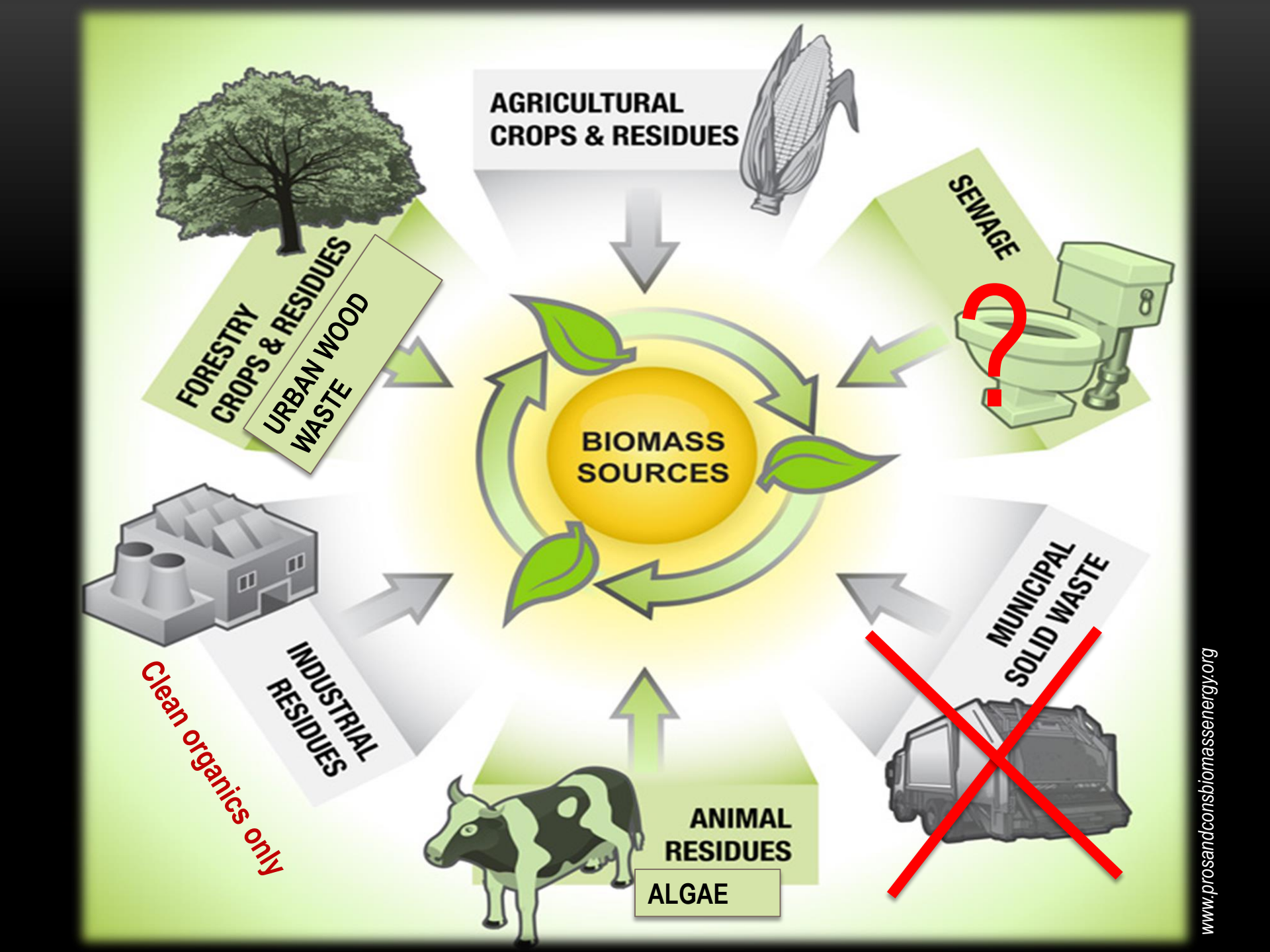
C-

CARBON WITH AMENITIES

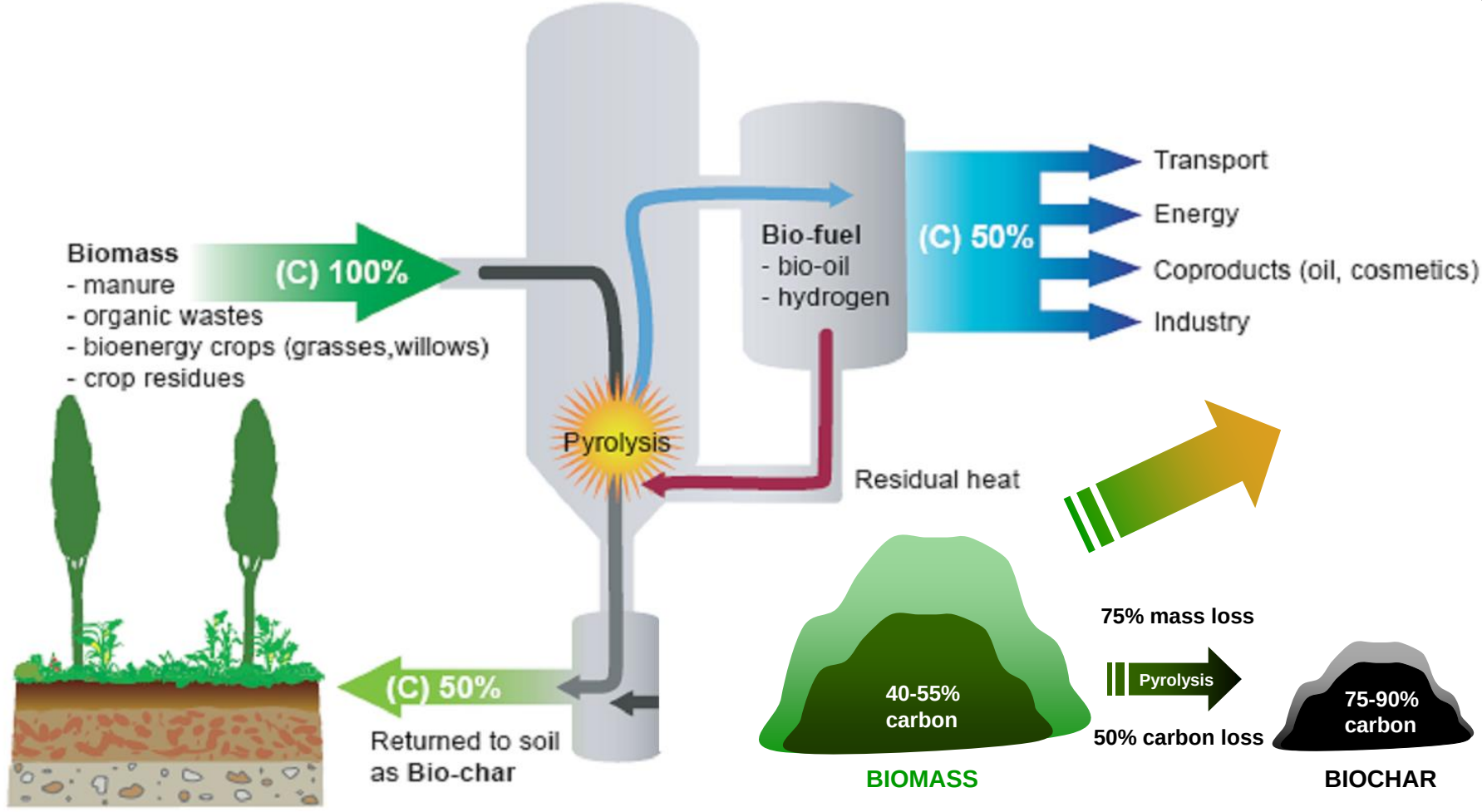
NUTRIENTS

CO_2 CH_4 N_2O

WATER


AGRICULTURAL CROPS & RESIDUES
FORESTRY CROPS & RESIDUES
URBAN WOOD WASTE
SEWAGE
?
BIOMASS SOURCES
INDUSTRIAL RESIDUES
Clean organics only
MUNICIPAL SOLID WASTE
ANIMAL RESIDUES
ALGAE
www.prosandconsbiomassenergy.org

BIOCHAR: the carbon-rich residue of heating biomass without oxygen



Lehmann, 2007, *Frontiers in Ecology and the Environment* 7, 381-387

PRODUCTS OF PYROLYSIS

Non-Fossil Fuel Energy

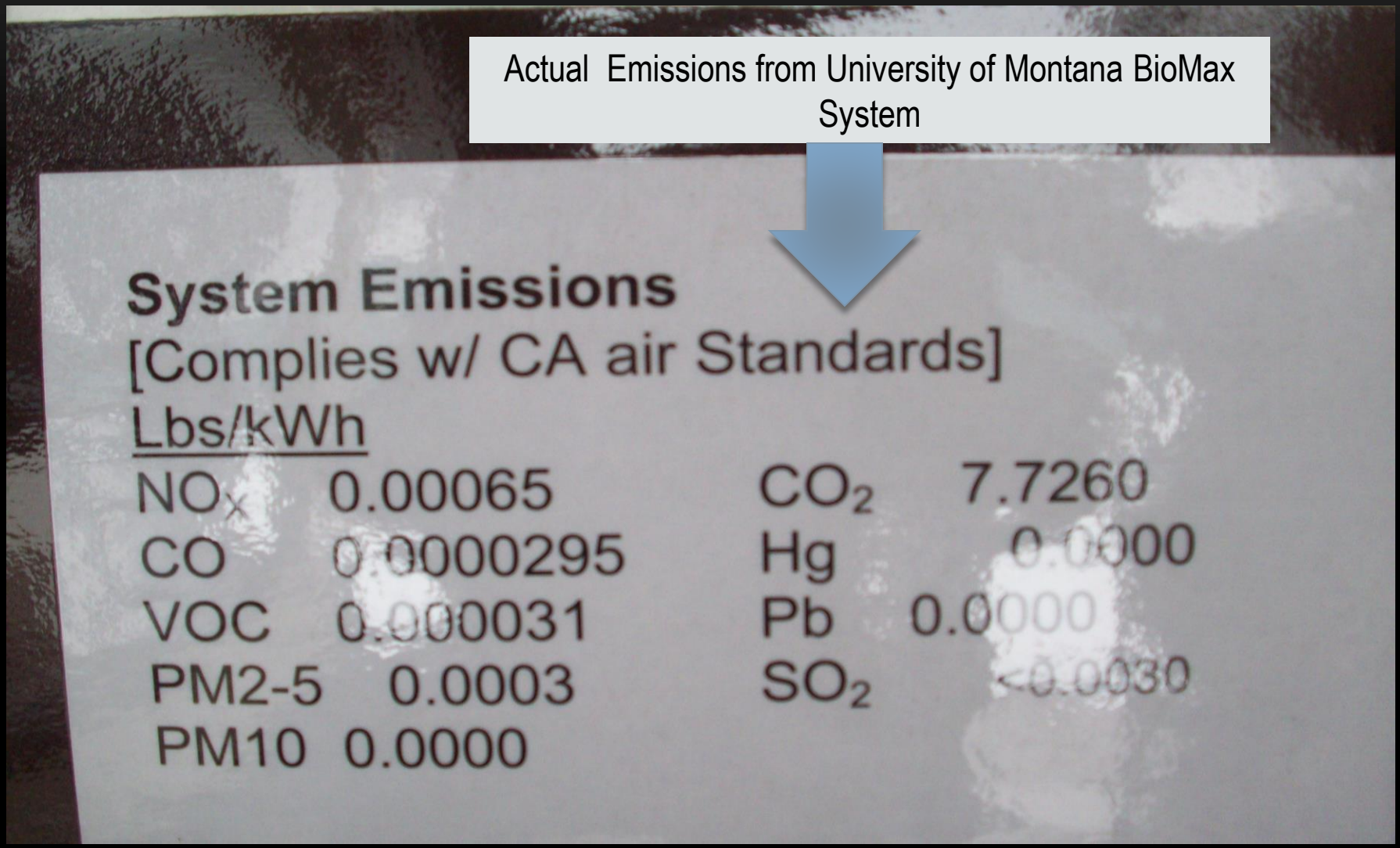
- **Syngas** - substitute for propane
- **Bio-oil** - bunker fuel, pre-cursor to bio-diesel
- **Heat** - space heating, steam production, producing electricity

More Climate Benefits

- **Biochar** - carbon sequestration, soil amendment, less NPK fertilizer use, GHG capture, carbon credits
- **Waste** – reduce by conversion
- **Emissions** – captured and recycled

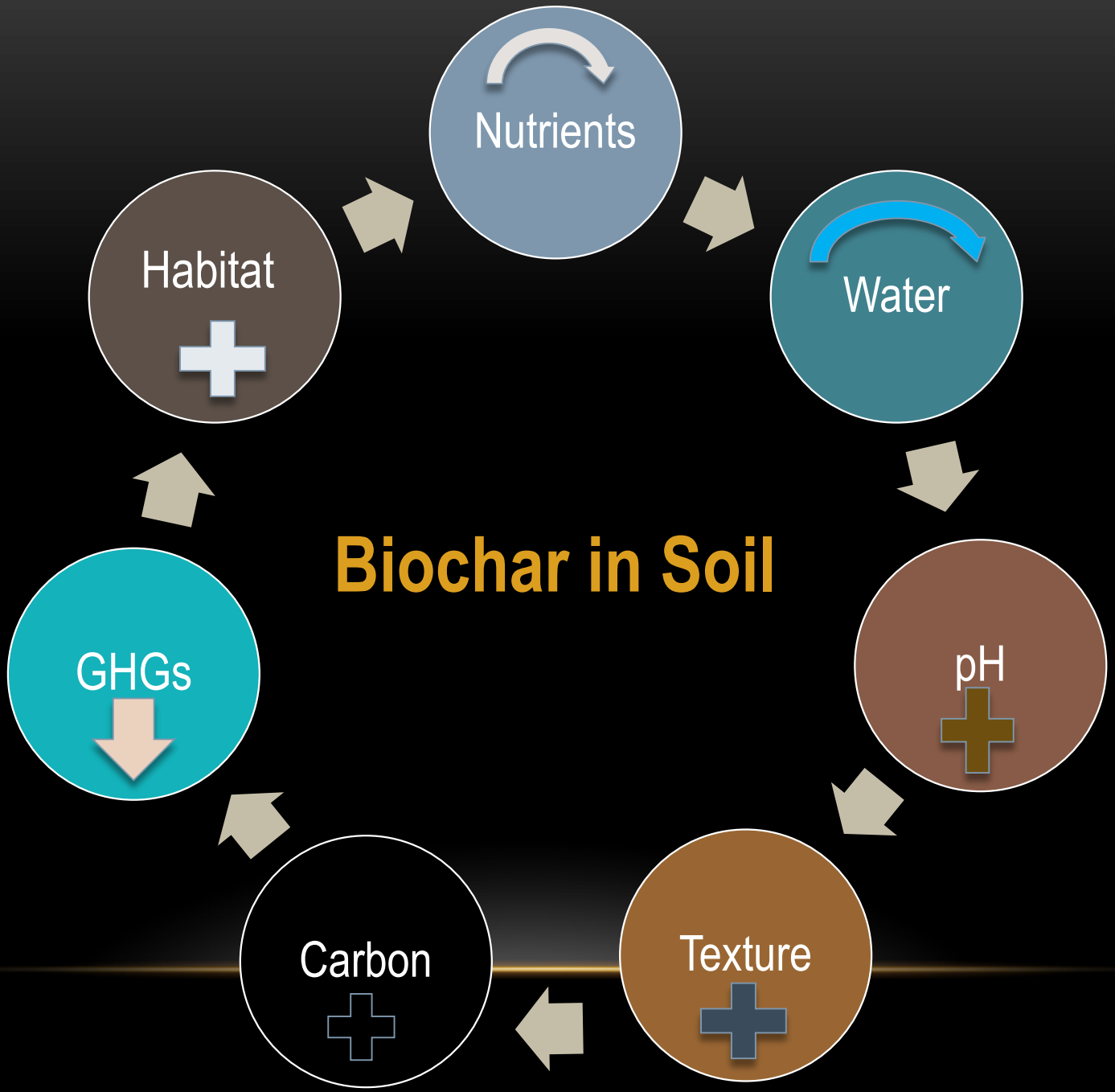
FULL CIRCLE SOLUTION

MINIMAL EMISSIONS



Putting the Bio in the Char

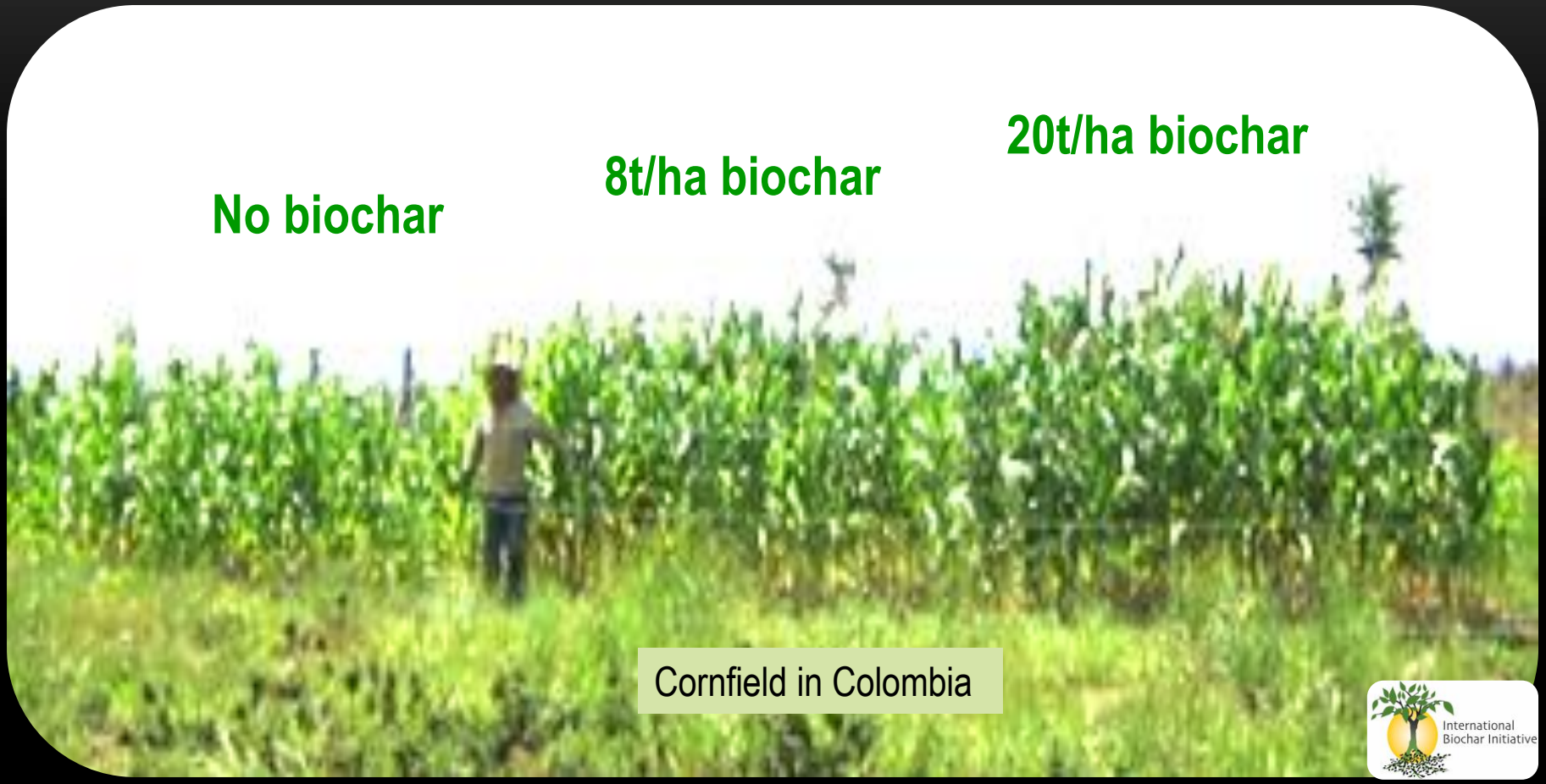
SOILS, PLANTS & ANIMALS


Nutrients
Water
pH
Texture
Carbon
GHGs
Habitat
Biochar in Soil

BIOCHAR in COMPOST

- 10% by volume reduces CH_4 and N_2O off-gassing and nutrient run-off
- Reduces odors
- Retains well-distributed moisture in production piles
- Absorbs more radiant heat
- Compost charges biochar with nutrients
- Enhances soil fertility long-term

BIOCHAR IMPROVES PLANT GROWTH



Plants absorb CO_2. Increasing primary productivity increases CO_2 sequestration.

BIOCHAR AND LIVESTOCK

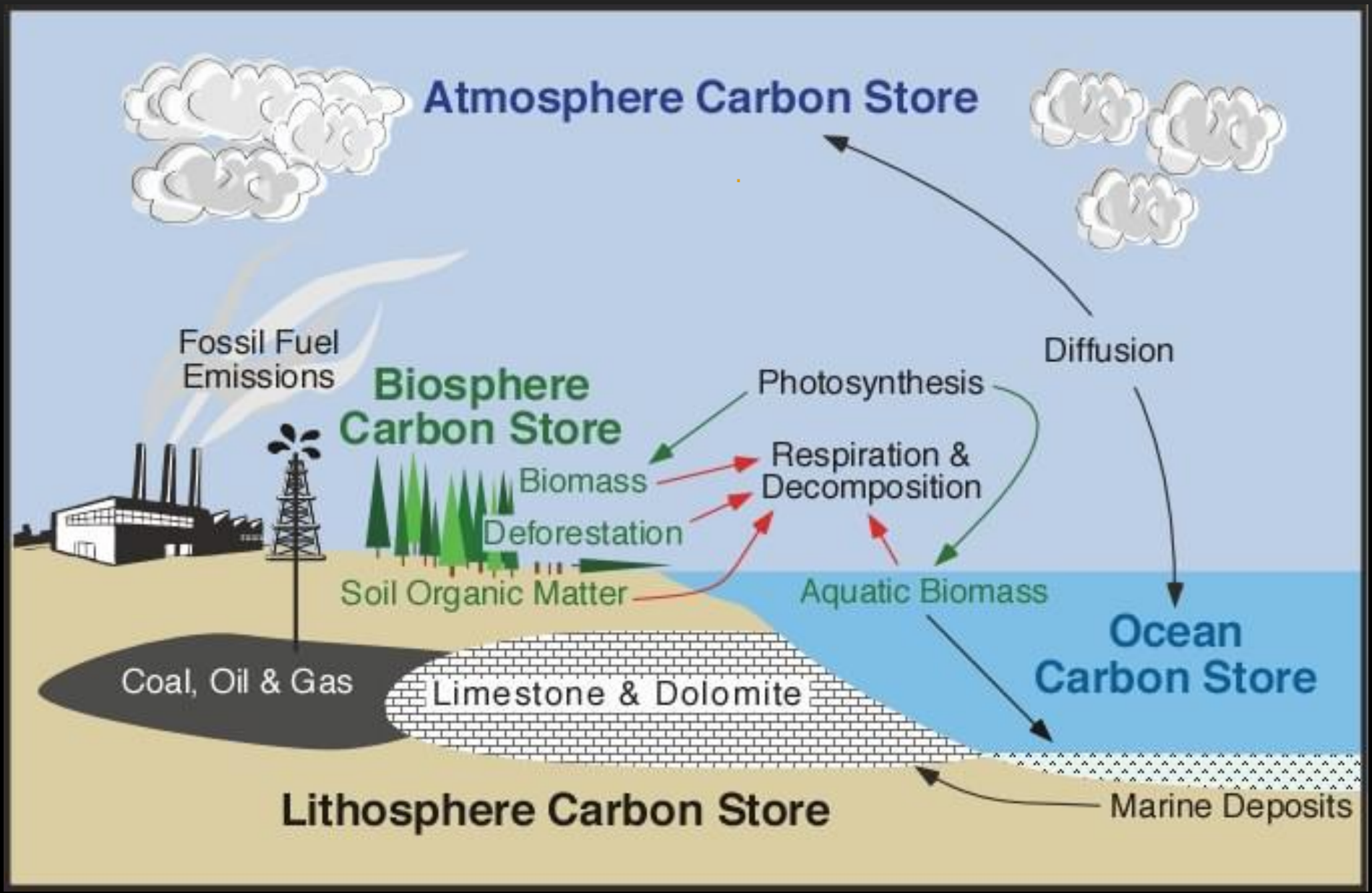
Add to litter to reduce odor, capture ammonia and nitrates, increase efficacy of composted litter

Biochar in feed reduces methane emissions by 50%

Moving C out of the Active Cycle

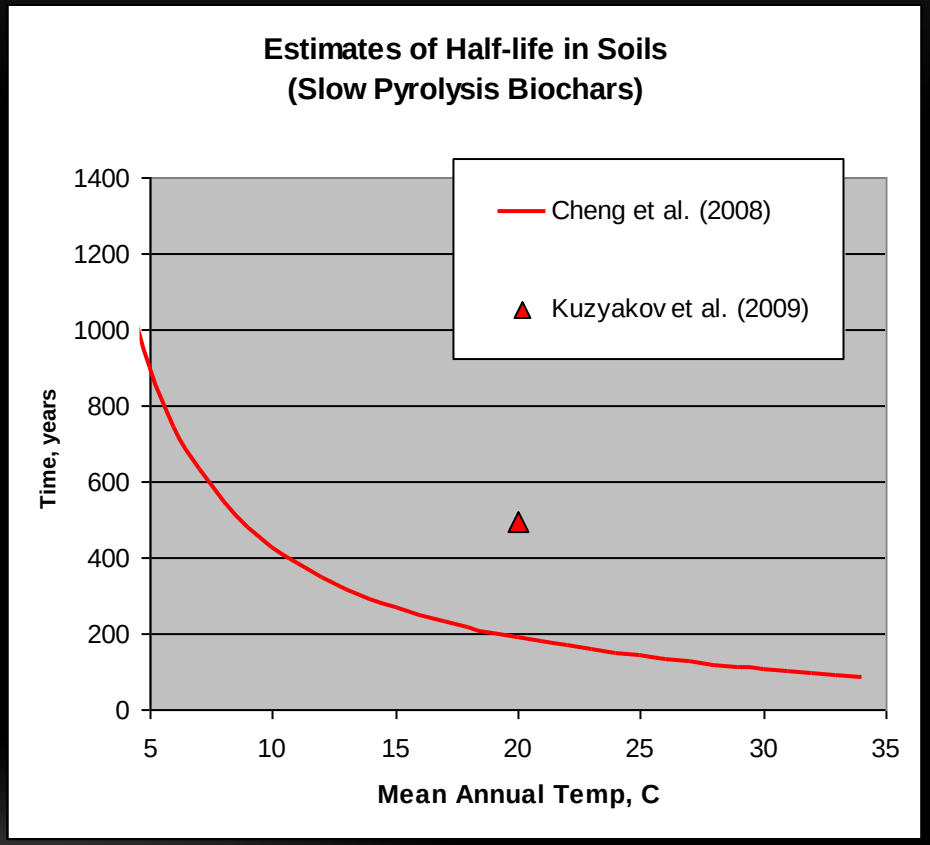
CARBON SEQUESTRATION

CARBON: ACTIVE VS. INACTIVE CYCLE



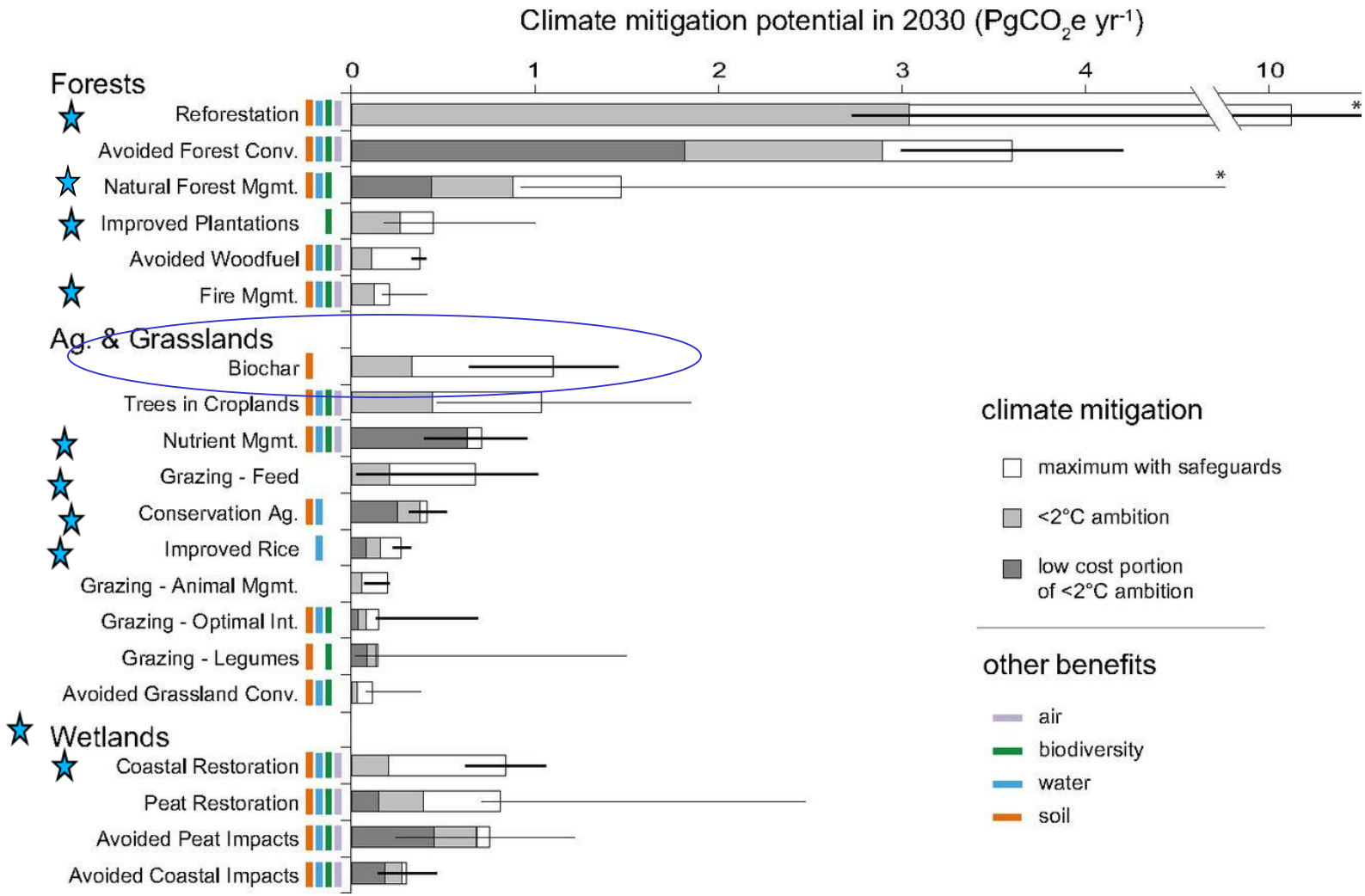
CARBON SEQUESTRATION USING BIOCHAR

- Slow pyrolysis biochars are highly recalcitrant in soils with half-lives of 100-900 years
- Half lives of 80 years or more are sufficient to provide a credible C sink



J.Amonette/PNEL

Climate mitigation potential of 20 natural pathways.



Bronson W. Griscom et al. PNAS 2017;114:44:11645-11650

PROJECT DRAWDOWN

BIOCHAR'S POTENTIAL FOR CARBON REDUCTION AND SEQUESTRATION FROM CROP RESIDUES

2.22–4.39
GIGATONS CO_2 e
REDUCED / SEQUESTERED
(2020–2050)

0.95 tons CO_2e
AVOIDED EMISSIONS FROM BIOCHAR TON OF FEEDSTOCK

$195.87–383.3 Billion $US

NET FIRST COST TO IMPLEMENT

$194
OPERATING COSTS/TON

$-1.44–0.73 Trillion **$US**
LIFETIME NET
OPERATIONAL SAVINGS

Total Life Cycle Assessment

Project Drawdown: https://drawdown.org/solutions/biochar-production

WOOLF, ET. AL. STUDY
BIOCHAR'S POTENTIAL CARBON DRAWDOWN

Considering agriculture and forestry wastes

12%

ANTHROPOGENIC GHG EMISSIONS/YEAR OFFSET

3.53

GIGATONS CO_2E SEQUESTERED 2020-2050

BIOCHAR BENEFITS SUMMARY

Renewable Energy

- Heat
- Power
- Bio-oil & syngas
- Replacing fossil fuels

Water Quality

- Filters toxins
- Holds heavy metals
- Captures N and P run-off
- Raises pH

Soil Amendment

- Persistent
- Less fertilizer
- Reduces water demand
- Increases plant growth

Climate Benefits

- Sequesters carbon
- Reduces GHG emissions
- Increases plant growth
- Retains soil moisture

If it’s not sustainable, don’t do it.

SUSTAINABILITY GUIDELINES

SUSTAINABLE BIOCHAR

Derived from terrestrial biomass and produced in way that, on a life-cycle assessment basis, at both the feedstock source and point of use:

- Preserves smallholder farms and watersheds
- Reduces competition for & use of natural resources and energy
- Maintains or improves soil quality
- Reduces greenhouse gas emissions
- Protects habitats and native ecosystems
- Mimics nature and natural processes
- Provides community benefits, jobs and fair labor

Sources: PNW Biochar, USBI and SOS

SUSTAINABLE BIOCHAR INDUSTRY

Meets triple bottom line metrics of economic profitability, environmental protection and social equity because it's:

- Geographically decentralized, distributed
- Close to biomass sources and markets, minimizing transportation
- Supplying diverse markets and value-add products with no waste
- Participating in carbon markets and trading programs
- Production is carbon neutral or negative in life cycle assessment
- Product is quality-assured through transparent processes
- Compatible with and supportive of ecosystem services
- Provides community benefits, jobs and fair labor

Sustainability, Business Models, and Techno-economic Analysis of Biomass Pyrolysis Technologies, Garcia-Perez, et.al.

THANK YOU!

Gloria Flora, Sustainable Obtainable Solutions

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BIOMASS-TO-ENERGY CONCERNS

- Use of food or animal-feed as feedstock
- Conversion of cropland to grow biomass
- Conversion of CRP lands
- Industrial-scale centralized production and/or collection of biomass
- Transportation carbon footprint & costs
- Ecologically unsustainable amount of biomass from cropland & forests removed
- Effects on visual quality and wildlife habitat

BIOCHAR FOR CLIMATE

Large amounts of forestry and agricultural residues and other biomass are currently burned or left to decompose thereby releasing carbon dioxide (CO_2) and/or methane (CH4)—two main greenhouse gases (GHGs)—into the atmosphere. Under biochar conversion scenarios, easily mineralized carbon compounds in biomass are converted into fused carbon ring structures in biochar and placed in soils where they persist for hundreds or thousands of years. When deployed on a global scale through the conversion of gigatonnes of biomass into biochar, studies have shown that biochar has the potential to mitigate global climate change by drawing down atmospheric GHG concentrations (Woolf et al, 2010).