N-Sense

Biochar's impact on soil carbon sequestration and sustainability of crop residue harvesting for bioenergy

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Effect of cultivation on SOC

Soil organic C in top 15 cm (6 inches) of adjacent native prairie and cultivated sites (across the fence)

Site	Prairie	Agriculture
	(lb-C/Ac)	
Hayden	162,636	112,692
Chipera	151,500	60,820
Larson	130,785	72,801
Kalsow	127,659	84,694
Doolittle	95,255	63,938
Ketelsen	87,757	42,580
Average	**125,932**	**72,921**

Average difference = 53,011 lb-C/Ac -42%

Effect of residue removal on SOC

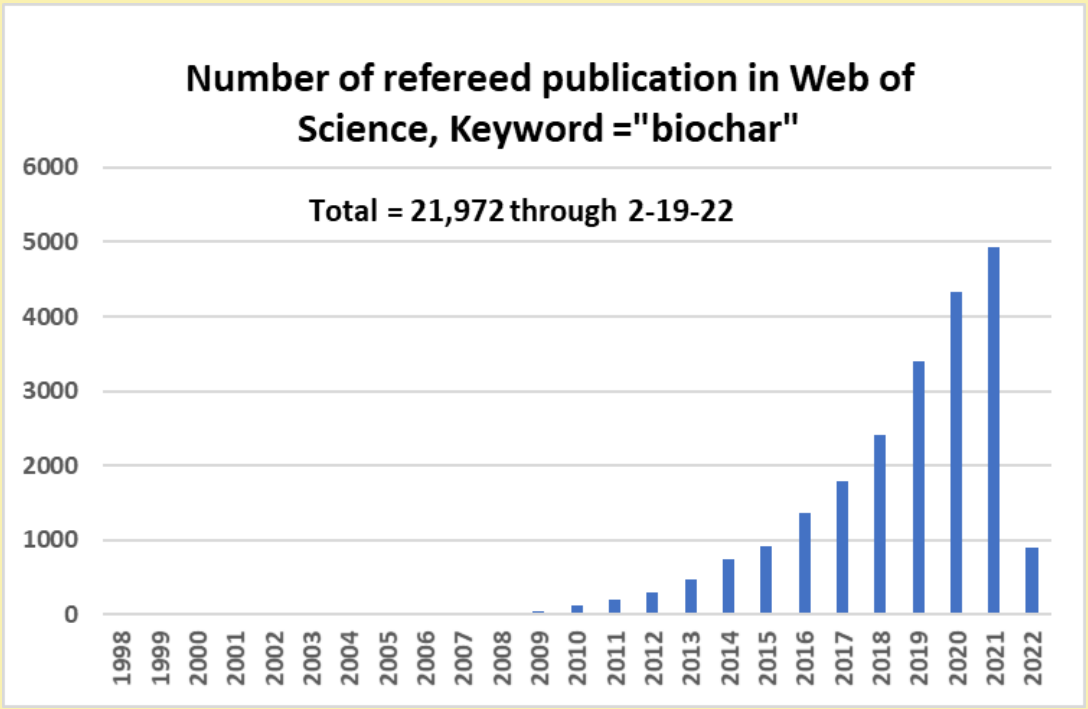
Soil Organic Carbon (%)

	Depth (cm)	Grass	Fallow	% Difference
Control	0-5	4.00	2.38	-40.6****
	5-15	2.47	2.23	-9.5
	Depth (cm)	**Not Removed**	**Removed**	**% Difference**
Chisel	0-5	2.95	2.47	-16.5****
	5-15	2.78	2.47	-11.1****
Plow	0-5	2.71	2.45	-9.4***
	5-15	2.72	2.32	-14.8****
No-till	0-5	3.17	2.58	-18.5*
	5-15	2.67	2.60	-2.5

Laird and Chang, 2013

After 19 years: >7.8 Mg-C ha^{-1}

Biochar Literature



Consensus

Sequesters C (>100 yr half life)
Reduces soil bulk density
Increases soil porosity
Increases soil water retention
Recycles nutrients
Liming agent (most biochars)
Increases nutrient cycling
Enhances soil quality/health

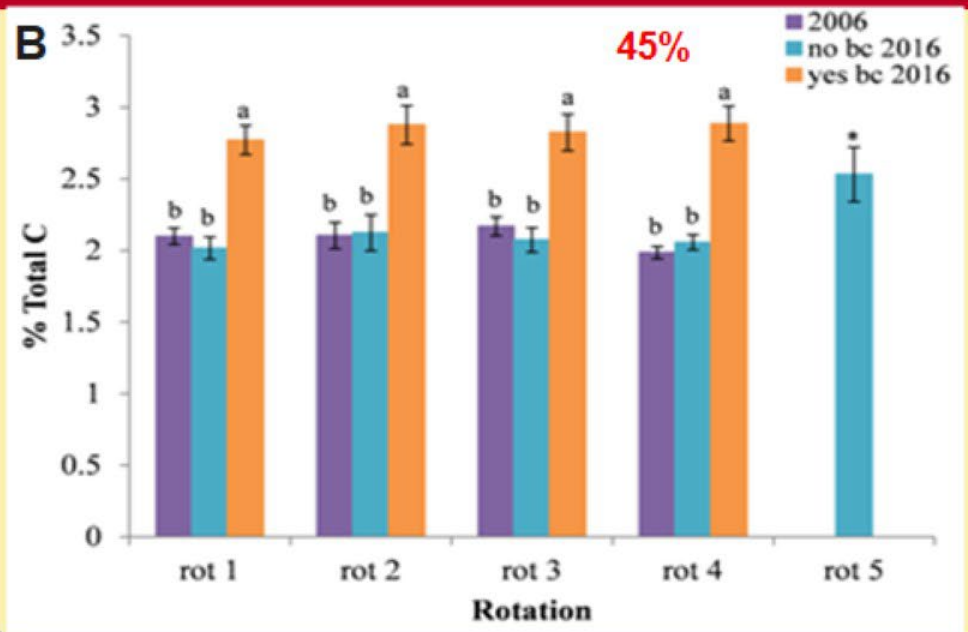
Knowledge Gaps

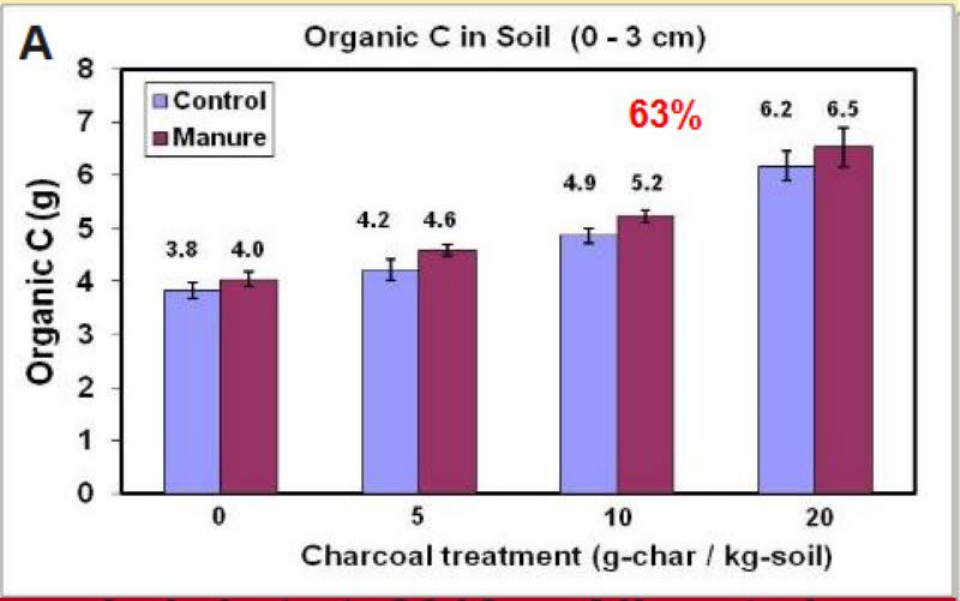
Value proposition for farmer (Problem: ecosystems services discounted)
Optimum management strategies (Problem: diverse soils/climates/crops)
Defining/grading biochar quality (Problem: biochar diversity)
System level LCAs (Problem: systems diversity)

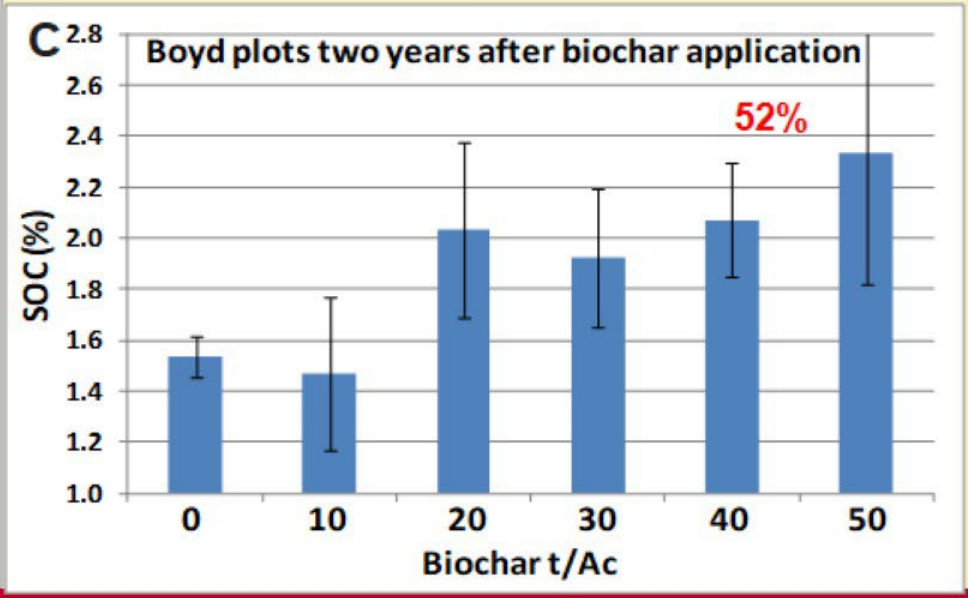
Solution: Agronomic and Environmental modeling & field trials

Impact on SOC

Biochar impact on SOC:
(A) Column study, +/- manure, 500 days. (B) Field study, crop rotations. (C) Field study 6 rates of biochar.







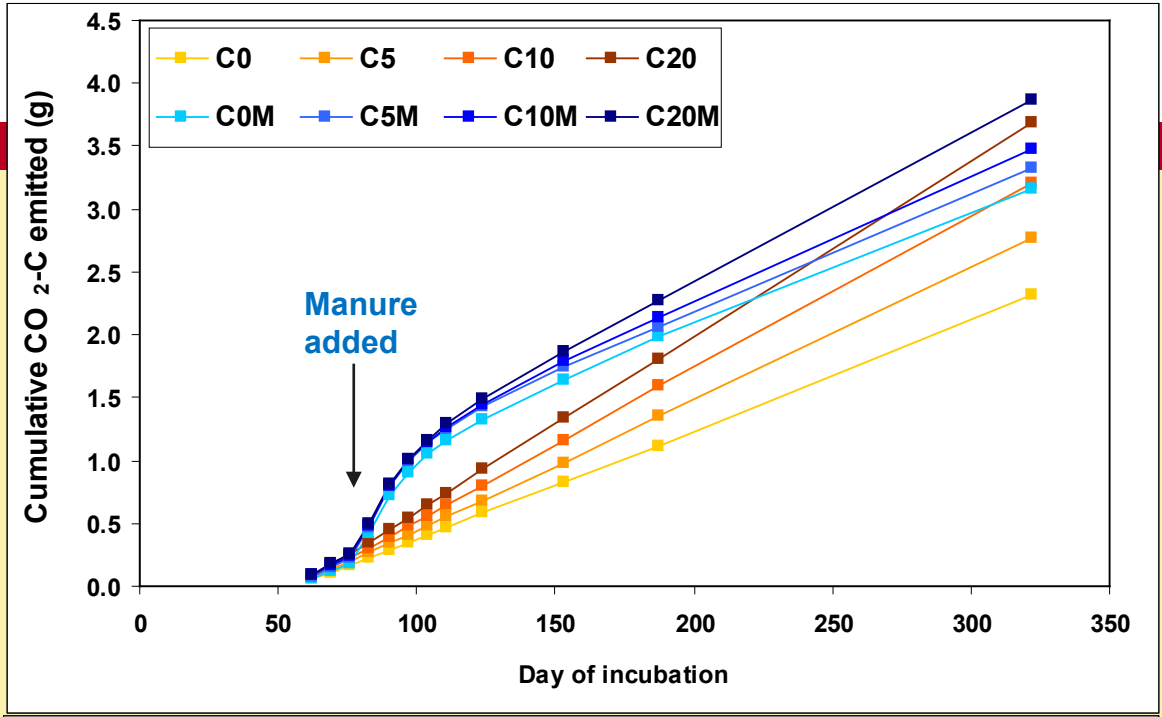
Laird et at. 2010: Aller et al.

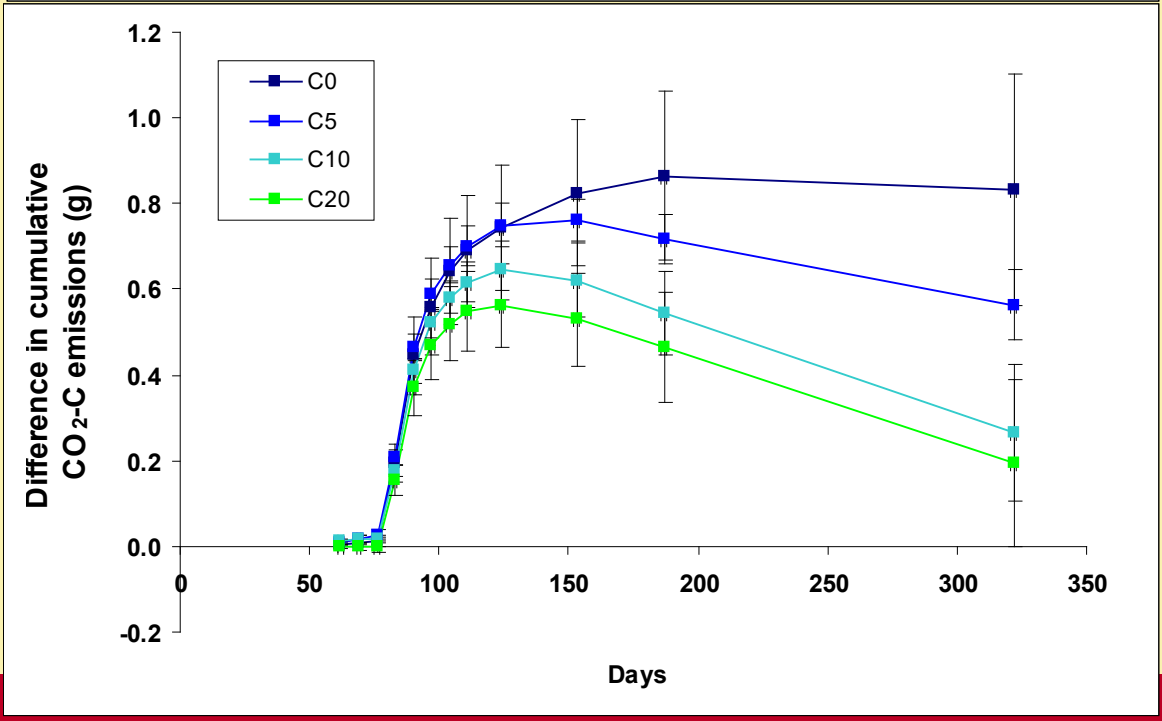
Priming

Slope (mg CO_2-C/day)

Biochar treatment	Control	Manure
C0	8.89	8.95
C5	10.56	9.38
C10	12.10	9.99
C20	13.84	11.85

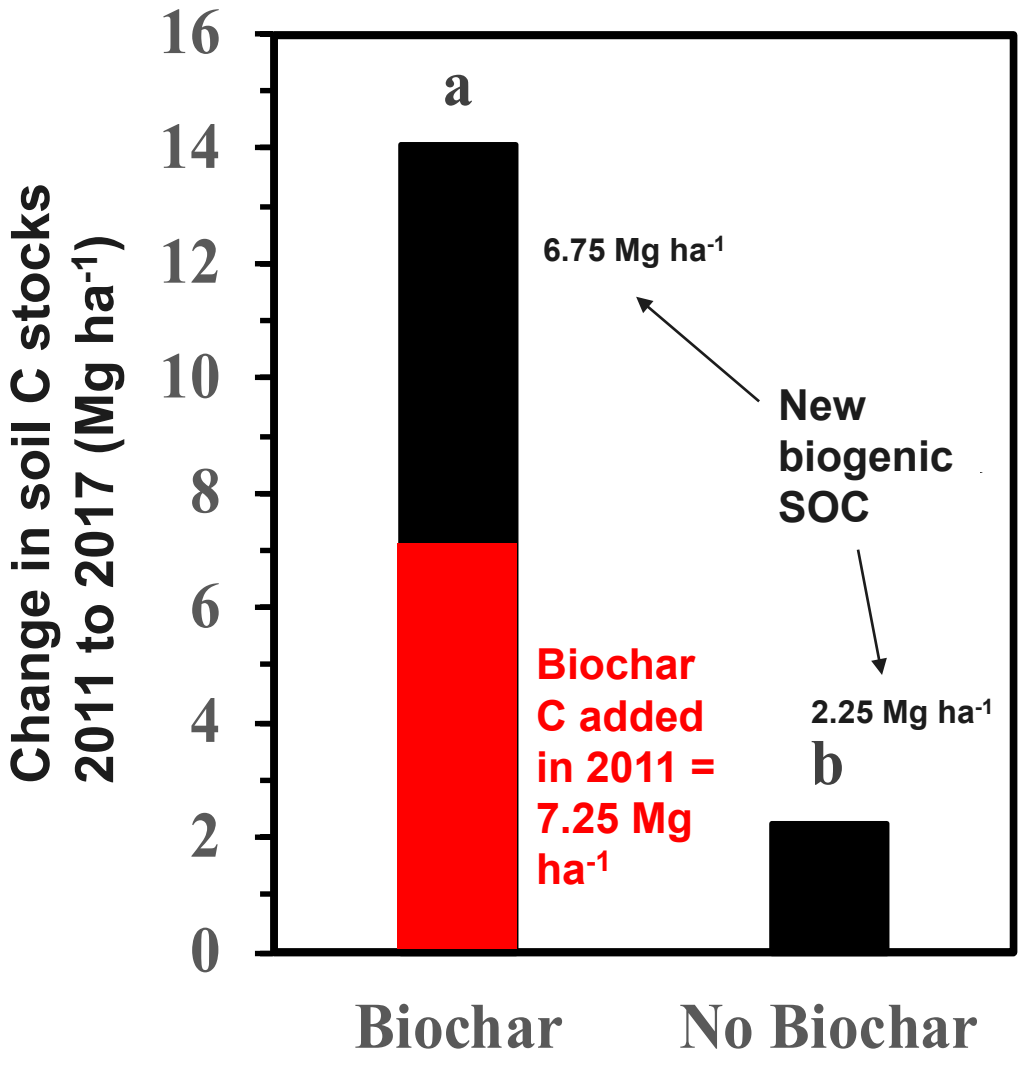
Difference in cumulative CO_2-C emissions between manure and no-manure columns for the same biochar level.





Rogovska et al. 2011

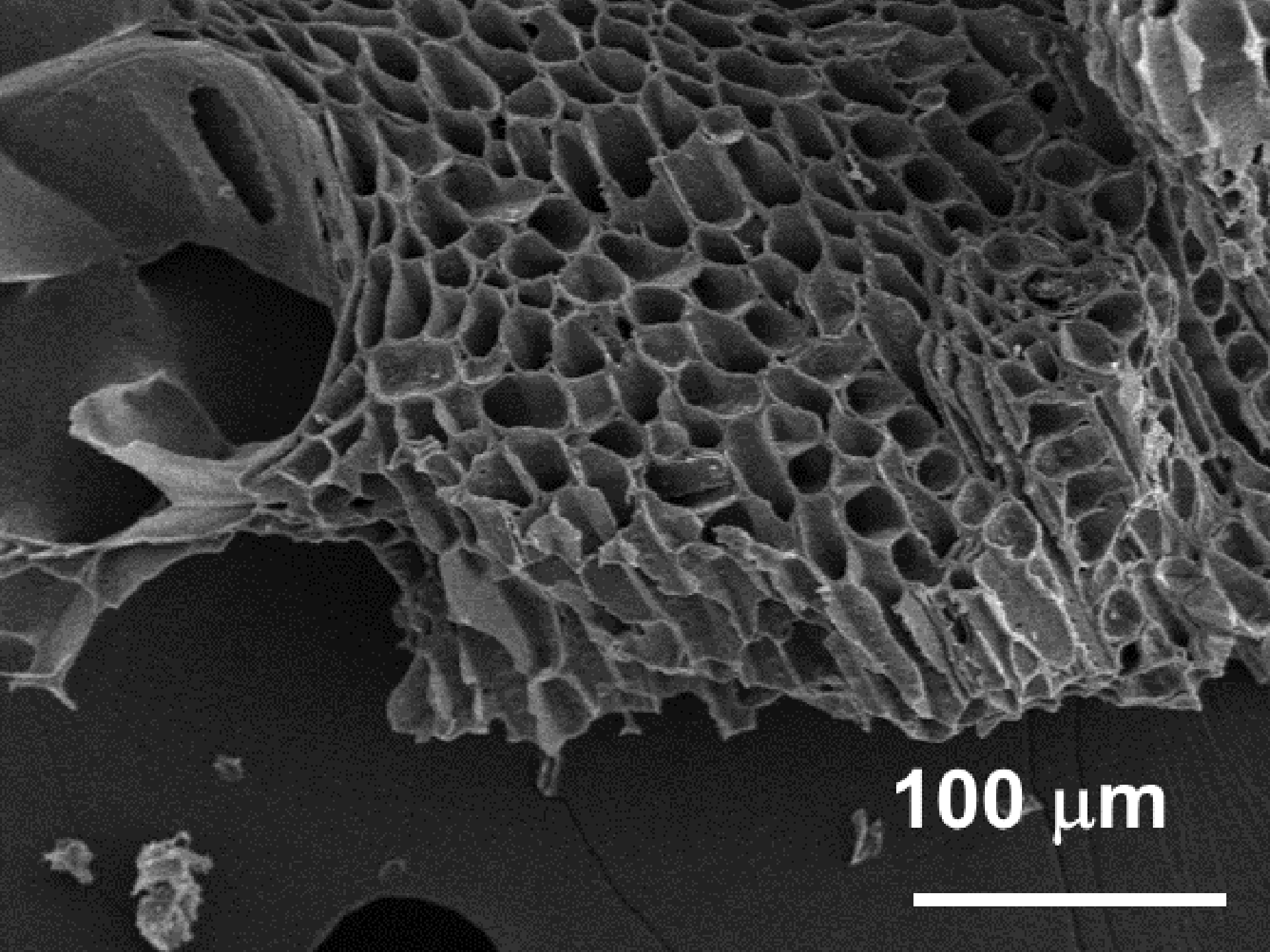
Negative Priming from Biochar



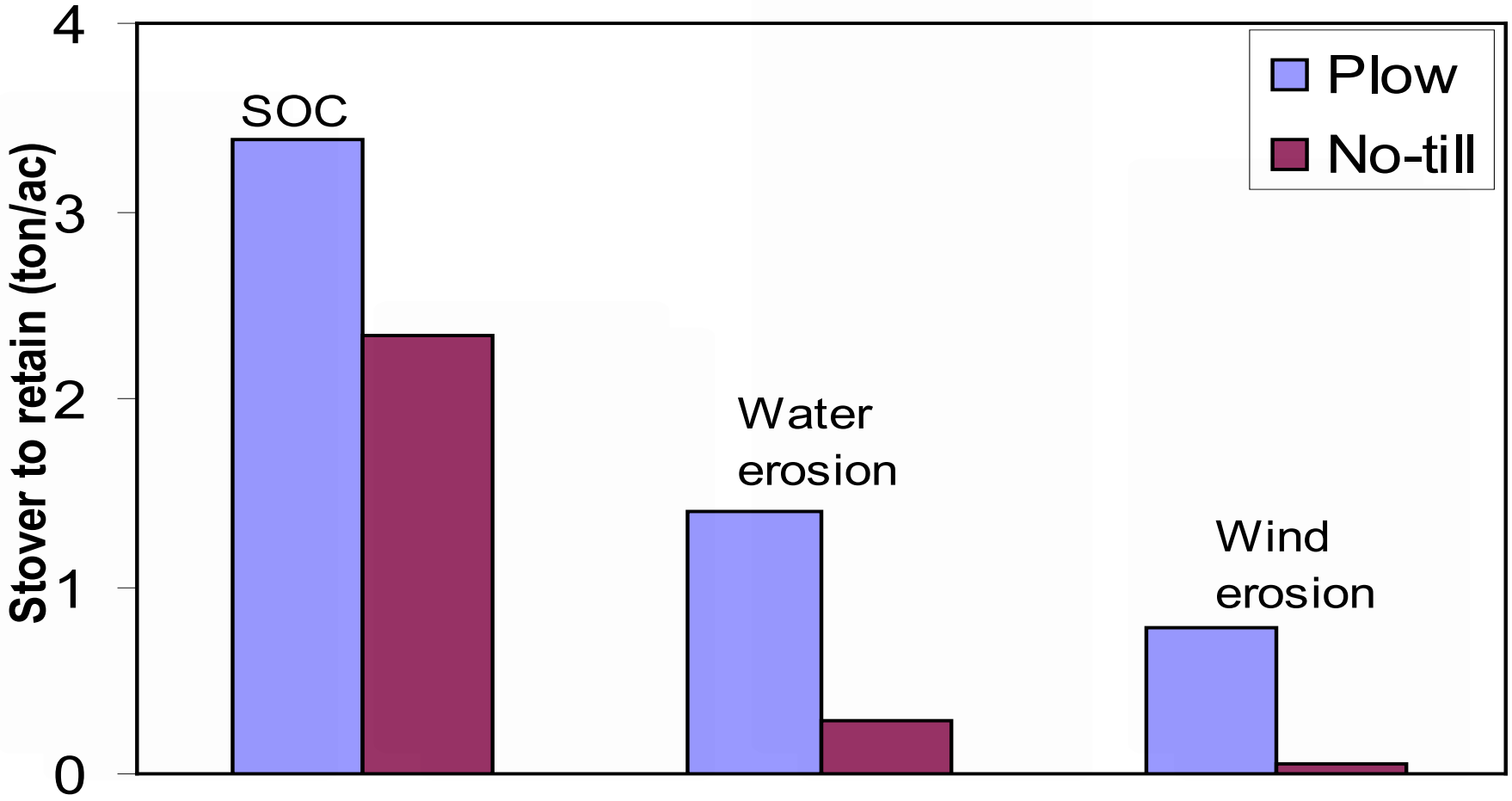
Blanco-Canqui et al., 2019

Biochar impact on soil organic C stocks (change between 2011 and 2017)

Large scale field trials in SW Iowa


100 μm

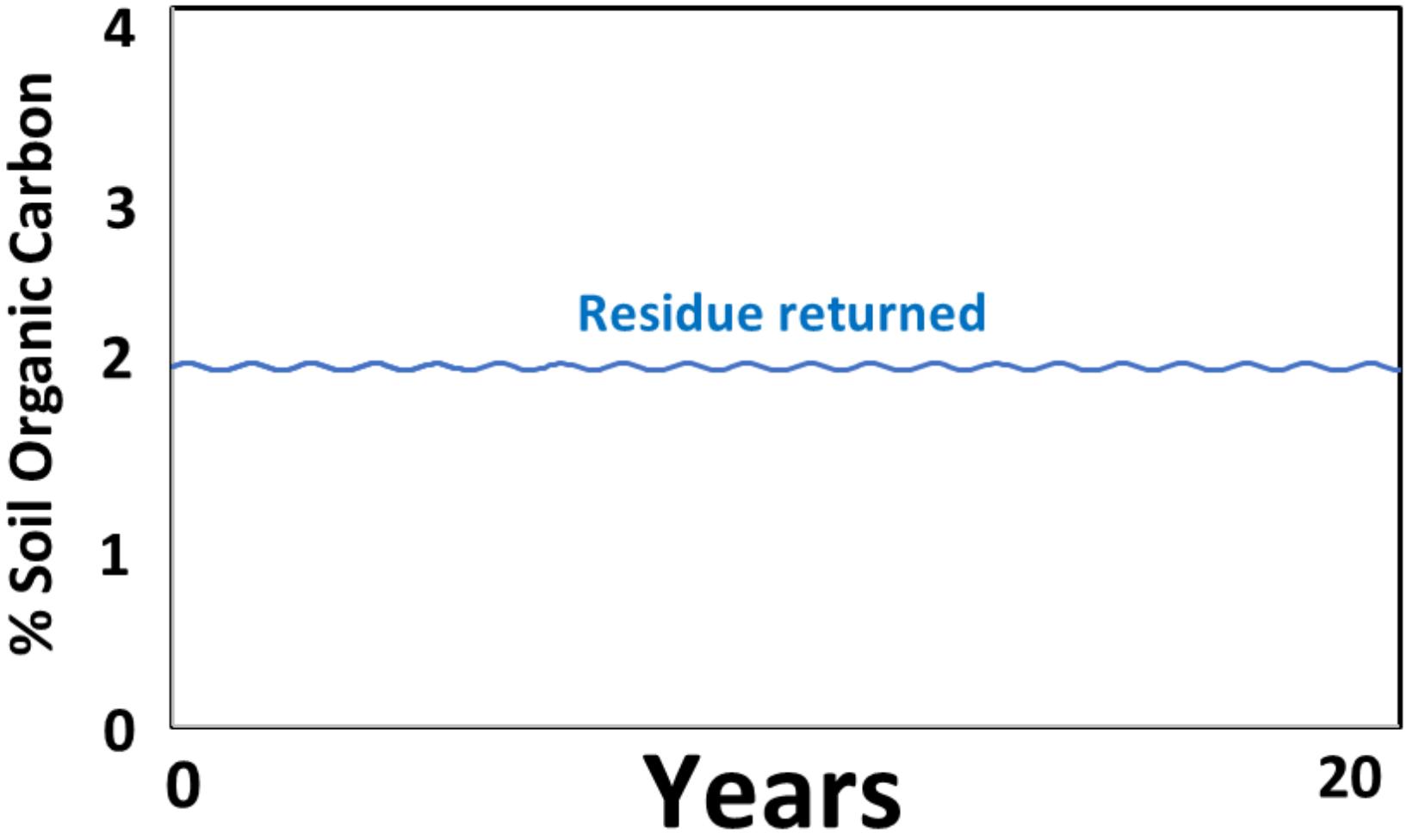
Residue required for sustainability (continuous corn)



Wilhelm et al., 2007, Agron. J.

Biochar Additions and Residue Harvesting

Impacts on Soil Organic Carbon



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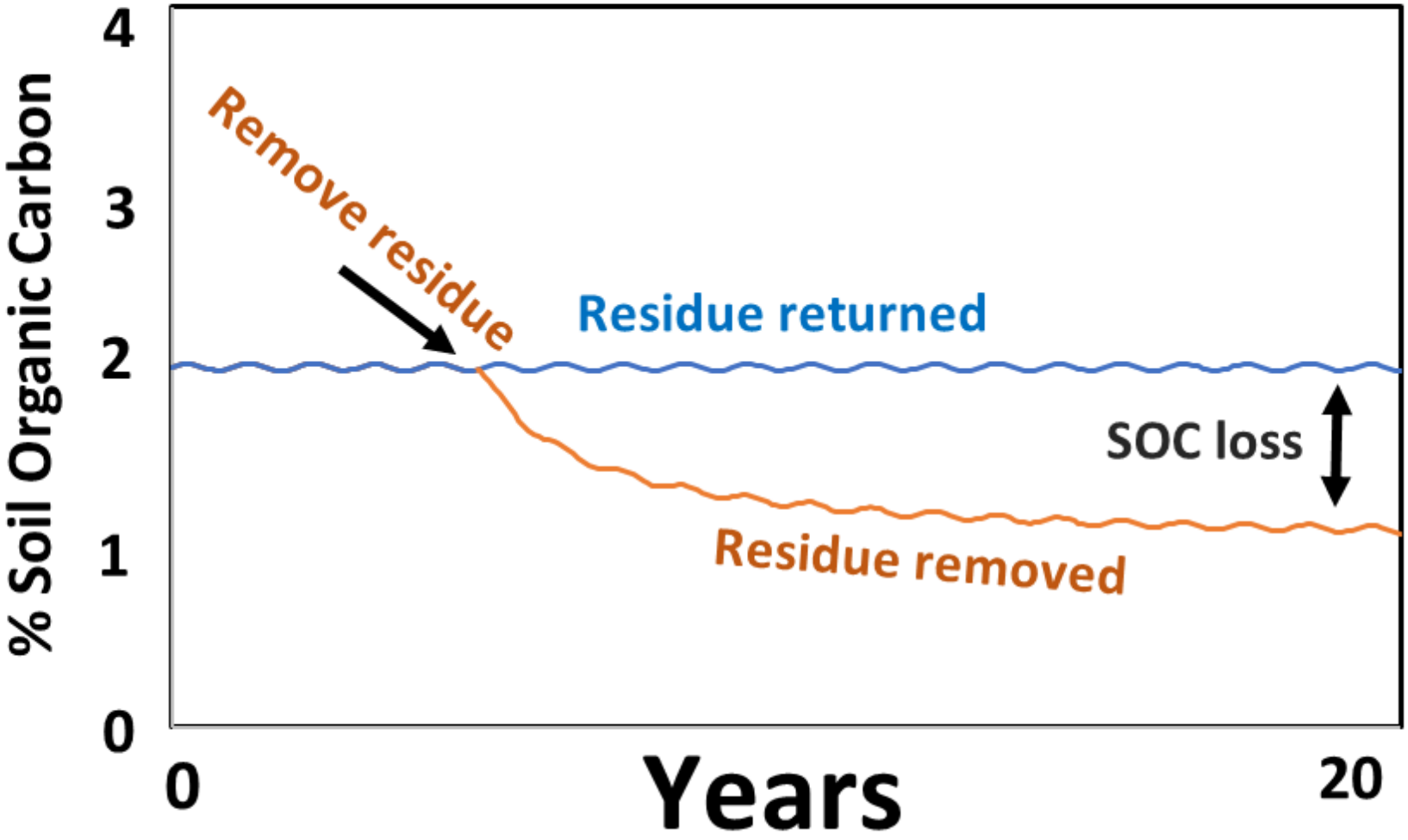

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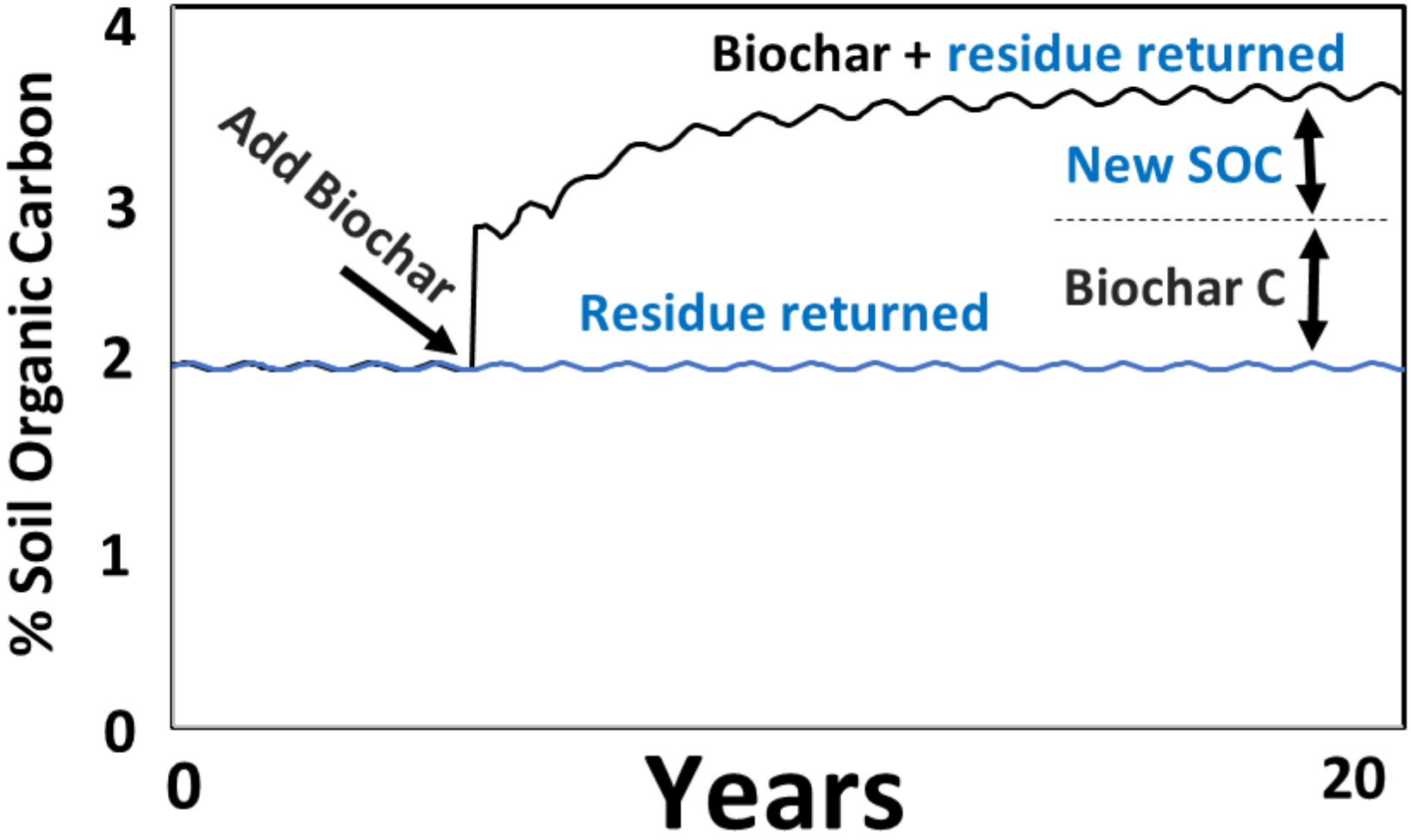

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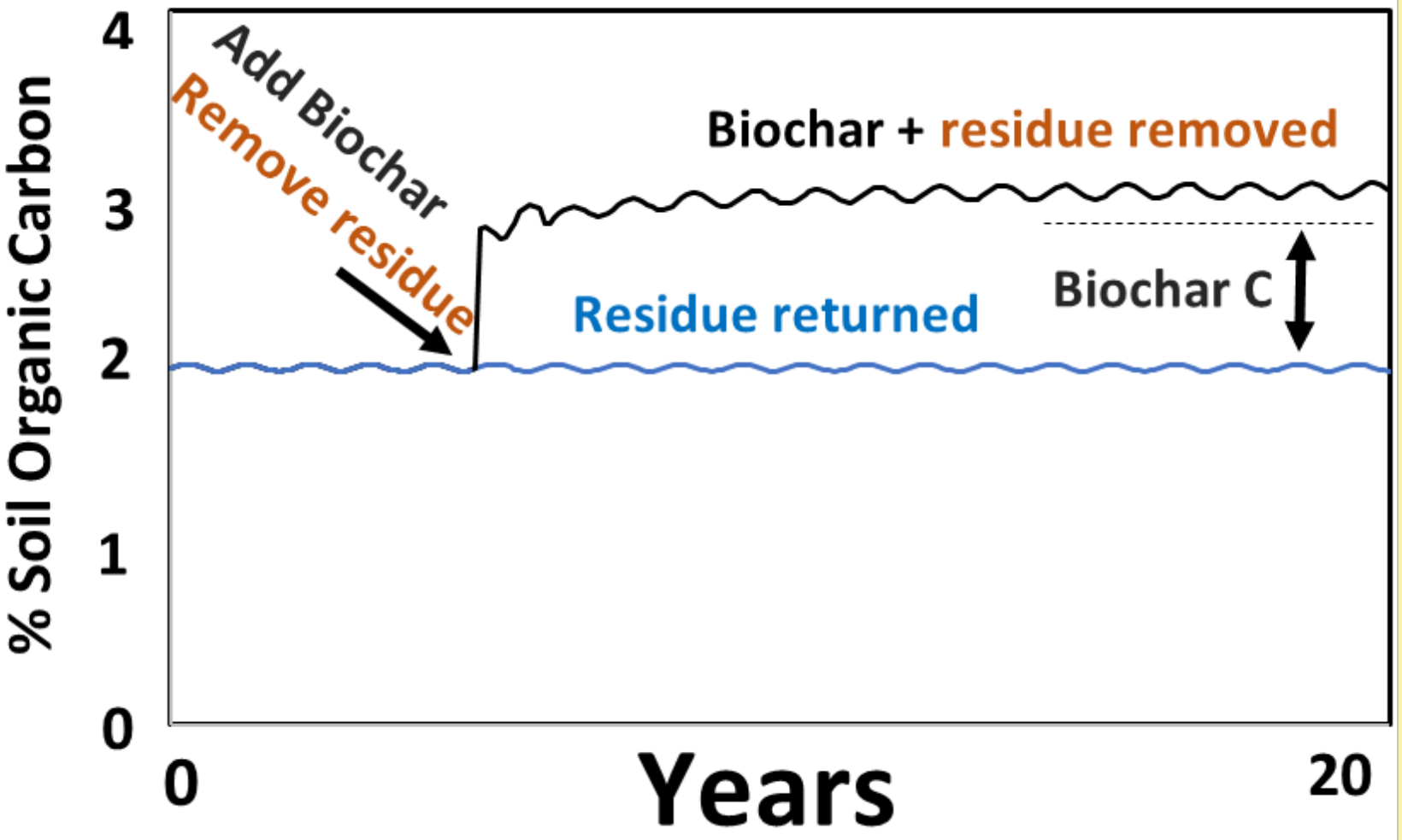

Vision for Pyrolysis Biochar-Bioenergy Industry