



# **Greenhouse Gas Emissions from Soils as Affected by Addition of Biochar**



**Natalia Rogovska<sup>1</sup>, Pierce Fleming<sup>2</sup>,  
David Laird<sup>2</sup> and Richard Cruse<sup>1</sup>**



<sup>1</sup>Dept. Of Agronomy, Iowa State University

<sup>2</sup>National Soil Tilth Laboratory, USDA, ARS

Ames IA, 50011



## **Agriculture may help reduce greenhouse gas (GHG) emissions through**

cropping systems that enhance soil carbon sequestration

practices that reduce energy consumption

land use changes



**Much attention has been given to production of “carbon neutral” biofuels**



# Pyrolysis

Thermal decomposition of organic material in the absence of oxygen

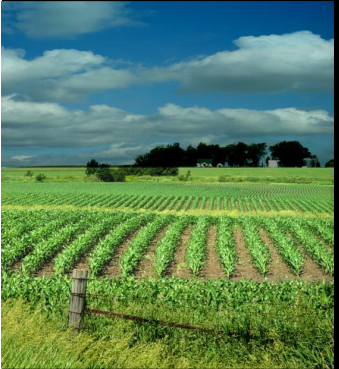
**Bio-oil:** is used as an alternative to fossil fuel.



**Biochar:** used as a CO<sub>2</sub> neutral fuel or soil amendment.



**Syngas:** can be used as a natural gas replacement.





# What was done

**Soil column study was initiated to study the effect of biochar and manure addition on soil respiration and N<sub>2</sub>O emission**

**Soil used:** *Clarion fine-loamy, mixed, superactive, mesic typic Hapludolls*

**Biochar:** *0, 5, 10, and 20 g biochar kg<sup>-1</sup> of soil (biochar was <0.5 mm from slow pyrolysis of mixed hardwood)*

*Well mixed and packed into the soil columns made of PVC tubes. Total of 48 columns*

*Initial soil bulk density ~ 1.1 g cm<sup>-3</sup>*

**Manure:** *0 and 5 g manure kg<sup>-1</sup> of soil added at week 12*

# What was done

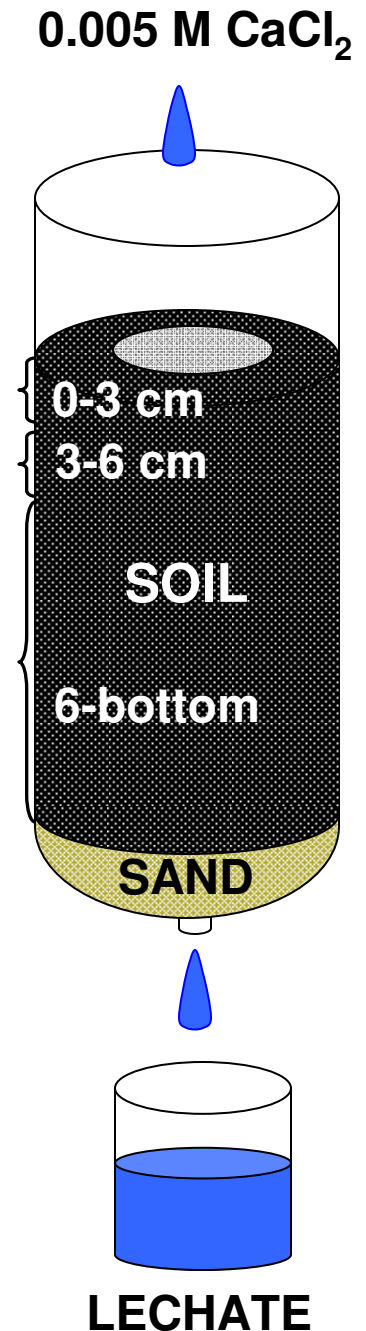
Columns incubated at 22°C and 80% relative humidity for 71 weeks

Leached weekly with 200 ml of 0.005 M  $\text{CaCl}_2$



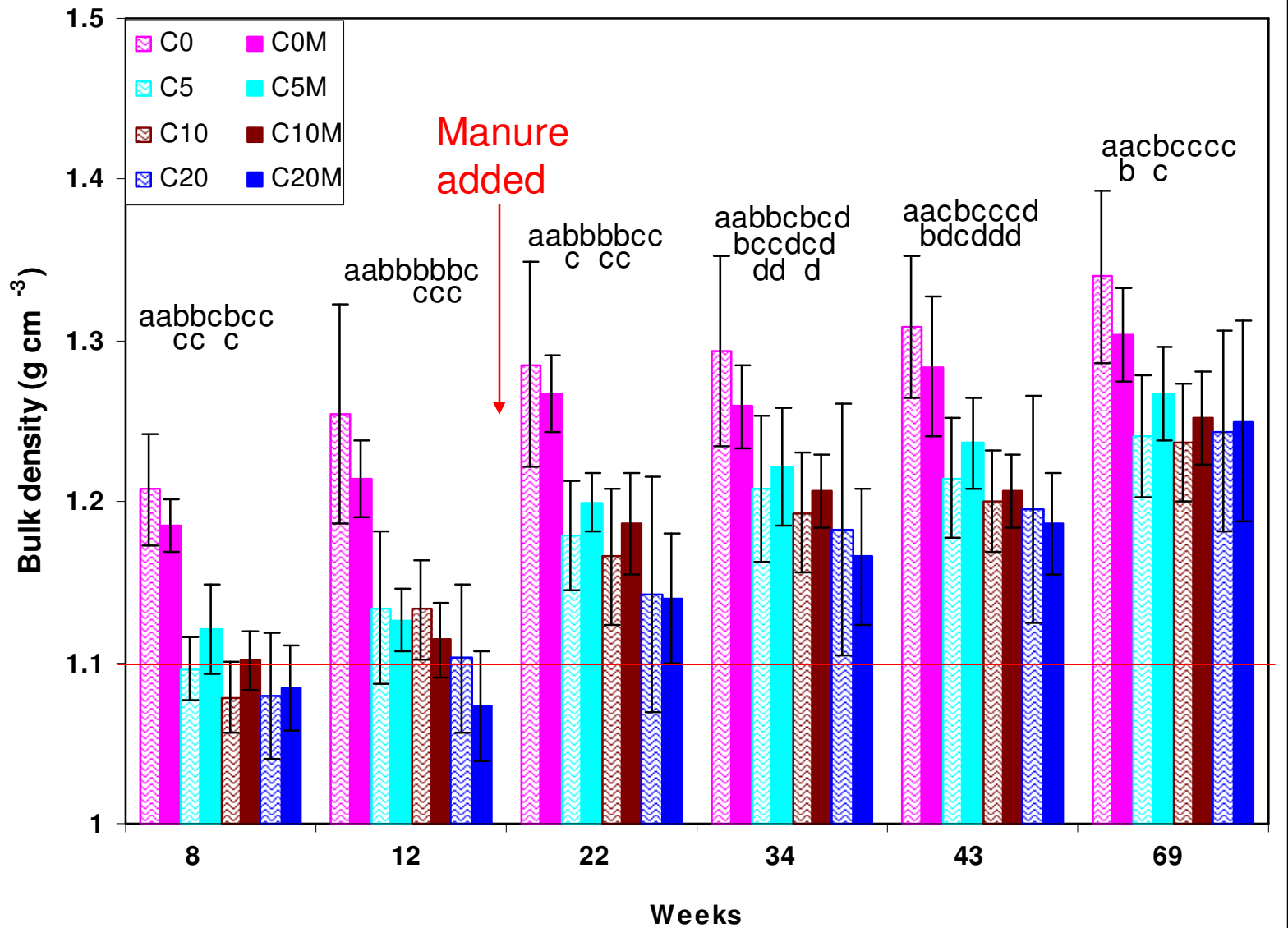
Soil bulk density and  $\text{CO}_2$  emissions monitored throughout incubation period

$\text{N}_2\text{O}$  emissions, soil total C and N measured at the end of the study

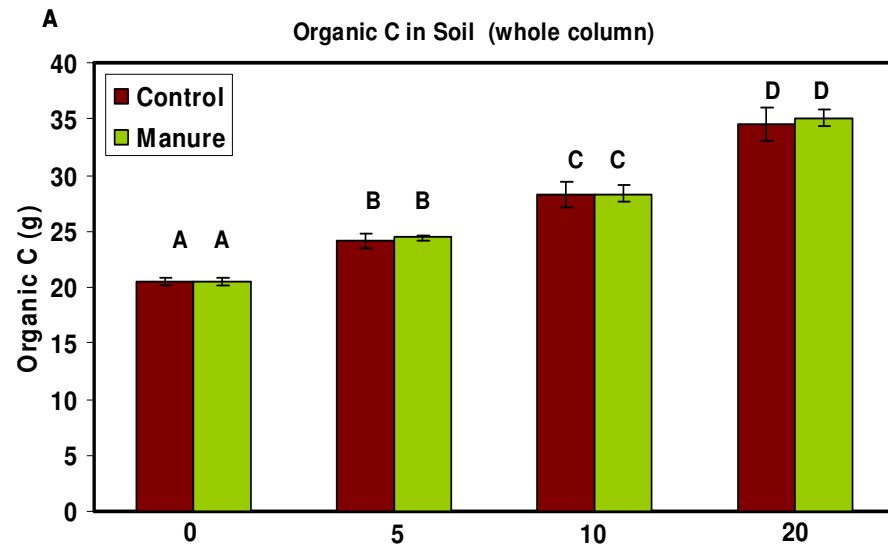




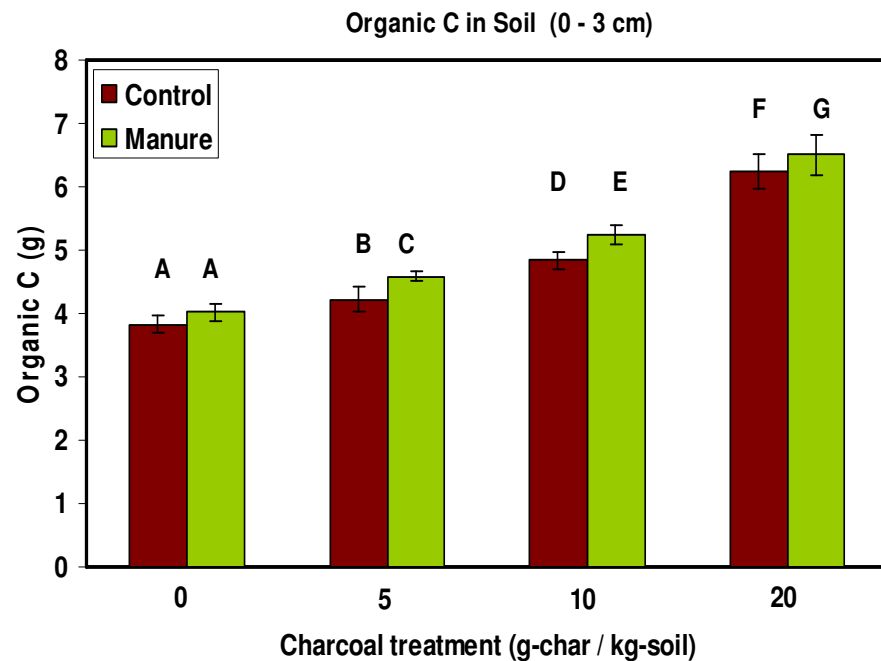
## Biochar addition had significant impact on soil bulk density



## Recovery of organic C after 71 weeks (end of the study)

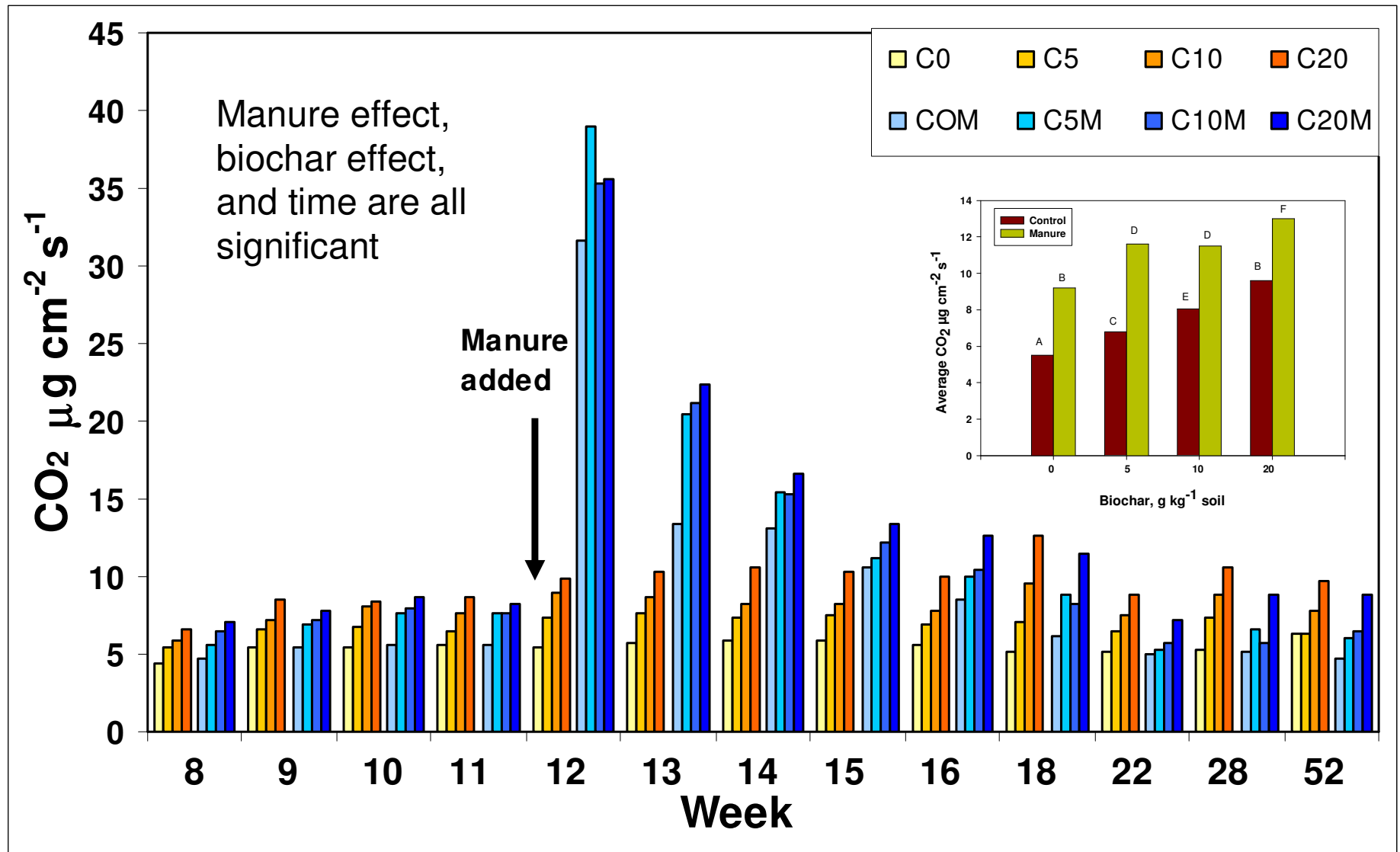


Biochar added	Biochar C recovery
g kg <sup>-1</sup>	%
0	-
5	102
10	109
20	98



Biochar added	Manure C recovery
g kg <sup>-1</sup>	%
0	9
5	17
10	20
20	12

# Impact of biochar on soil respiration





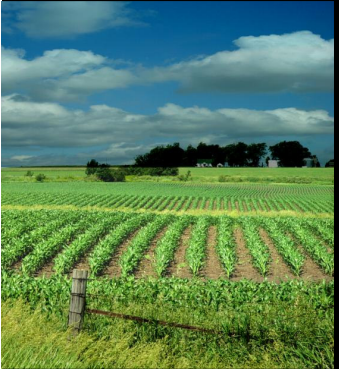
# Impact of biochar on soil respiration

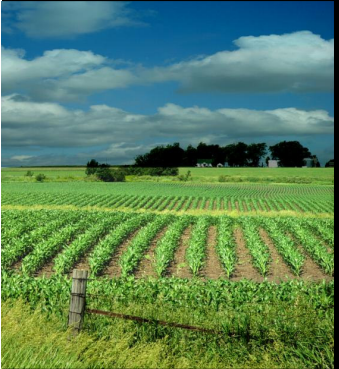
## Respiration increased possibly due to

**Increase in aeration and O<sub>2</sub> consumption by aerobic microorganisms**

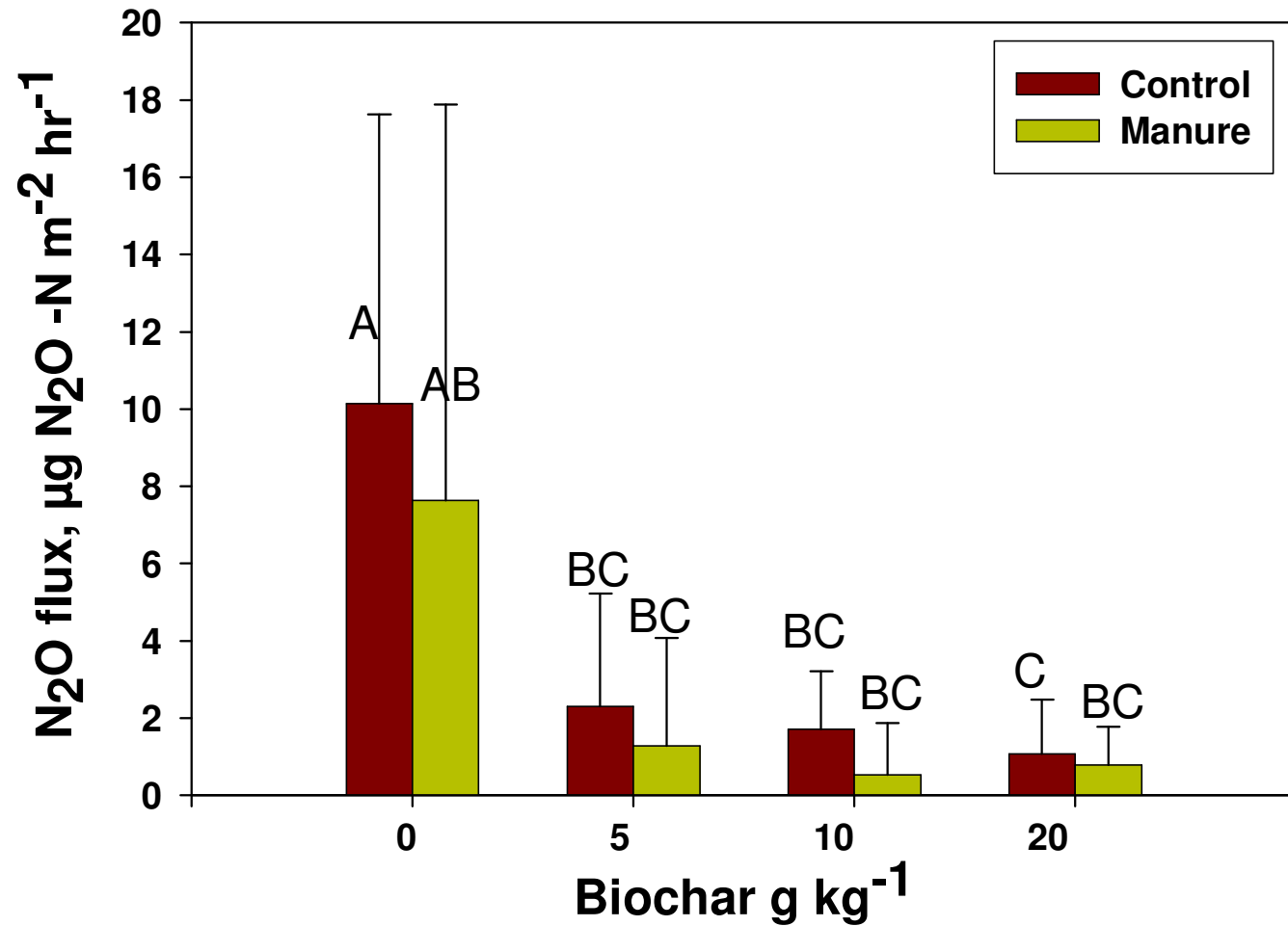
**Biochar addition may have lead to acceleration of decomposition rates of humus**

Wardle et al. (2008) observed that mass loss of mixture containing charcoal and humus was much greater than was predicted if two components were considered separately





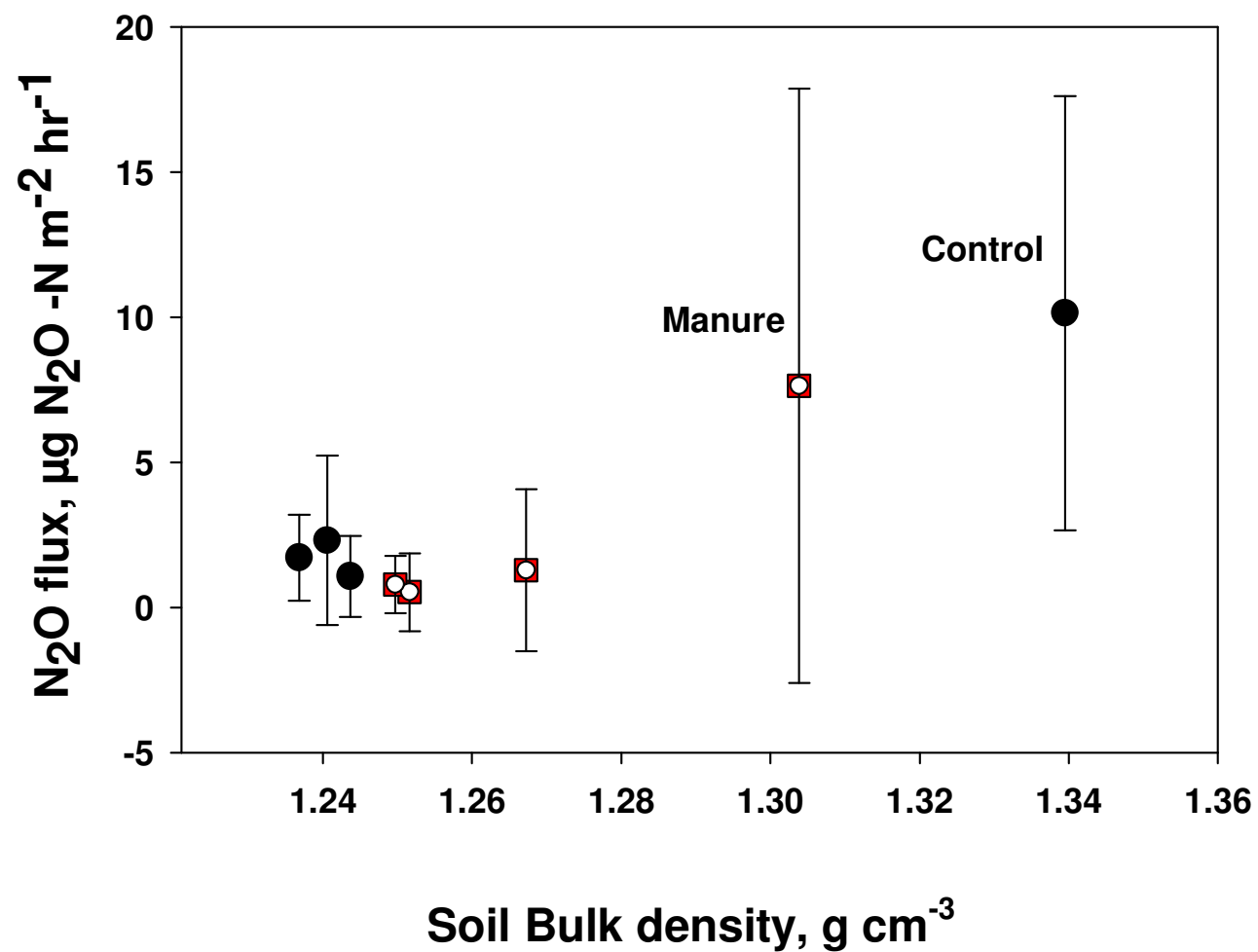
# Impact of biochar on N<sub>2</sub>O emissions

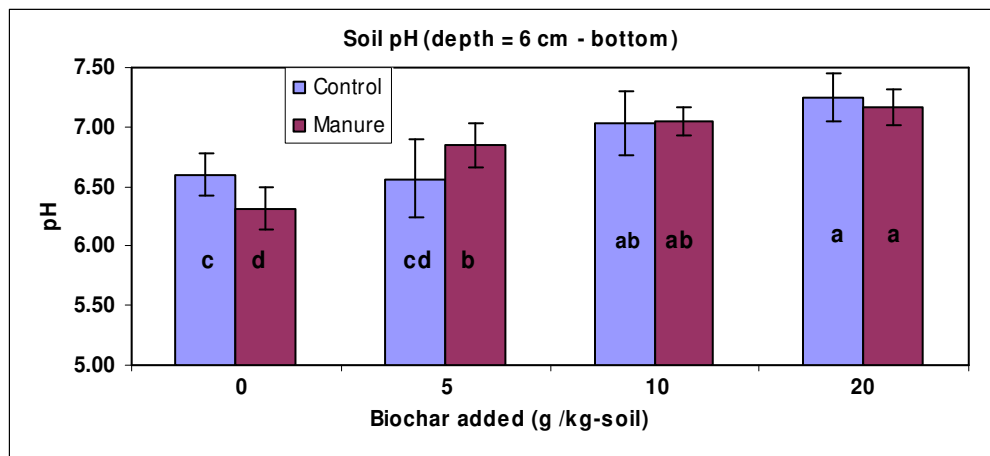
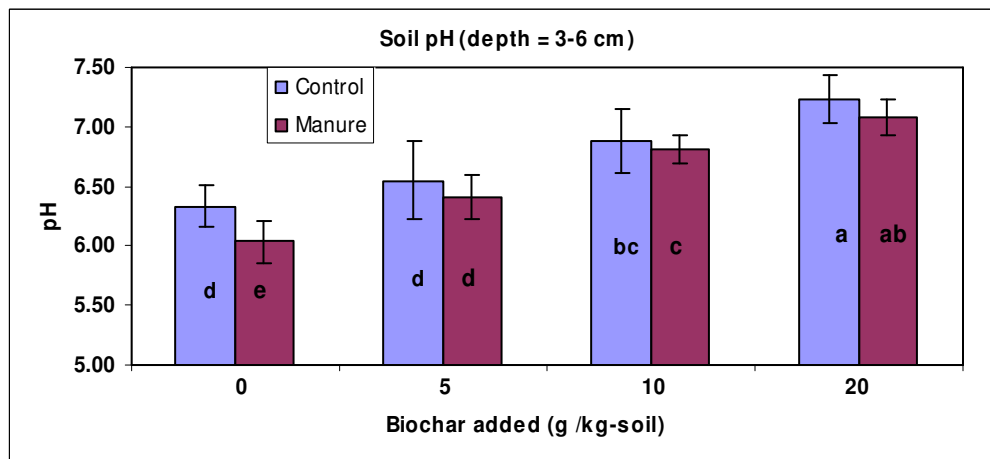
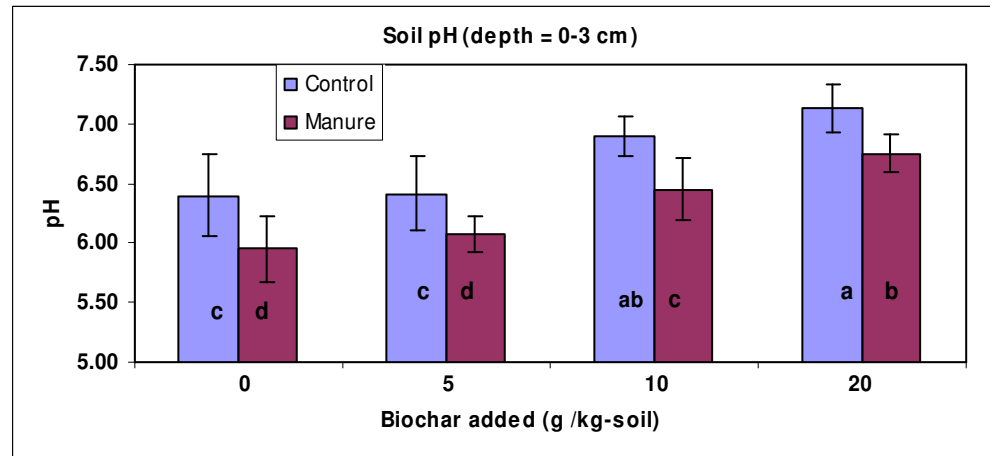


N<sub>2</sub>O is 296 times more potent than CO<sub>2</sub>



## Relationship between soil bulk density and N<sub>2</sub>O flux





# Biochar effect on soil pH

Ash content of  
biochar = 7.5%

Assuming the ash is  
CaO then:

$$\text{CCE} = 12.5$$

# Conclusions

## Biochar addition to soils significantly :

decreased soil bulk density

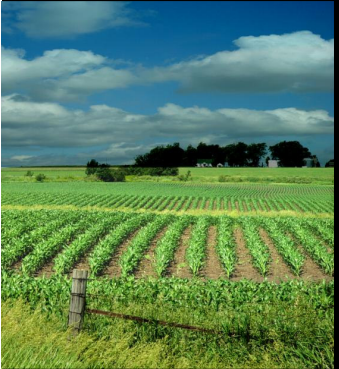
increased microbial respiration and CO<sub>2</sub> emissions

decreased N<sub>2</sub>O emissions

increased soil pH

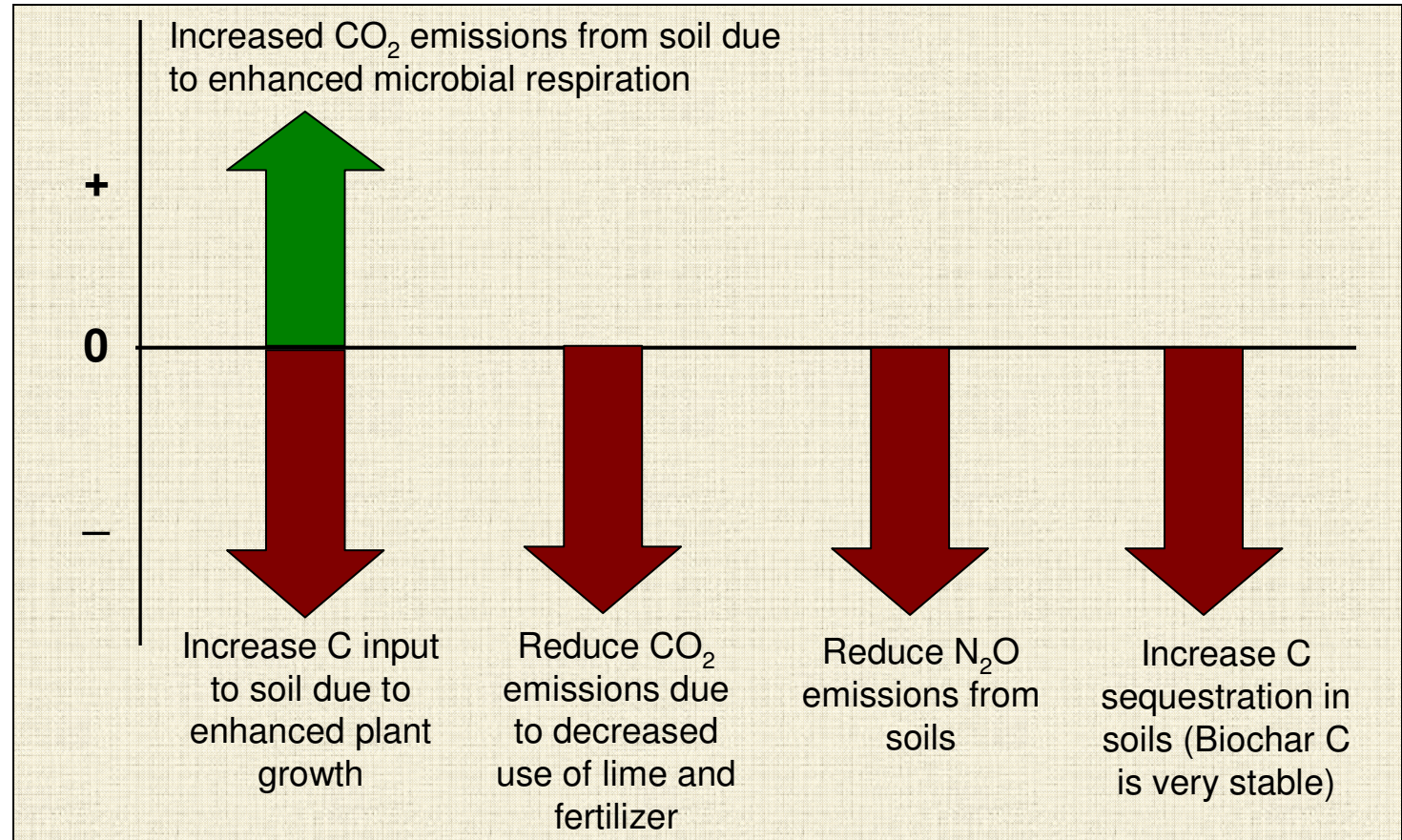
increased levels of soil organic C

**Within our ability to measure, no biochar carbon was mineralized during incubation period**





# Impact of soil biochar additions on GHG emissions



**Other unknowns:**

**Impact of biochar on humus formation?**

**Impact of biochar on land use?**

**????**



# Acknowledgements

**National Soil Tilth Lab., USDA, ARS:**

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