Update on Biochar Characterization/Field Studies

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USDA-ARS

Agricultural Research Service

Illinois Biochar Group Meeting
June 14, 2012

“The use of charcoal (*biochar*) as a fertilizer is not a new thing, though it is only within the few last years that agriculturists have taken much notice of it.”

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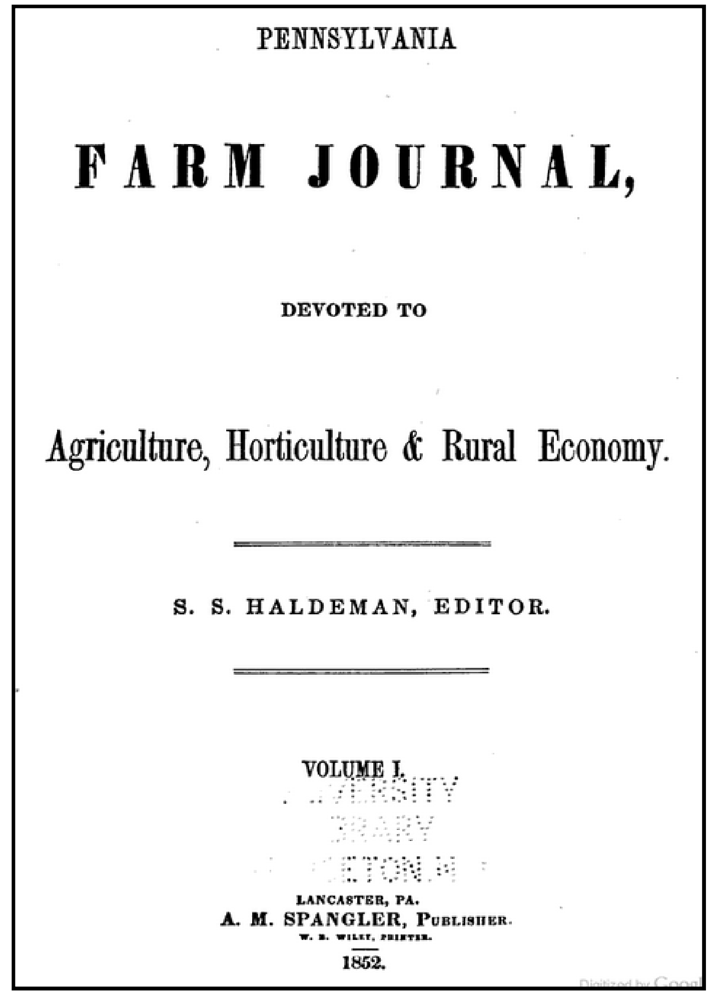
Biochar: Not new for soil additions….

“The use of <u>charcoal</u> (*biochar*) as a fertilizer is not a new thing, though it is only within the few last years that agriculturists have taken much notice of it.”

-- **Pennsylvania Farm Journal (1852)**
Editorial (Haldeman) Page 57


PENNSYLVANIA

FARM JOURNAL,

DEVOTED TO

Agriculture, Horticulture & Rural Economy.

S. S. HALDEMAN, EDITOR.

VOLUME I.

LANCASTER, PA.
A. M. SPANGLER, Publisher.
W. B. WILEY, PRINTER.
1852.

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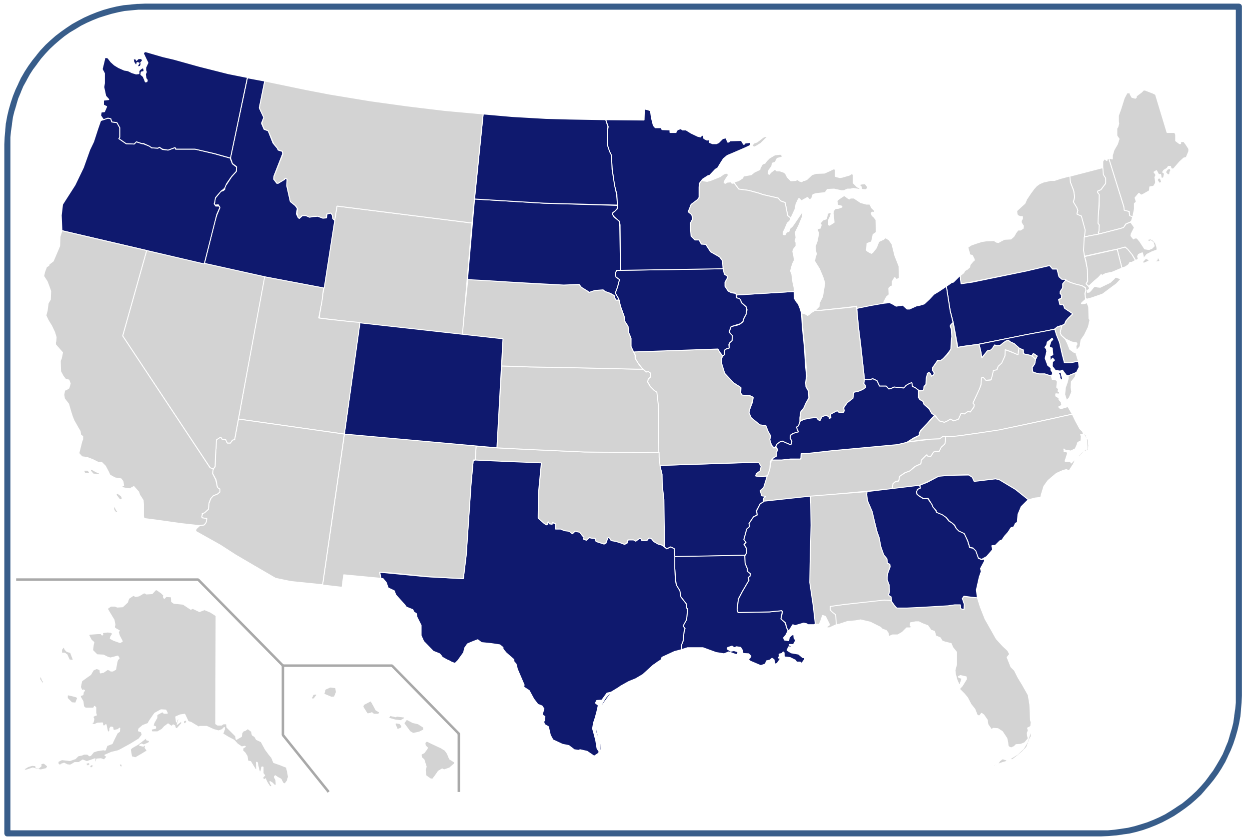
USDA-ARS Biochar Research

- Over 20 locations involved in biochar research



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3 Main USDA-ARS Biochar Research Areas

I. Biochar for improving soil fertility

II. Biochar for soil remediation

III. Biochar impacts on soil microbial communities

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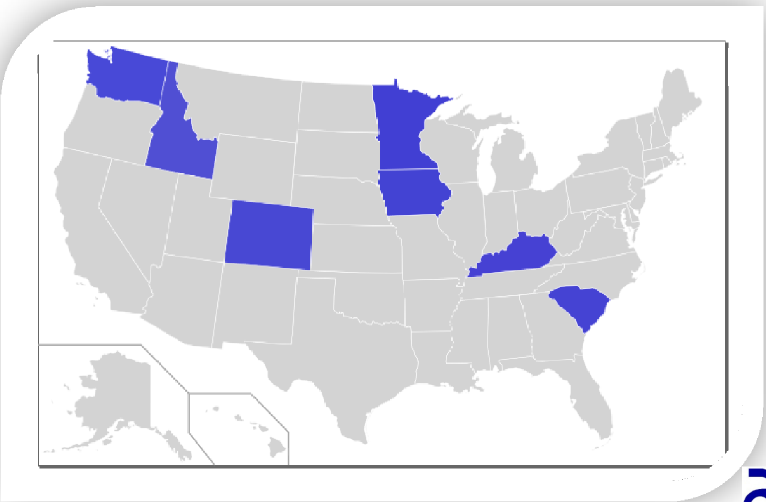
3. Soil Microbial

- Net Soil Greenhouse Gas Production (7 locations)
  - Focusing on mechanisms of biochar-microbe interactions
    - Chemical and physical interactions
      - Sorbed organic compound volatiles →Signaling compounds
        - » Interactions with microbial enzymes/plant hormones
      - Field aging effects / weathering
      - Soil moisture interactions
    - Impact on microbial populations & diversity



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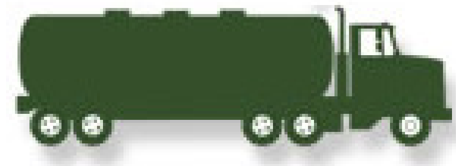
Current Ethanol Production

>30% in MN

Future?

Ethanol

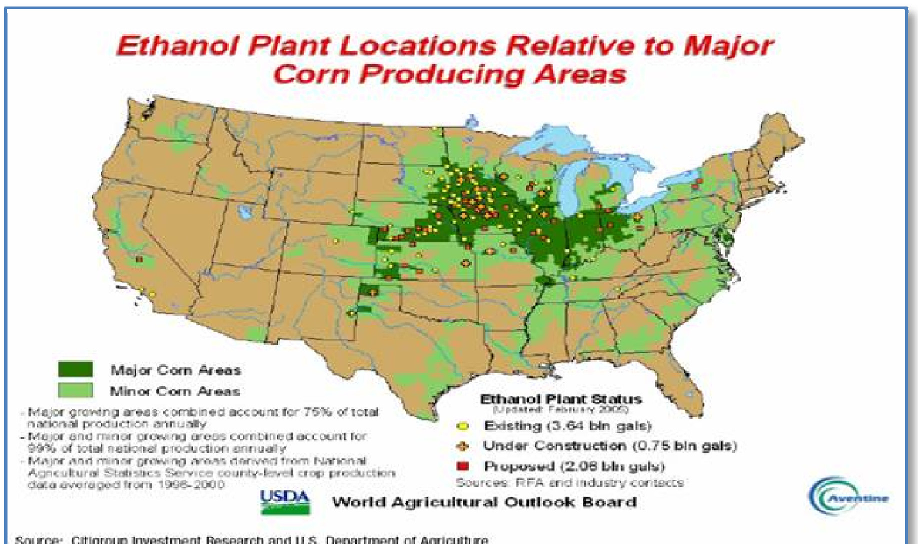


Ethanol → market

wet cake separated

DDGS → market

Syrup/thin silage → market



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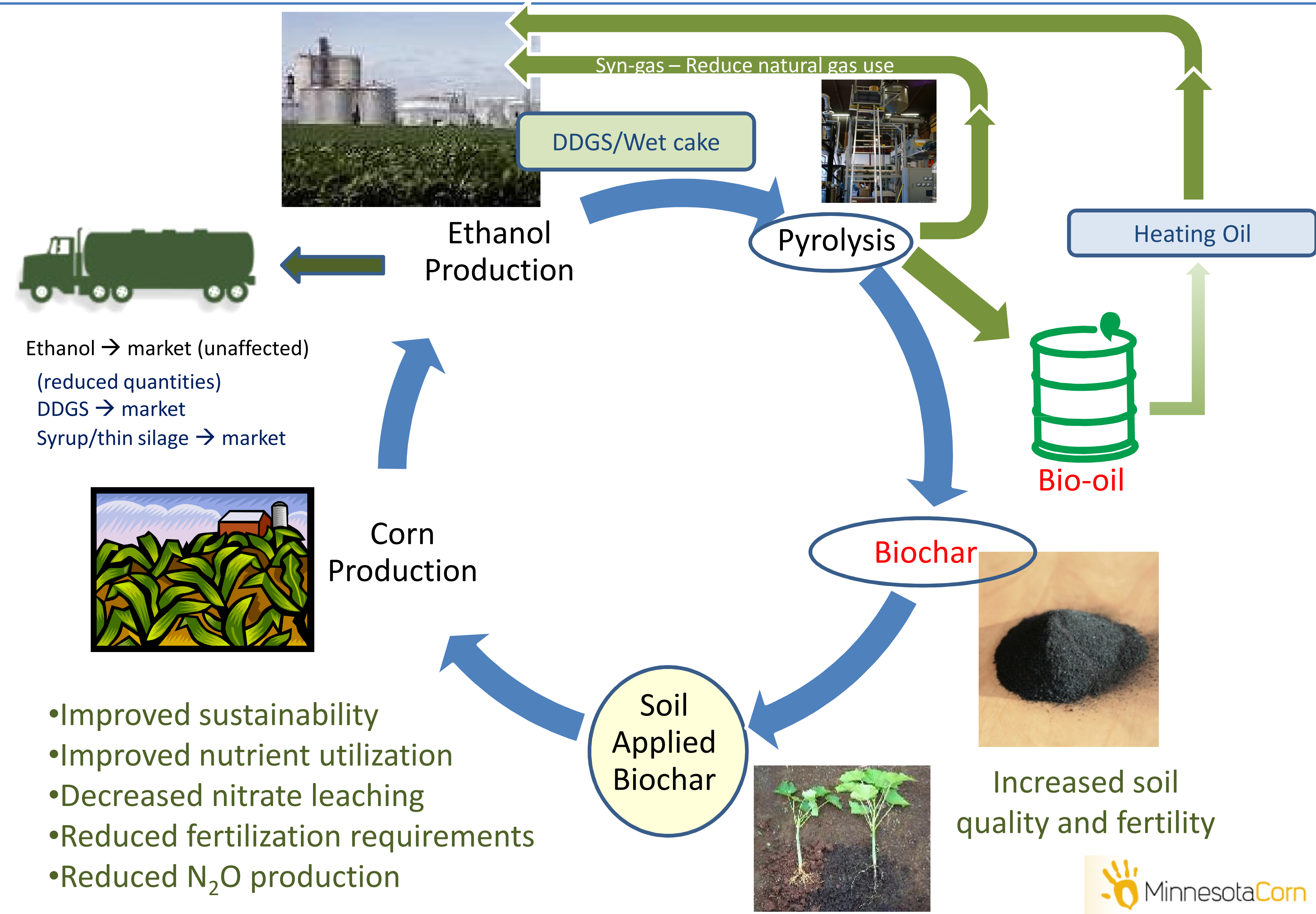
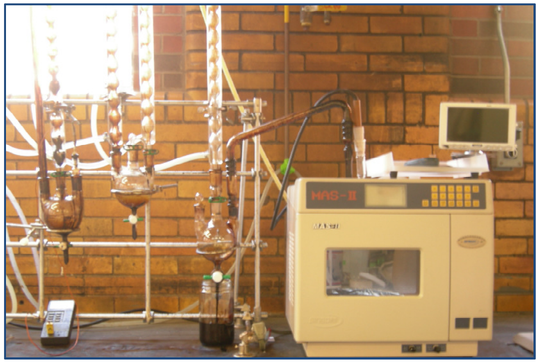
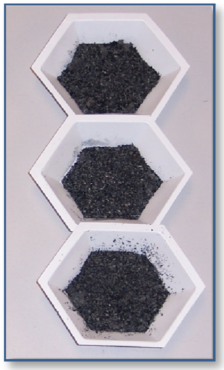
Proposed New Vision of Ethanol Plant Production



MAP Pyrolysis Products





Feedstock	Char (%)	Liquid		Gas (%)
		Organic Phase (%)	Water Phase (%)	
100% Corn stover	27.8	38.9		33.3
DDGS:Corn stover 25:75	26.2	43.7		30.1
DDGS:Corn stover 50:50	25.4	41.8		32.8
DDGS:Corn stover 75:25*	27.0	17.2	28.6	27.2
100% DDGS*	25.0	18.3	27.5	29.2

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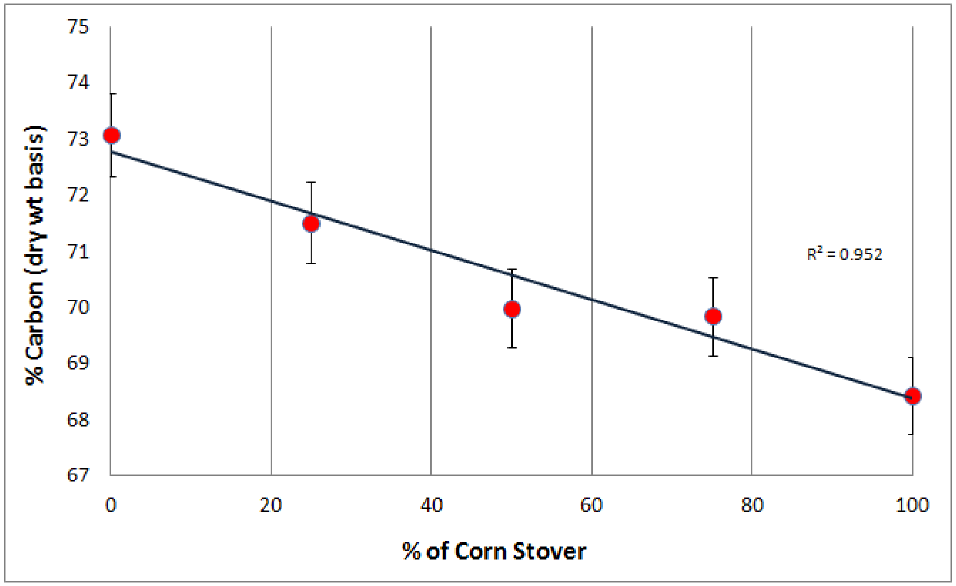
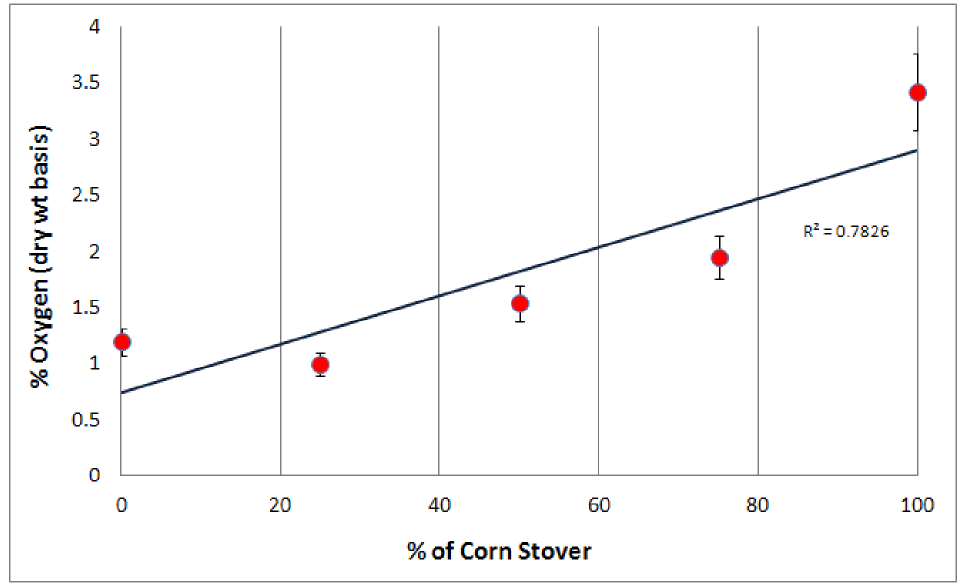
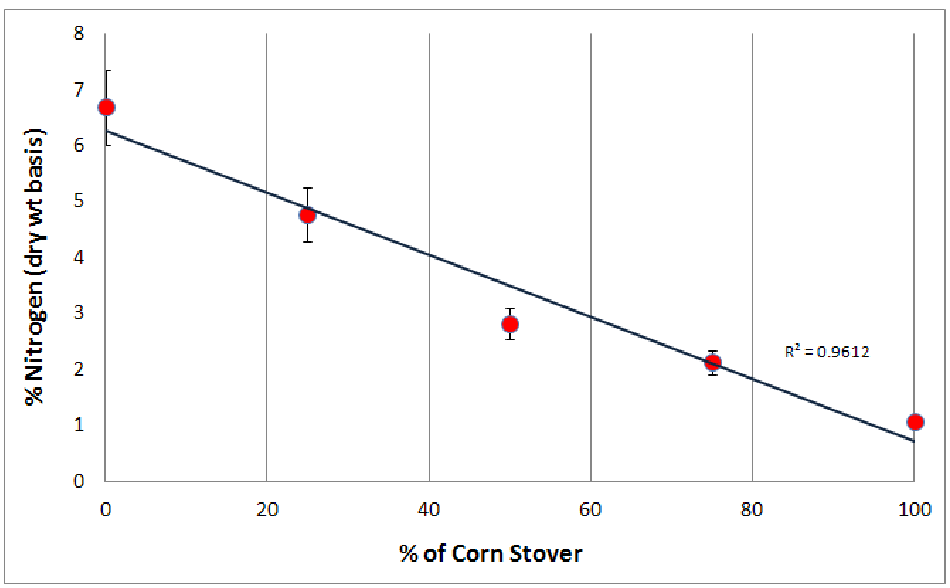
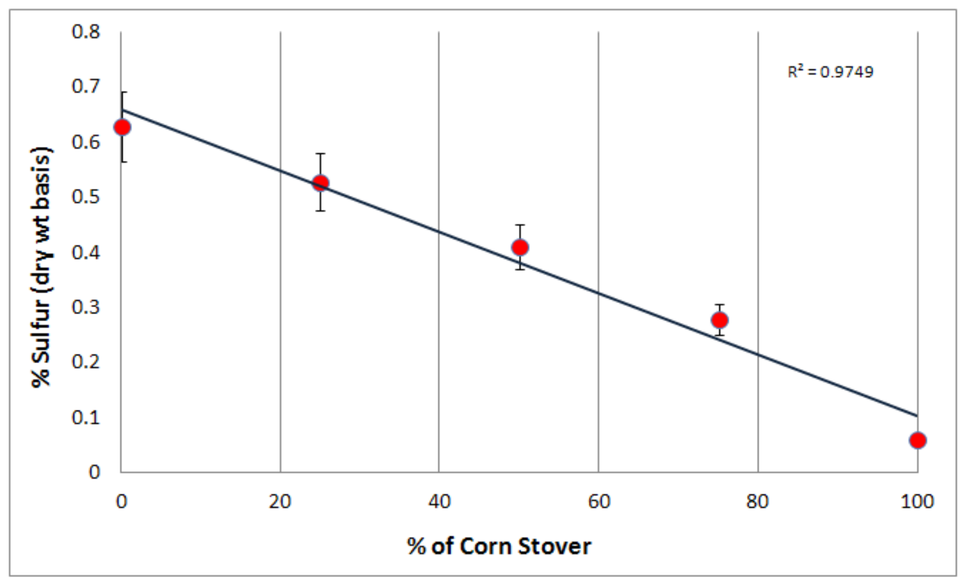
Chemical Quality of MAP Biochars

- Biochar elemental properties varied as a function of feedstock ratios









Laboratory Soil Incubations

<u>Laboratory soil incubations:</u>

- Monitor the production/consumption of greenhouse gases (CO_2, N_2O, and CH_4)

- Monitor nutrient cycling
    Inorganic N-forms

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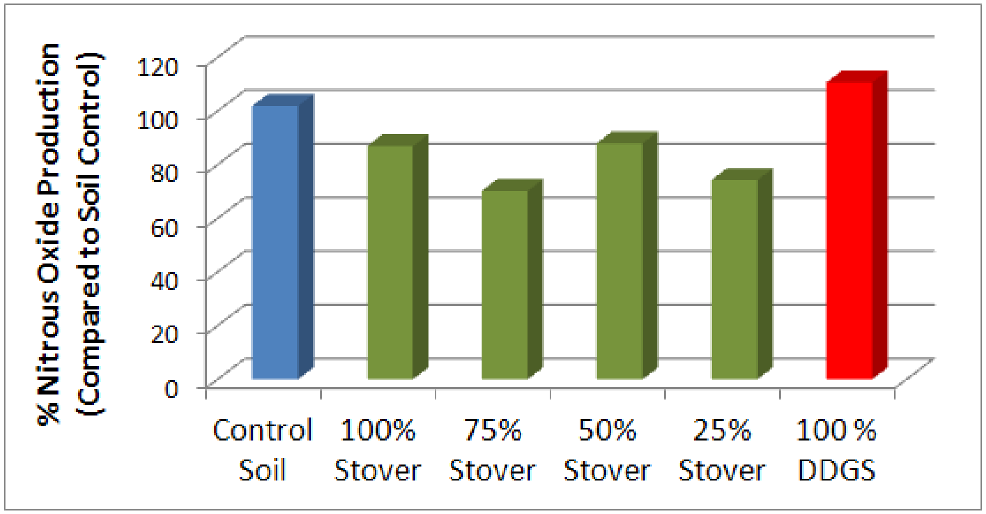
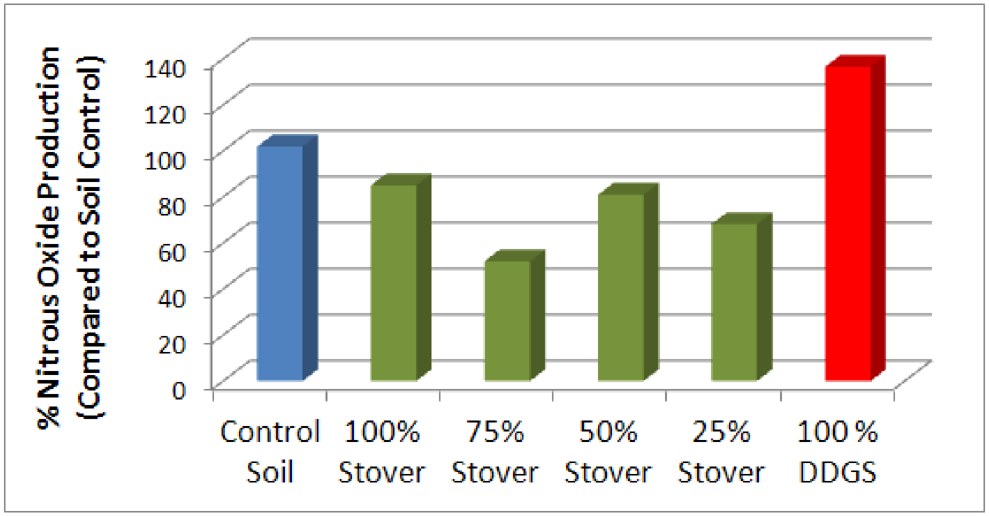
Soil : N_2O Impacts

- Morris, MN Soil – Barnes-Aastad clay loam



2% w/w addition

- *Despite linear trends in chemical composition; no similar linear trends in the response of the soil microbial system*



10 % w/w addition

- *Benefit to feedstock mixtures:*
  Corn stover + DDGS mixtures suppressed the N_2O production observed with the 100% DDGS biochar addition

Biochar feedstock mixing ratios

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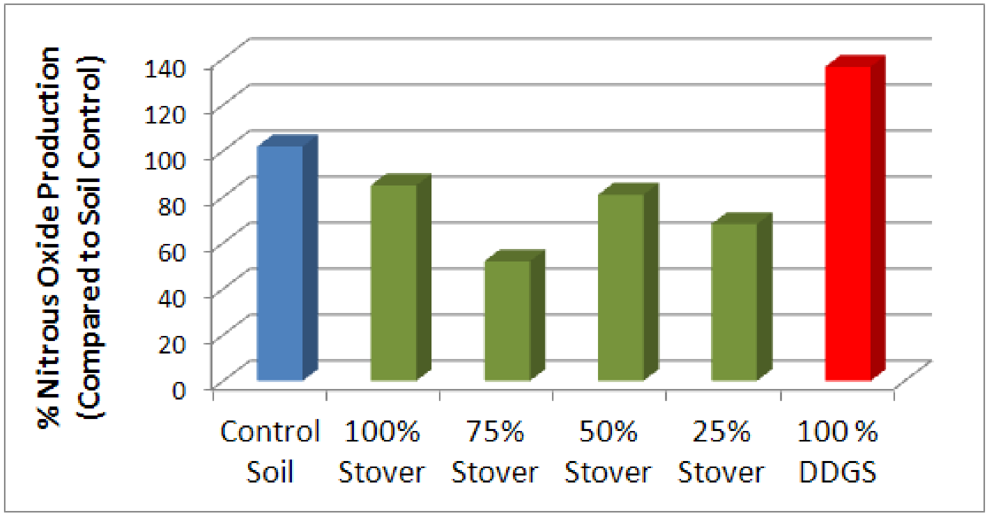
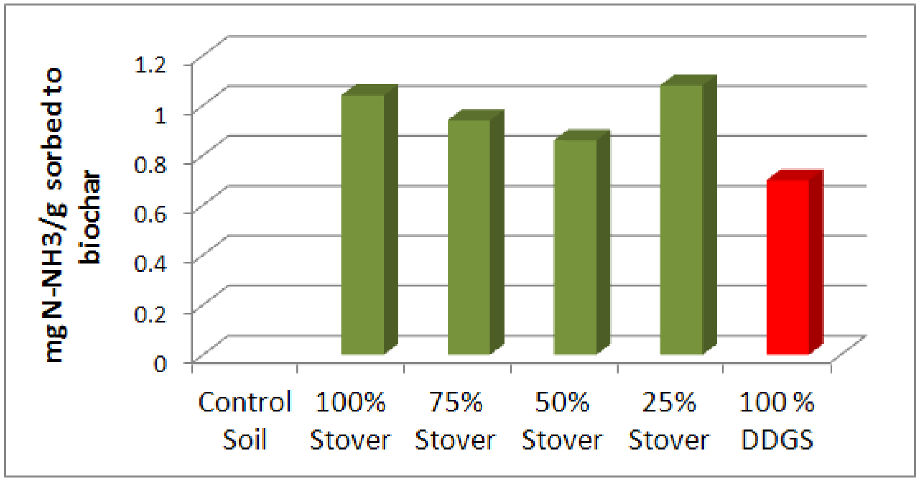
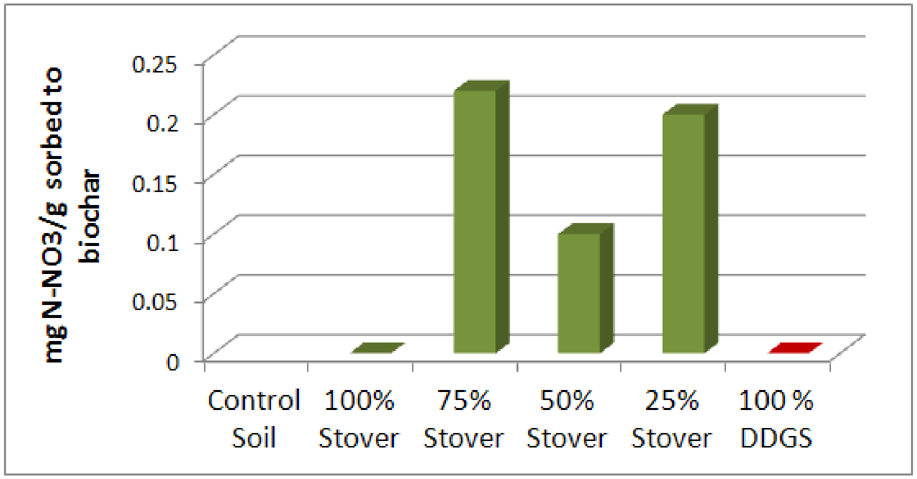
Nitrate/Ammonia Sorption

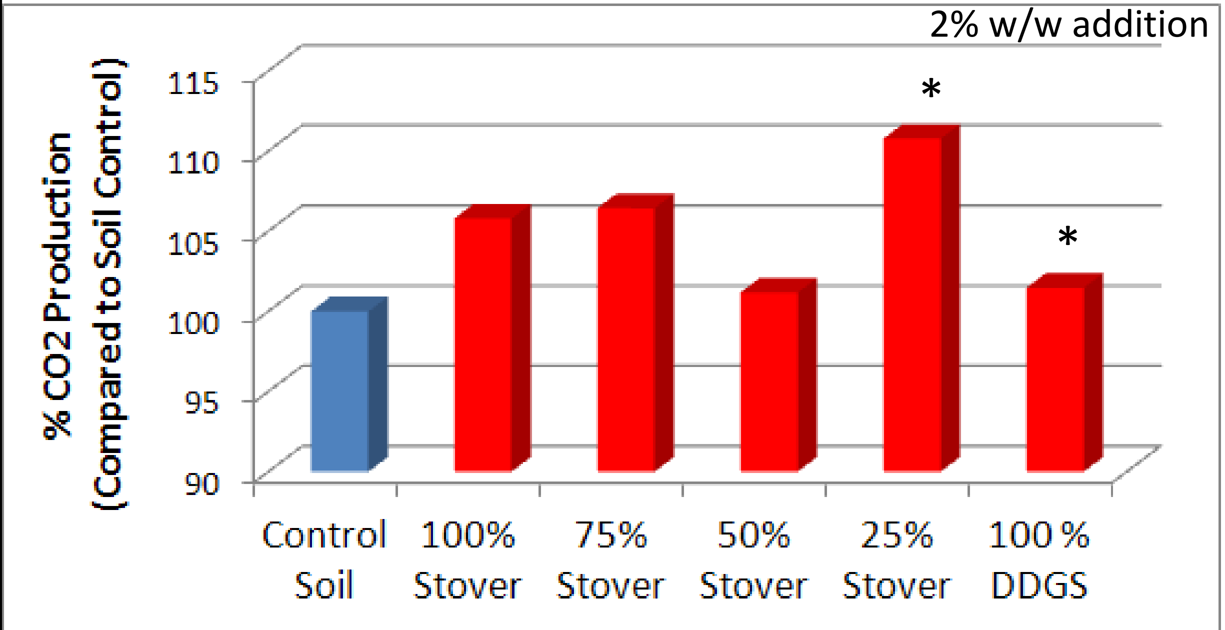
- Direct nutrient sorption to biochar?

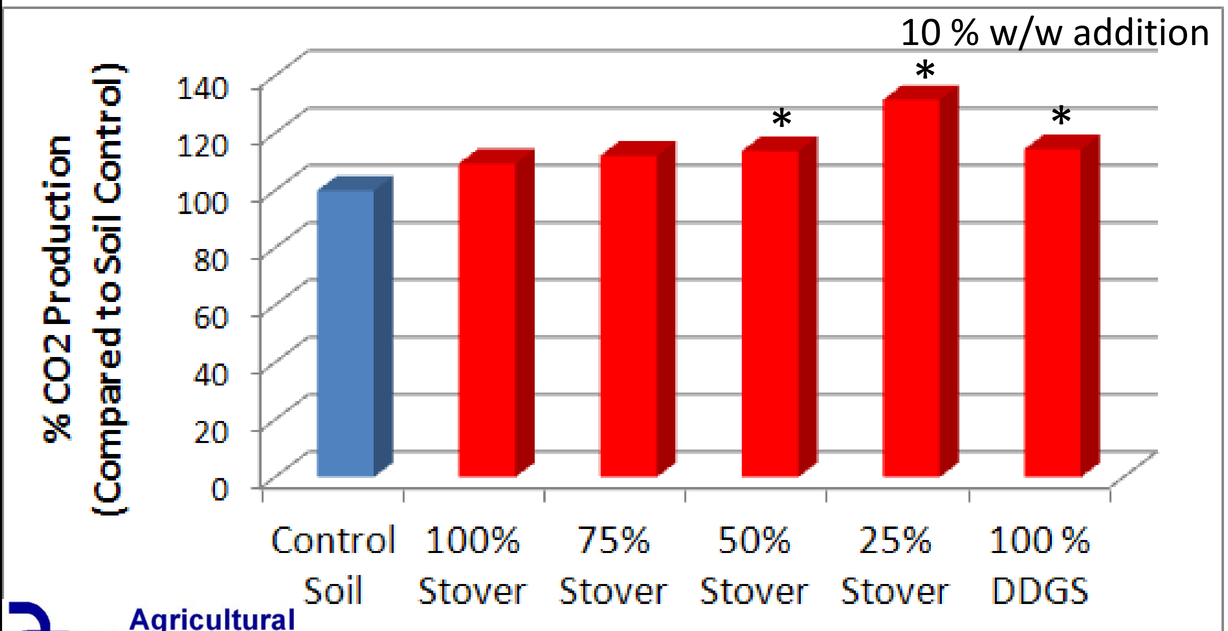






CO_2 Production – C mineralization





- All biochar additions stimulated soil CO_2 production
- Assumption is that the biochar provided some source of additional degradable substrates
- However - Not all statistically significant

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CO_2 effects – C mineralization

- Assumption: The extra CO_2 production is of biochar origin

- Max observed mineralization rate of biochar-C :
  - 0.9 µg C/g_soil/day -or – <0.1% mineralized after 1 yr
  - 99.9% of C remains in the soil after 1 yr

- For comparison:
  - Non-pyrolyzed DDGS: 80% C lost in 60 d (Cayuela et al., 2010)
  - Non-pyrolyzed corn stover: 55% C lost in 180 d

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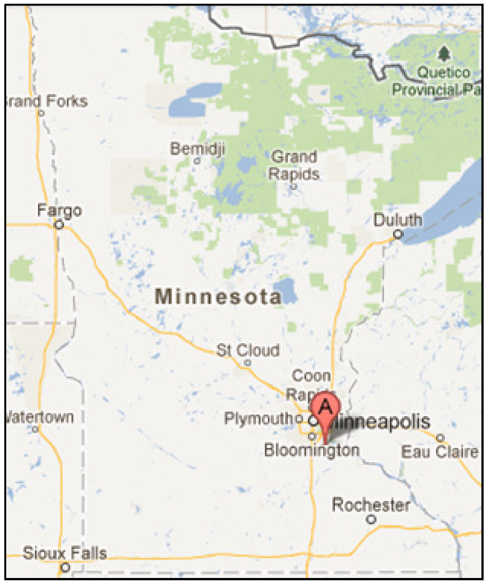
Rosemount, MN Field Plots



CE2	SYLVA			SYLVA		CE2	SYLVA
IWM	IP1	WP 3	IWM	CE2	WP 1	IWM	WP 2
WP 2	WP 1	CB	WP 2	IP1	CE	WP 1	WP 3
IP1	WP 3	B	BE	C	MN	M	BM
CB	BE	C	CE	MN	M	B	BM
CE	CB	C	B	MN	BM	M	BE

4.9 m

4.9 m

Fall 2008 /Spring 2009
C-CONTROL
B – DYNAMOTIVE FAST PYROLYSIS BIOCHAR (20,000 lb/ac)
BM – DYNAMOTIVE FAST PYRLOYSIS BIOCHAR + MANURE
M – MANURE ONLY
BE - BEST ENERGIES SLOW PYROLYSIS CHAR (20,000 lb/ac)
MN – MACADEMIA NUT BIOCHAR (20,000 lb/ac)
Spring 2010 applications
CE - Chip Energy (wood pellet biochar) (20,000 lb/ac)
CB - Cowboy Lump (hardwood) Charcoal (20,000 lb/ac)

Spring 2011 Applied
WP1 – Wood Pellet (5,000 lb/ac)
WP2 – Wood Pellet (10,000 lb/ac)
WP3 – Wood Pellet (20,000 lb/ac)
IP1 – Pine chip BC from ICM (20,000 lb/ac)
IWM – Wheat midds BC from ICM (20,000 lb/ac)

Spring 2012 applied
CE2 – Corn Cob BC (Chip Energies) (10,000 lb/ac)
SY – Wood Chip Biochar from Syvla (10,000 lb/ac)

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ASA Biochar Community

- Meeting in Cincinnati, OH
- Oct. 21-24, 2012
- 1 ½ days of biochar talks:
  - Monday morning and afternoon oral session
  - Tuesday morning session
  - Poster Session Monday late afternoon

- Biochar researcher of the year, best presentation and student poster awards