Manure Management by Biochar Practice: Nutrient, Water Quality, and Greenhouse Gas

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Biochar: Charcoal-like Material from Various Wastes

Various feedstocks:
- Manure
- Grass (including hays)
- Crop residue
- Wood
- Biosolids (sludge) at WWTP

Pyrolysis = thermal process (heating at 300-800 °C, with little O_2)

Little greenhouse gas generation

Lab-scale pyrolysis reactor

Full-scale pyrolysis reactor

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Biochar for Agriculture
- Plant Growth, Soil Fertility and Soil Microorganisms -

- Slow release biofertilizer
  - ✓ Slow and steady release of nutrients to plants
  - ✓ Dairy manure biochar: Nutrient release - five times slower than dairy manure
- Nutrient retention
  - ✓ Biochar's adsorption of excessive nutrient from manure and chemical fertilizer
  - ✓ Release of nutrients from biochar to soil/plants
- Water holding capacity
  - ✓ Wood and manure BC - higher capacities (x17 and x7 times) than sandy loam soil
  - ✓ Drought mitigation
- Biochar providing nutrient, water and organic carbon at steady rates to soil and plants
  - ✓ Enhanced plant growth, soil fertility and soil microorganisms
  - ✓ Reduced environmental pollution from agricultural practices
- 2.5-10 tons of BC/ha for agronomic and environmental applications

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Current Project (Biochar-driven Manure Management)

- Title: Sustainable Ecosystems for Dairy Manure - Integrating field, lab and decision support tools to develop management guidelines across soils, crops and water
  - Sponsor: USDA NRCS
  - Duration: 1/2021 - 12/2023
  - Project Teams: Texas A&M AgriLife Research
- Goal: Understanding fundamental processes of nutrient, antibiotics, microbial pathogens, and microbial community in dairy manure-applied fields
  - ✓ Monitoring of P, N, antibiotics, antibiotic resistant bacteria, and microbial communities
  - ✓ Evaluation of biochar for management and removal of nutrients and contaminants
  - ✓ Understand fate, transport and transformation of contaminants via modeling

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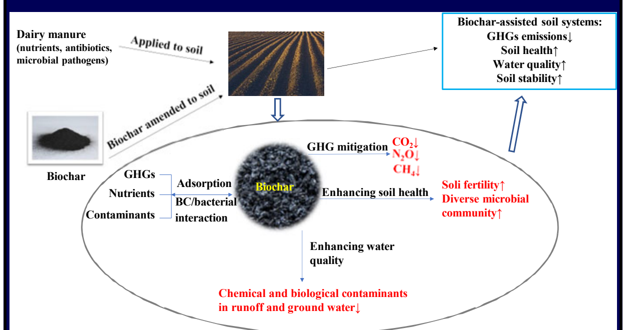
Biochar for Water Quality, Soil Health and Greenhouse Gas Emission



Amendment of biochar to soil:
- Lowering water contamination (nutrients, antibiotics, pathogens) from manure-applied fields
- Reducing greenhouse gas emission from manure-applied fields

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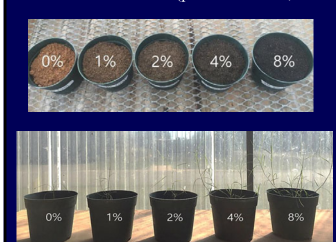
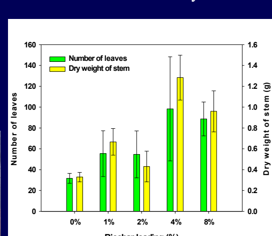
Effects of Biochar on Plant Growth

[Biochar-driven plant growth and soil fertility]
- Amending 0-8% biochar to soil for growth of bermudagrass in the greenhouse
- Saturated biochar (biochar with higher nutrients from dairy wastewater)
- Unsaturated biochar (pristine biochar, no addition of nutrients from dairy wastewater)





- More enhanced plant growth with saturated biochar (1-8% biochar in soil)
- Higher carbon-nutrients in soil with biochar

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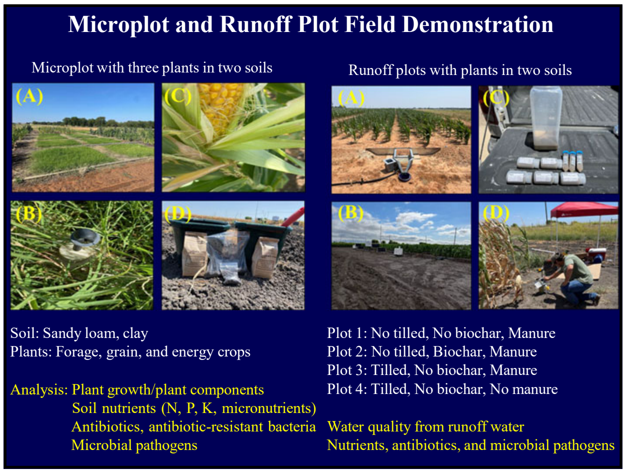
Microplot and Runoff Plot Field Demonstration
Microplot with three plants in two soils
Runoff plots with plants in two soils
(A)
(C)
(B)
(D)
Soil: Sandy loam, clay
Plants: Forage, grain, and energy crops
Analysis: Plant growth/plant components
Soil nutrients (N, P, K, micronutrients)
Antibiotics, antibiotic-resistant bacteria
Microbial pathogens
Plot 1: No tilled, No biochar, Manure
Plot 2: No tilled, Biochar, Manure
Plot 3: Tilled, No biochar, Manure
Plot 4: Tilled, No biochar, No manure
Water quality from runoff water
Nutrients, antibiotics, and microbial pathogens

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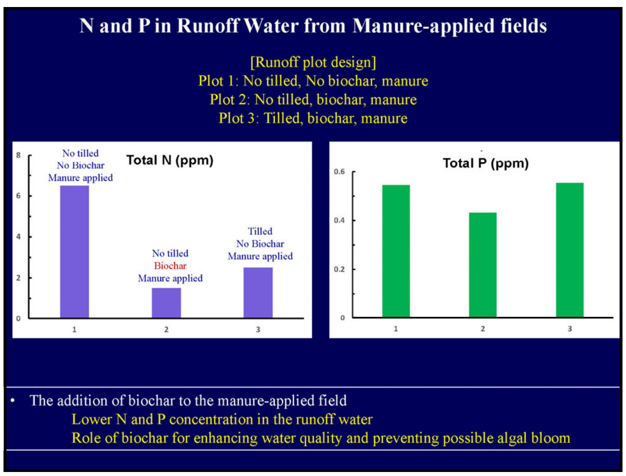
N and P in Runoff Water from Manure-applied fields
[Runoff plot design]
Plot 1: No tilled, No biochar, manure
Plot 2: No tilled, biochar, manure
Plot 3: Tilled, biochar, manure
Total N (ppm)
No tilled
No Biochar
Manure applied
No tilled
Biochar
Manure applied
Tilled
No Biochar
Manure applied
Total P (ppm)
• The addition of biochar to the manure-applied field
Lower N and P concentration in the runoff water
Role of biochar for enhancing water quality and preventing possible algal bloom

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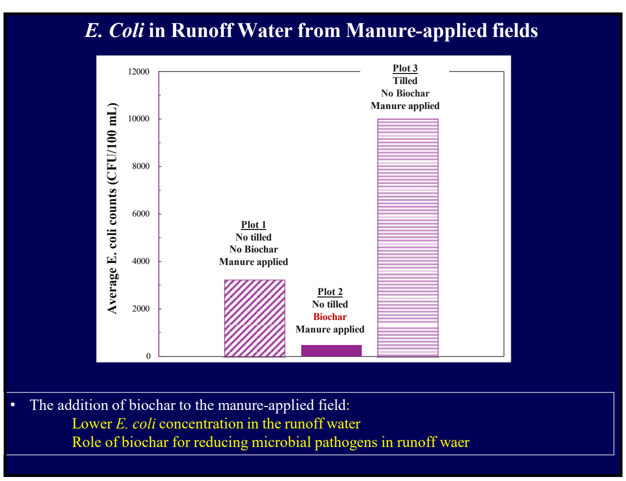
E. Coli in Runoff Water from Manure-applied fields
Average E. coli counts (CFU/100 mL)
Plot 1
No tilled
No Biochar
Manure applied
Plot 2
No tilled
Biochar
Manure applied
Plot 3
Tilled
No Biochar
Manure applied
• The addition of biochar to the manure-applied field:
Lower E. coli concentration in the runoff water
Role of biochar for reducing microbial pathogens in runoff waer

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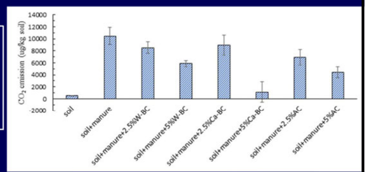
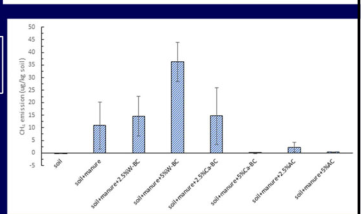
Effects of Biochar on Greenhouse Gas Emission Control

[Experimental design]

- Soil
- Soil + dairy manure (DM)
- Soil + DM + wood BC (W-BC)
- Soil + DM + calcium-coated BC (Ca-BC)
- Soil + DM + activated carbon (AC)



5% Ca-BC and 5% AC:
Significant reduction of greenhouse gas emission from the dairy manure-applied soil



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