IOWA STATE UNIVERSITY
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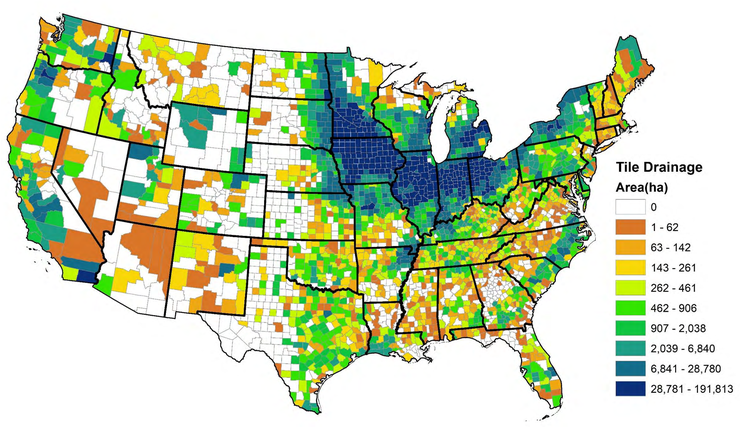
Microbial Communities as a Pathway to Improved Woodchip and Corncob Bioreactor Design and Performance

Background and Motivation

- Nutrient loading in waterways creates limitations for recreational and drinking water usage
- Iowa contributes an average of 55% of the long-term nitrate load to the Missouri River Basin[i]
- Woodchip and corncob bioreactors are edge-of-field practices that intercept tile drained fields before nearby waterways



Tile drainage across the United States[ii]

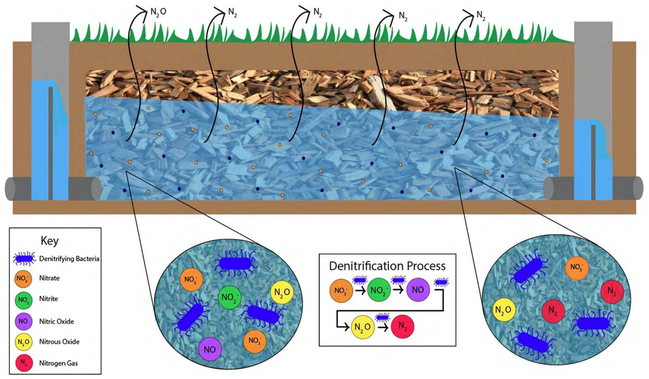
Experimental Design

- Column lab experiment run in triplicate for 3 months at 8 h HRT, 3 months at 16 h HRT, 3 months at 2 h HRT
- Weekly water sampling (ORP, DRP, DO, pH, NO_3-N, NO_2-N, NH_4^+, and TOC), weekly water DNA filtering, weekly greenhouse gas production sampling
- Monthly ground woodchip and corncob extractions to reflect the occurring denitrification process to understand the dynamics of the microbial community

Hypothesis and Objectives

Hypothesis

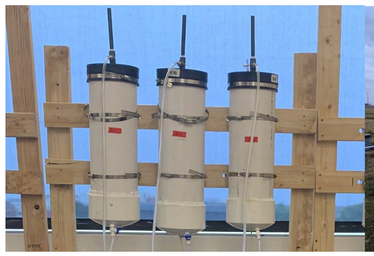
- There are key microbes present in every woodchip and corncob bioreactor that originate from the carbon source and the agricultural environment feeding into the system
- These key microbes react with the composition of nitrate loaded freshwater and can be manipulated by design to improve effectiveness



Denitrification process in woodchip bioreactors[iii]

Objectives

- Identify key components of microbial communities to optimize design by analyzing nitrate removal and greenhouse gas production
- Evaluate dynamic interactions of microbes to allow for system improvement

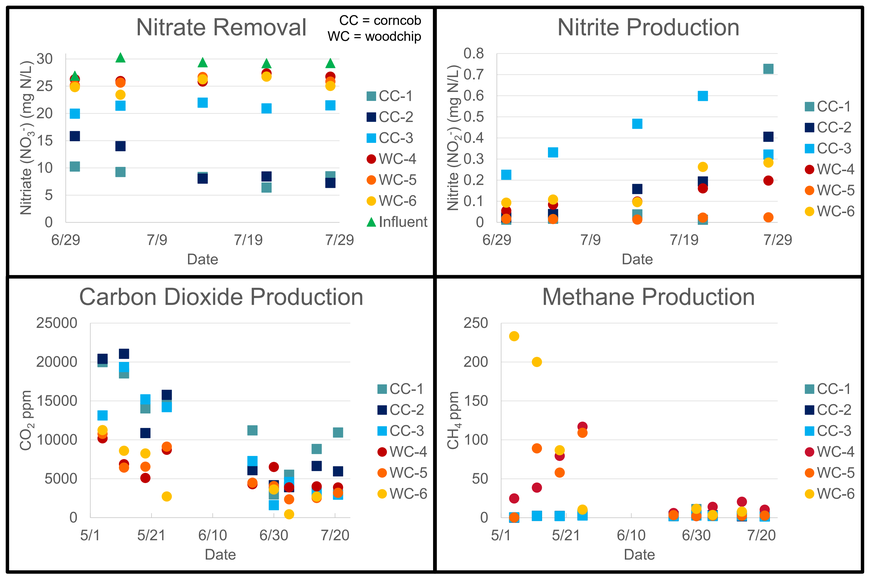


Lab up flow columns packed with woodchips

Construction of nine pilot scale woodchip bioreactors at Iowa State University

Results and Conclusions

- Preliminary data demonstrates noticeable trends in nitrate removal, nitrite production, and greenhouse gas production
- Corncob columns (CC) are removing nitrate at a more efficient rate than woodchip columns (WC)
- Woodchip columns tend to produce more nitrite, reflecting an incomplete denitrification process
- Corncob columns are producing more carbon dioxide than woodchip columns as a result of heightened decomposition
- Woodchip columns have greater methane production than corncob columns



Resources

[i] Jones, C. S., Nielsen, J. K., Schilling, K. E., & Weber, L. J. (2018). Iowa stream nitrate and the Gulf of Mexico. PLOS ONE, 13(4). https://doi.org/10.1371/journal.pone.0195930

[ii] Valayamkunnath, P., Barlage, M., Chen, F., Gochis, D. J., & Franz, K. J. (2020). Mapping of 30-meter resolution tile-drained croplands using a geospatial modeling approach. Scientific Data, 7(1). https://doi.org/10.1038/s41597-020-00596-x

[iii] Hartfiel, L. M., Schaefer, A., Howe, A. C., & Soupir, M. L. (2021). Denitrifying bioreactor microbiome: Understanding pollution swapping and potential for improved p erformance. Journal of Environmental Quality, 51(1), 1–18. h ttps://doi.org/10.1002/jeq2.20302

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