

Denitrifying Bioreactor

Midwestern Cornbelt Nutrient Sequestration: Fine Tuning Treatment Technology

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Nutrient Reduction Strategy

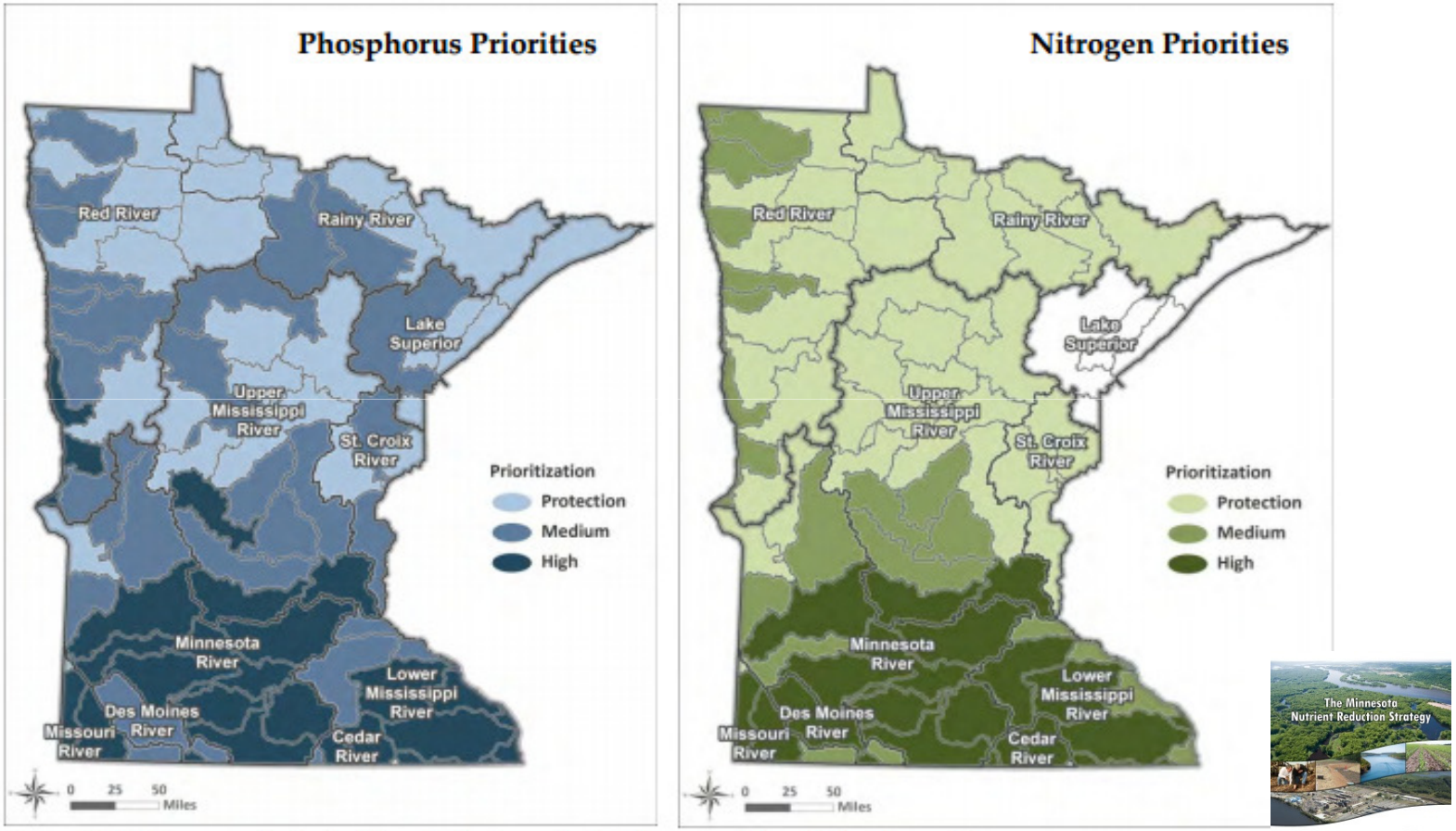
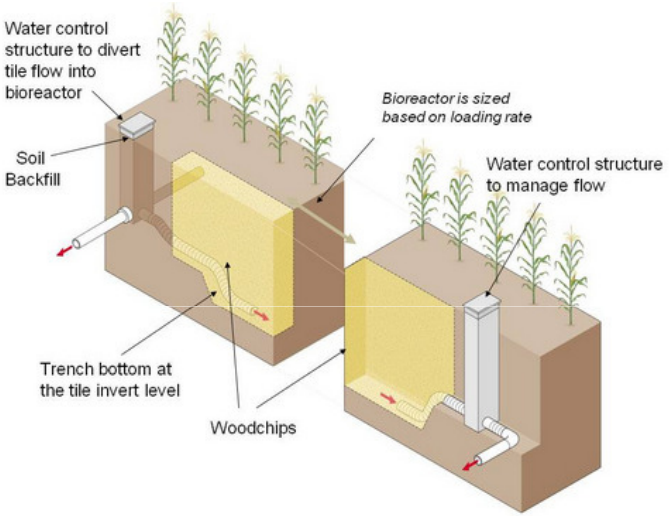
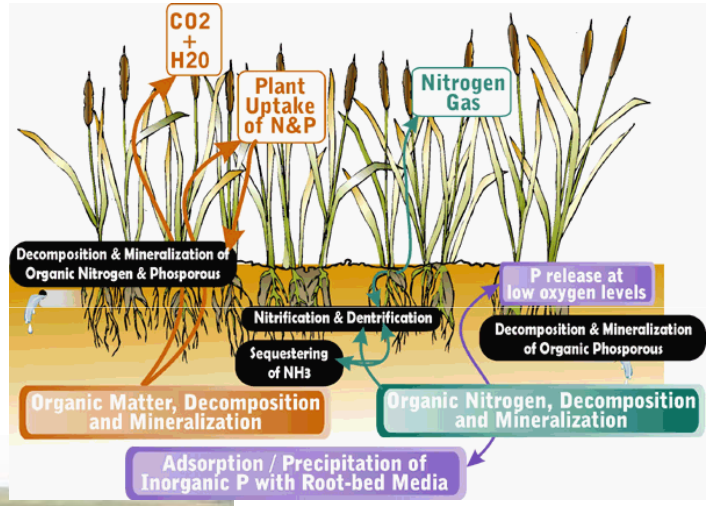


Figure 4. HUC8 watershed priorities (Lake Superior Basin not evaluated for nitrogen).

Denitrification Overview

NO_3^- NO_2^- NO N_2O N_2







Why Bioreactor

- Subsurface flow
- Relatively consistent nitrate concentration over a drainage season at a given site
- Biostimulation
- High reduction rate
- Space

Lab Study



Design Schematic

- The two bioreactors simulate horizontal flow in the field with a length to width ratio of 14:7.
- The size of each bioreactor is 0.98m (L) * 0.2m (W) * 0.67m (H).
- One has transparent sides to provide view of the inside. Both sides are covered with tarp to prevent light effect on microbial growth.
- Each chamber has two baffles inside to guide the flow. Water enters from the bottom on one side and comes out from the top on the other side.
- Soil from the field site (mostly Clarion-Storden loams) is used to seal the top. When water is running, the soil on top is always saturated providing anaerobic condition inside.
- Nutrient water is prepared in the storage tank and pumped into the overhead tank. Six flow meters are used to control the flow rate in each chamber.
- PVC containers are used to catch outflow for nitrate probe uses.

Lab Study



Design Components

Variables

- Alternative C sources: food source for denitrifying bacteria
  - Woodchips- mix of hardwood
  - Biochar- “caramelized woodchips”
  - Corn cob
- Residence time
  - 24 and 8-hour

Controlled factors

- Nitrate concentration: 21 ± 1 ppm
- Temperature: T is around room temperature
- Processes competing for available C: oxygen availability

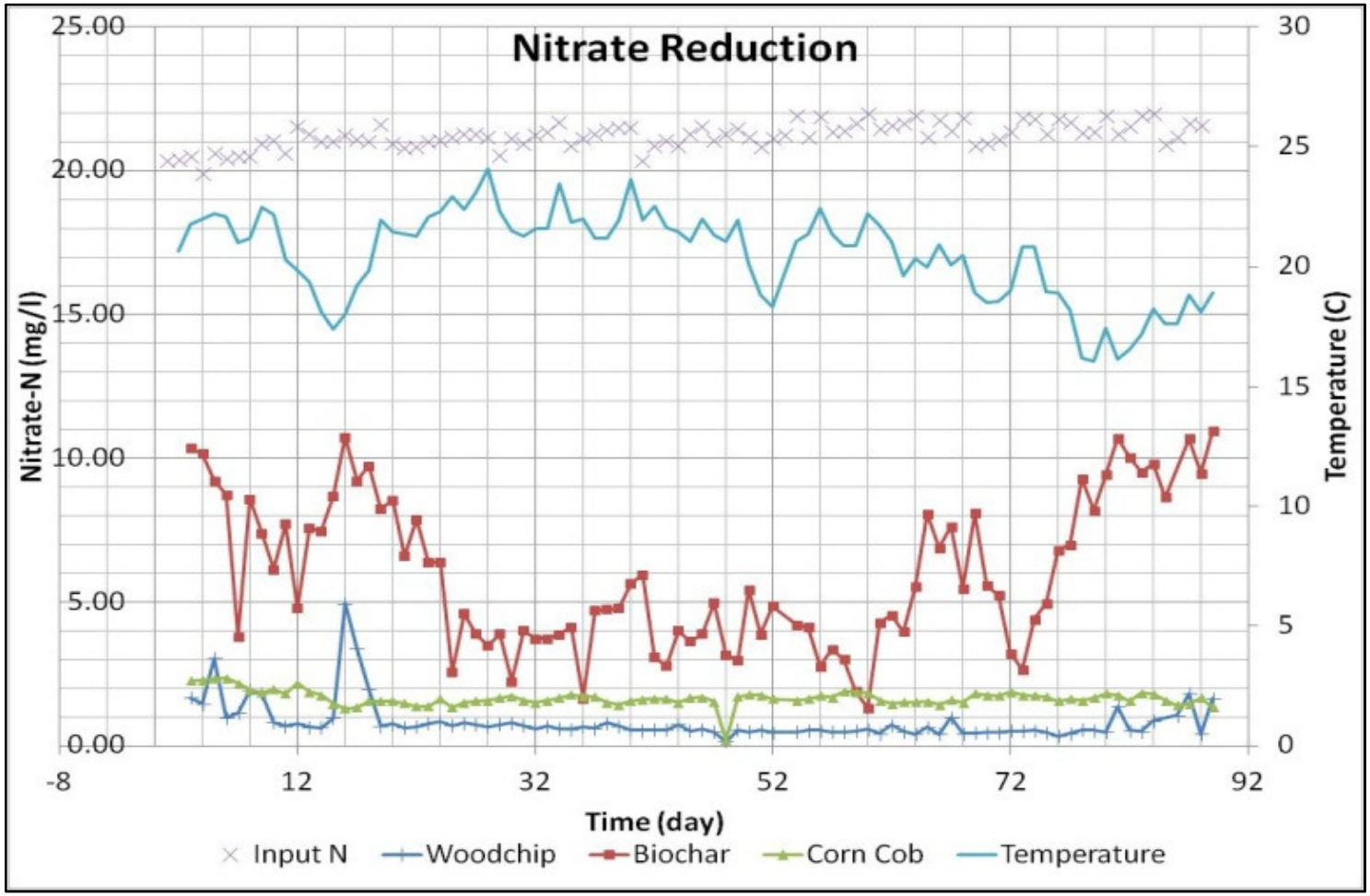
Lab Study



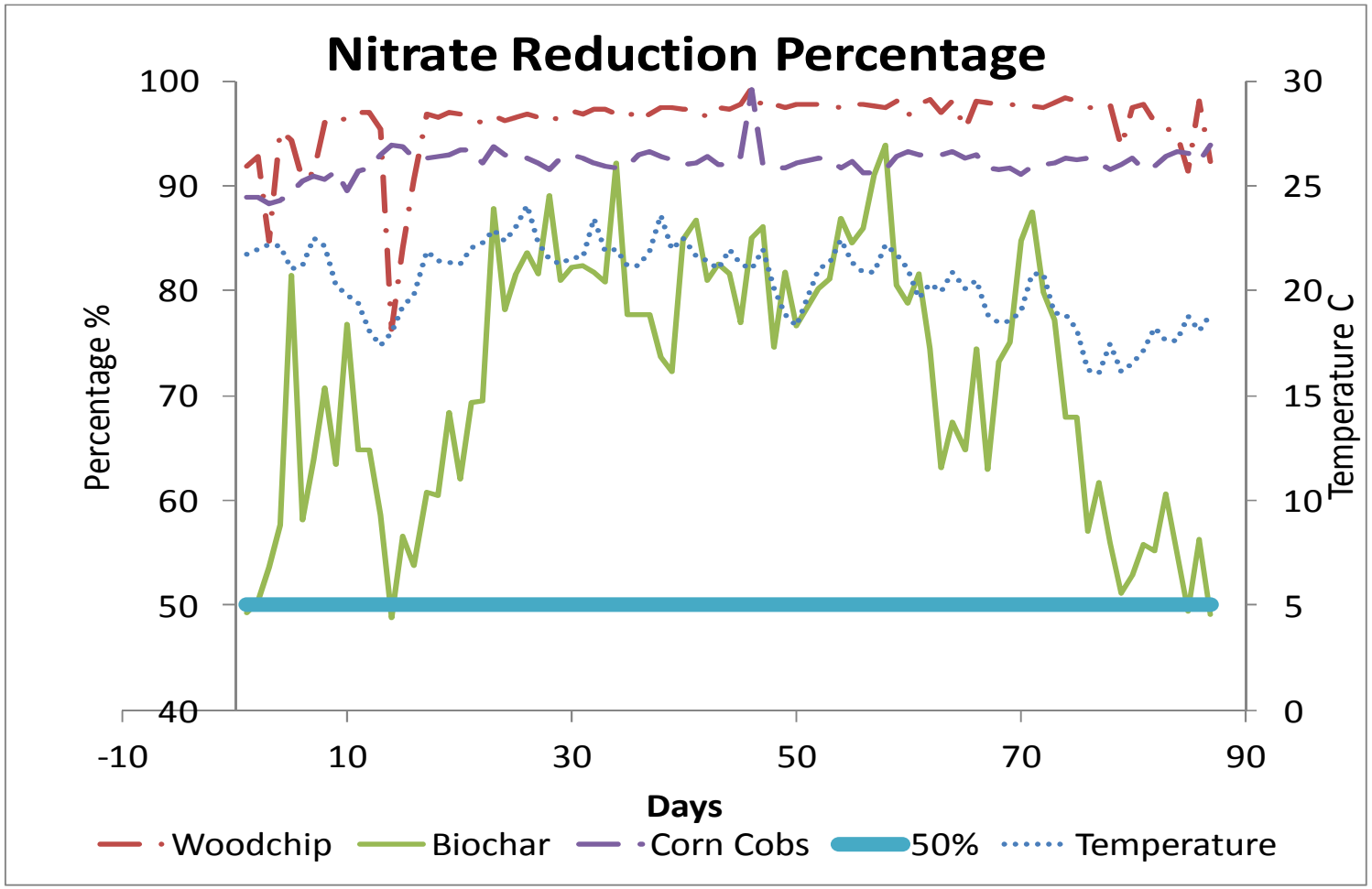
Research Method

- Nutrient removal is evaluated by nitrate reduction and phosphorus reduction. Nitrate is measured on a daily-base. Phosphorus is measured every three days.
- Nitrous oxide production will be measured to determine the effect on greenhouse gases emission.
- The in-situ residence time will be determined by bromide tracer.
- Residence time is designed to be 24 hours (50ml/min flow rate) for the first 3 months and 8 hours (150 ml/min) for the next 2 months.

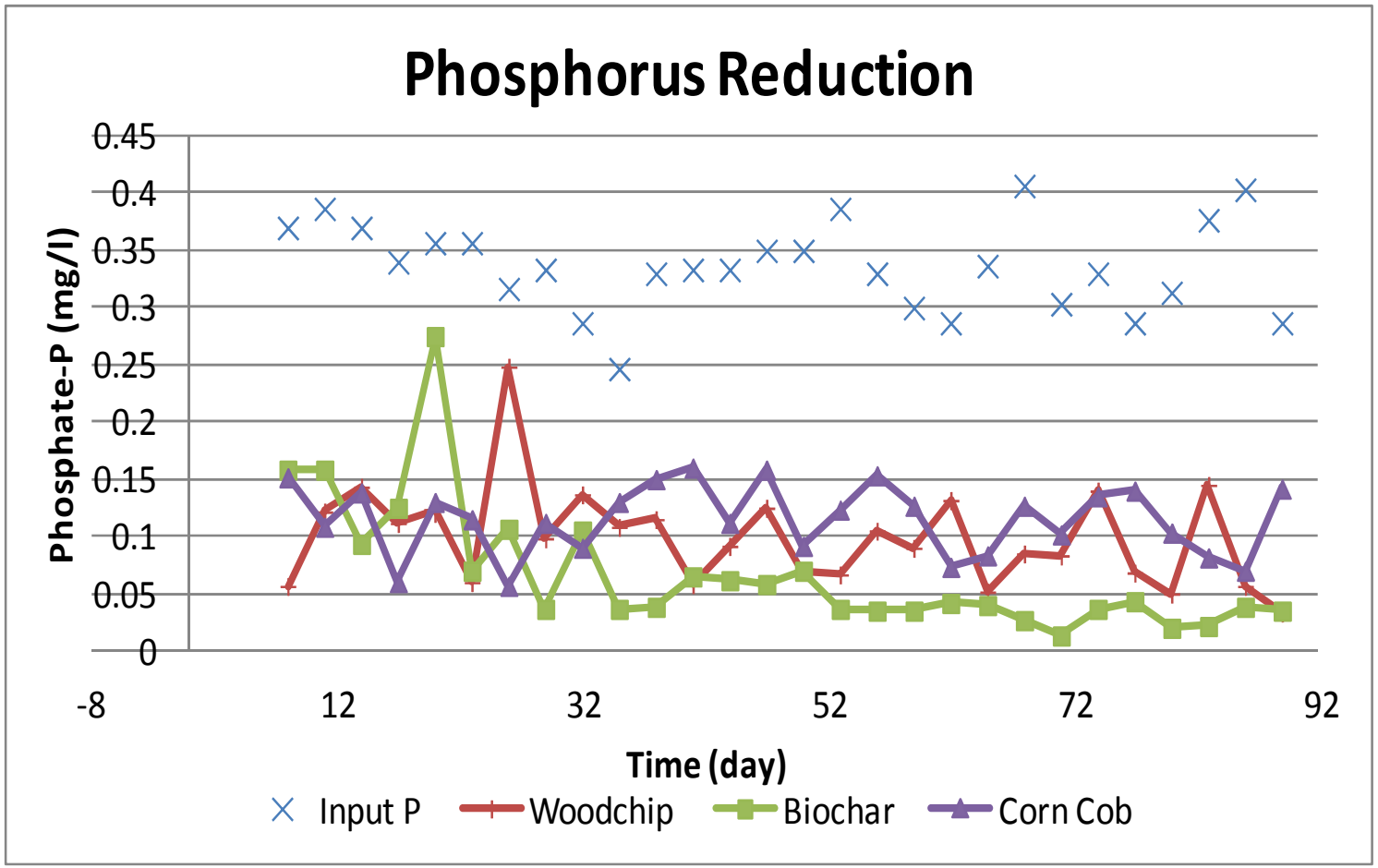
Lab Study- 24 hr result



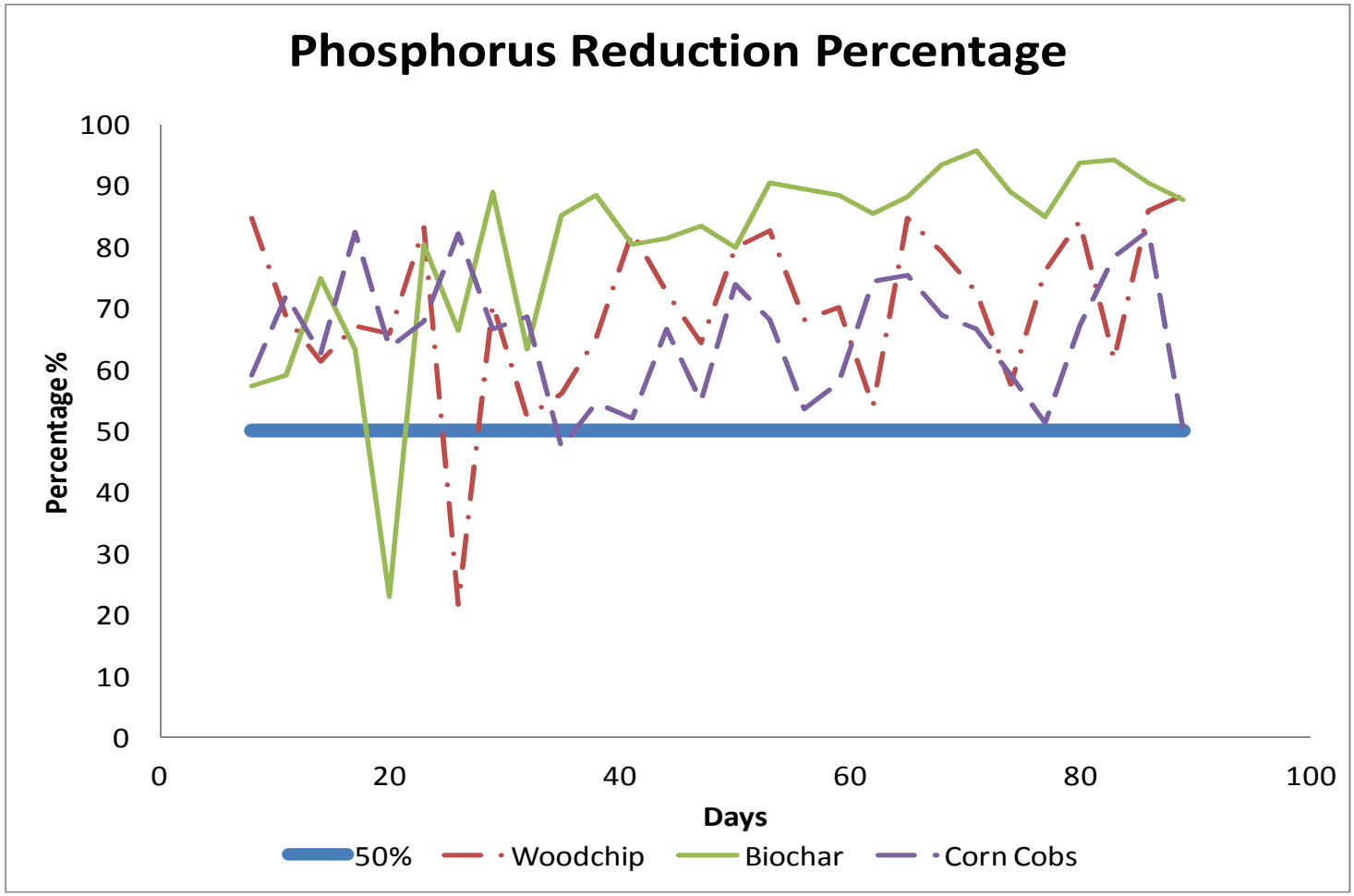
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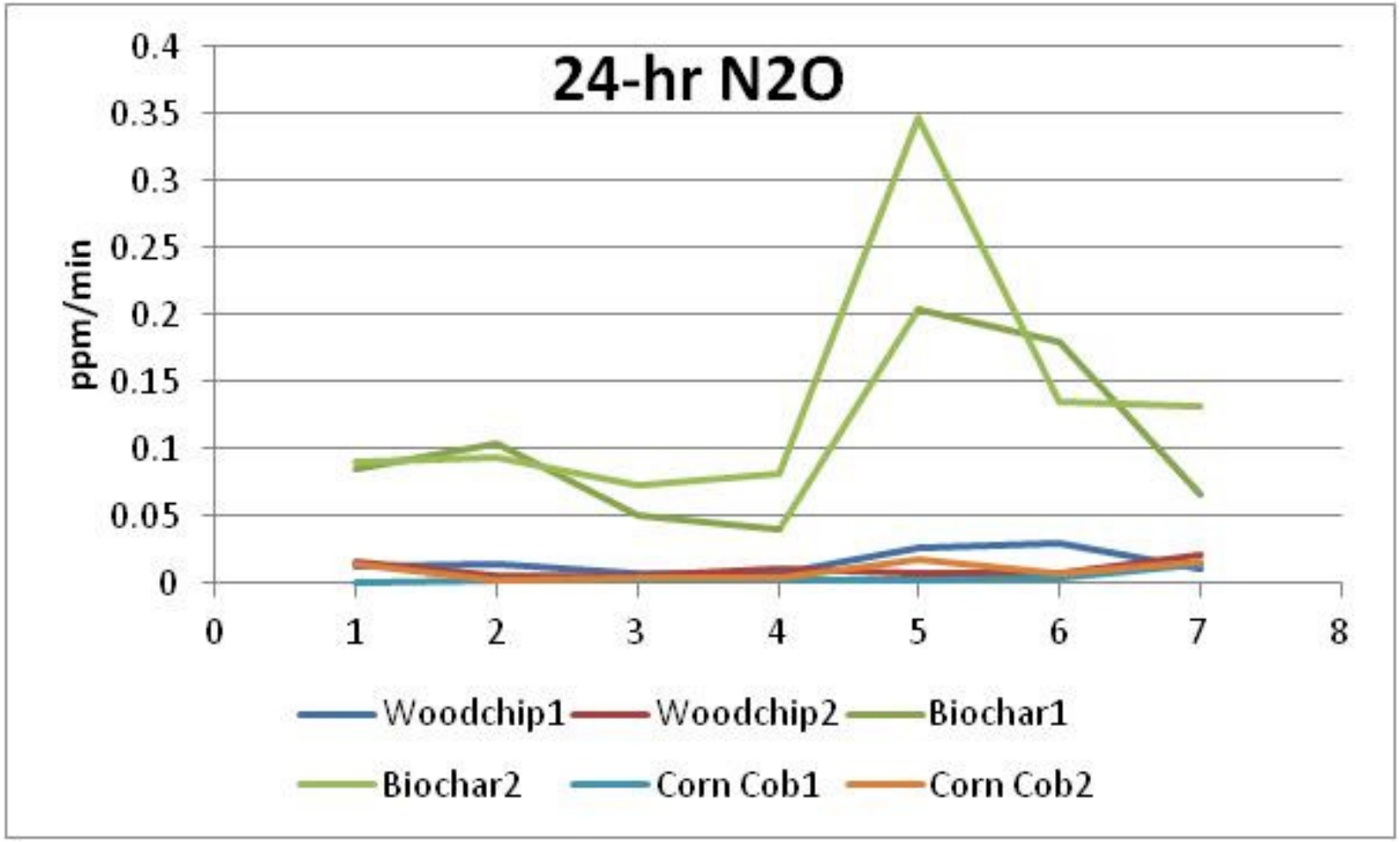
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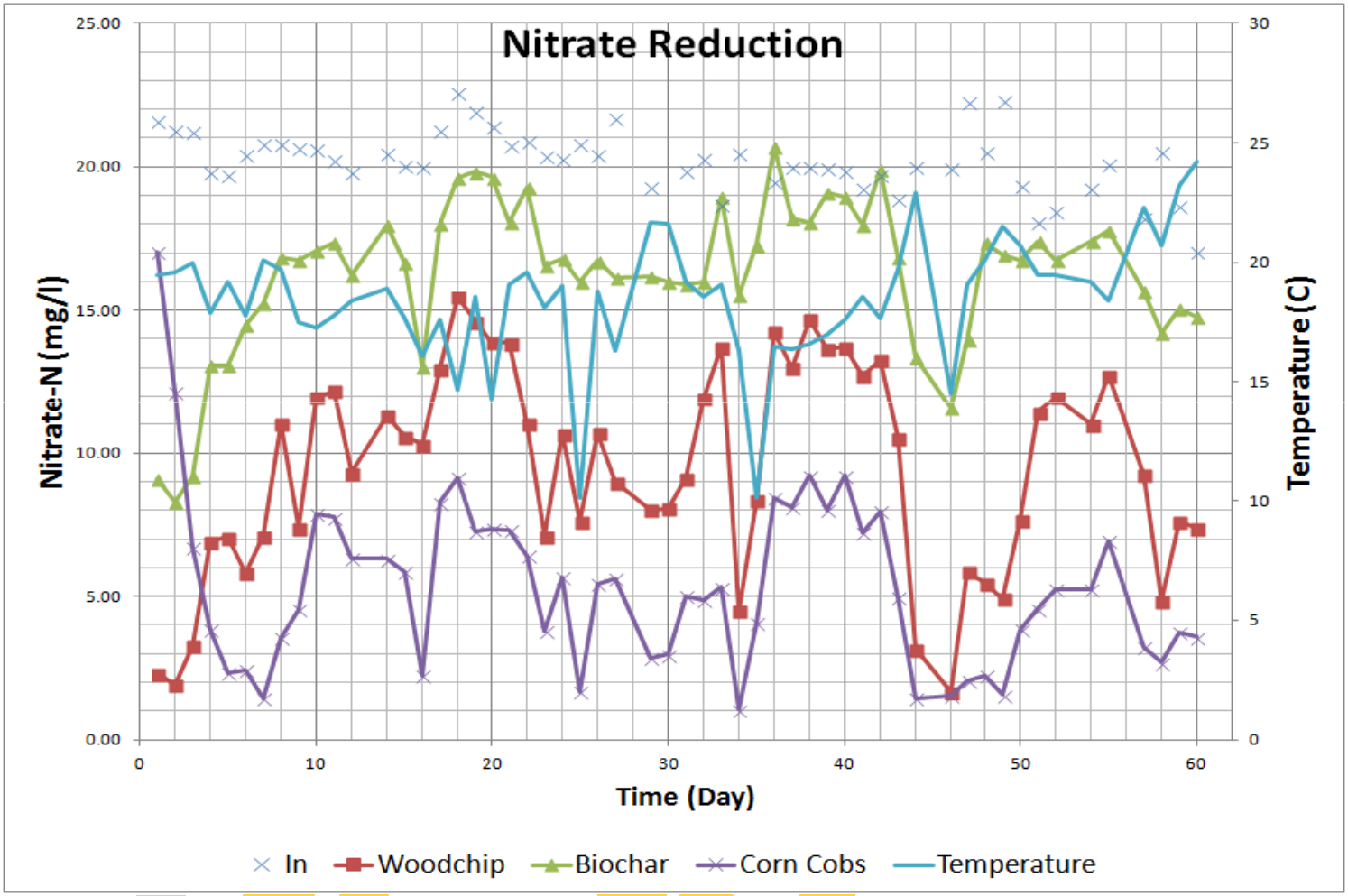
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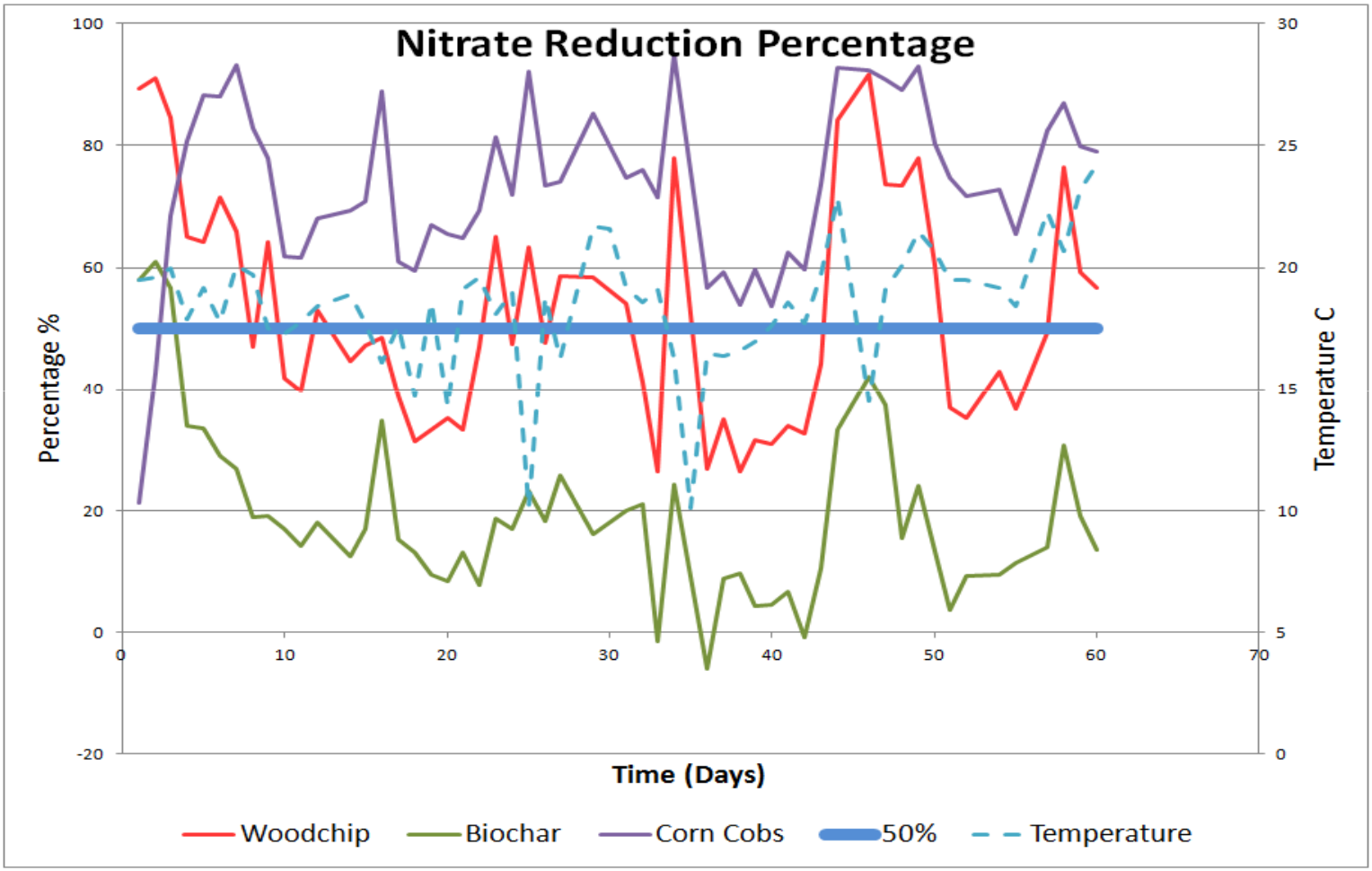
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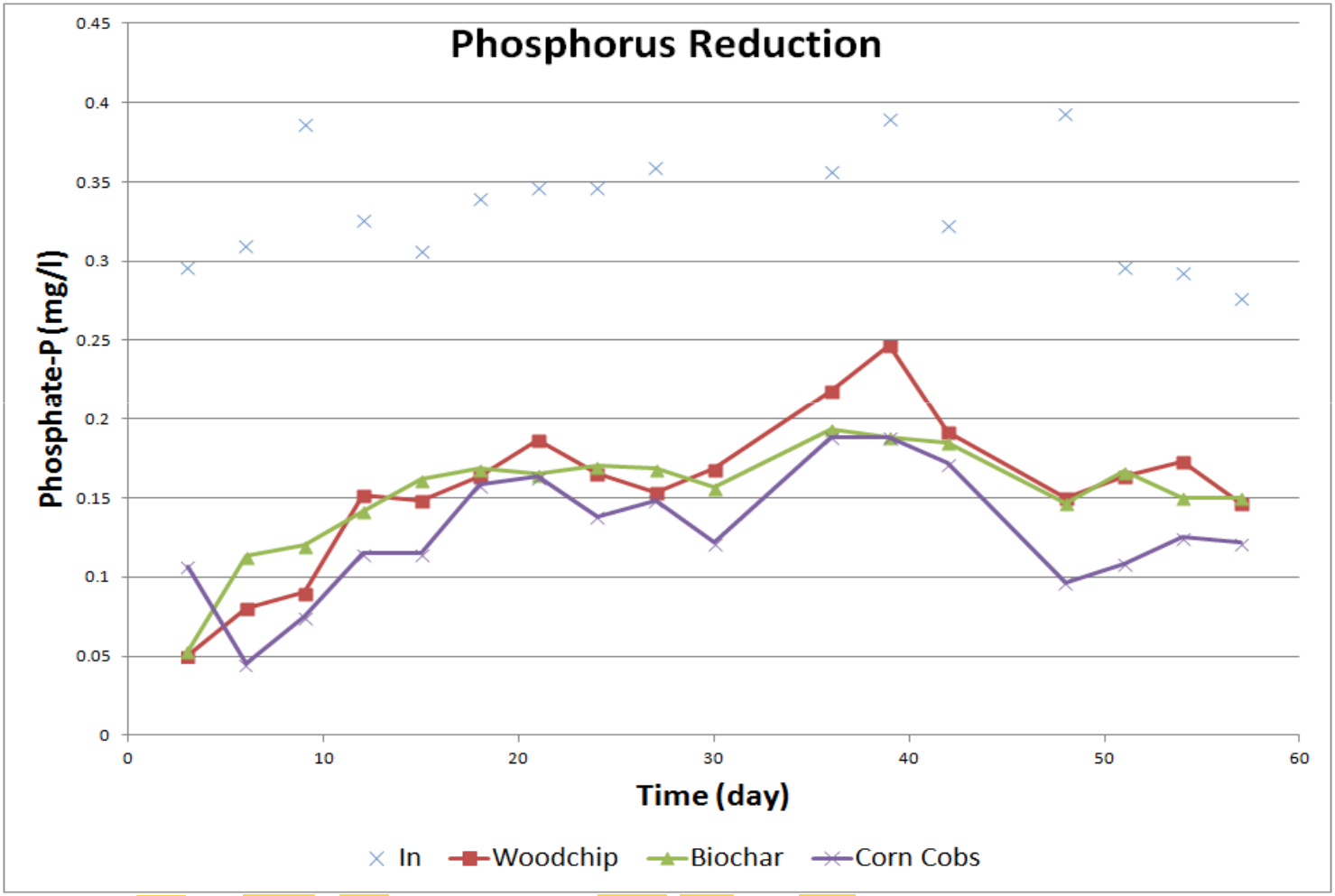
Lab Study- 8 hr result



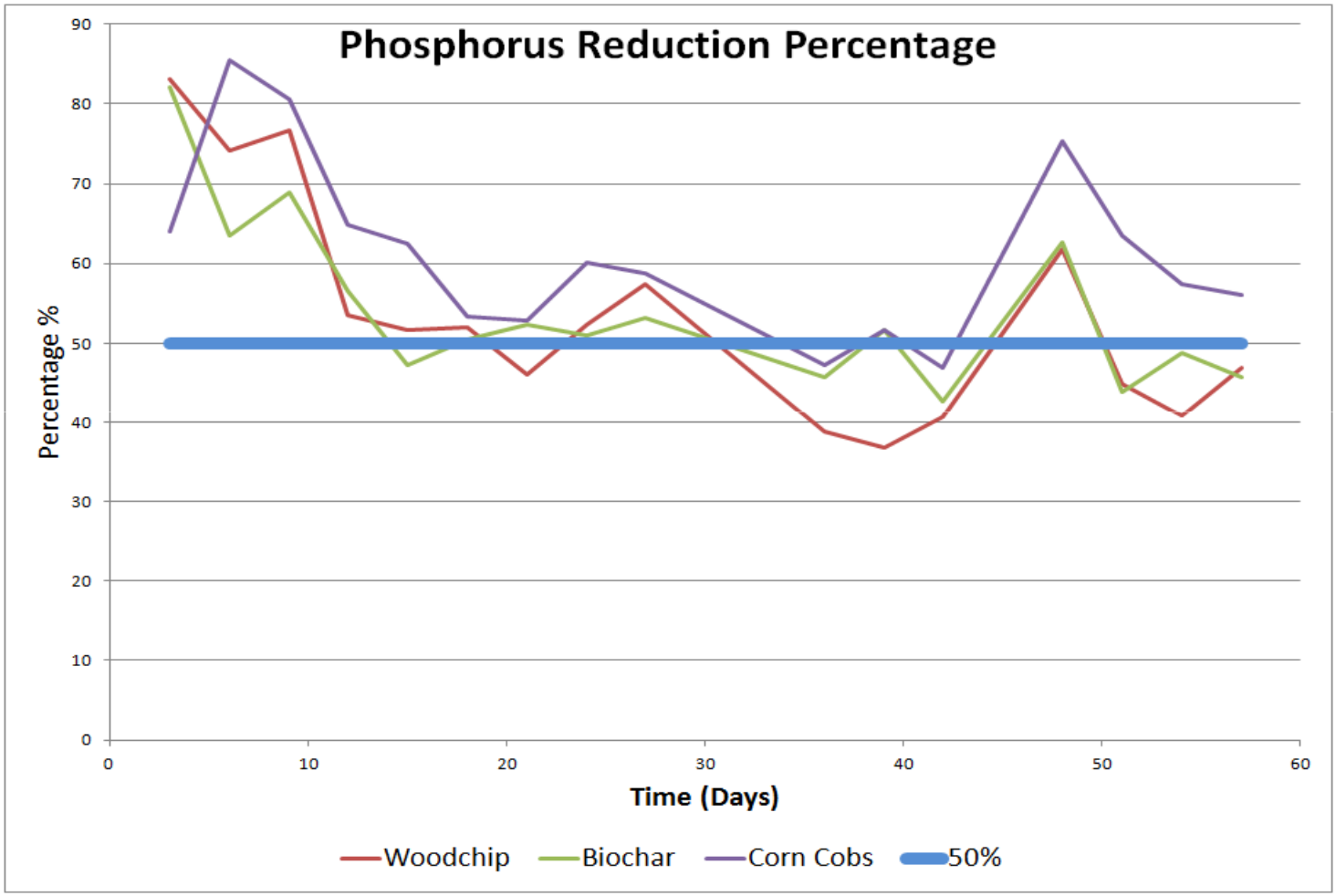
Lab Study- 8 hr result



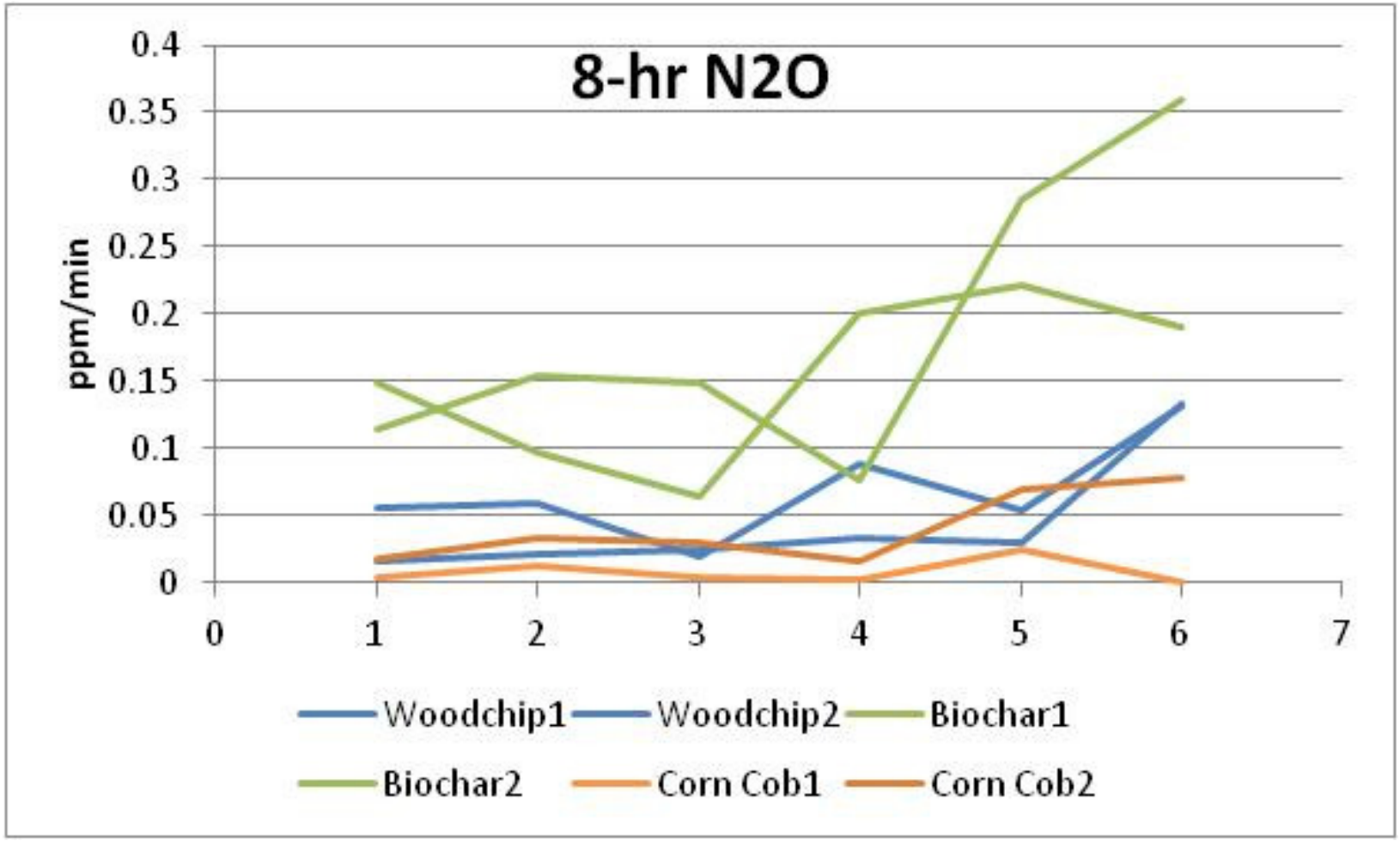
Lab Study- 8 hr result



Lab Study- 8 hr result



Lab Study- 8 hr result



Summary

- Woodchip: nitrate removal
- Biochar: orthophosphate removal, N2O, longevity
- Corn Cob: environmental resilience

Questions?