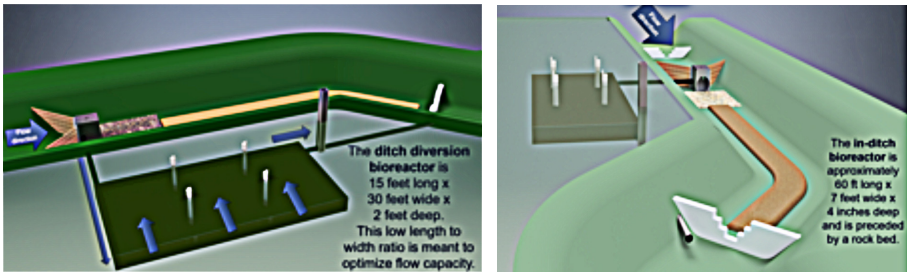
August 2020

Investment Insight

How do Woodchip Bioreactors Work?

A woodchip bioreactor is just one edge-of-field nitrogen management tool that farmers can use to reduce the amount of runoff of lost nutrients. Dr. Laura Christianson and Cameron Pittelkow from the University of Illinois have been working on woodchip bioreactors for several years. Denitrifying bioreactors are used to reduce nitrate in agricultural drainage water by using woodchip-filled excavated pits to denitrify nitrate-Nitrogen in tile drainage water.



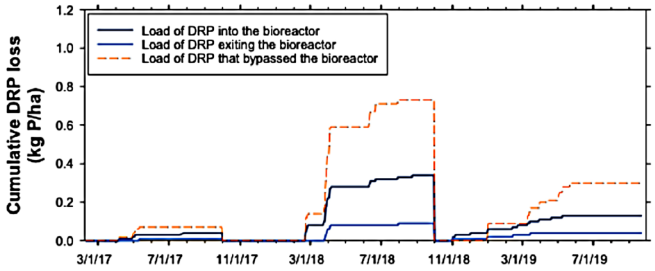
The ditch diversion bioreactor and the in-ditch bioreactor.

- Woodchips are the key component in these bioreactors' ability to denitrify nitrate Nitrogen. Saturated hydraulic conductivity (rate of which water flows through or Ksat), porosity, and particle size of the woodchips are key properties needed for effective bioreactor design and performance. An NREC study in combination with a related NRCS Conservation Innovation Grant and cooperative agreements studies determined Ksat, porosity, particle size, and other related parameters of approximately 30 types of woodchips, including woodchips used in NREC-funded bioreactors.
- This work will continue collecting physical property data to create a database of woodchip media properties.

Another novel approach being investigated is treating larger drainage areas (>70 acres) with two small bioreactors rather than one large bioreactor as well as using ditches for bioreactor placement ("double duty ditches").

- The in-ditch bioreactor has proven tricky to design and install without reducing ditch drainage capacity. Moreover, reductions in nitrate concentrations when comparing upstream and downstream of the in-ditch bioreactor have been small. This may improve as the ditch flow slows during the summer months.
- Tracer testing using bromide as a conservative tracer will be done on these bioreactors to improve understanding of how the water is moving through the woodchips. To perform a tracer test, a concentrated sodium bromide solution is poured into the inlet of the bioreactor and samples are collected from the outlet over time and are analyzed for bromide. A bromide molecule moves like a nitrate molecule through the bioreactor but doesn't get converted into gas like nitrate does. The speed which the bromide exits the bioreactor indicates if there are preferential flow paths through the woodchips or if water is getting trapped in the corners (that is, trapped in dead zones).

The Dudley Smith Farm bioreactor has shown an unusual and **consistent trend of dissolved Phosphorus (P) removal in addition to nitrate-N removal (see below).** This exciting observation is being explored at other bioreactors and experiments to test removal mechanisms are being investigated.



Dudley Smith Farm bioreactor cumulative dissolved reactive Phosphorus (DRP) loss entering, exiting, and by-passing the bioreactor. Loads restart at the water year (October 01) and the three annual periods have DRP loss reductions of 72, 73, and 68% for treated water (20-24% removal at the edge of field including untreated by-pass flow).

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