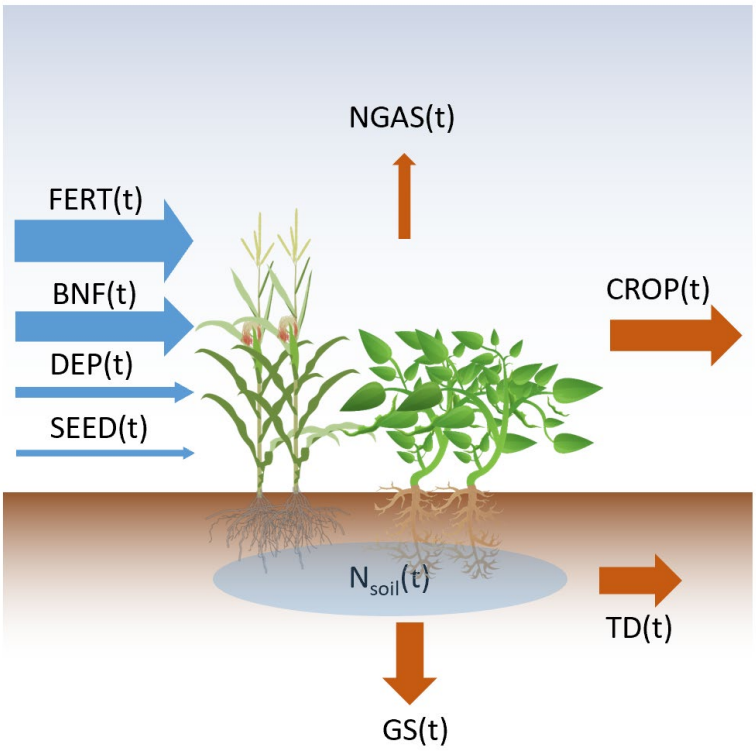
Monitoring tile water to inform farm N management

Dr. Bin Peng, Assistant Professor on Water, Agriculture, and Conservation at Department of Crop Sciences, University of Illinois Urbana-Champaign, binpeng@illinois.edu

1. Why do we care about tile water?



The full nitrogen budget (lb N ac^{-1}) of a typical farmland is defined as following mass balance equation: $\Delta N_{soil}(t) = INPUT(t) - OUTPUT(t) + \varepsilon$, where the N input to the system $INPUT(t) = FERT(t) + BNF(t) + DEP(t) + SEED(t)$, and N output from the system $OUTPUT(t) = HRVT(t) + TD(t) + GS(t) + NGAS(t)$, and ε is the residual term.

The INPUT terms are fertilizer N application (FERT), biological nitrogen fixation (BNF), atmospheric decomposition (DEP), planting seed input (Seed).

The OUTPUT terms are crop harvest removal (CROP), tile drainage loss (TD), lateral and vertical groundwater seepage (GS), and N gaseous losses (NGAS).

We do care about nitrogen use efficiencies (NUE), which can be defined in different ways:

(1) $NUE_{crop}(t) = CROP(t)/INPUT(t)$, NUE_{crop} ranges from 0 to ∞ and characterizes whether there is a net removal ($NUE_{crop} > 1$) or net surplus ($NUE_{crop} < 1$) of nitrogen in the cropping systems.

(2) $NUE_{soil}(t) = OUTPUT(t)/INPUT(t)$, NUE_{soil} ranges from 0 to ∞ and characterizes whether the soil is net sink ($NUE_{soil} > 1$) or net source ($NUE_{soil} < 1$) of nitrogen.

(3) $NUE_{system}(t) = NUE_{crop}(t)/NUE_{soil}(t) = CROP(t)/OUTPUT(t)$. NUE_{system} ranges from 0 to 1 and characterizes the fraction of system nitrogen outputs that are captured as harvested nitrogen yield rather than lost to the environment.

2. How do we monitor tile water flow and N concentration?

- Remember nitrogen **Load (L)=Discharge (Q) × Concentration (C)**. So, we need to measure both discharge and concentration to estimate the total N losses through tile drainage.

Table 1. Pros and cons of different methods to monitor tile water flow.

Method	Pros	Cons
Bucket method	• Very low cost • Easy to operate	• High labor cost for high-frequency data collection • Lower accuracy
Compound V-notch Weir + transducers	• High-frequency data collection with limited labor cost • High accuracy	• Need to install water control structure • High financial cost
Tipping Bucket	• High-frequency data collection with limited labor cost • High accuracy	• Need to install water control structure • High financial cost
Inline flow meters (electromagnetic/ultrasonic)	• High-frequency data collection with limited labor cost • High accuracy	• Need to install water control structure • High financial cost
Low-cost camera + AI	• Low cost • Easy to install • High-frequency data collection with limited labor cost	• Accuracy needs to be demonstrated

Table 2. Pros and cons of different methods to monitor tile water N concentration.

Method	Pros	Cons
Manual grab sampling + Lab testing	• Very low cost • Easy to operate	• High labor cost for high-frequency data collection
Auto-sampler sampling + Lab testing	• High-frequency data collection with limited labor cost	• Need to install water control structure. • High financial cost
Auto-sensor	• High-frequency data collection with limited labor cost	• Need to install water control structure. • High financial cost

3. Interested in participating in tile water monitoring research or need lab testing service?

- For tile-monitoring research, please contact: Dr. Bin Peng, Assistant Professor on Water, Agriculture, and Conservation at Department of Crop Sciences, University of Illinois Urbana-Champaign, binpeng@illinois.edu
- Lab testing service available at **WE Testing Lab**: https://publish.illinois.edu/wetesting/. Please contact Mike Wallace at mwallace@illinois.edu for lab services.