

Summary of tile drainage water quality monitoring for seven years in Southeast North Dakota

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STATE UNIVERSITY

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STUDENT FOCUSED • LAND GRANT • RESEARCH UNIVERSITY

Acknowledgements

Our appreciation goes to the landowner at Fairmount, ND for providing his highly productive land for this research since 2007.

Collaborators:

Thomas Scherer and Dean Steele at ABEN

Thomas DeSutter at Soil Science

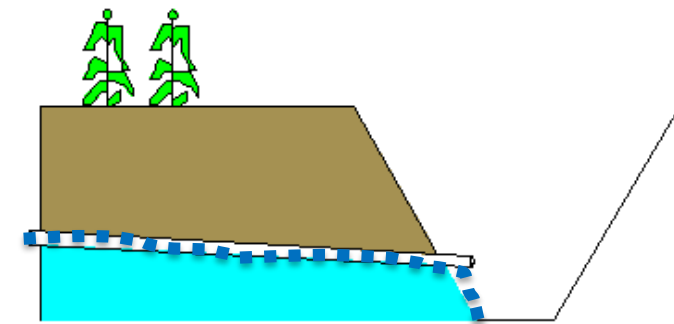
Bill Schuh at ND State Water Commission

7 graduate students at ABEN & ECS

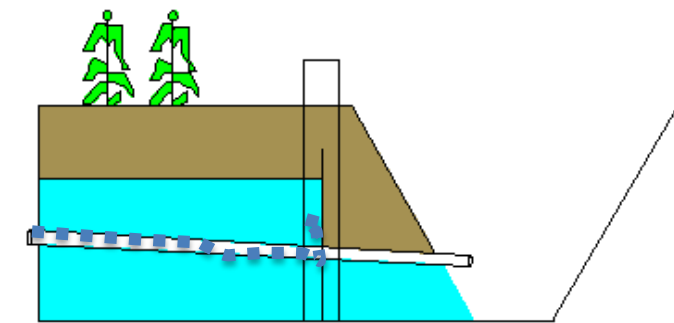
3 undergraduate students at ABEN

Background

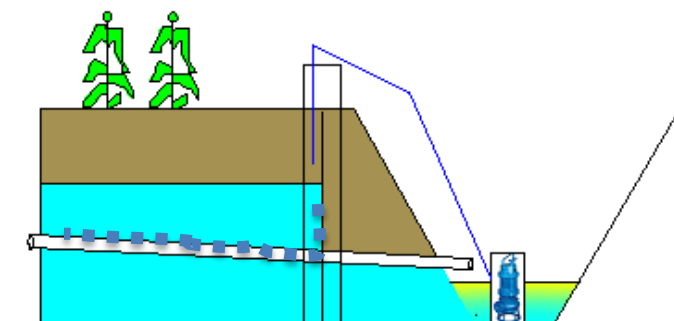
- Subsurface Drainage is used to drain excess water from soil profiles
- Controlled Drainage is the process of controlling the timing and quantity of water from fields
- Subirrigation is the application of irrigation water directly to the root zone to raise the effective water table depth



Subsurface Drainage



Controlled Drainage



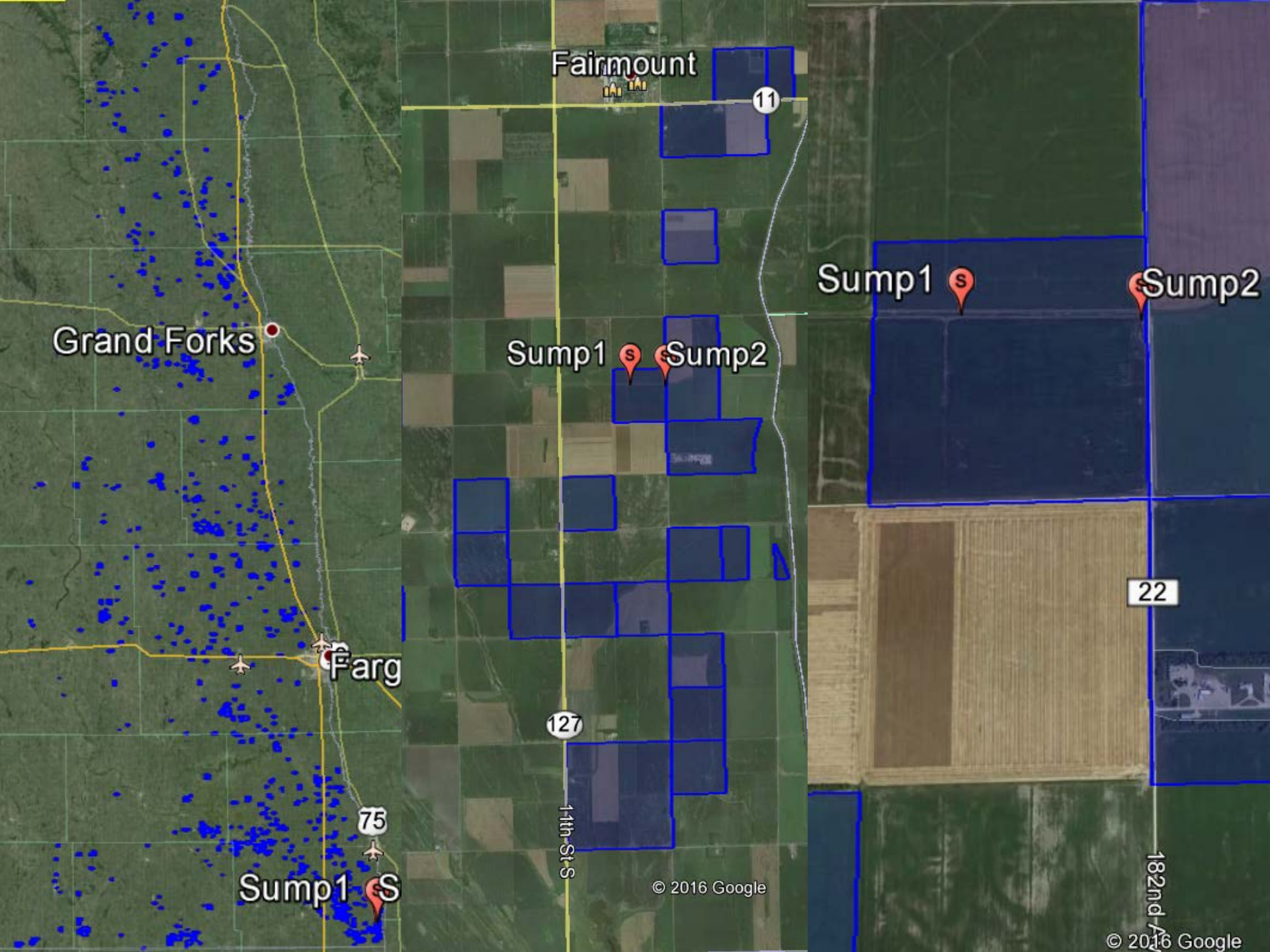
Subirrigation

The Red River Valley drainage basin



**Experimental Site:
Fairmount
Richland County
North Dakota**

<http://www.rrbdin.org/red-river-basin-overview-2>



Fairmount

11

Sump1

Sump2

Sump1

Sump2

Grand Forks

Fargo

22

127

11th St S

Sump1

75

182nd Ave

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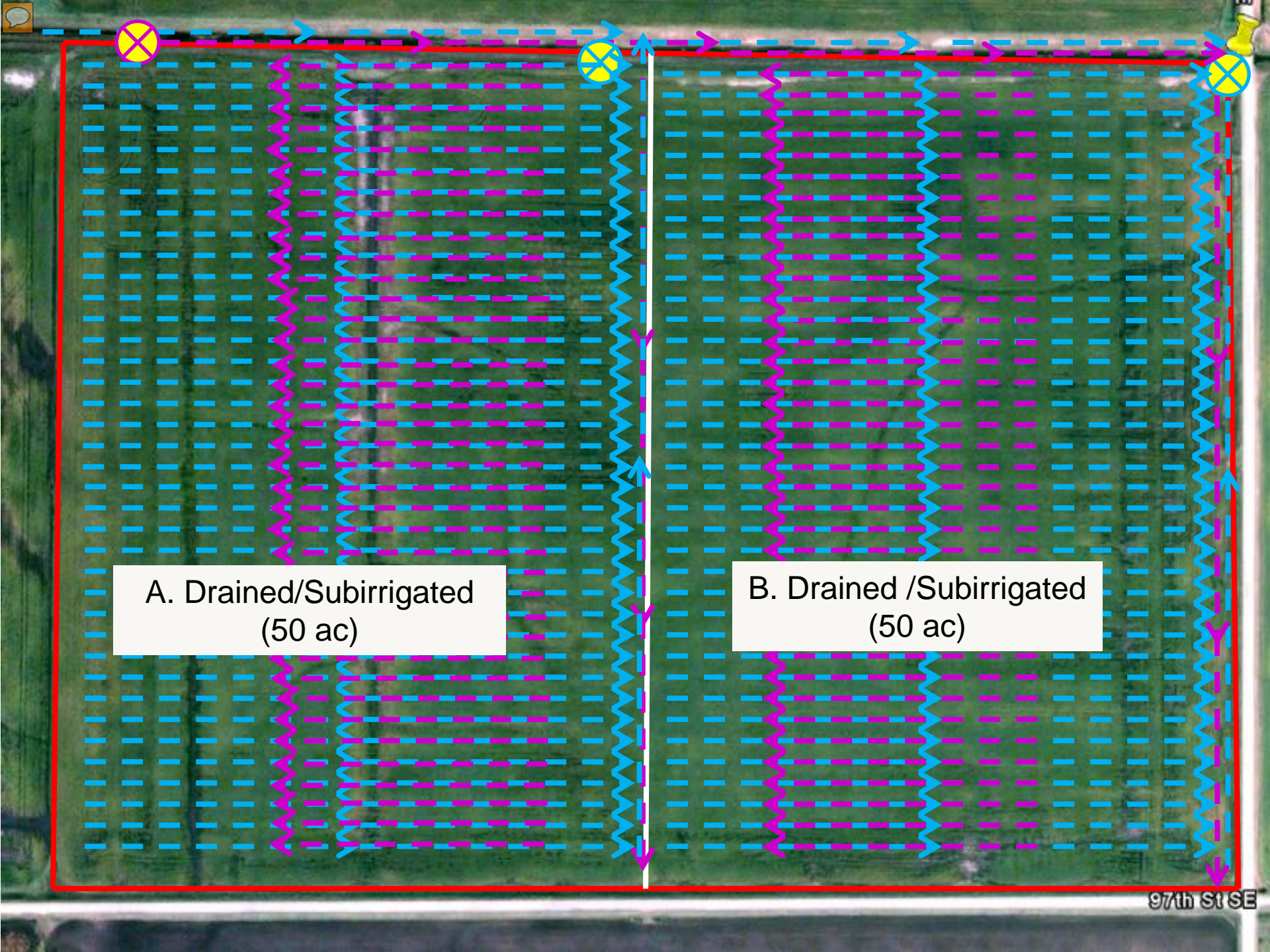


A. Undrained
(50 ac)

B. Tile Drained
(25 ac)

C. Drained /Subirrigated
(25 ac)

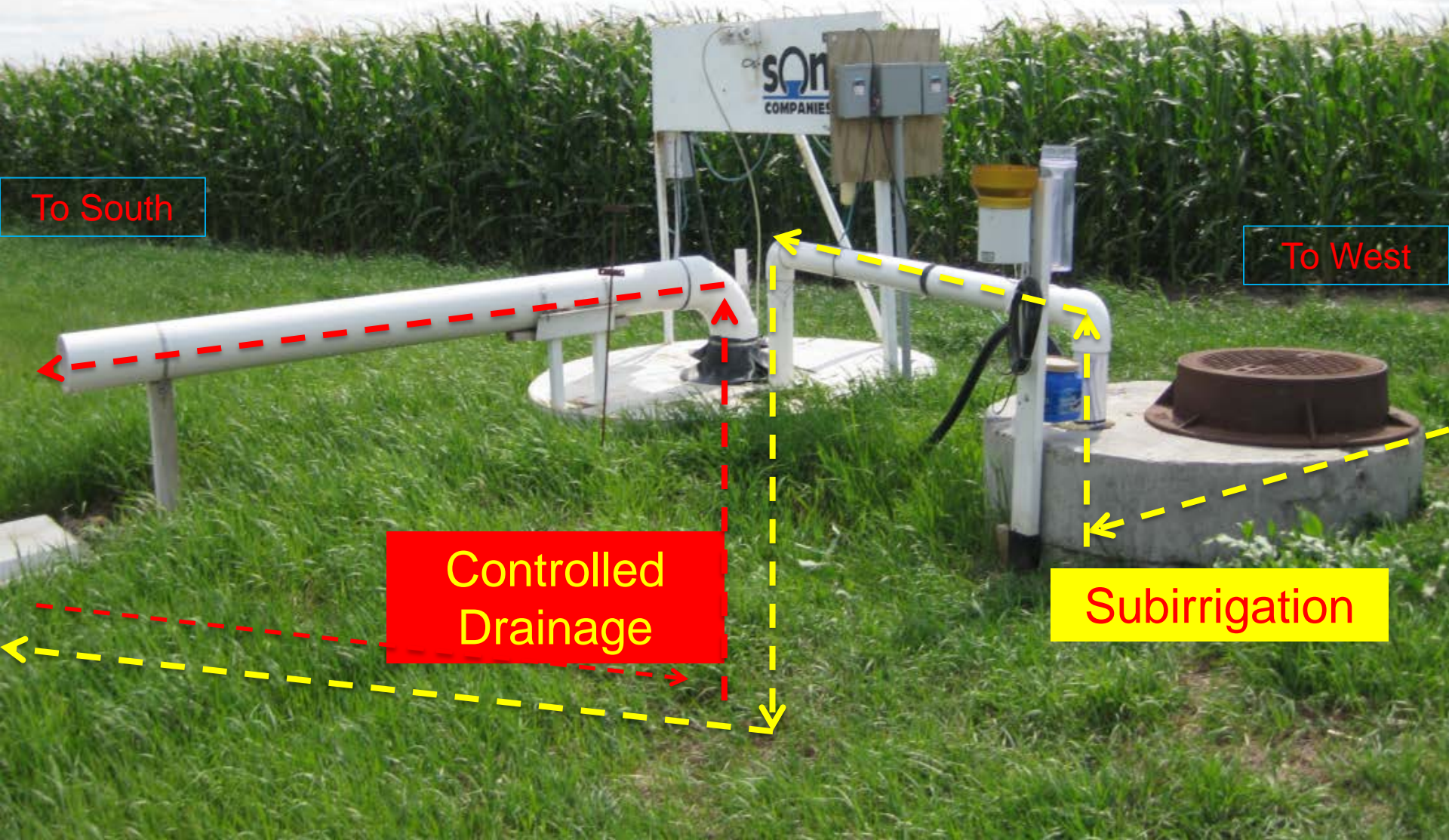
97th St SE



A. Drained/Subirrigated
(50 ac)

B. Drained /Subirrigated
(50 ac)

Controlled Drainage and Subirrigation at Fairmount, Richland County, ND



To South

To West

Controlled
Drainage

Subirrigation

Water Quality Monitoring

-- surface ditch, subsurface drainage outflow
& shallow groundwater

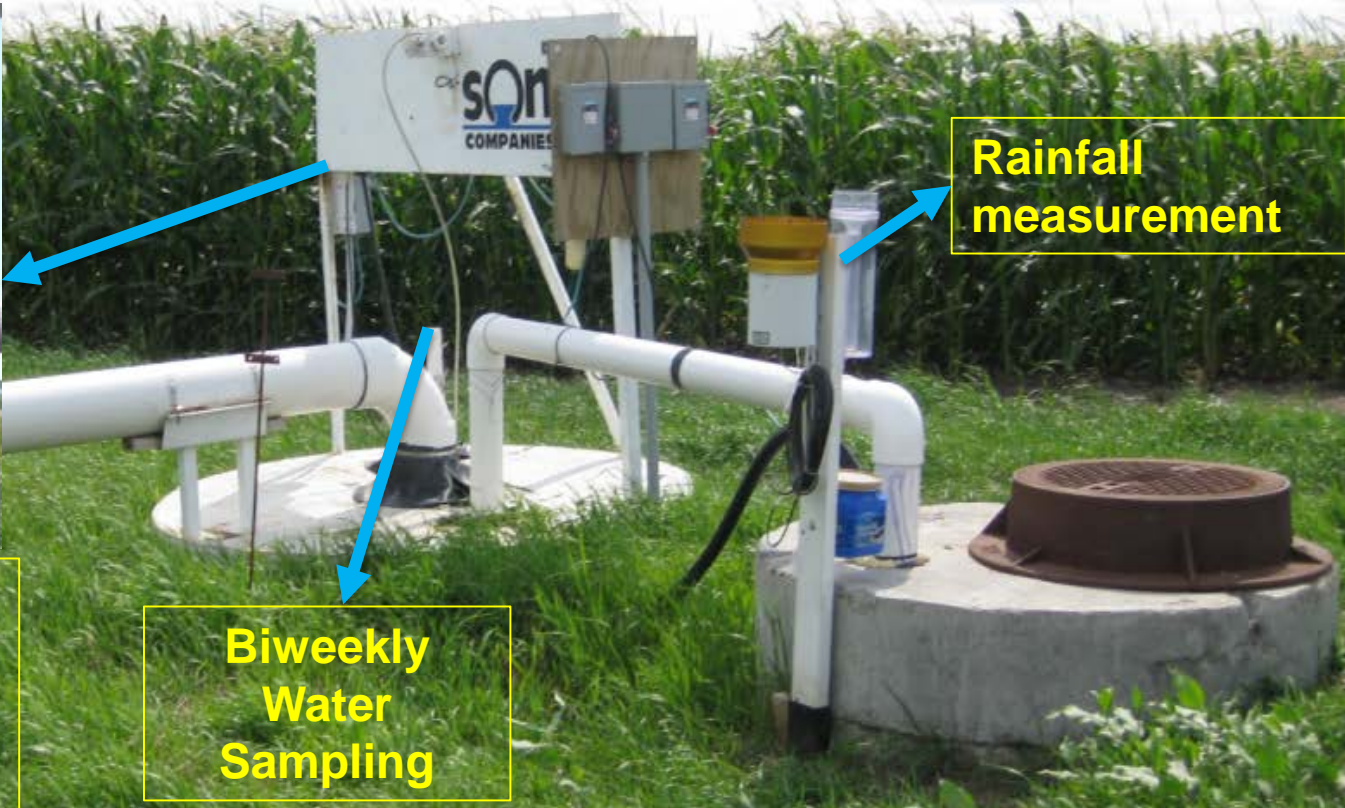
Year	Locations	Cations	Anions	Calculated	Additional
2008	26	23	13	2	
2009	26	26	13	2	39 Pesticides at 2 sites
2010	26	23	13	2	
2012	4	23	7	2	
2013	4	23	7	2	
2014	4	23	7	2	
2015	4	23	7	2	

Jia, X., T.M. DeSutter, Z. Lin, W.M. Schuh, and D.D. Steele. 2012. Subsurface drainage and subirrigation effects on water quality in southeast North Dakota. *Transactions of the ASABE* 55(5): 1757-1769.

Water Quality Monitoring at the Outlet



Current sensor and Hobo event datalogger – Drainage outflow

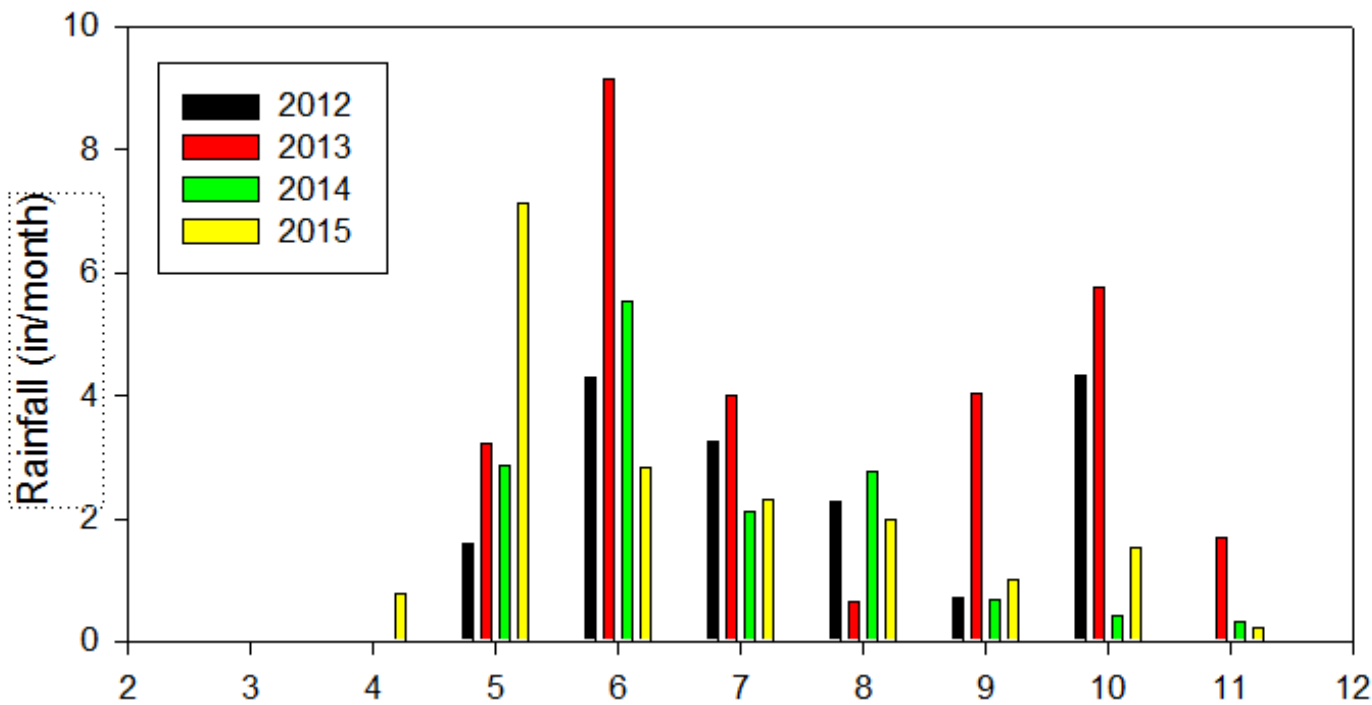
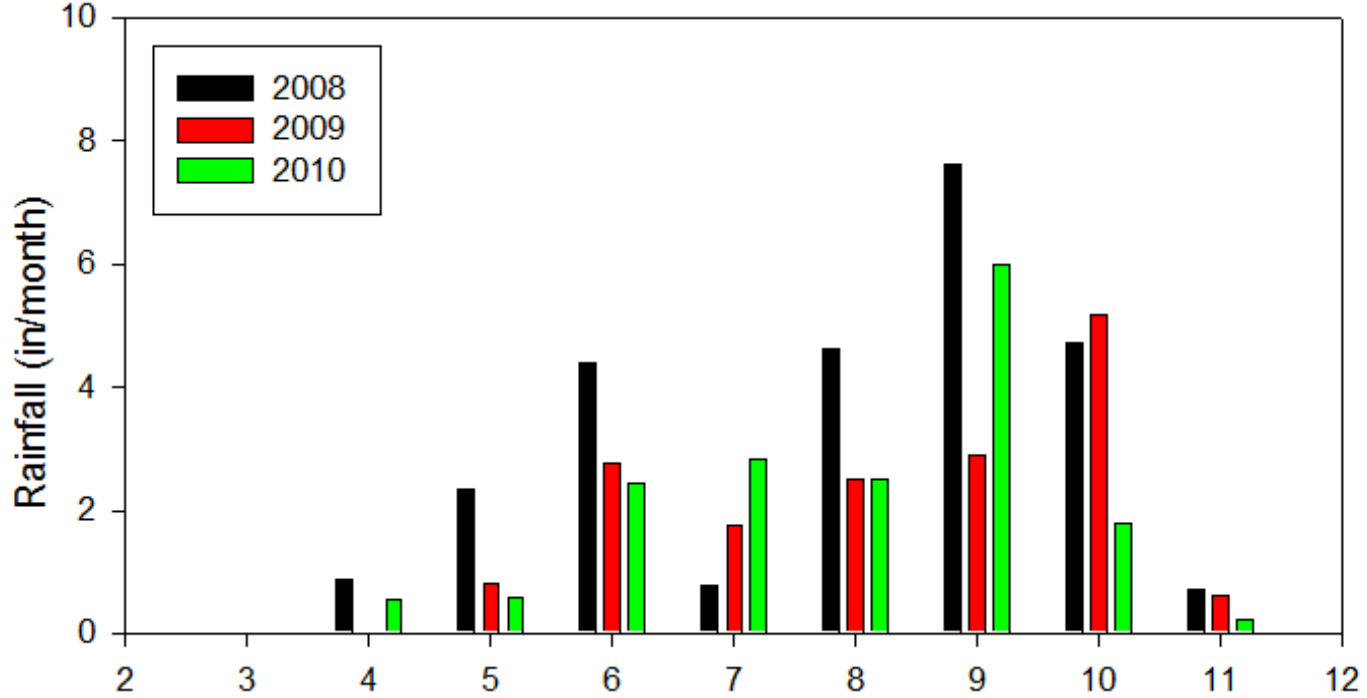


Rainfall measurement

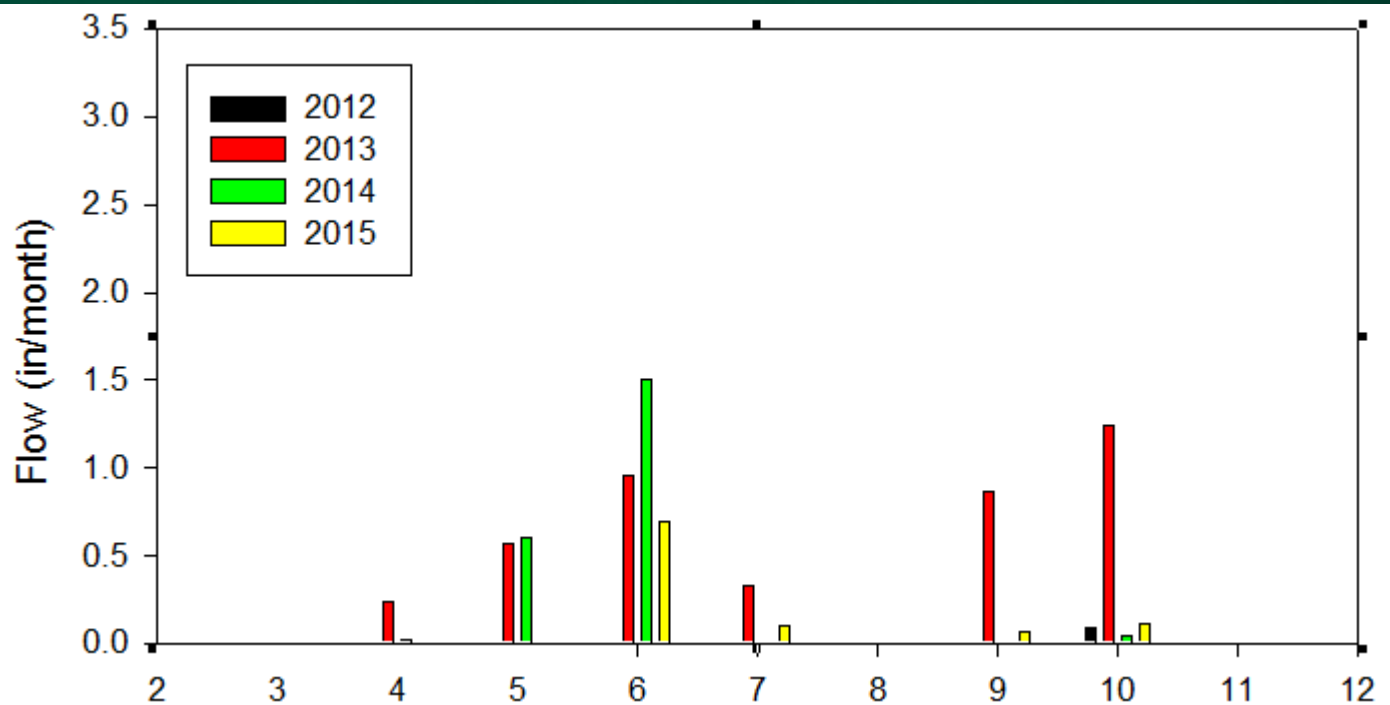
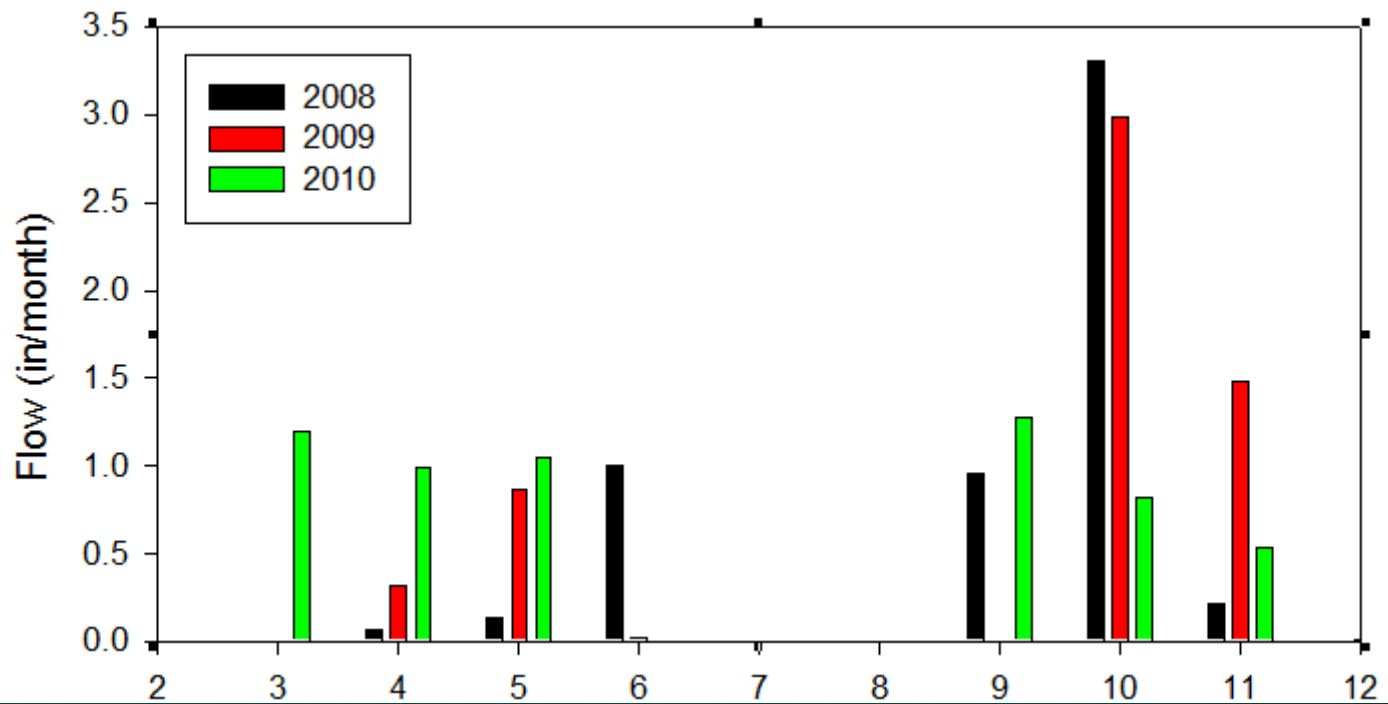
Biweekly Water Sampling

Rainfall, drainage outflow, and Nitrate-N, Sulfate, Phosphorus, and Total Dissolved Solids in 7 yrs → 2008-10, and 2012-15.

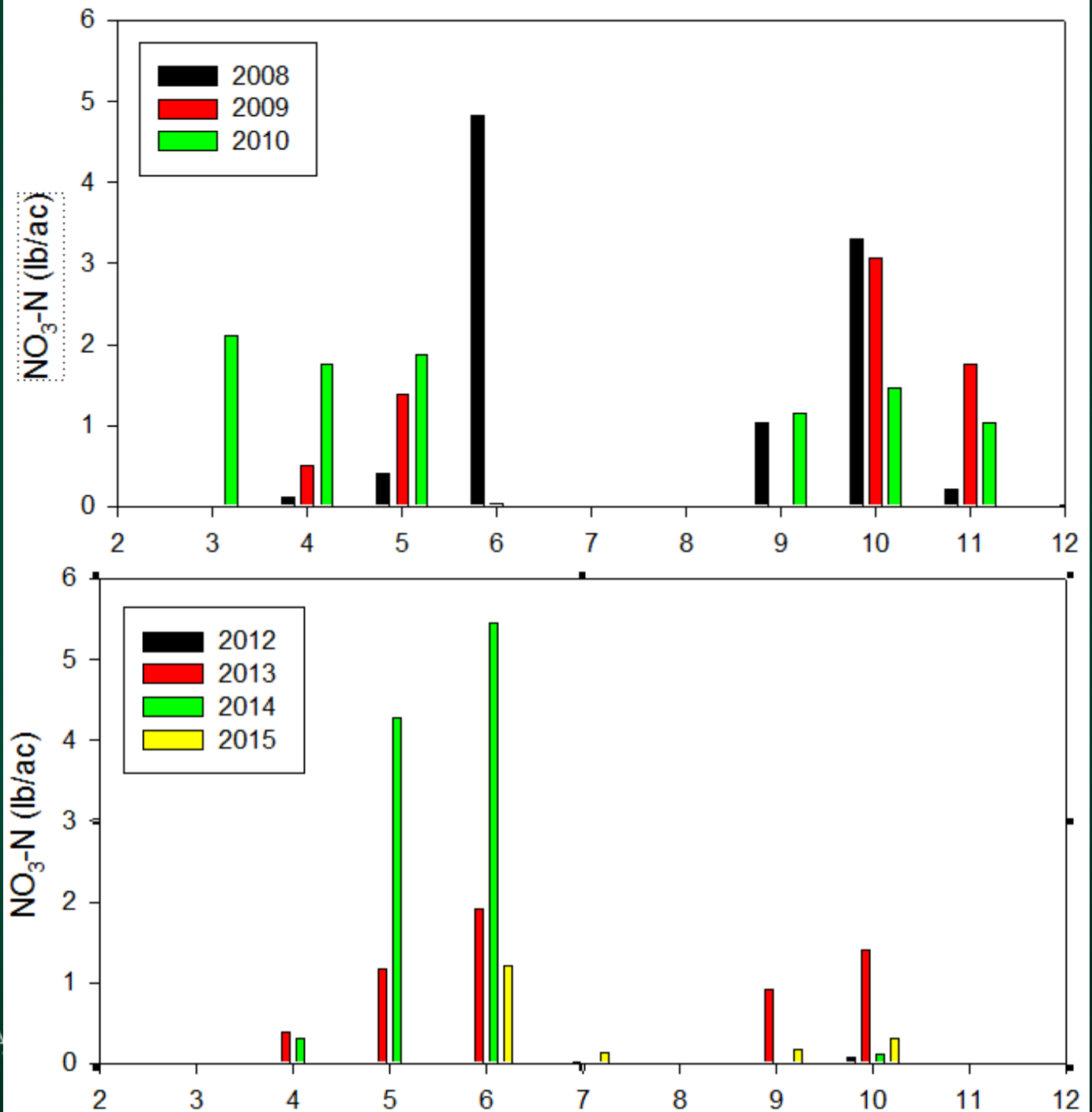
Monthly Rainfall



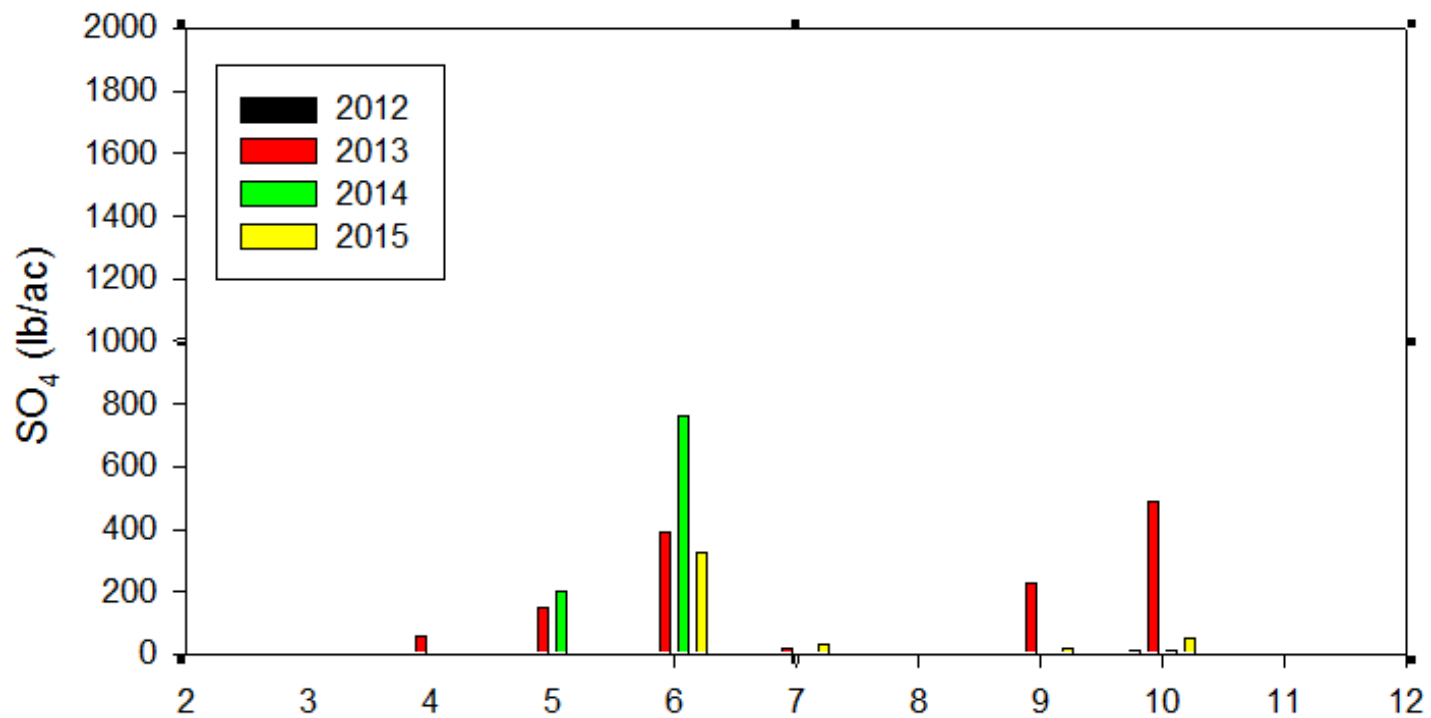
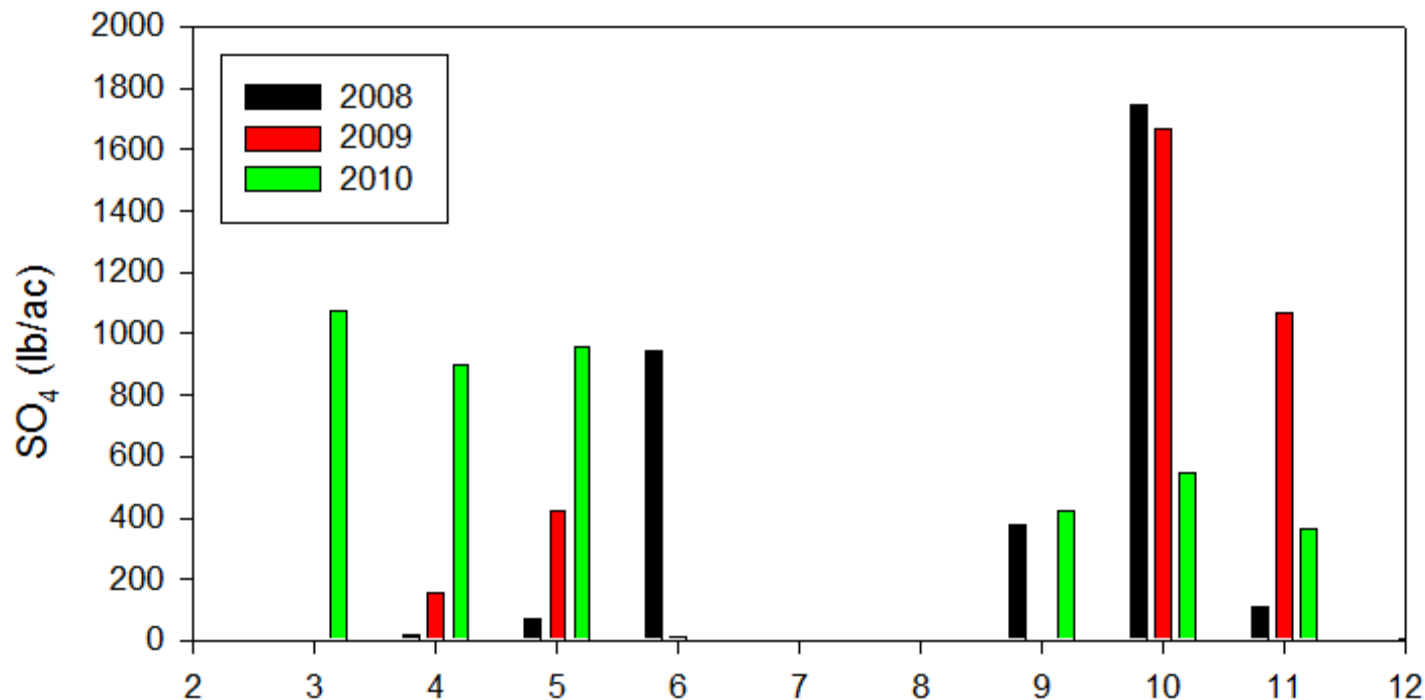
Monthly Flow



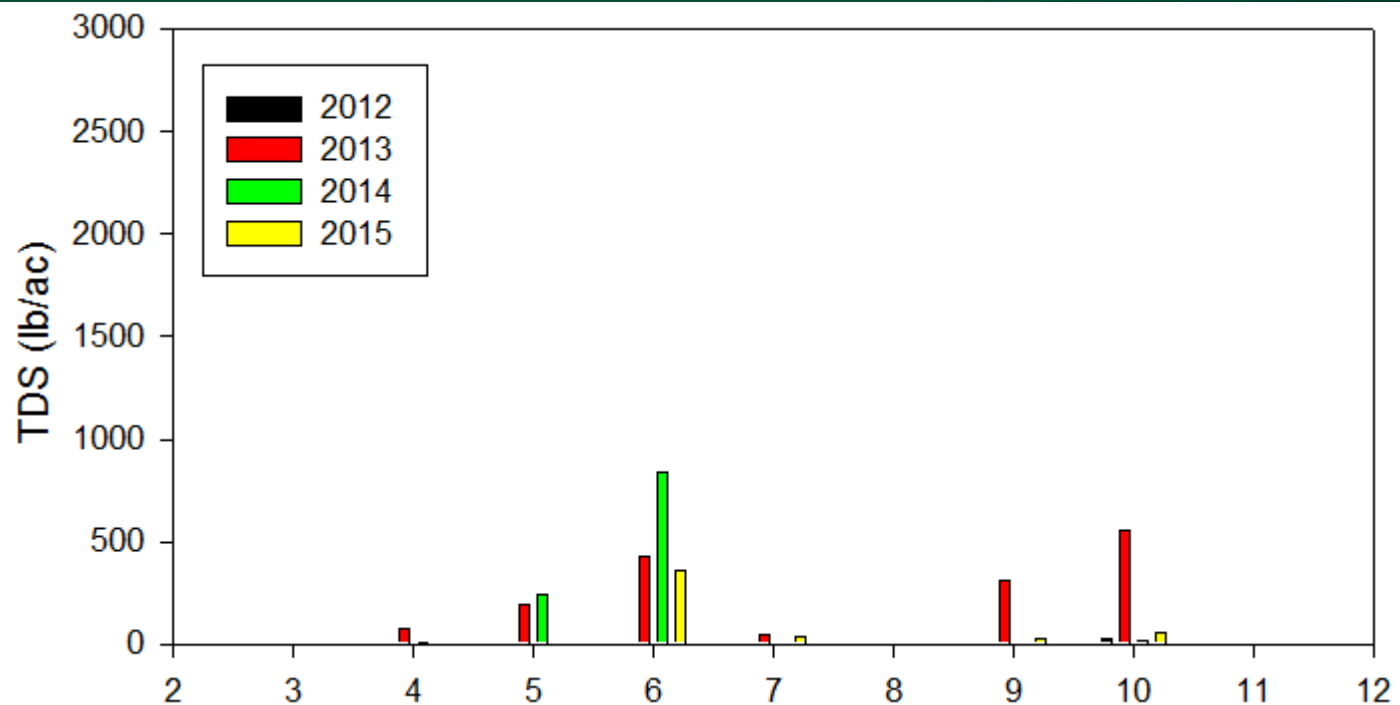
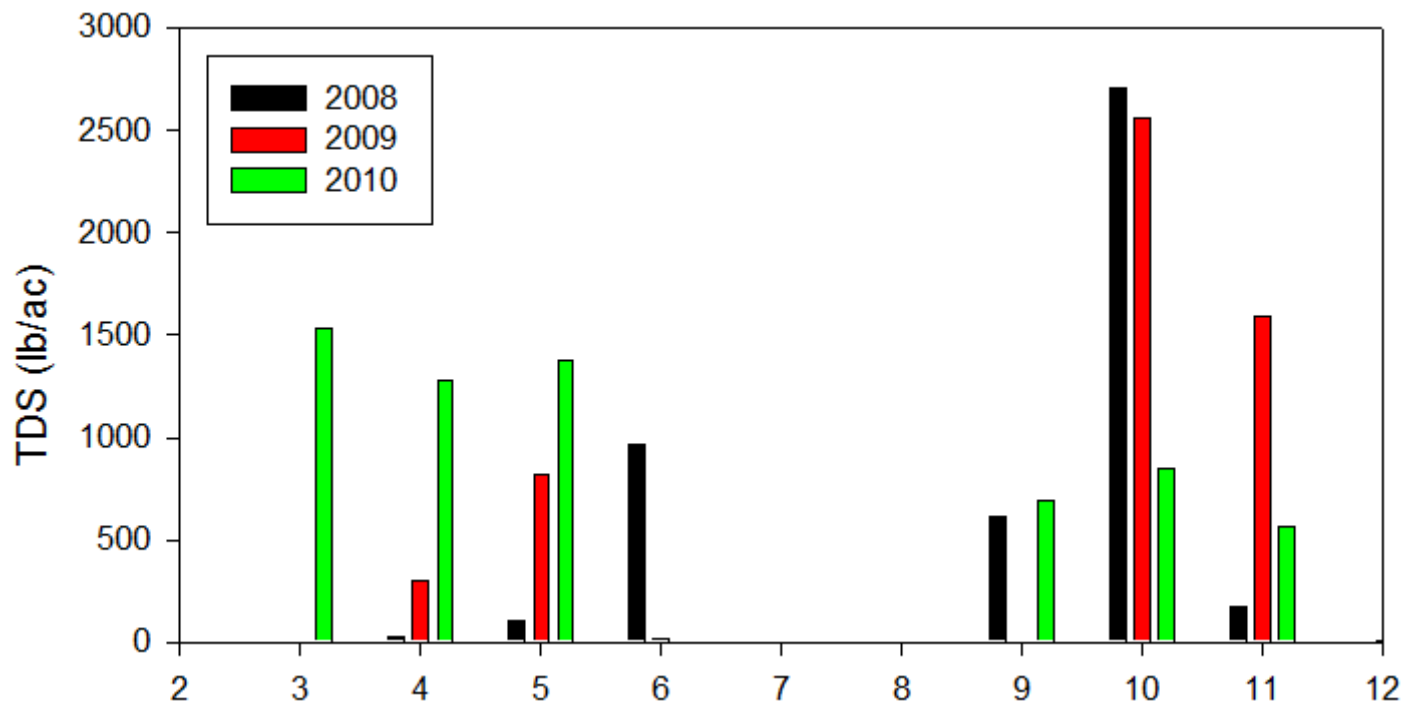
Monthly Nitrogen Load



Monthly Sulfate Load



Monthly TDS Load

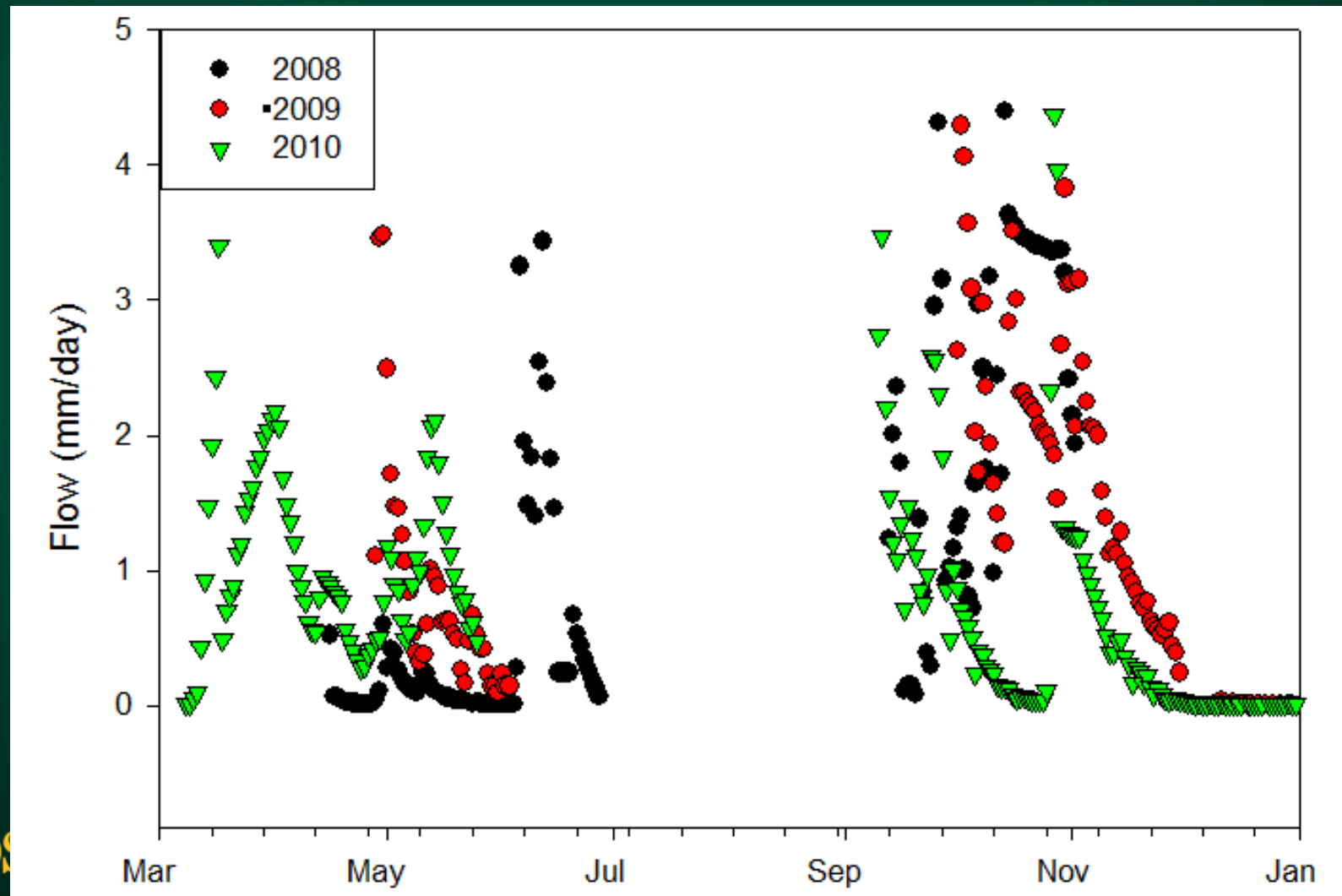


Monthly data comparison between 2008-10 and 2012-15

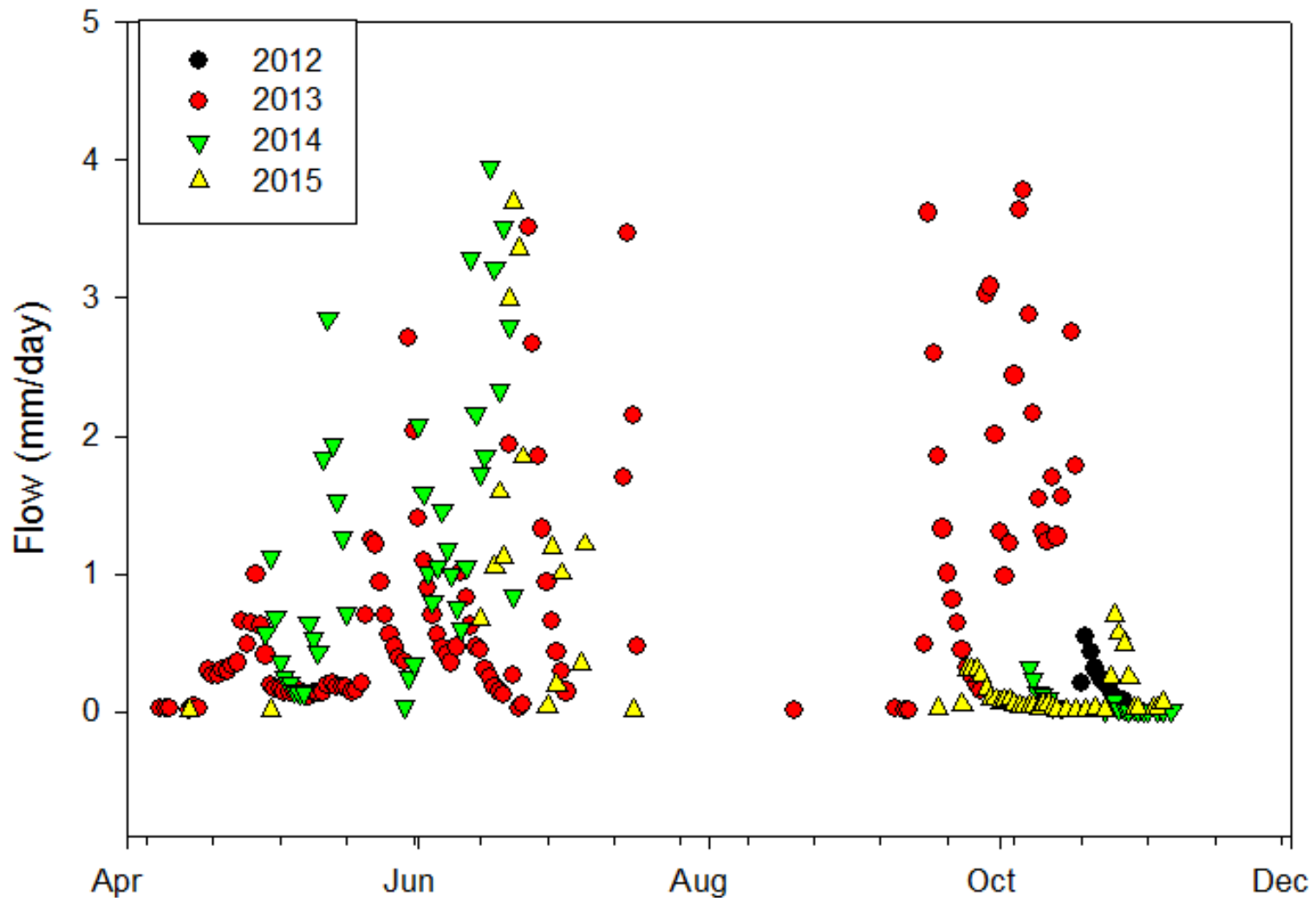
1. Similar rainfall amount
2. Less drainage outflow in 2012-15
3. Similar nitrogen load in May and June, but less in other 2012-15 months
4. Less sulfate and TDS in 2012-15

What's the cause of less flow in 2012-15???

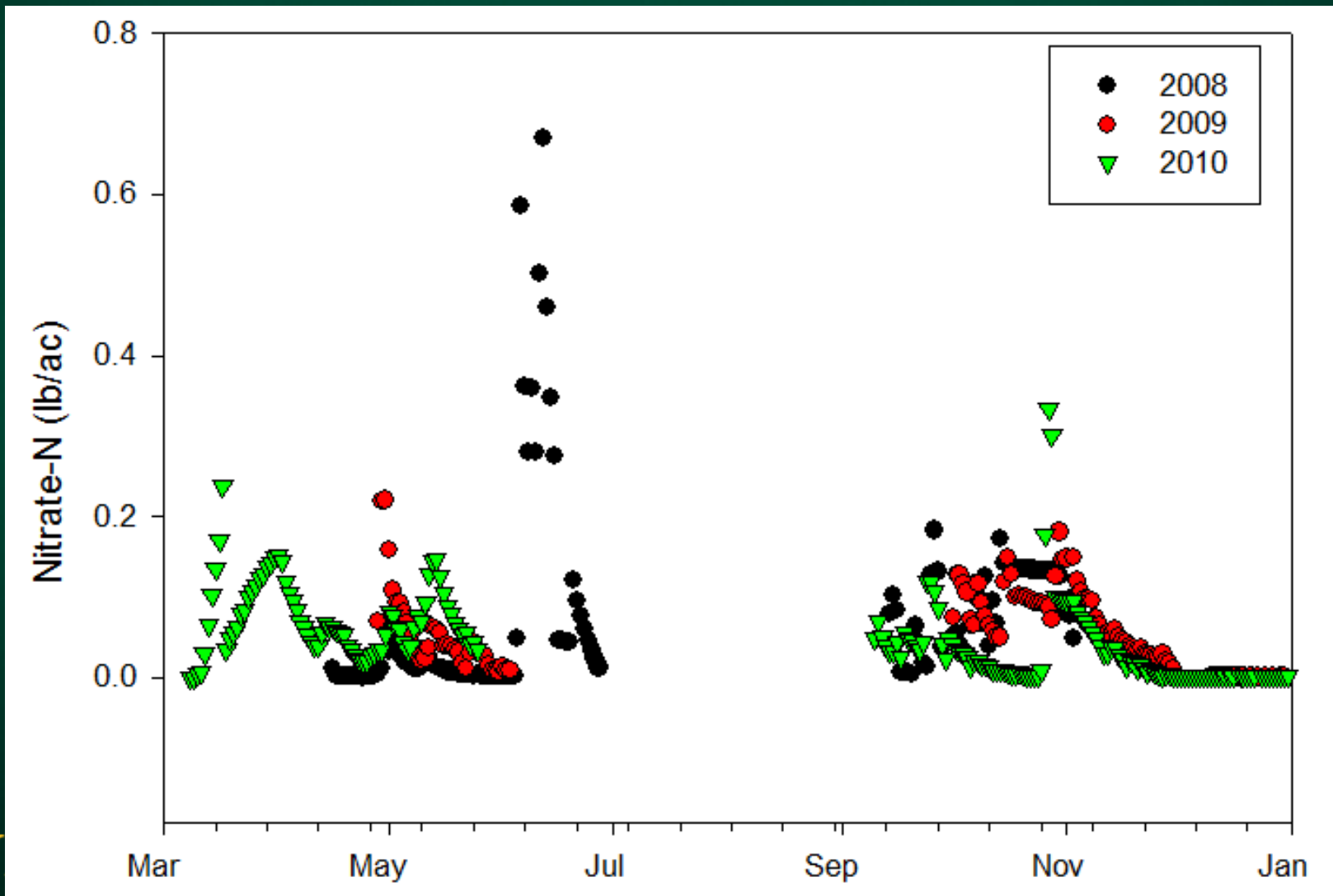
Daily Drainage Outflow (2008-10)



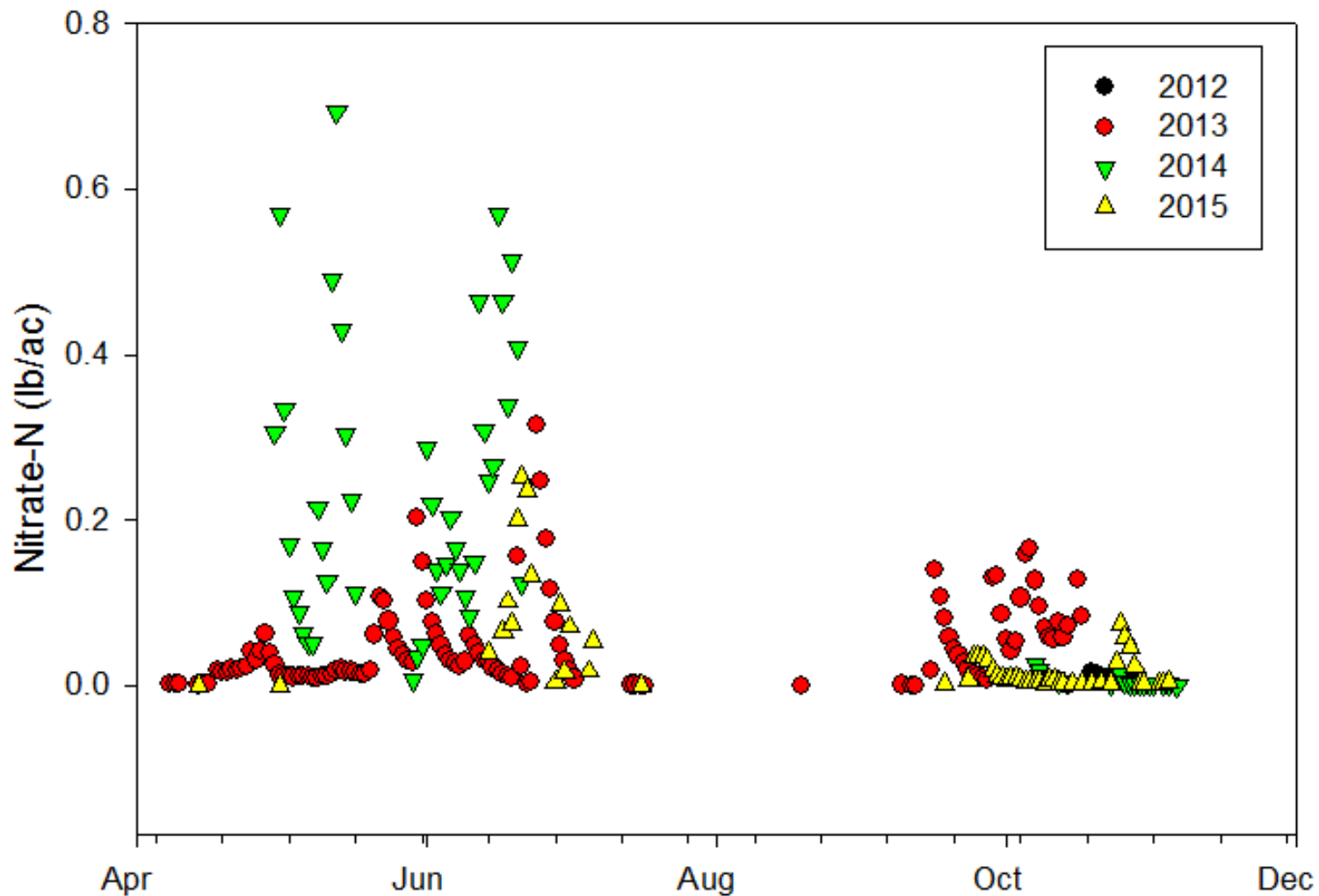
Daily Drainage Outflow (2012-15)



Daily Nitrogen Load (2008-10)



Daily Nitrogen Load (2012-15)



Daily flow and nitrogen load comparison between 2008-10 and 2012-15

1. Daily flows were in the similar range, but maximal daily flows were slightly lower in 2012-15, 4.4 mm/day in 2008 vs. 3.95 mm/day in 2014.
2. Daily nitrogen loads were in similar range, and the maximal daily nitrogen loads were similar, 0.67 vs. 0.69 lb/ac in 2008 and 2014, respectively.

What's the cause of less flow in 2012-15???

What's the cause of less flow in 2012-15?

- There should be more flow in 2012-15 because the system was converted to 30 ft spacing, 3.2-4 ft depth, and 1% grade in 2011. Narrow spacing results in higher drainage flow.
- Subirrigated with groundwater from the down stream using the same mains. Added water to the field.
- Used the same outlet and same method for flow measurements.

Annual Water Quality Monitoring

Year	2008	2009	2010	2012	2013	2014	2015
Crop	Corn	Corn	Soybean	Sugarbeet	Corn	Corn	Soybean
Rainfall (in)	26.1	16.5	16.9	16.5	28.5	14.7	17.8
Drainage (in)	5.68	5.67	5.89	0.10	4.20	2.18	0.99
Drainage duration (day)	126	115	190	13	122	60	54
NO ₃ -N (lb/ac)	9.87	6.77	9.43	0.08	5.81	10.15	1.85
PO ₄ -P (lb/ac)	0.17	0.23	0.29	0.01			
SO ₄ (lb/ac)	3267	3337	4283	15	1323	973	430
TDS (lb/ac)	4589	5315	6318	26	1619	1104	482

Soil difference



What's the cause of less flow in 2012-15?

- Reduced drainage duration using controlled drainage
 - Reduced the drainage outflow
 - Reduce the chemical loads to the surface water
 - Soil difference?

SUMMARY OF WATER QUALITY MONITORING

- ✓ Chemical loads were reduced from 2008-10 to 2012-15
- ✓ Decrease of drainage flow led to chemical load reduction
- ✓ Shorter drainage times caused less drainage flow
- ✓ Drainage water management resulted in shorter drainage times

- ✓ Change of drainage area (soil properties) leads to reduced flow and load?

Current funding:

North Dakota Agricultural Experiment Station
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North Dakota State Water Commission
North Dakota Department of Health
ND Soybean Council
USDA AFRI

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Thank you!

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