Adapt-N:
A Cloud Computational Tool for Precision Nitrogen Management

AFRI Project Overview

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New Tools and Incentives for Carbon, Nitrogen, and Greenhouse Gas Accounting and Management in Corn Cropping Systems

Project Director (PD): David Wolfe, Cornell University

Co-PDs: Keith Paustian, Steve Ogle (Colorado State University); Cynthia Rosenzweig (Columbia University); Antonio Bento, Jeff Melkonian, Harold van Es, Peter Woodbury (Cornell University).

Objectives:

- Improve and validate model-driven web-based tools for farm-level carbon (C), nitrogen (N) and greenhouse gas (GHG) accounting and management.

- Develop low-cost approaches to quantify soil C change.

- Analyze regional impacts of climate change scenarios.

- Evaluate impacts of economic and policy incentives

Cornell University

Colorado State University

COLUMBIA UNIVERSITY

USDA

United States Department of Agriculture   National Institute of Food and Agriculture

COMET-FARM

Estimates the 'carbon footprint' for all or part of your farm/ranch operation and allows you to evaluate different options, **which you select**, for reducing GHG emissions and sequestering more carbon.
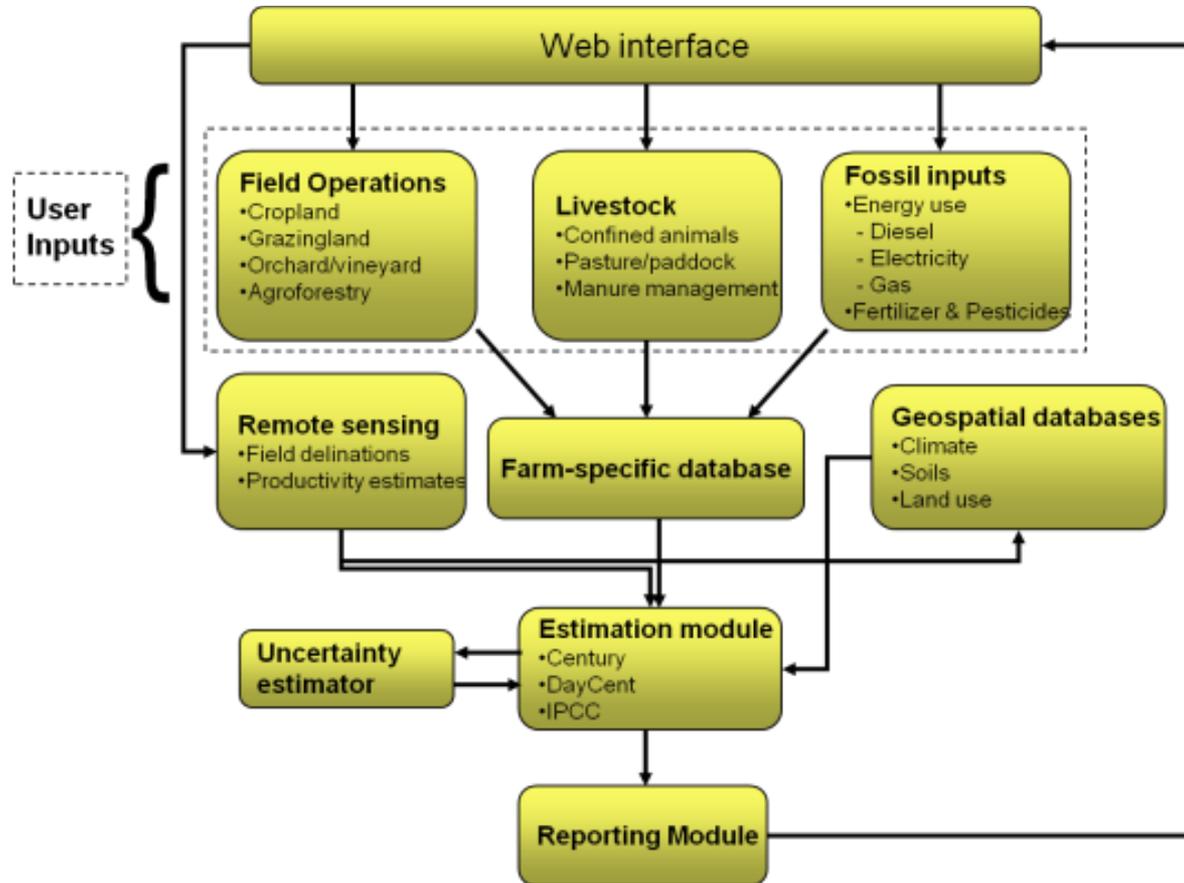
Adapt-N
disclosure

According to Cornell University policy, I am disclosing that I have an equity interest in Agronomic Technology Corporation, which has received a license for the use and further development of the Adapt-N tool.

This tool was developed as part of my Cornell research program, and Agronomic Technology Corporation is providing some support to my program for the further development of this technology.

Key Research Findings for Adapt-N
(Sogbedji et al., 2001)

- Early-season weather strongly impacts the optimum N rate
- Computer models can use weather, soil and management inputs to make more accurate N rate recommendations.
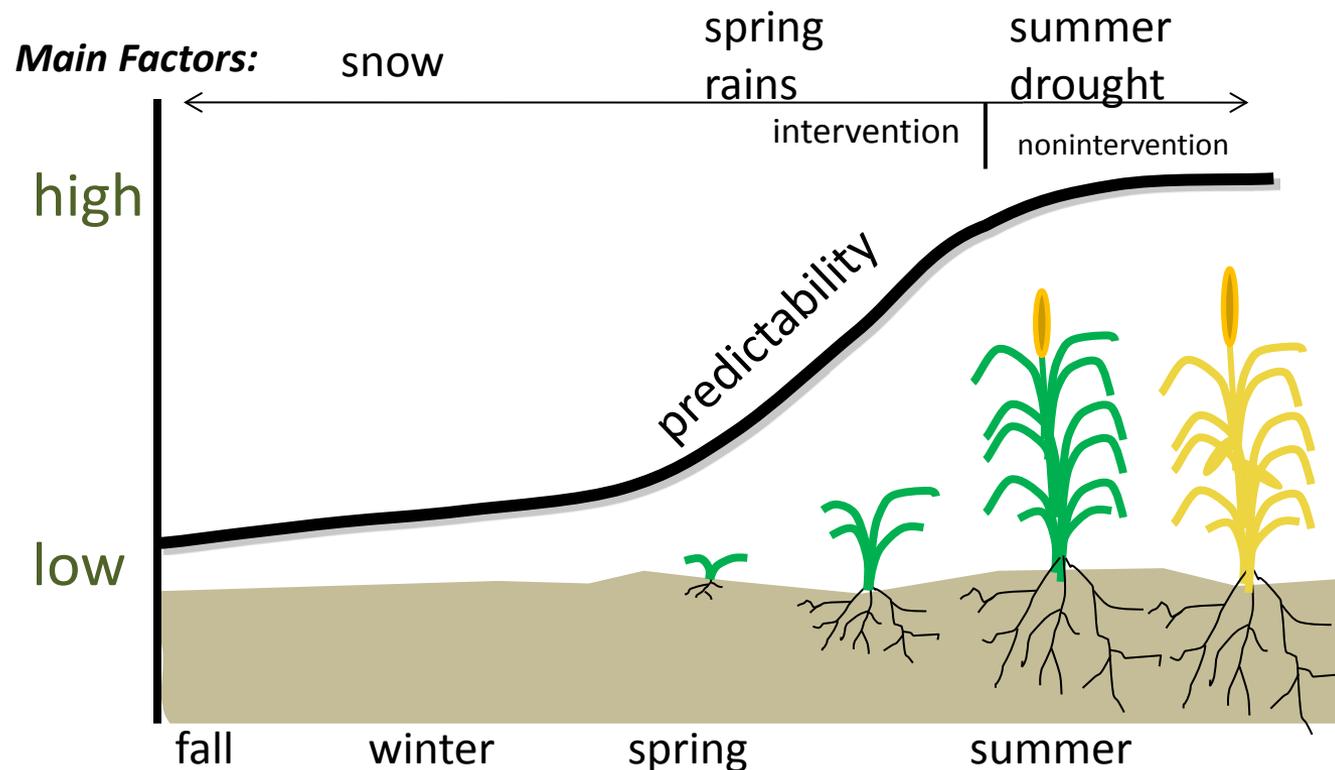
Adapt-N History

- 1980's through early 2000's: field research and model development

- 2004-2007: Semi-weekly adaptive N recommendations through email

- 2008-2013: Adapt-N tool available through web-based user interface (cloud) through Cornell University servers

- 2011-2014: extensive field testing through on-farm trials

- 2014: Adapt-N licensed and commercialized through Agronomic Technology Corporation

Adapt-N Infrastructure

High Resolution Weather Data

Computer Model

simulates soil and crop processes on Cornell University server

Stakeholder
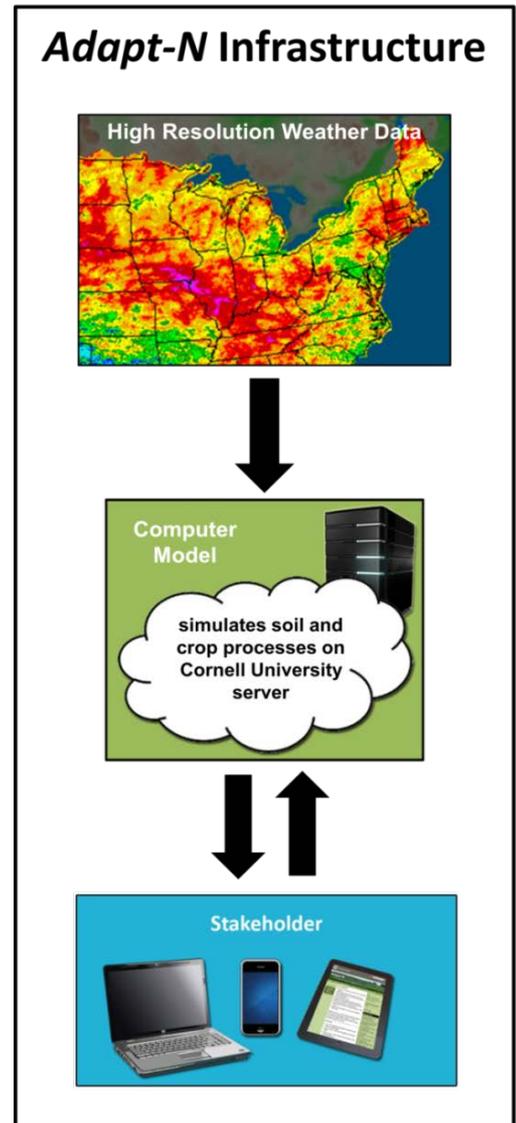
Nitrogen Management with Cloud Computational Tools

- Universal access through web-based services
- Move from generalized to adaptive, real-time, site-specific recommendations using information on
  - Weather
  - Local soils
  - Soil and crop management
- Real-time and post-season evaluations

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Adapt-N Commercialization through Agronomic Technology Corporation

- Public-private partnership
- Scientific integrity with continued advancements
- Organization-level functionality and customization

Adapt-N.com

What factors does *Adapt-N* include in making a recommendation?

- High resolution daily precipitation & temperature data
- Soils: texture/soil type, slope, rooting depth, % organic matter (NRCS databases)
- N fertilizer applications: rate, type, timing, placement
- Cultivar: Silage, grain, or sweet corn; planting date, maturity class
- Population and expected yield
- Tillage: fall or spring plowing; conservation tillage/residue management
- Manure applications: date, rate, N analysis, incorporation info
- Rotations: soy, corn - silage or grain, or sod - last 3 yrs, % legume, surface killed or incorporated
- Irrigation amounts and dates
- Fertilizer and grain prices & profit loss risk

High Resolution Climate Data (4x4 km)
Critical Input to Adapt-N Tool

Iowa, June 14, 2011
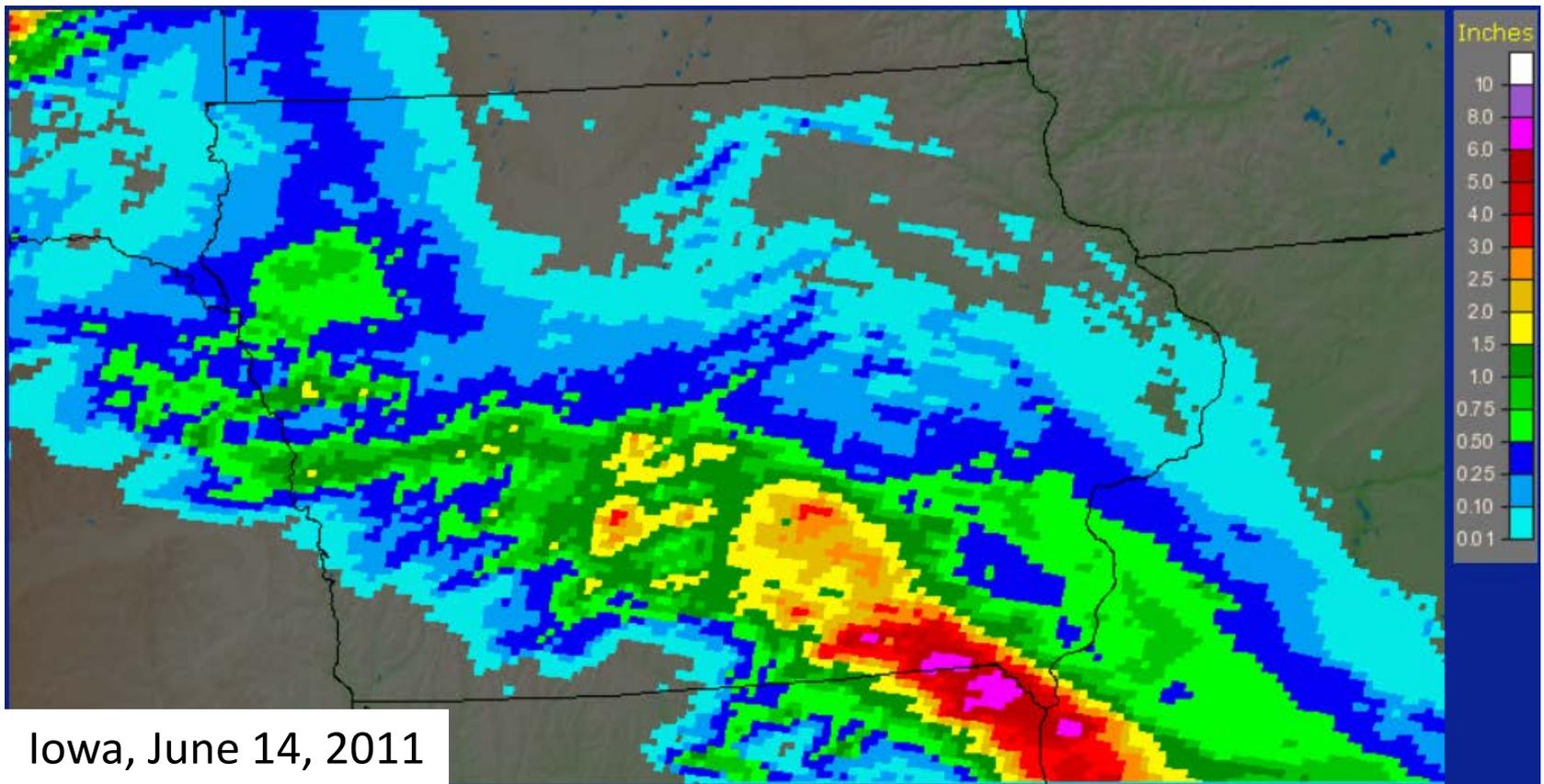
Adapt-N Interface
Defining your location
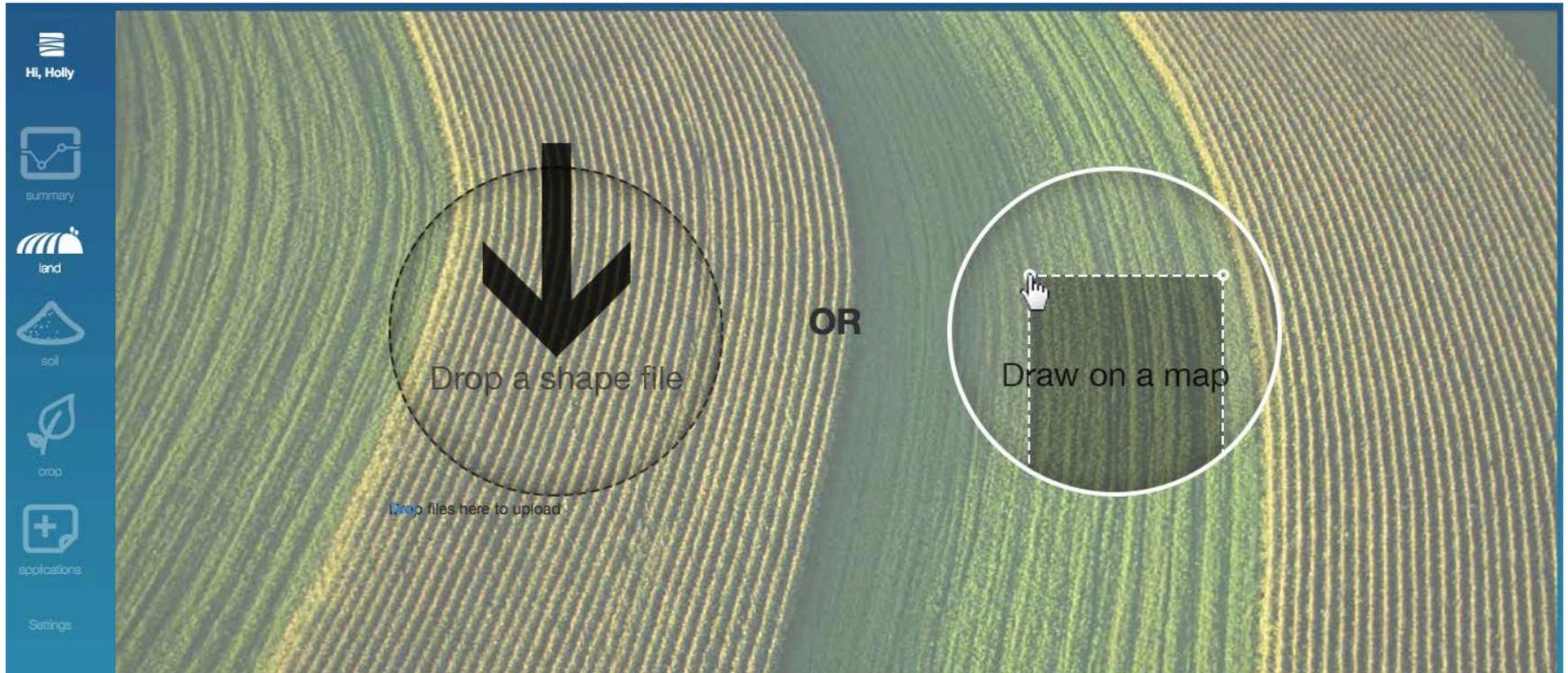
Adapt-N Interface
Viewing your locations

Adapt-N Interface
Entering Soil Information

Adapt-N Interface
Entering Soils Information

Adapt-N Interface
Entering Crop Information

Adapt-N Interface
Entering N Fertilizer Inputs

Adapt-N Interface
Entering Manure Inputs

Adapt-N Interface
Entering Irrigation Inputs

Zone Recommendation

Date selection

Farm Summary

ABOUT FARM DONALD

V2 V4 V6 V8 V10 V12 V14 V16

897 · 103

Active Acres · Acres Unused

NITROGEN RECOMMENDATION

7120lbs
Total Recommendaton

3 fields
Calling for Nitrogen

19 fields
Not Calling for Nitrogen

180lbs/acre
Maximum Recommendation

105lbs/acre
Average Recommendation

35lbs/acre
Minimum Recommendation

FIELDS & ZONES

Action needed first

NAME	VEGETATIVE STAGE	STATUS	APPLICATION NEEDED	PREVIOUSLY APPLIED	ACTION
⌄ Field: NE					✎
Zone 1	V8	+ Nitrogen	85 lbs/acre (4023 lbs)	40lbs	✎
Zone 2	V8	+ Nitrogen	105 lbs/acre (2218 lbs)	40lbs	✎

Hi, David

Summary

Land

Soil

Crop

Applications

Agronomist Summary

AGRONOMIST VIEW

Graphs will appear when more information is available.

NITROGEN RECOMMENDATION

52 Growers Setup

15 Growers Need Nitrogen

137 fields — Active Fields

2 fields — Inactive Fields

11 fields — Fields Not Setup

175 lbs/acre — Maximum Recommedation

0 lbs/acre — Minimum Recommedation

74 fields — Fields Need Nitrogen Application

GROWERS, FARMS & FIELDS

NAME	ACTIVE	ACRES	STAGE	RECOMMENDATION	PAST APPLIED	ACTION
Grower: April Wright Lucas	-	24	V0 - V0	Setup Needed		
Farm/Field: Grantson Farm : Lowes West	✔	12		No zones	-	🔍
Farm/Field: Grantson Farm : Lowes West&East	✔	12		See Detail for Error	0.0 - 0.0 lbs/acre	🔍
Grower: Becky Wiseman	-	0	V0 - V0	No Nitrogen Needed		
Grower: Ben Reinhart	-	19	V0 - V20	+Nitrogen		
Farm/Field: 2014 AdaptN : Simmons20	✔	19	V20 - V20	85 - 85 lbs/acre	60.0 - 60.0 lbs/acre	🔍
Grower: Bianca Moebius-Clune	-	681	V0 - V19	+Nitrogen		
Farm/Field: 2014Trials : WillsboroDrainage5	✔	2		See Detail for Error	0.0 - 0.0 lbs/acre	🔍
Farm/Field: MyLand : IthacaCommunityGarden	✔	0	V15 - V15	15 - 15 lbs/acre	0.0 - 0.0 lbs/acre	🔍
Farm/Field: Test Fields : HanshawRd	✔	49	V15 - V15	See Detail for Error	0.0 - 75.0 lbs/acre	🔍
Farm/Field: Test Fields : IAnorthwest	✔	603	V19 - V19	150 - 150 lbs/acre	0.0 - 0.0 lbs/acre	🔍
Farm/Field: Test Fields : TestField2	✔	27		See Detail for Error	0.0 - 0.0 lbs/acre	🔍
Grower: Bob Schindelbeck	-	2	V0 - V11	+Nitrogen		
Farm/Field: Musgrave Research Farm : E	✔	2	V11 - V11	95 - 105 lbs/acre	24.0 - 24.0 lbs/acre	🔍
Grower: Branton Farms	-	0	V0 - V0	No Nitrogen Needed		
Grower: Brent Myers	-	41	V0 - V0	No Nitrogen Needed		

Standard Report - PDF

Nitrogen Recommendation

Grower: Mattes Farms
Farm: Test
Field: Bridge
Zone: Test 1

adapt-N

Nitrogen recommendation for July 10, 2014:

140 lbs N/Acre N recommendation	121-158 N recommendation range

Recommendation based on supporting estimates and assumptions:

246 lbs N/Acre Expected N in crop at harvest	31 lbs N/Acre N mineralization so far	98 lbs N/Acre N loss so far
0 lbs N/Acre Partial credit from prior crop	110 lbs N/Acre N in crop now	24 lbs N/Acre Expected future loss
4 lbs N/Acre Expected future mineralization	7 lbs N/Acre N in soil now	15.5" / 20.2" Rainfall since planting / Rainfall since 11/11/13
2 lbs N/Acre Current Nitrate N top 12" Virtual PSNT: 0.4 ppm	3.8" / 4.8" Water in root zone / Water at field capacity	7 lbs N/Acre Root zone inorganic N

Planted: 04/21/14
Expected Yield: 240.0 bu/acre
Estimated Growth Stage: V20
N fertilizer already applied: 185 lbs N/Acre
Irrigation Applied: None
Manure Applied: No
Adapt-N Zone ID: 7155

LAND INFORMATION

Zone Name	Test 1
Estimated Acres	1
Slope	9-12%
Artificially Drained	Yes
Soil Type	Shelby
Rooting Depth	31"

SOIL INFORMATION

Tillage Method	Conservation Tillage
Tillage Date	None
Tillage Depth	N/A
Tillage % Residue	50
Test Sample Depth	7.0"
Soil Organic Matter %	1.93

CROP INFORMATION

Maturity Class	Grains: 112 day corn
Yield Target	240.0 bu/acre
Planting Date	2014-04-21
Harvest Population	27,500
Previous Crop	Grain Corn

NITROGEN APPLICATION

DATE	APPLICATION TYPE	FERTILIZER TYPE	RATE	DEPTH
05/03/14	Sidedress	Solution N (UAN)	30	0.00"
11/11/13	Pre-Plant	Anhydrous Ammonia	150	9.00"
04/21/14	Starter	Solution N (UAN)	5	1.00"

MANURE APPLICATION

DATE	RATE	AMMONIUM	ORGANIC N	SOLIDS %
No manure to date				

IRRIGATION APPLICATION

DATE	INCHES WATER
No irrigation to date	

Daily Alerts

Harold van Es,

The following zones' recommended Nitrogen application exceed their alert threshold. Summary:

- 18 growers
- 59 farms
- 91 fields
- 152 zones, max: 175, min: 10, avg 80

Grower: Bob Schindelbeck

Summary of N Alerts across 1 farm, 1 field, 4 zones
max: 105, min: 95, avg 98
Alert Threshold: 10

Farm	Field	Zone	Stage	Rec
Musgrave Research Farm	E	PT - high OM	V10	95
Musgrave Research Farm	E	PT - low OM	V10	100
Musgrave Research Farm	E	ZT - high OM	V10	95
Musgrave Research Farm	E	ZT - low OM	V10	105

Adapt-N Graphs
Precipitation and Total N Loss
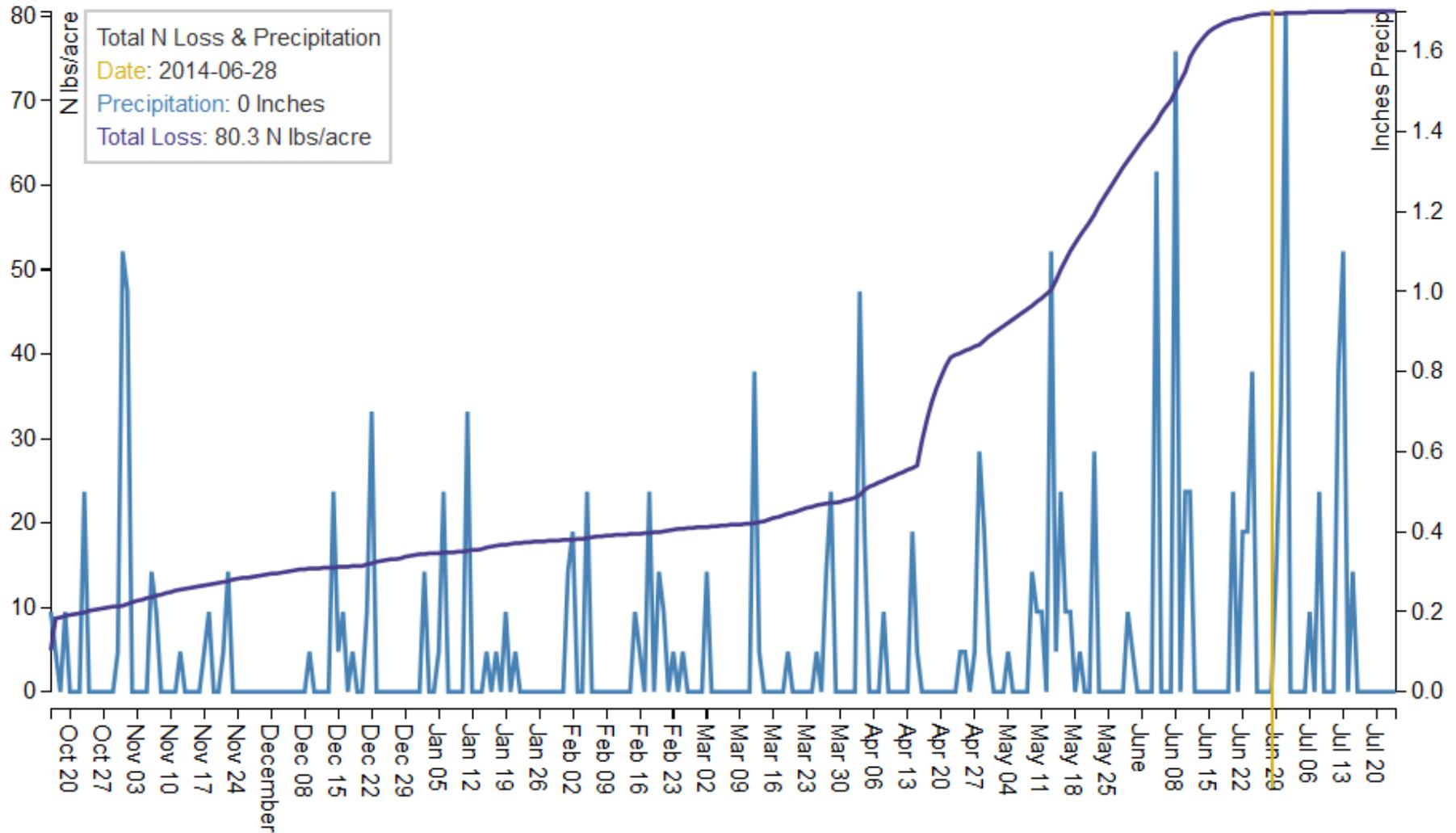
Adapt-N Graphs
cumulative precipitation; leaching and gaseous N losses

N Loss Breakdown
Date: 2013-10-28
Leaching Loss: 0 N lbs/acre
Total Precipitation: 0.9 Inches
Gaseous Loss: 10 N lbs/acre
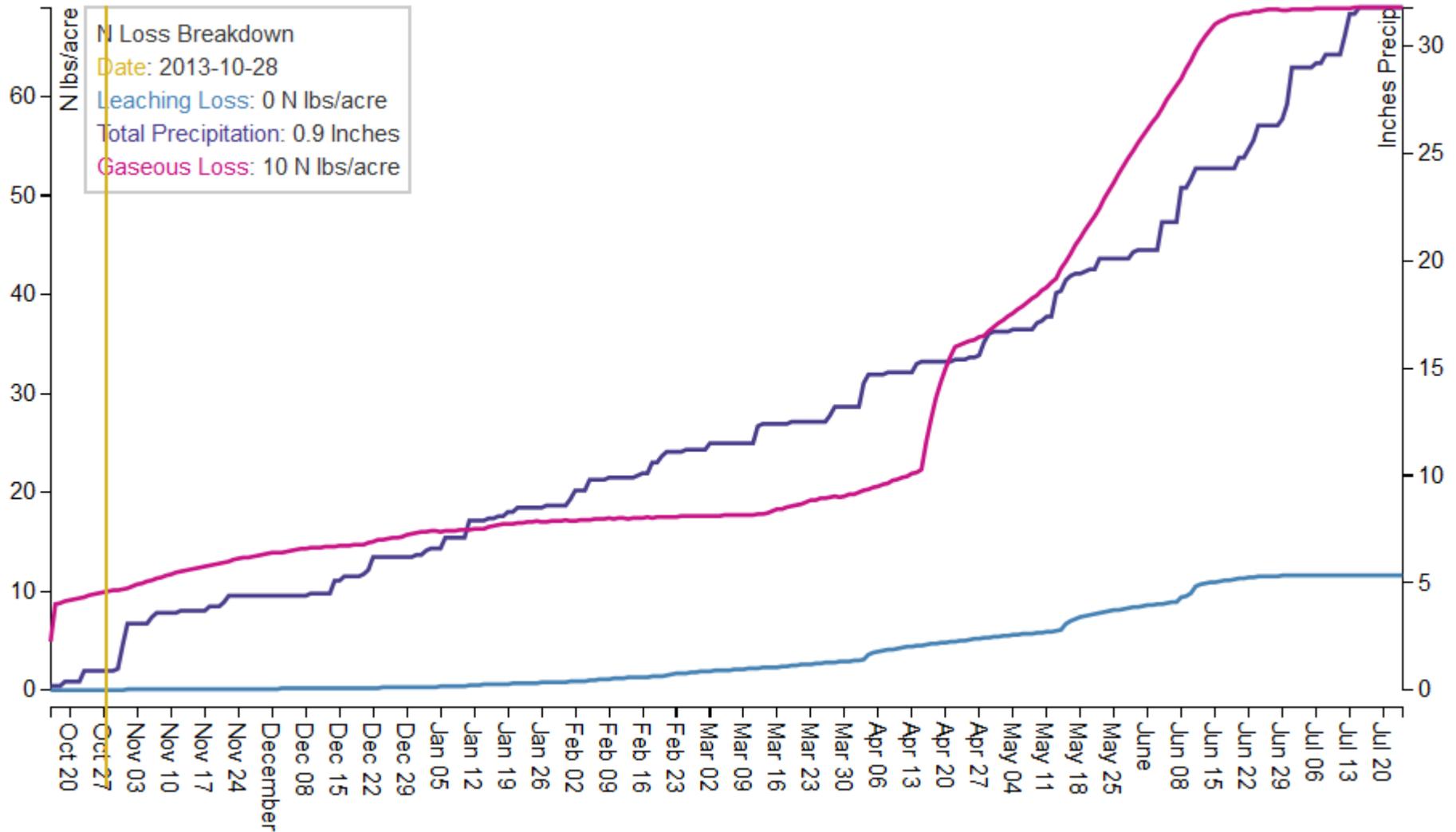
Adapt-N Graphs
Mineralized N and Temperature

Mineralized N & Temperature
Date: 2013-11-03
Mineralized N: 1.1 N lbs/acre
Average Temperature: 40.5 Degrees F
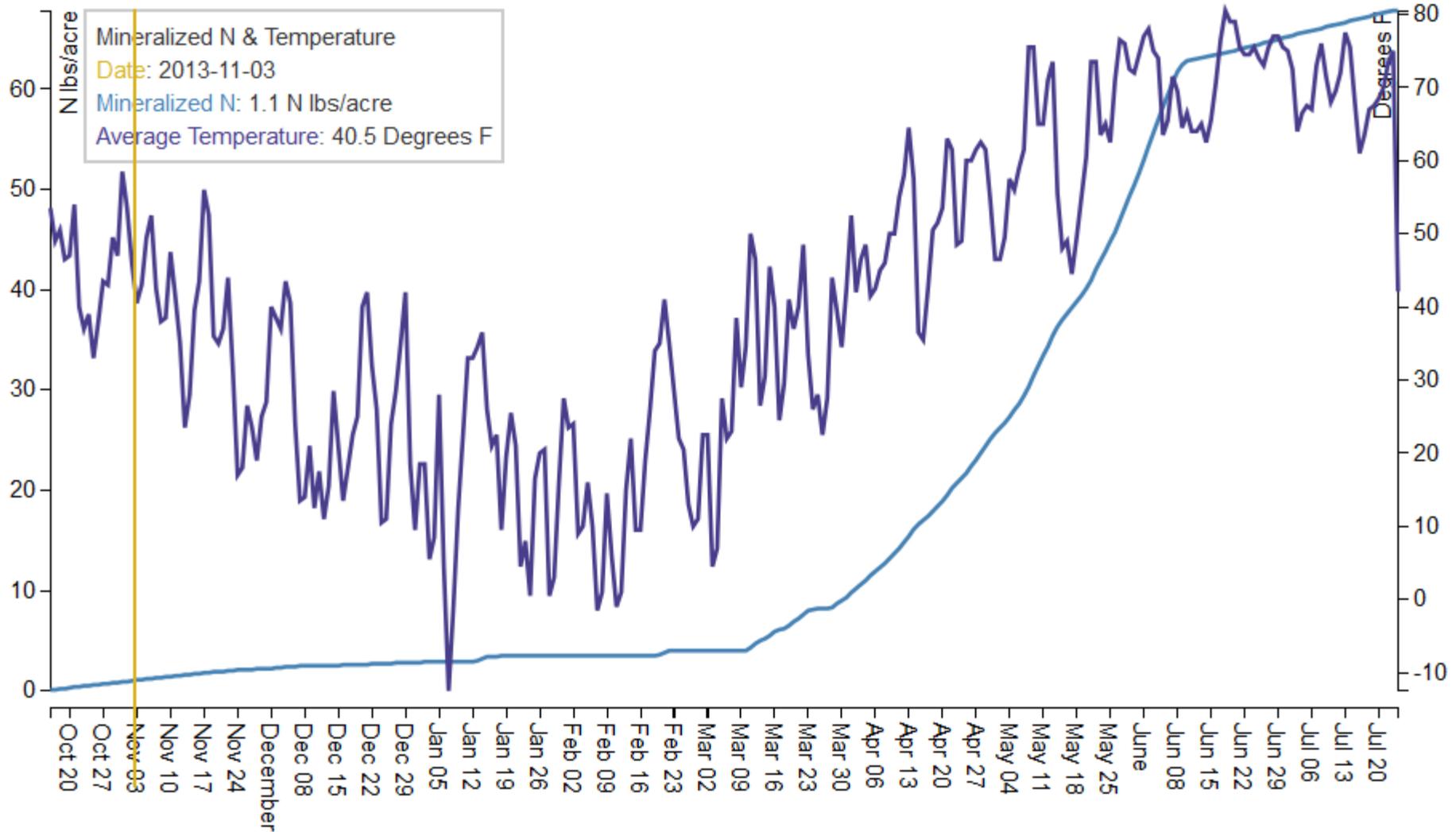
Adapt-N Graphs
Nitrogen Availability and Uptake
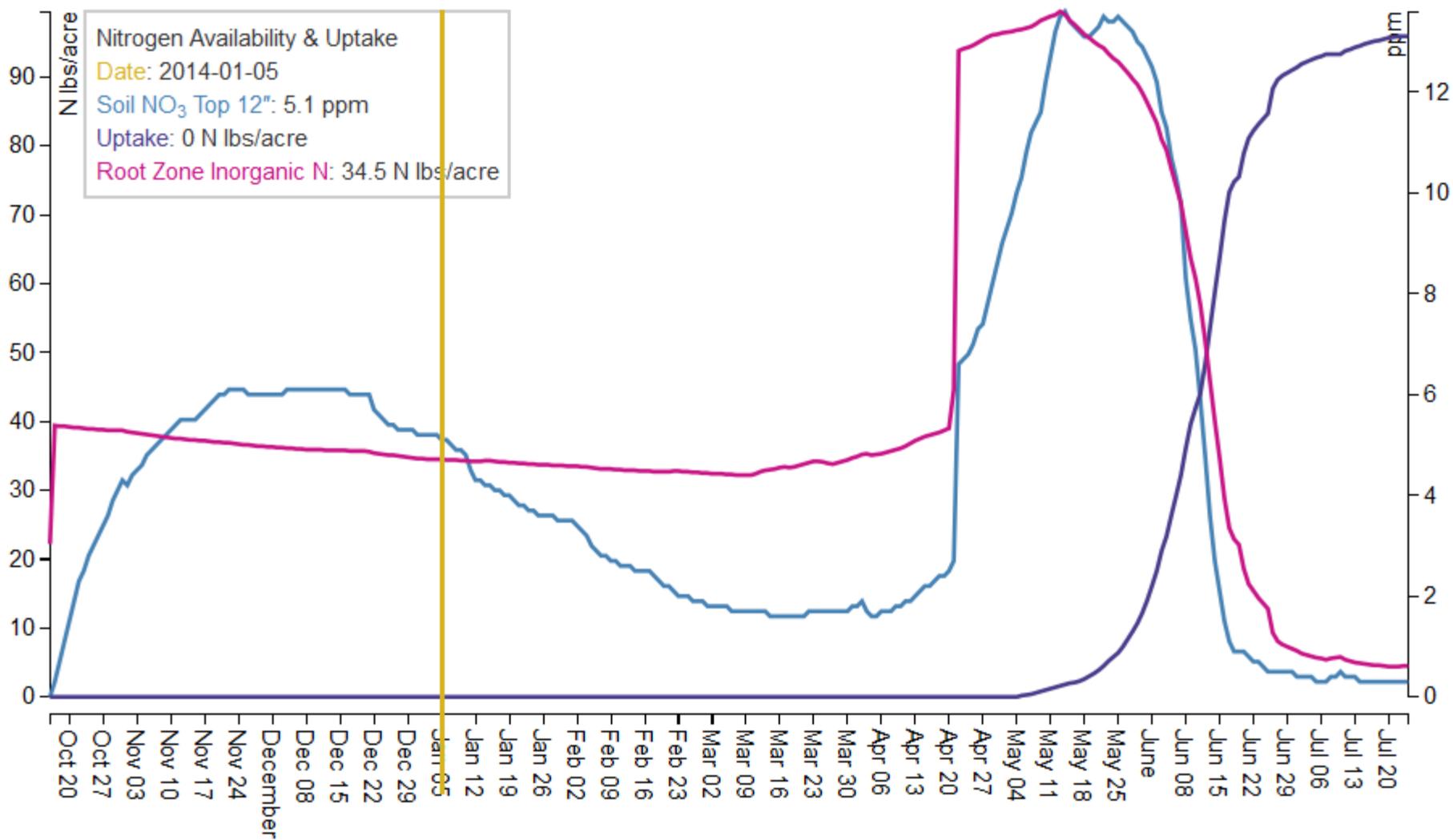
Adapt-N Graphs
Crop Growth and N Uptake

Crop Growth & N Uptake
Date: 2014-07-19
Growth Stage: 19
Uptake: 95.5 N lbs/acre
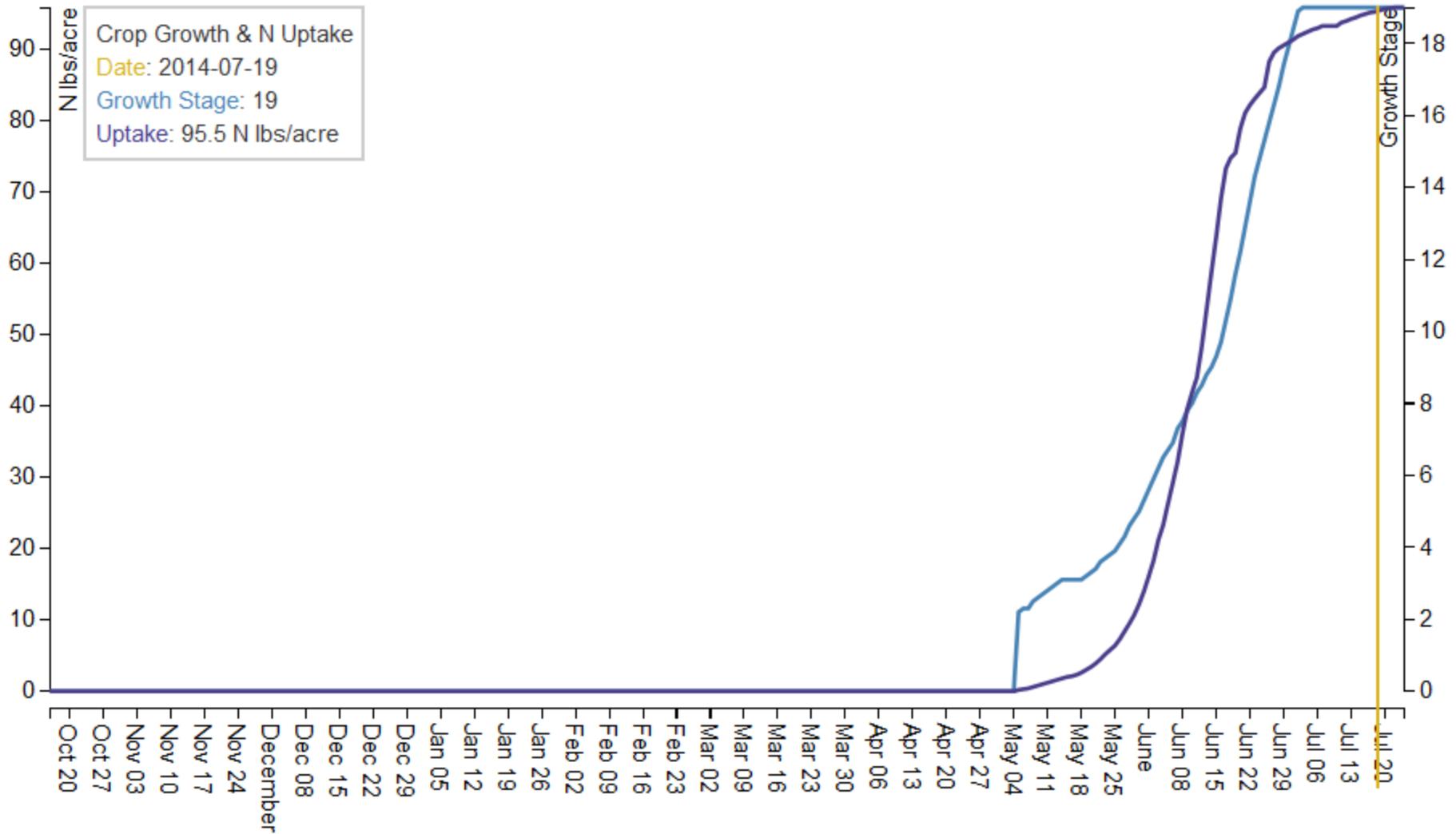
2011 – 2013 Adapt-N On-Farm Trials

Over 100 replicated trials in 10 states.

- Adapt-N vs. Grower rate: side-by-side; some with zero-N
- N response trials (4-6 N rates)

Overall Adapt-N Performance 2011-2013, New York and Iowa

Average Change due to Adapt-N use (Adapt-N - Grower-N)	By State		By N rate change		Grand Mean
	NY trials n=67	IA trials n=37	N decrease (A<G) n=87	N increase (A>G) n=17	n=104
Total N fertilizer applied (lb/ac)	-52	-29	-60	38	**-44**
Simulated N leaching loss (lb/ac)*	-11	-1	-10	3	**-8**
Simulated N total loss (lb/ac)*	-36	-4	-34	16	**-26**
Yield (bu/ac equivalent)	2	0	-2	17	**1**
Profit ($/ac)	$37	$17	$23	$65	**$30**

Wisconsin – 2013
five response trials w/ 6 N rates

Ensemble N Response

Farm: WI_107

AONR (lbs/ac): 135.4
EONR (lbs/ac): 132
Adapt-N Rate (lbs/ac): 86
Adapt-N Loss ($/ac): 22
MRTN Rate (lbs/ac): 111
MRTN Loss ($/ac): 4
Grower Rate (lbs/ac): 120
Grower Loss ($/ac): 5

$y = 1.5435x - 73.094$
$R^2 = 0.6564$

$y = 0.135x + 105.94$
$R^2 = 0.0191$
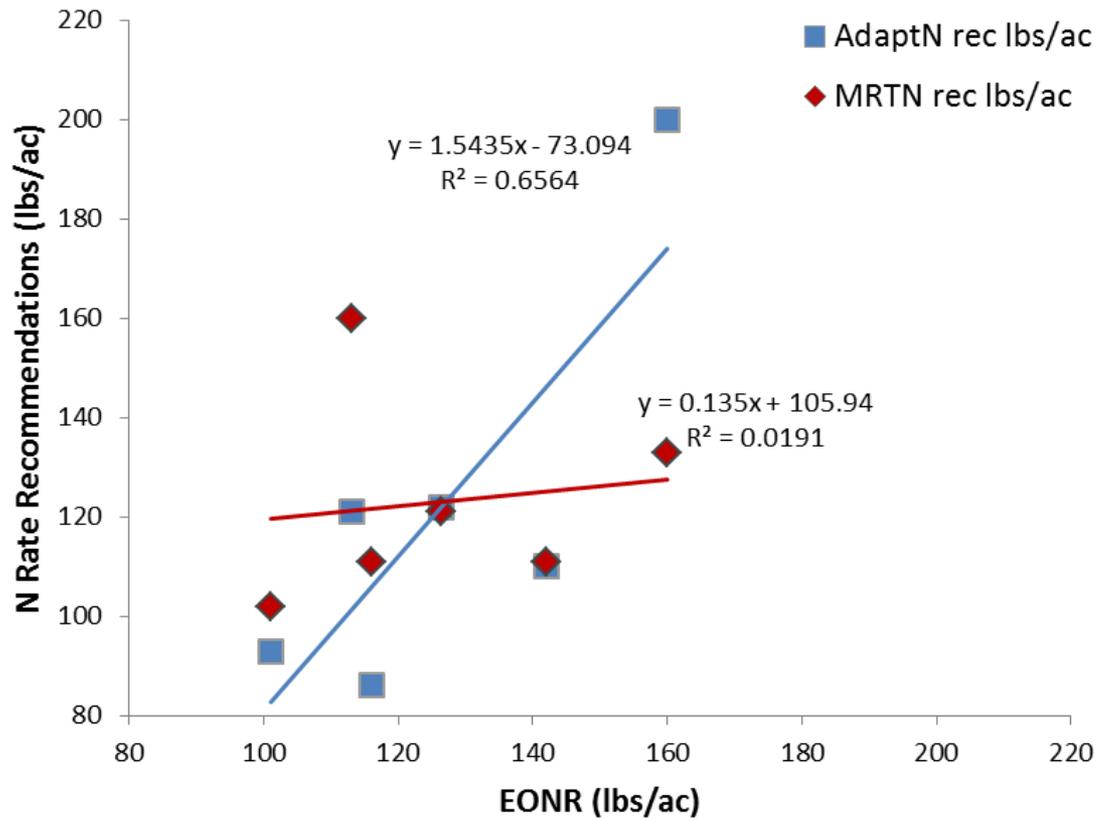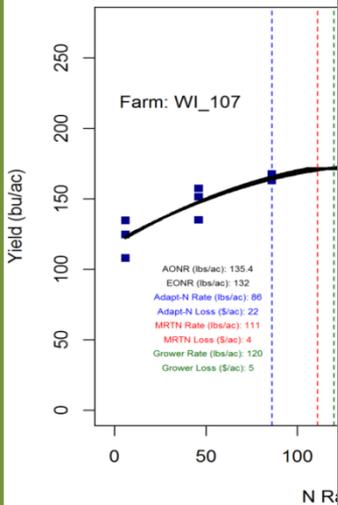
■ AdaptN rec lbs/ac
◆ MRTN rec lbs/ac

					TN		
						Profit loss	Farm Type
						$/ac	
						22	Grain
						4	Livestock
						19	Mixed
WI_109	142	70	10	111		9	Grain
WI_110	197	150	10	133		74	Grain
Average	143	104	15	121		26	

Bottom Line:
What are Adapt-N's Benefits?

- Profit increases, with overall less N use

- Economic and environmental benefits

- Transparency and insights

- Incentives for better management

Adapt-N Active Zones - July 2014
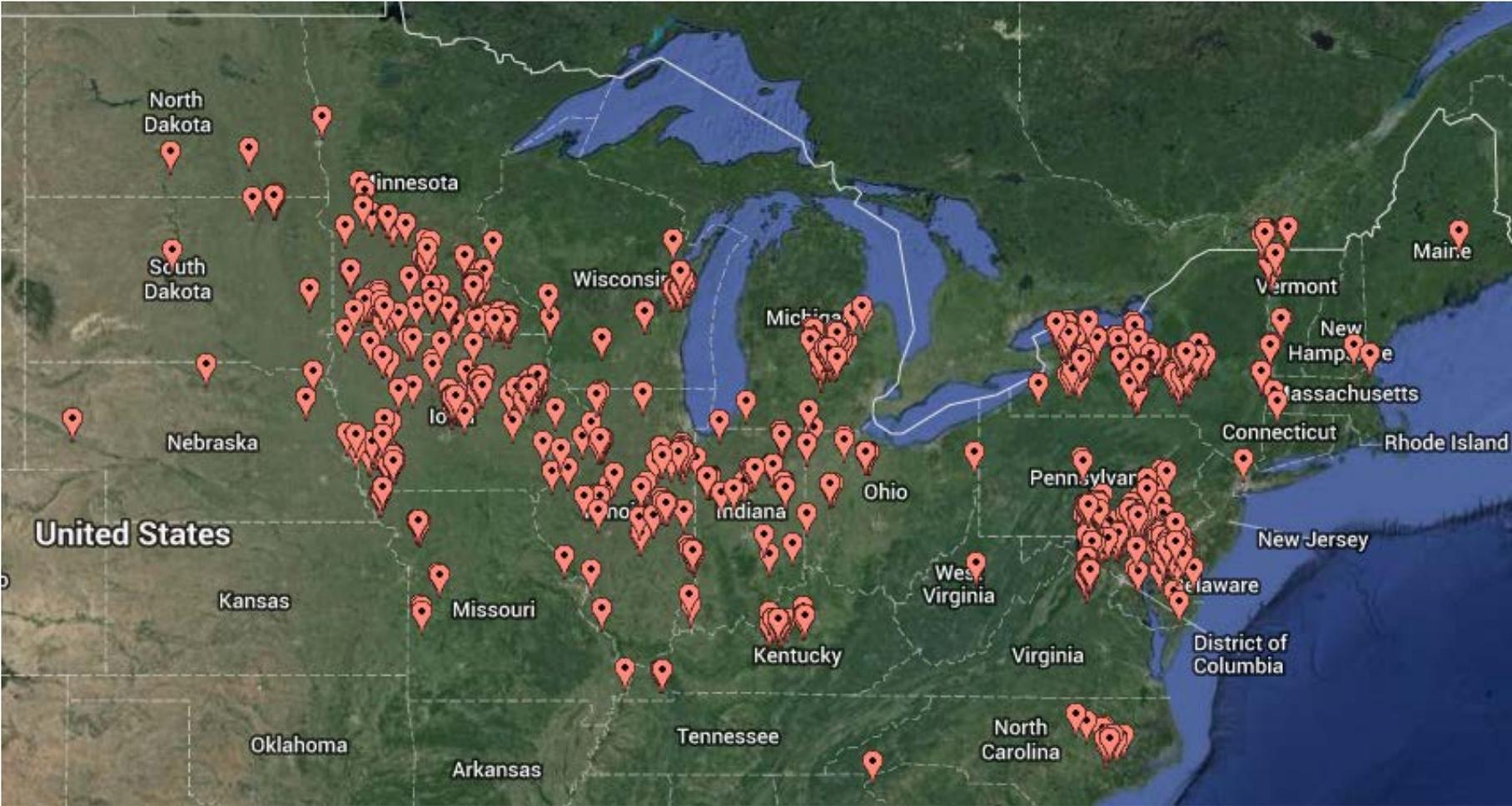
Adapt-N: In-progress

- Nitrous oxide losses (NIFA-AFRI project) – fall 2014
- Cover crops and soil health (NIFA-SARE project) – beta mode 2015
- Integration with farm GIS and data management software
- Enhanced efficiency compounds
- Canopy reflectance sensor technology?

Acknowledgements

Adapt-N Core Team

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