

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

AFRI Project Overview

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College of Agriculture and Life Sciences
Department of Crop and Soil Sciences

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

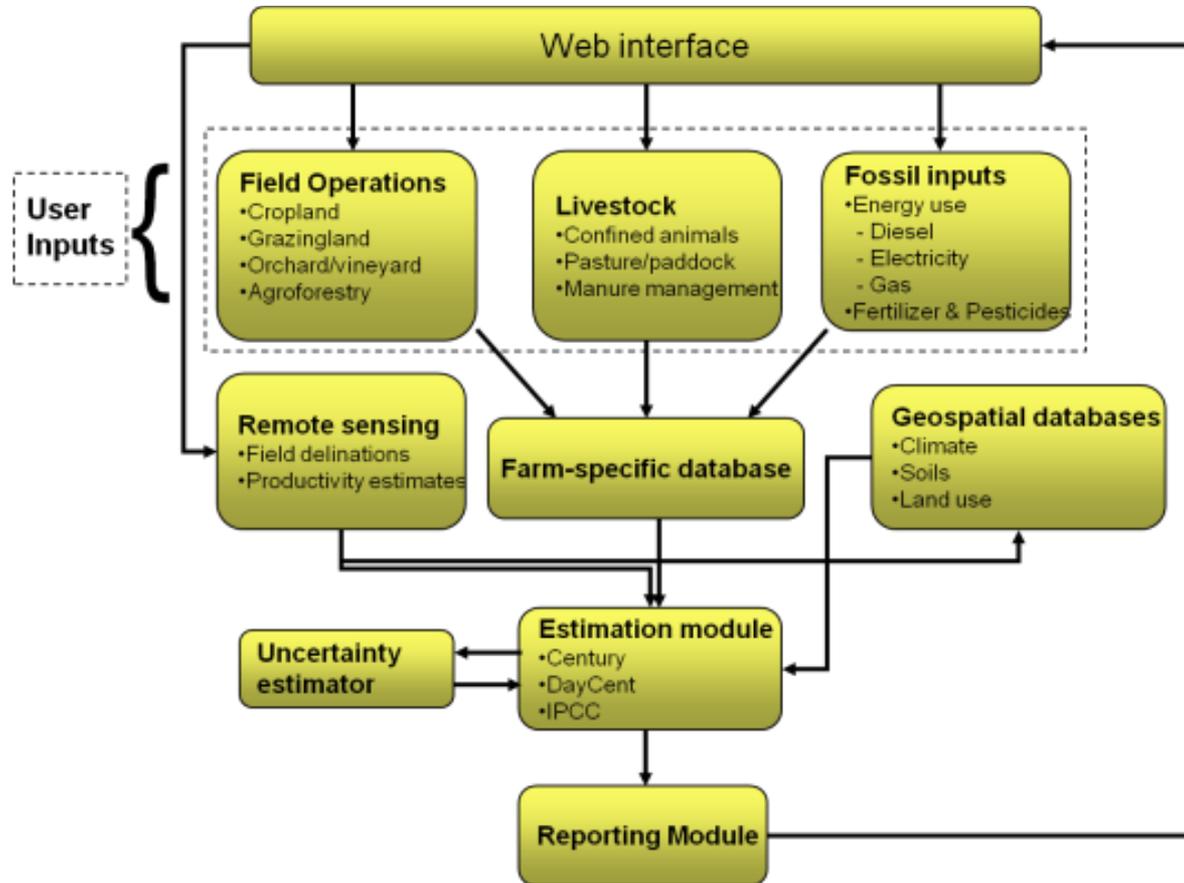


United States
Department of
Agriculture

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.



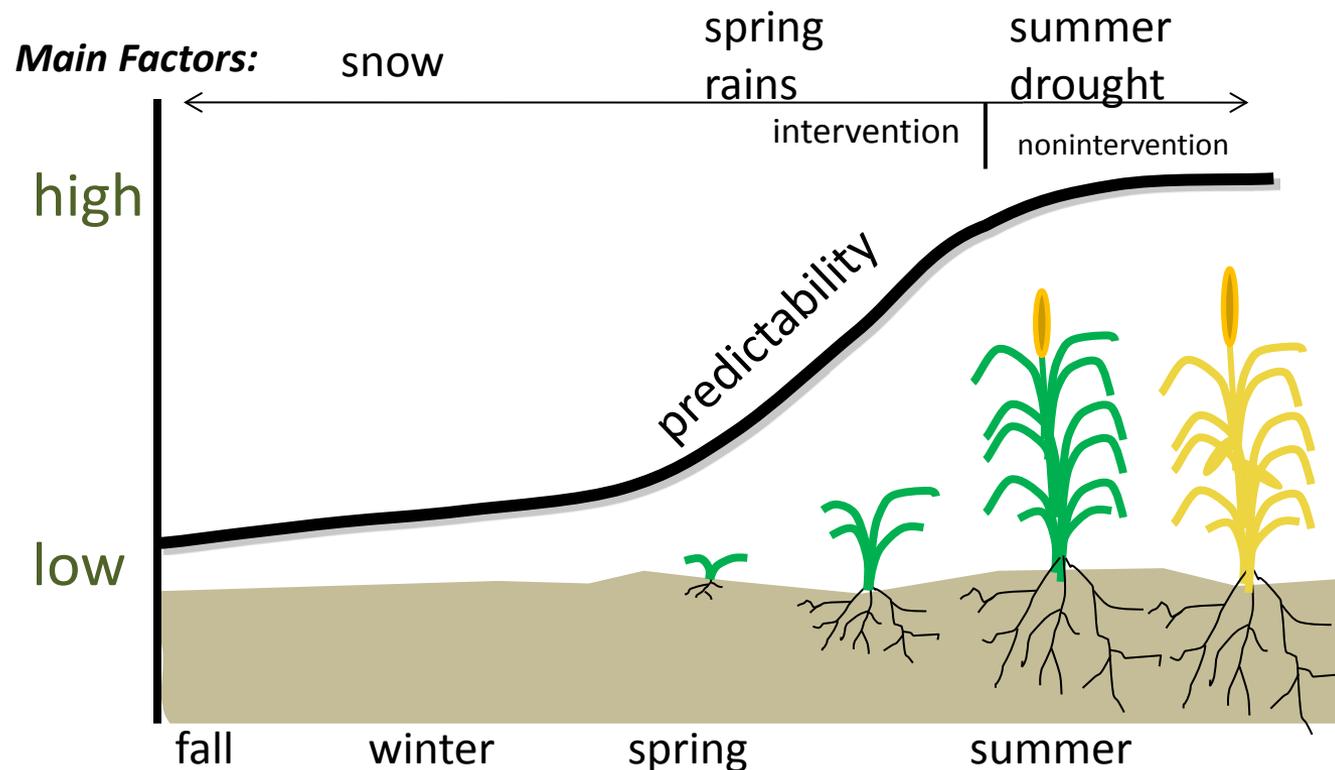
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TECHNOLOGY



Key Research Findings for Adapt-N

(Sogbedji et al., 2001)

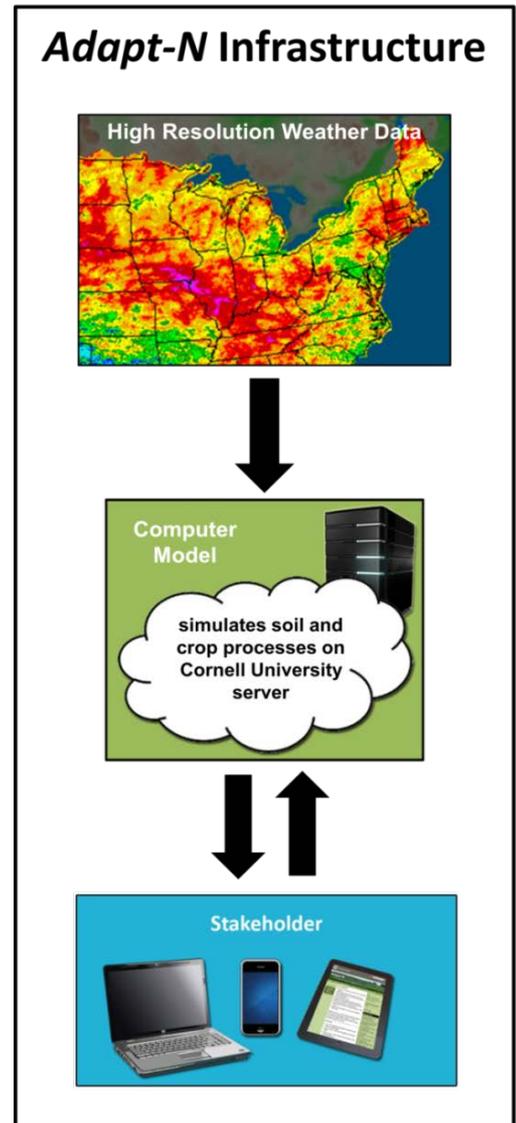
- Early-season weather strongly impacts the optimum N rate
- Computer models can use weather, soil and management inputs to make more accurate N rate recommendations.





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



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

Adapt-N Commercialization through Agronomic Technology Corporation

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



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TECHNOLOGY

Adapt-N.com

adapt-N Science Results Features Uses In Action ▾ Sign Up Login

The weather changes.
Shouldn't your nitrogen rates?

What

- The world's most advanced nitrogen recommendation software for corn production
- [AgProfessional's Best New Product of the Year](#)

Why

- Anticipate nitrogen stress to avoid yield losses
- Reduce excess fertilizer applications
- Identify yield improvement opportunities

How

- Real science, proven in the corn belt and beyond
- Results based on weather, crop, and soil factors
- Designed for in-field use

Who

- A science + technology team focusing solely on your results
- Independent: No affiliation with seed, fertilizer, or insurance sales
- We firmly believe your data is yours. Period.

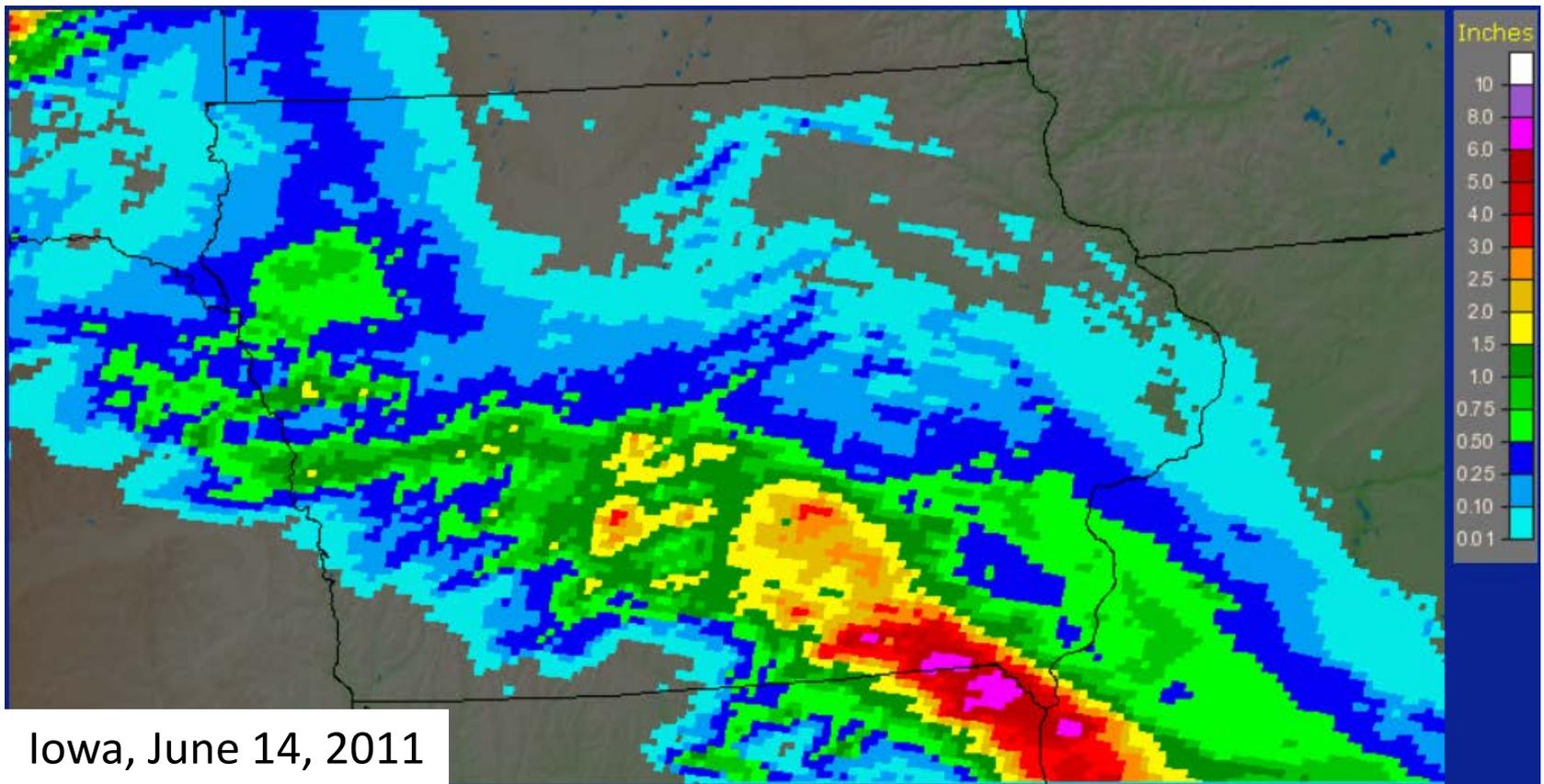
Put Adapt-N to work for your farming operations [+ Sign up](#)

Scientist created. Agronomist tested. Grower approved.

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

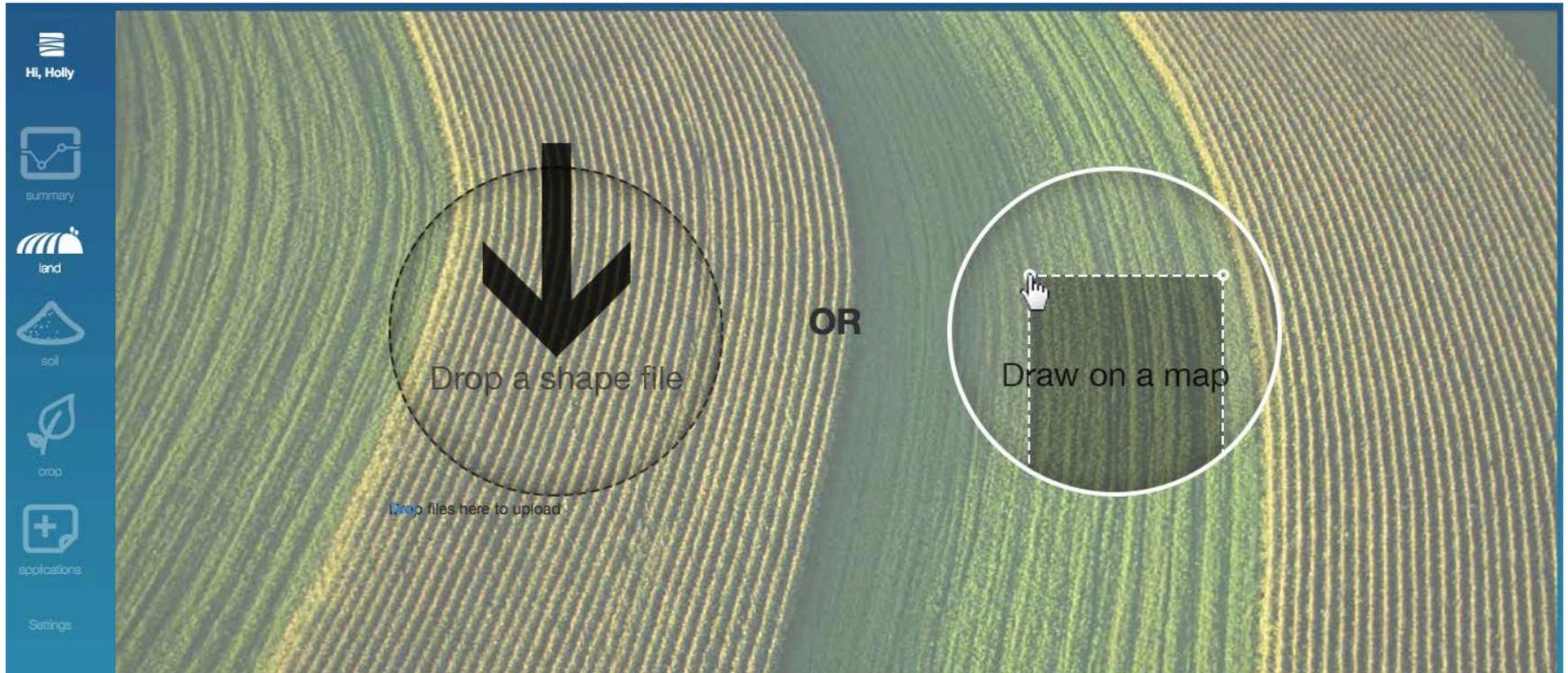
- High resolution daily precipitation & temperature data
- Soils: texture/soil type, slope, rooting depth, % organic matter (NRCS databases)
- N fertilizer applications: rate, type, timing, placement
- Cultivar: Silage, grain, or sweet corn; planting date, maturity class
- Population and expected yield
- 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



Adapt-N Interface

Defining your location



Adapt-N Interface

Viewing your locations

The screenshot displays the Adapt-N interface. On the left is a sidebar with navigation icons for Summary, Land, Soil, Crop, and Applications. The main panel is titled 'FIELDS & ZONES' and shows a list of zones for a field named 'NE'. The zones are numbered 1 through 4, each with specific soil and planting information. To the right is a satellite map of the field, with the four zones highlighted in different colors (yellow, green, blue, purple) and numbered 1 through 4. The map is divided into sections labeled 'West', 'East', and 'NE'. A control panel on the left of the map includes a compass, a person icon, and zoom in/out buttons.

Hi, David

FIELDS & ZONES

Field: NE
Soil: Clarion Loam,
140.37 Acre; Zones: 4
Planting date: Apr 12, 2014.

+ Zone

- 1 Zone: 1**
Soil: Anken Fine Sandy Loam
Planting: Apr 12, 2014.
112 day grain corn
- 2 Zone: 2**
Soil: Dickinson Fine Sandy Loam
Planting: Apr 12, 2014.
112 day grain corn
- 3 Zone: 3**
Soil: Clarion Loam
Planting: Apr 12, 2014.
112 day grain corn
- 4 Zone: 4**
Soil: Webster Clay Loam
Planting: Apr 12, 2014.
112 day grain corn

West East NE

Imagery ©2014 DigitalGlobe, Kucera Intl./Story County

Adapt-N Interface

Entering Soil Information

The screenshot displays the Adapt-N web application interface. On the left is a dark blue sidebar with navigation icons and labels: 'Hi, John', 'summary', 'land', 'soil', 'crop', 'applications', 'Settings', and 'Logout'. The main content area is divided into a form on the left and a satellite map on the right.

Form Fields:

- Zone Name:
- Estimated Acres:
- Slope %:
- Artificial Drainage:
- Soil Type/Texture:

Soil Type/Texture Dropdown Menu:

- Select
- Soil Textures --
- Clay Loam
- Loam
- Sandy Loam
- Silty Clay** (highlighted)
- Silty Clay Loam
- Silt Loam
- Soil Series --
- Ackmore
- Adair
- Afton
- Albaton
- Arispe
- Atterberry
- Bassett
- Bode
- Bolan

Map: A satellite map showing a rural landscape with fields, roads, and water bodies. A red location pin is placed on a field. Labels on the map include 'CAMERIDGE', 'Ballard Creek', 'South Skunk River', '4th St', and '595th Ave'. Map controls like a compass and zoom are visible in the top left of the map area. 'Map' and 'Satellite' buttons are in the top right.

Adapt-N Interface

Entering Soils Information



Hi, Holly



summary



land



soil



crop



applications

Settings

SOIL INFORMATION

Tillage Method	Conservation Tillage	Soil Test	There was a soil test in the last 3 years
Tillage Date	N/A	Soil Test Sample Depth (Inches)	6.7
Tillage Depth (Inches)	N/A	Soil Organic Matter %	3.3
Tillage % Residue	25%		

Submit

Adapt-N Interface

Entering Crop Information

Hi, Dashboard

summary

land

soil

crop

applications

Settings

CROP INFORMATION

Cultivar Type	76 - 80 days to harvest	Previous Crop	Grain Corn
Expected Yield	Select Yield	Sod Termination Date	None
Planting Date	None	Sod Legume Percent	Select Percentage
Planting Density	22500	Sod Termination Method	Select Method

Submit

Pick fields or zones to apply:

- Field: East
- Zone: NW Slope
- Zone: NW Plain
- Zone: North Creek
- Zone: Southern Wood
- Zone North
- Field: Southeast
- Field: South
- Field: Southwest
- Field: West
- Field: North

Adapt-N Interface

Entering N Fertilizer Inputs

The screenshot shows the Adapt-N interface for entering nitrogen fertilizer inputs. The interface is divided into three main sections: a left sidebar, a central application configuration panel, and a right sidebar for field selection.

Left Sidebar: A vertical navigation menu with icons and labels for 'Summary', 'Land', 'Soil', 'Crop', and 'Applications'. The 'Applications' icon is highlighted with a white plus sign. The user's name 'Hi, David' is displayed at the top of the sidebar.

Central Panel: APPLICATION: NITROGEN

- Starter:** A toggle switch set to 'No'.
- Placement depth:** An empty text input field.
- Type:** A dropdown menu.
- Date:** An empty text input field.
- Amount (lbs/acre):** A dropdown menu.
- Buttons:** 'Submit' (black) and 'Cancel' (white) buttons.

Right Panel: Pick fields or zones to apply:

- Field: East:** Unchecked checkbox. A yellow tooltip above it says 'Last updated Apr 21, 2014.' A mouse cursor is hovering over the checkbox.
- Zone: NW Slope:** Checked checkbox.
- Zone: NW Plain:** Unchecked checkbox.
- Zone: North Creek:** Unchecked checkbox.
- Zone: Southern Wood:** Unchecked checkbox.
- Zone North:** Unchecked checkbox.
- Field: Southeast:** Unchecked checkbox.
- Field: South:** Unchecked checkbox.
- Field: Southwest:** Unchecked checkbox.
- Field: West:** Unchecked checkbox.
- Field: North:** Unchecked checkbox.

Adapt-N Interface

Entering Manure Inputs

Hi, Dashboard

summary

land

soil

crop

applications

Settings

APPLY MANURE

Application Date

Incorporation Method

Amount Applied

Unit

Ammonium N

Organic N

Solids

Add

PAST APPLICATIONS

DATE APPLIED	AMOUNT	AMMONIUM	ORGANIC	SOLIDS	INCORPORATED	REMOVE	EDIT
2013-11-04	5.0 ton/acre	26.00 lbs/ton	18.00 lbs/ton	5%	On Surface	X	

Adapt-N Interface

Entering Irrigation Inputs

The screenshot displays the Adapt-N interface. On the left is a dark blue sidebar with navigation icons and labels: 'Hi, Dashboard', 'summary', 'land', 'soil', 'crop', 'applications', and 'Settings'. The main content area is light gray. At the top, the heading 'APPLY IRRIGATION' is followed by two input fields: 'Application Date' with a placeholder 'YYYY-MM-DD' and 'Inches' with a dropdown menu showing 'Select Amount'. Below these is a dark blue 'Add' button. Further down, the heading 'PAST APPLICATIONS' is followed by a table with columns for 'DATE APPLIED', 'AMOUNT IN INCHES', 'DELETE', and 'EDIT'. The table contains two rows of data.

APPLY IRRIGATION

Application Date:

Inches:

Add

PAST APPLICATIONS

DATE APPLIED	AMOUNT IN INCHES	DELETE	EDIT
2014-03-04	0.75	X	
2014-03-12	1.25	X	

Zone Recommendation

Date selection

Hi, Greg

RECOMMENDATION

Farm: Cambridge Farm
Field: Skunk River 33
Zone: Whole Field

Soil Type: Webster
Planted: 2014-06-01
Growth Stage: V14

Map Data Terms of Use

summary
land
soil
crop
applications
Settings
Logout

YYYY-MM-DD

Created for 2014-Jul-23.

140 lbs N/Acre Sidedress N Recommendation	124 - 156 Rec Range (lbs N/Acre)	40 lbs N/Acre N Fertilizer Already Applied
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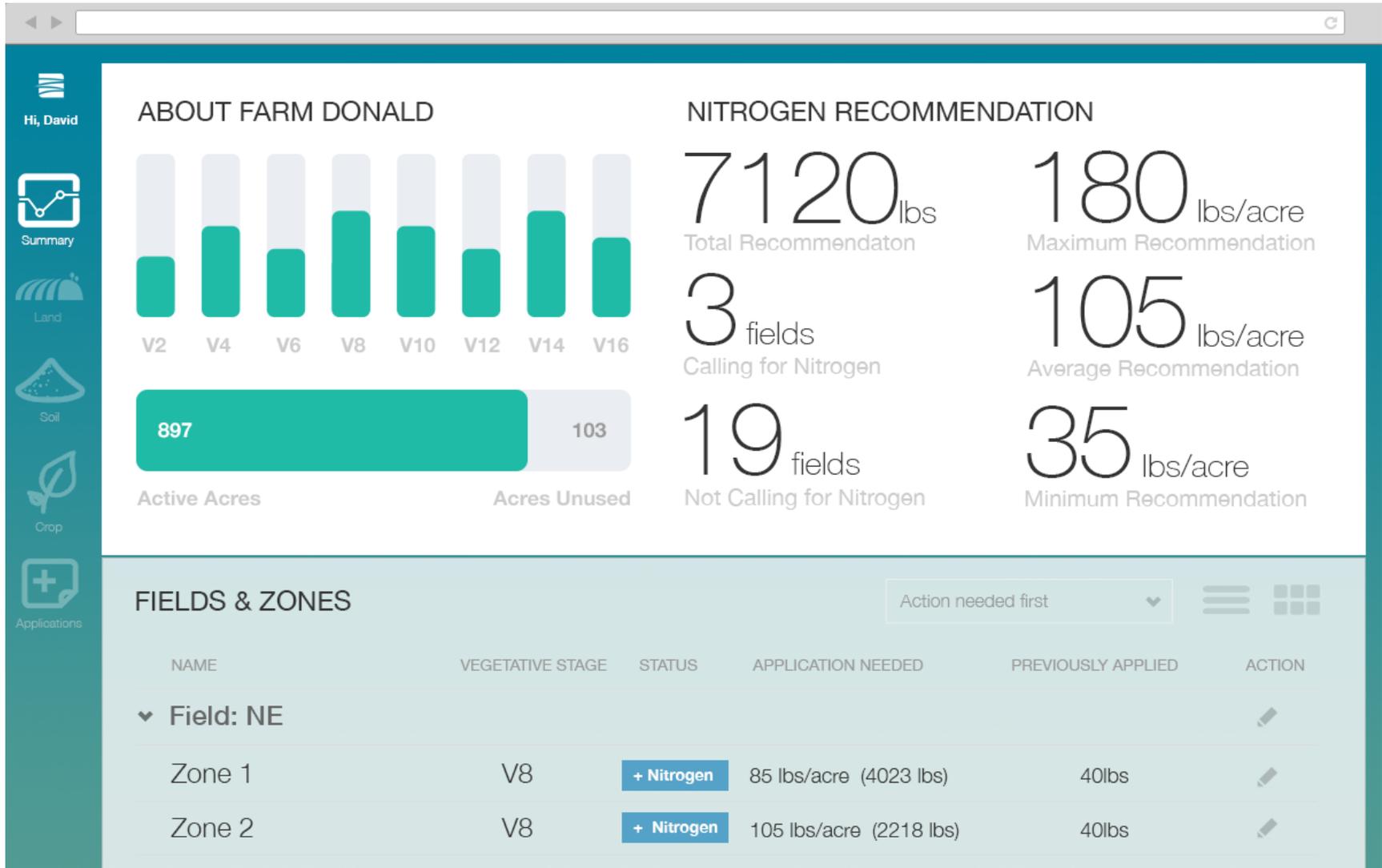
Recommendation based on supporting estimates and assumptions:

184 lbs N/Acre Expected N in crop at harvest	68 lbs N/Acre N mineralization so far	54 lbs N/Acre N loss so far
0 lbs N/Acre Partial credit from prior crop	48 lbs N/Acre N in crop now	21 lbs N/Acre Expected future loss
2 lbs N/Acre Expected future mineralization	6 lbs N/Acre N in soil now	13.2"/27.6" Rainfall since planting / since 01/01/14
2 lbs N/Acre Current Nitrate N top 12" Virtual PSNT: 0.5 ppm	2.2"/4.3" Water in root zone / field capacity	6 lbs N/Acre Root zone inorganic N

View as a short or full PDF. View Graphs.

Data was last updated 2014-Jul-23 05:39:37.

Farm Summary



Agronomist Summary

AGRONOMIST VIEW



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 Recommendation

0 lbs/acre

Minimum Recommendation

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 Nitroaen Needed		

Standard Report - PDF



Nitrogen Recommendation

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

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

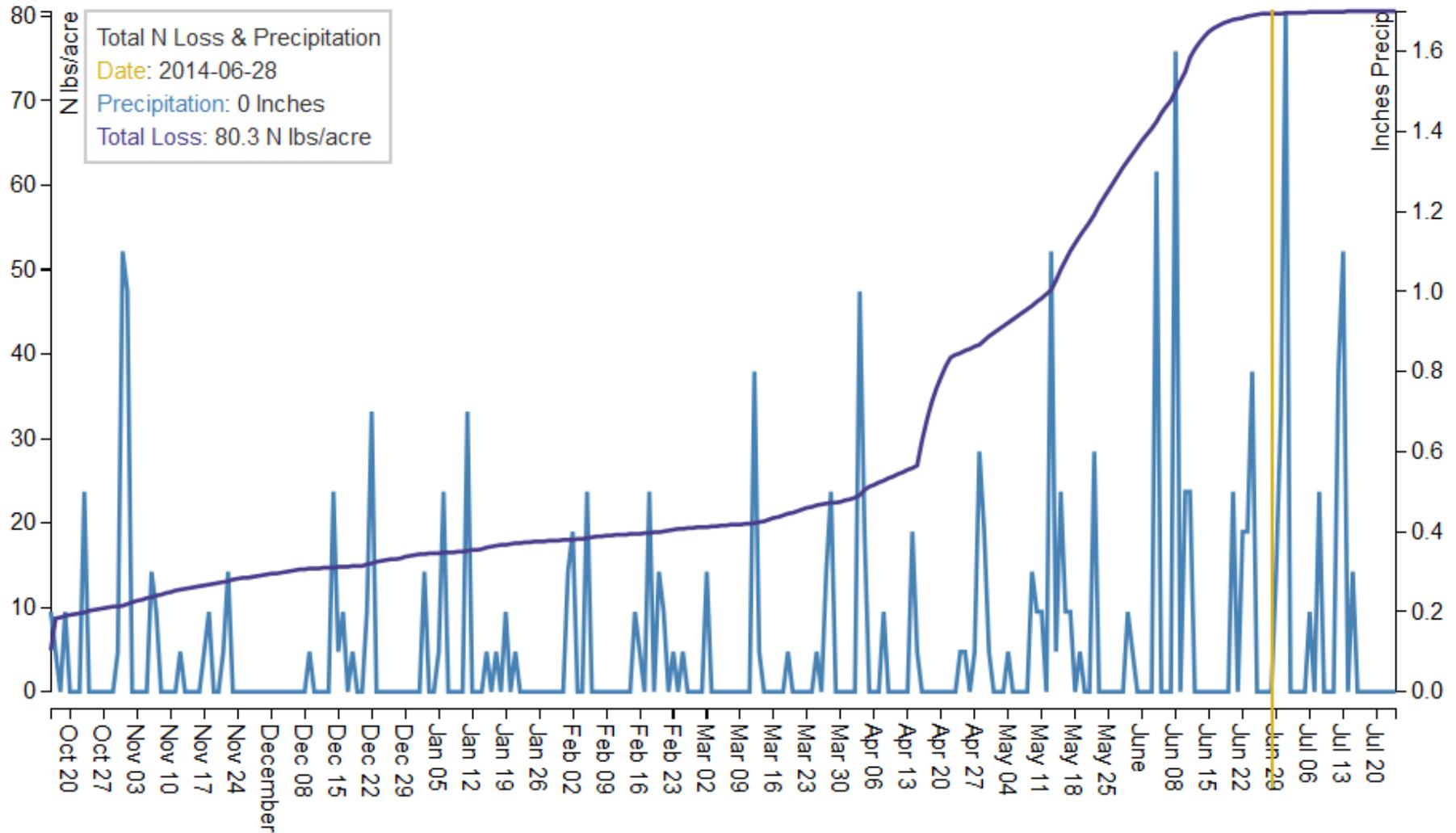
Summary of N Alerts across 1 farm, 1 field, 4 zones
 max: 105, min: 95, avg 98
 Alert Threshold: 10

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



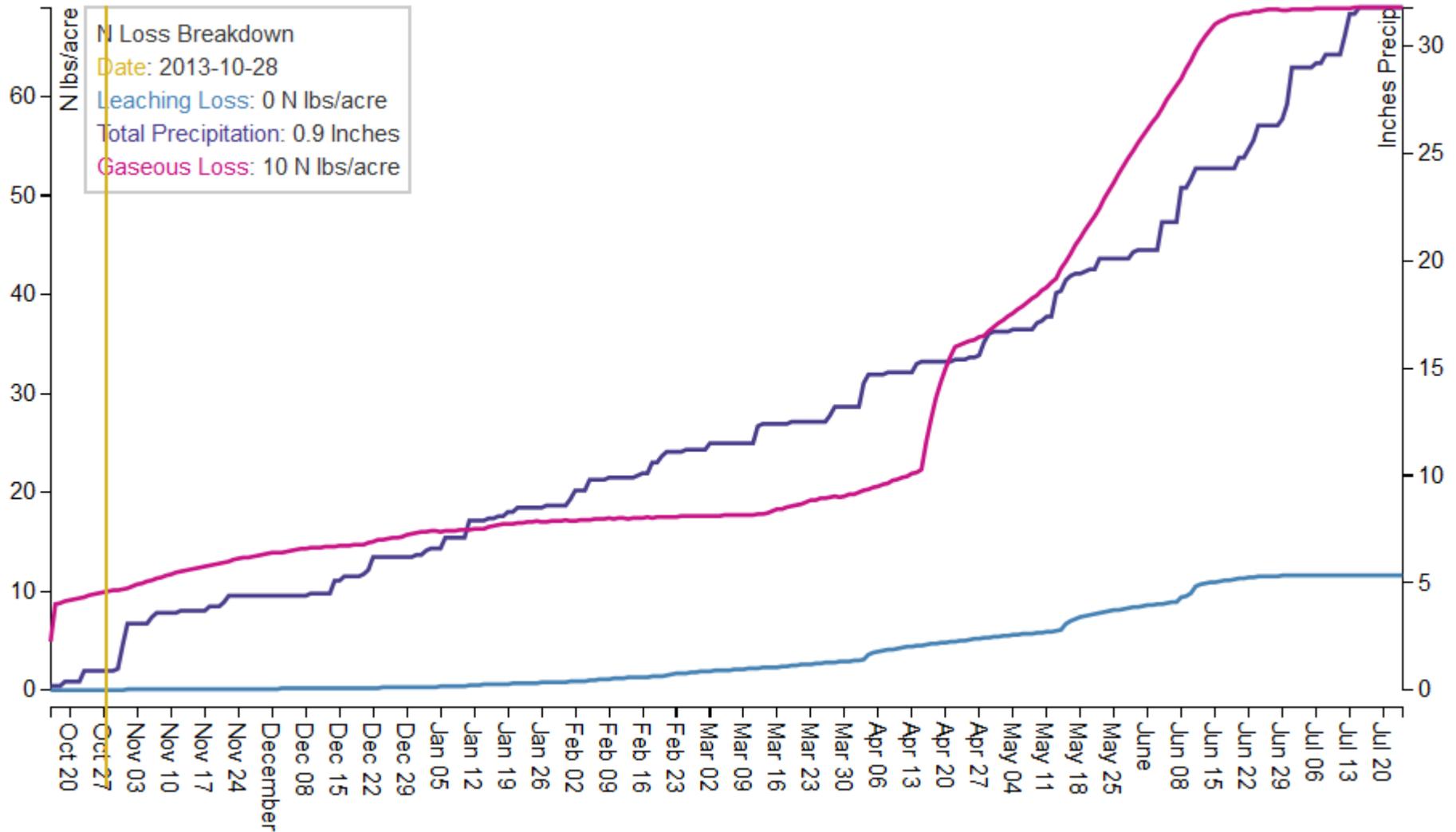
Adapt-N Graphs

Precipitation and Total N Loss



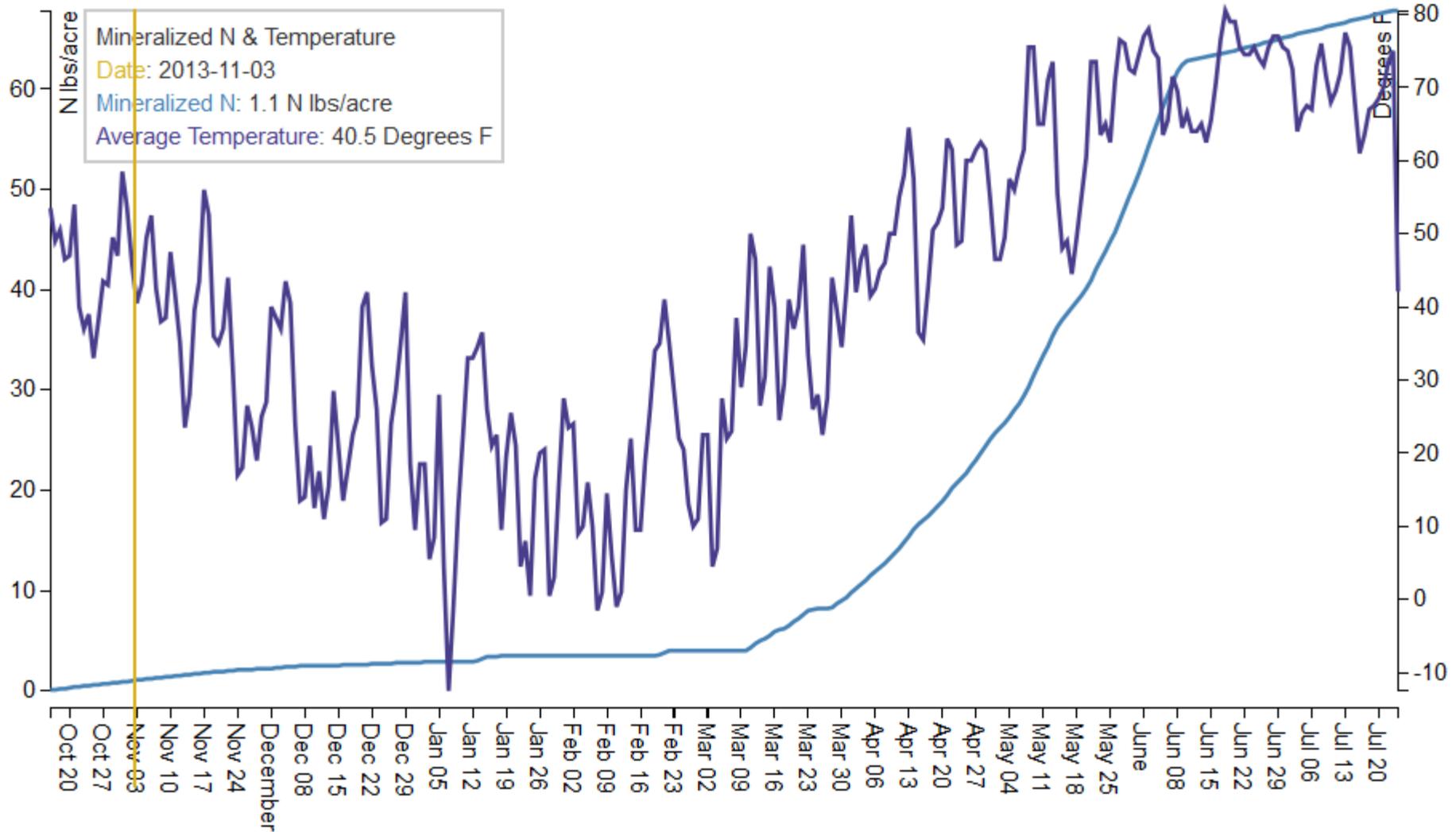
Adapt-N Graphs

cumulative precipitation; leaching and gaseous N losses



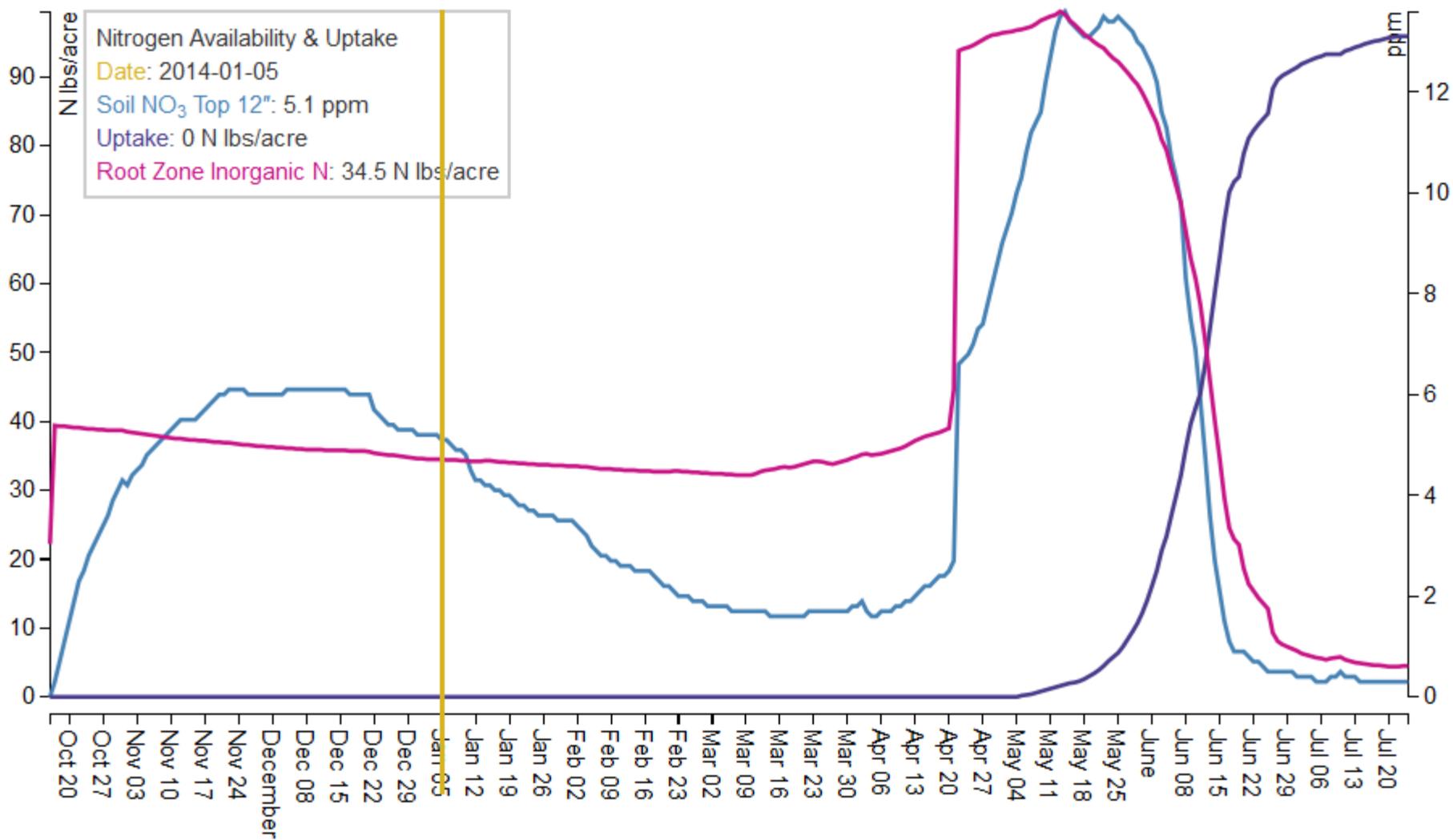
Adapt-N Graphs

Mineralized N and Temperature



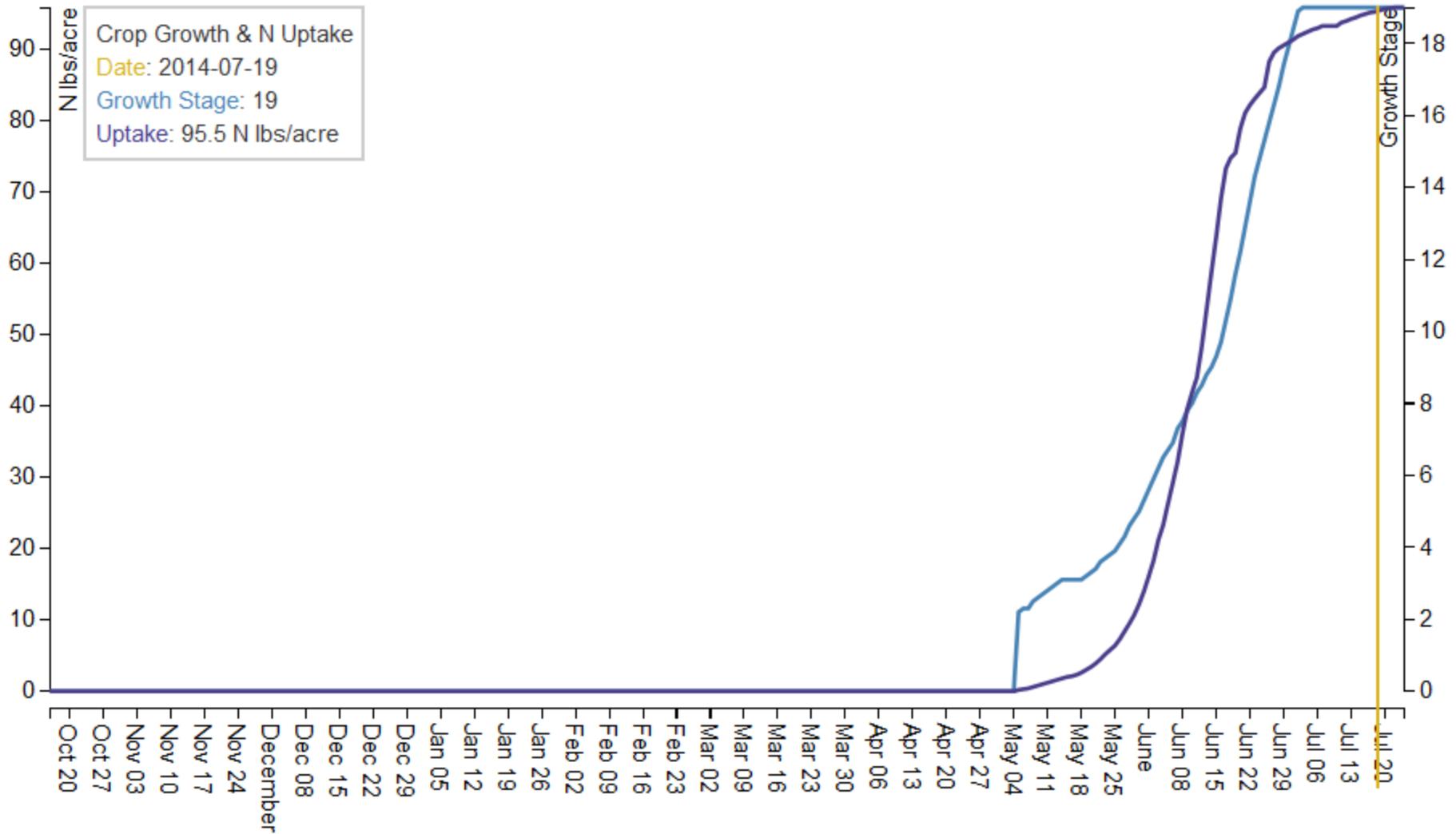
Adapt-N Graphs

Nitrogen Availability and Uptake



Adapt-N Graphs

Crop Growth and N Uptake



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)



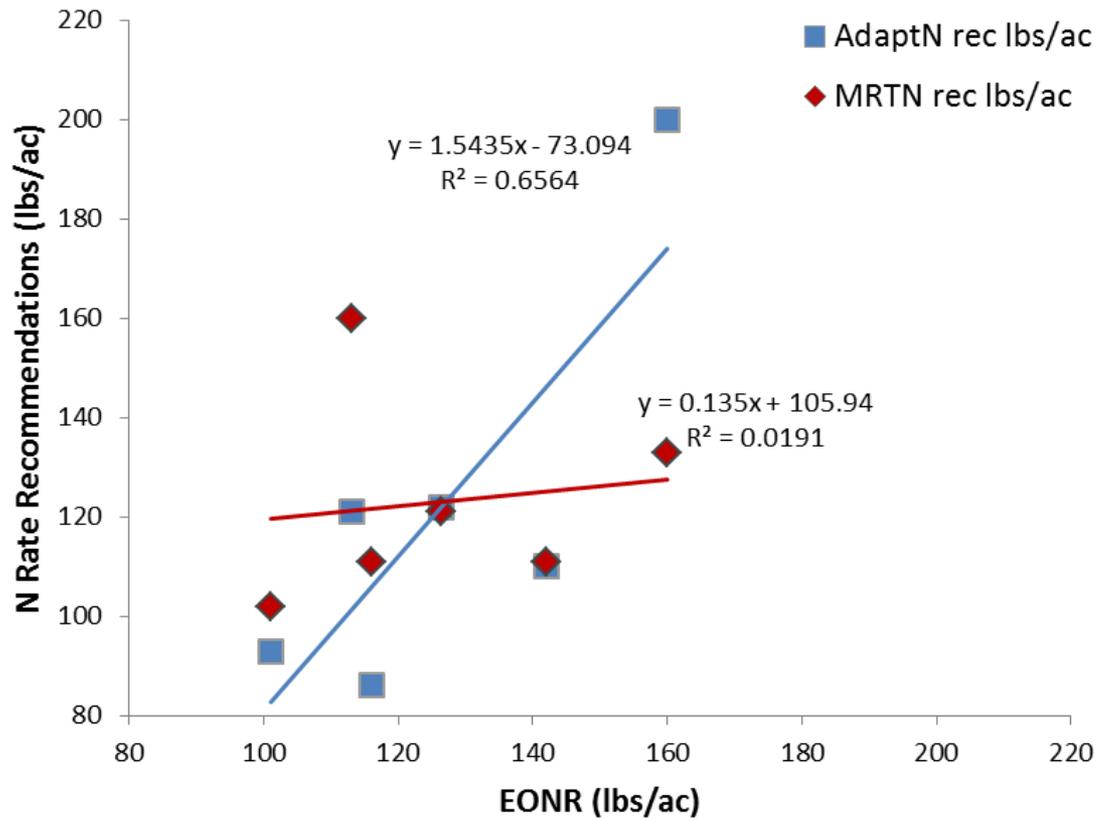
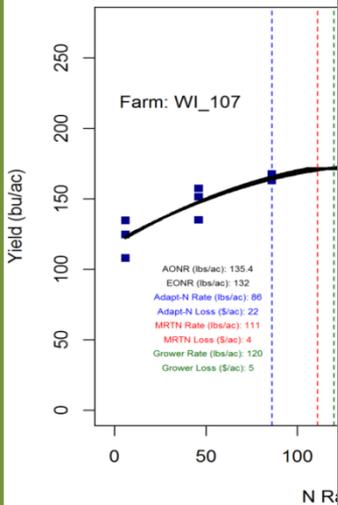
Overall Adapt-N Performance 2011-2013, New York and Iowa

Average Change due to Adapt-N use (Adapt-N - Grower-N)	By State		By N rate change		Grand Mean n=104
	NY trials n=67	IA trials n=37	N decrease (A<G) n=87	N increase (A>G) n=17	
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



	EONR (lbs/ac)	AdaptN rec lbs/ac	MRTN rec lbs/ac	Grower Rate (lbs/ac)	Grower Loss (\$/ac)	TN	Farm Type
WI_109	142	70	10	111	9	Grain	
WI_110	197	150	10	133	74	Grain	
Average	143	104	15	121	26		

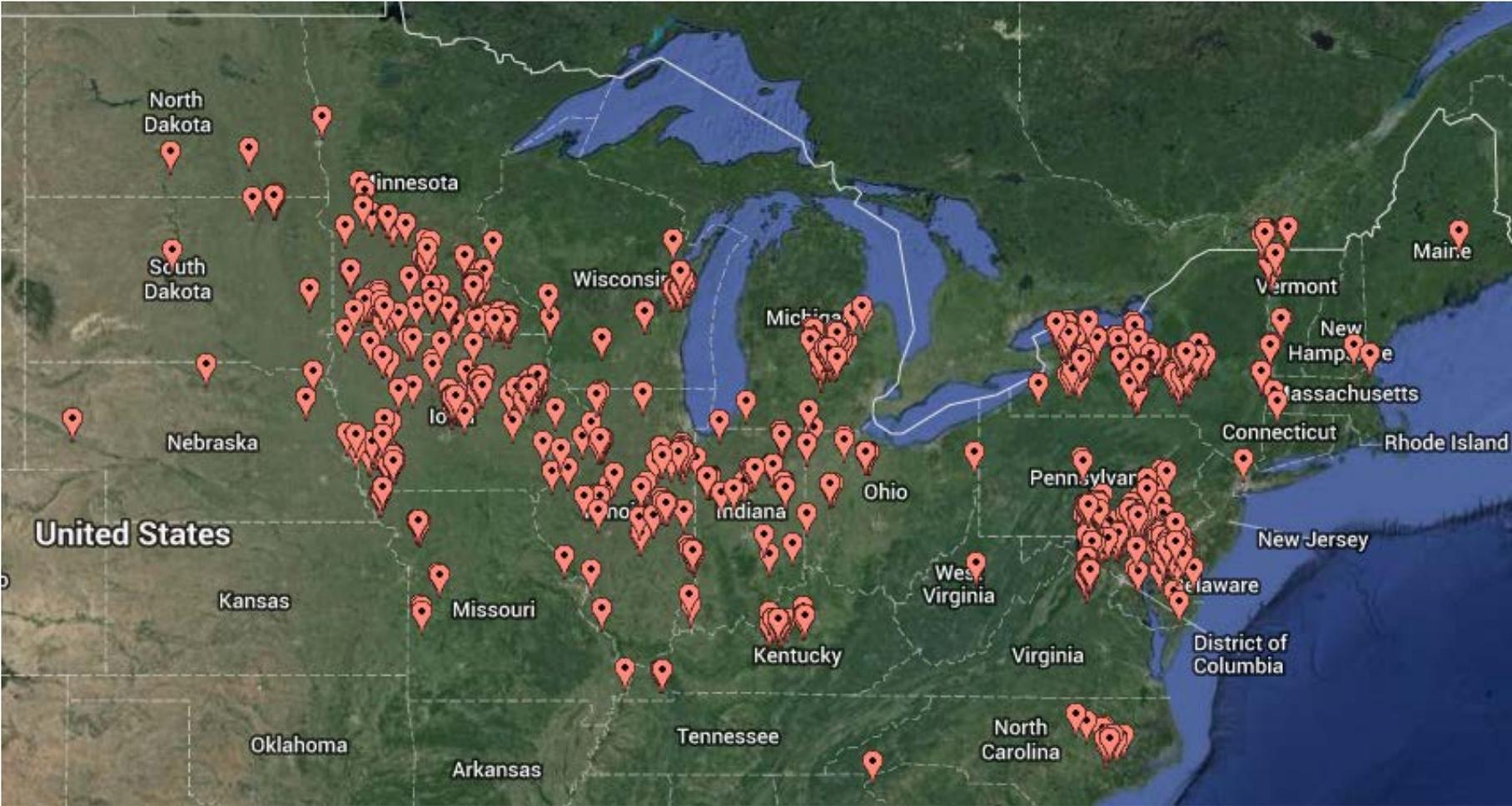
Bottom Line:

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

Harold van Es

Jeff Melkonian

Art DeGaetano

Laura Joseph

Bianca Moebius-Clune

Bob Schindelbeck

MGT Envirotec – Iowa

Agronomic Technology

Corporation

Funders

USDA-NIFA Special Grant

USDA-AFRI

Northern New York Agricultural
Development Program

New York Farm Viability Institute

USDA-NRCS

McKnight, Packard and Walton
Family Foundations

Environmental Defense Fund

International Plant Nutrition
Institute

