Adapt-N: Incorporating Weather Information Into Sweet Corn Nitrogen Management

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Adapt-N.cals.cornell.edu

Nitrogen Concerns in Maize Production Systems

Agronomic/Economic

- ~ $5 billion/yr of N fertilizer applied to corn; large input costs for a farmer
- N use efficiency low (30-70%)
- High uncertainty, and sensitivity to climate change

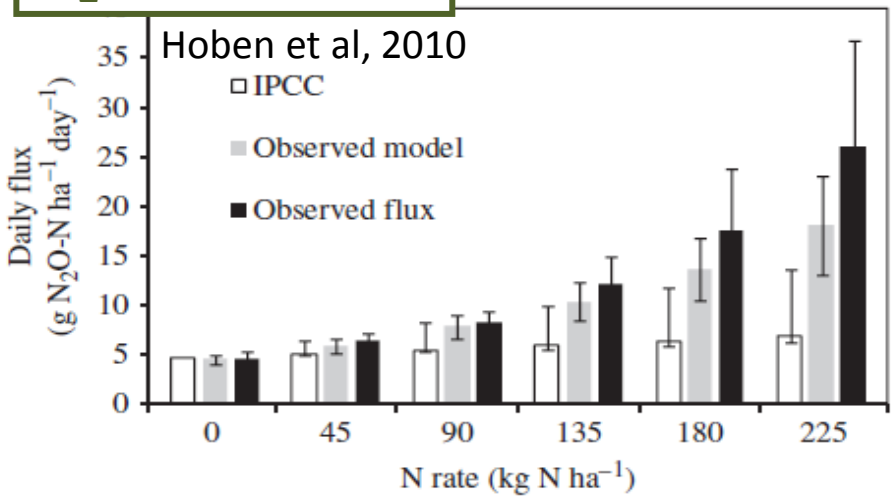
Environmental

- Largest energy input into cropping system
- Greenhouse gas emissions (esp. N_2O)
- High groundwater nitrate levels
- Hypoxia/anoxia in estuaries

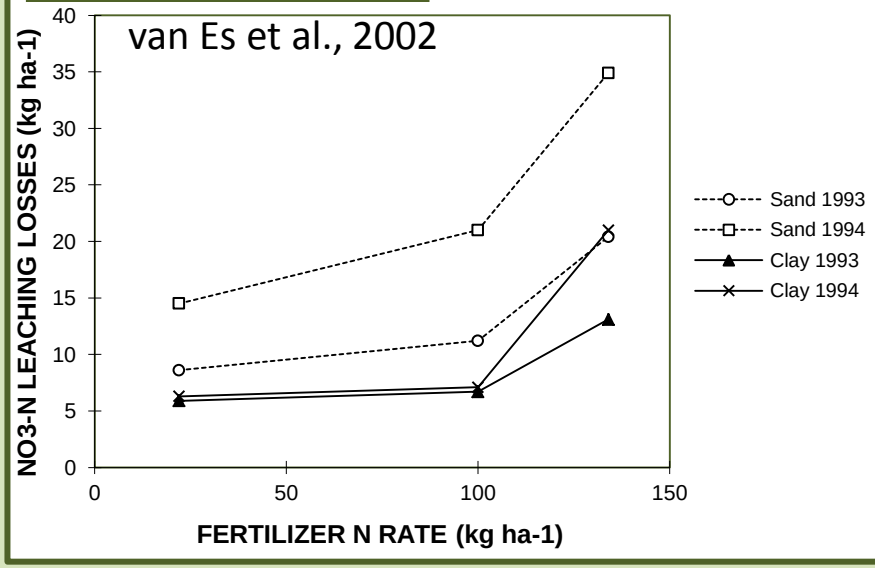
Win-Win Opportunities in Precise Estimation of Maize N Fertilizer Needs

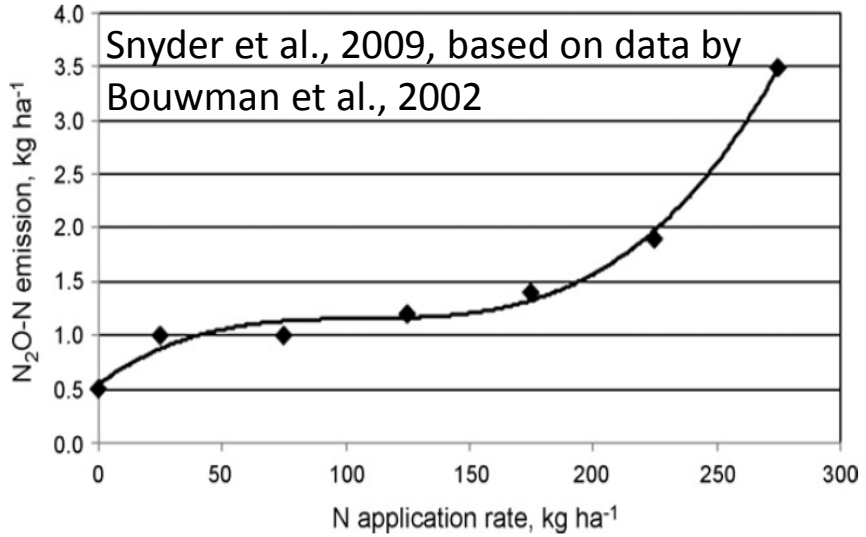
****Exponential N losses occur when crop demand is exceeded****

N_2O emissions



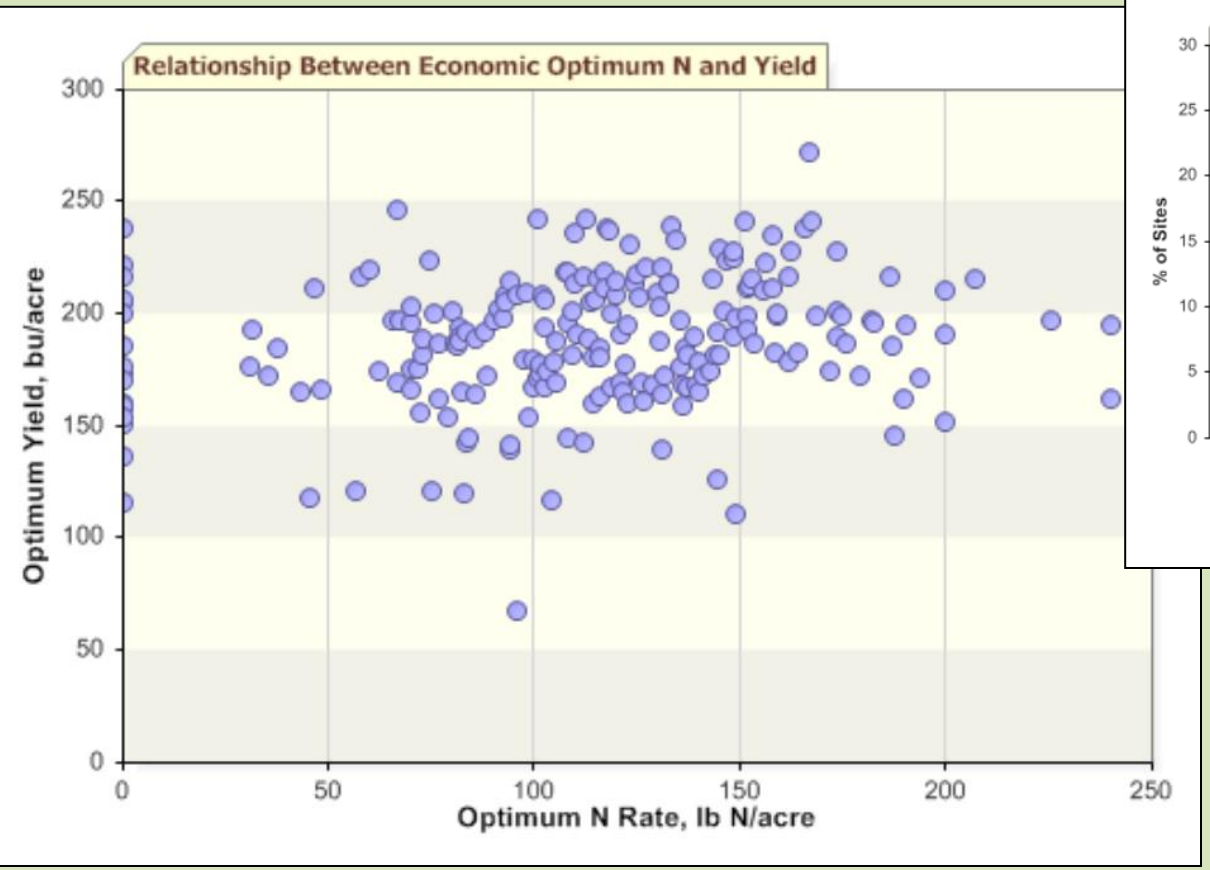
NO_3^- leaching

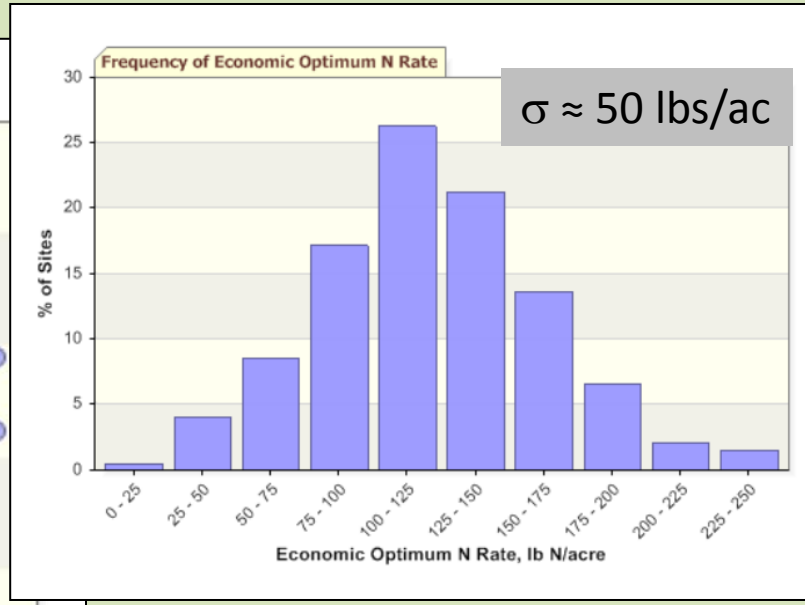




How Can We Predict Seasonal Corn N Fertilizer Needs?

Optimum Yield vs. Economic Optimum N Rate
(MRTN, fertilizer = $0.60/lb; corn = $6/bu)

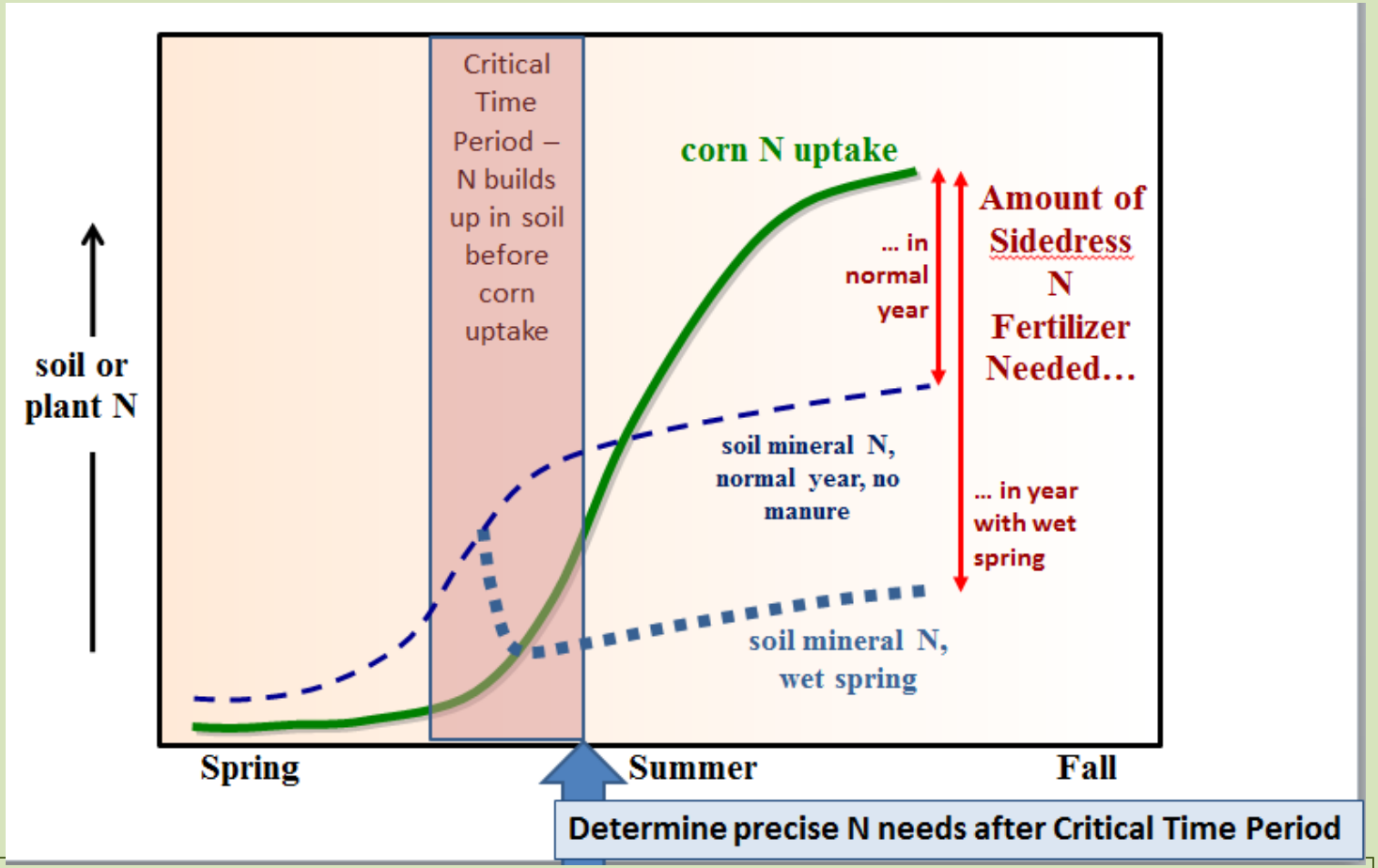




From: http://extension.agron.iastate.edu/soilfertility/nrate.aspx

Variation in N availability controlled by Weather Interacting with Soil and Management

Early-season weather, esp. rainfall quantities and timing

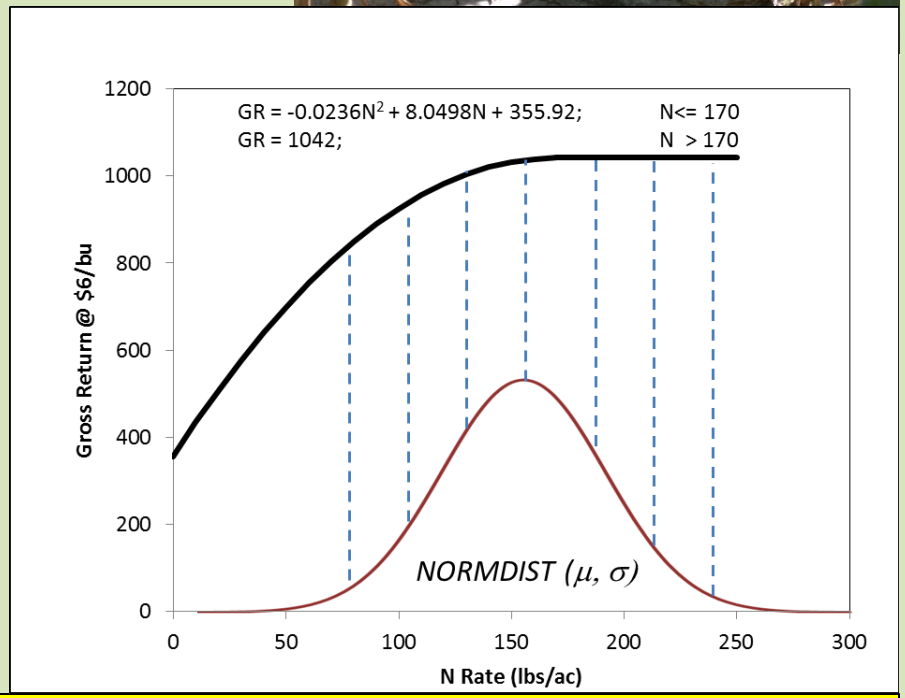


→ EONR <u>cannot</u> be accurately predicted at the beginning of the growing season

(Sogbedji et al, 2001, van Es et al, 2002; Kay et al, 2006; van Es et al. 2007; Tremblay et al 2012)

Some Reasons for Farmer Tendency to Over-Fertilize

- Uncertainty in N rate
- Under-fertilizing (yield penalty) is more expensive than over-fertilizing (excess fertilizer expense).
- Under-fertilization is visible, over-fertilization is not.
- Tools to adjust N rates for seasonal- or field-specific conditions not used

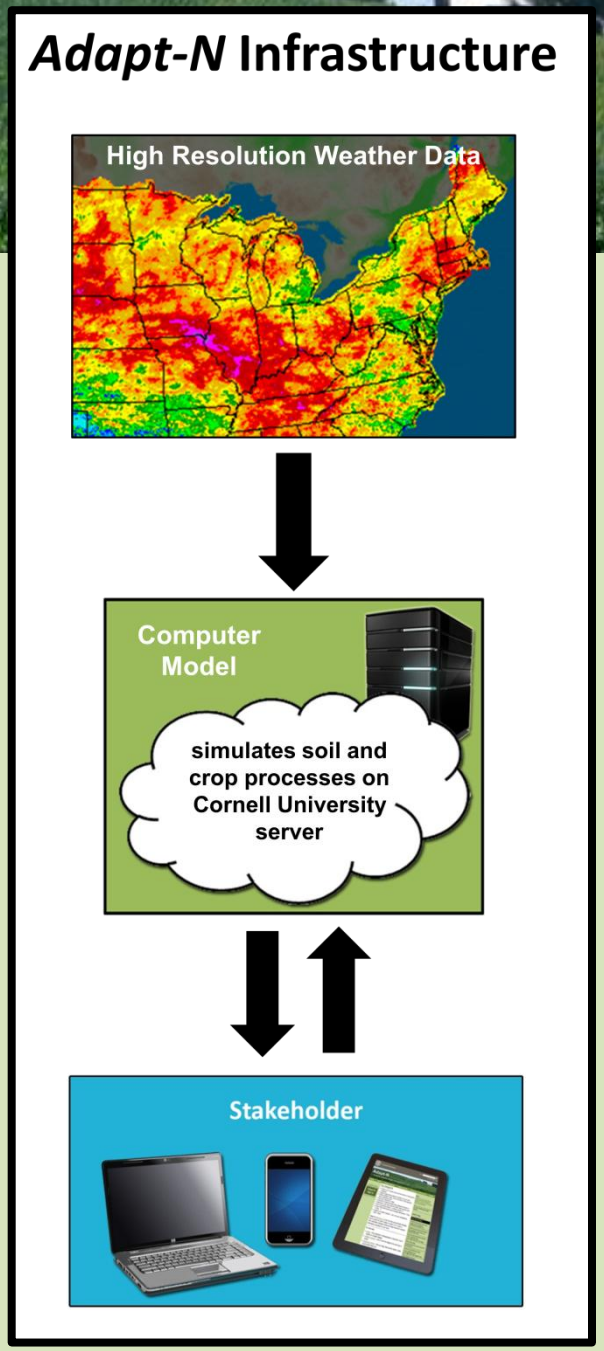


Most farmers rationally manage risks with N rate choice based on available information & tools

Adapt-N

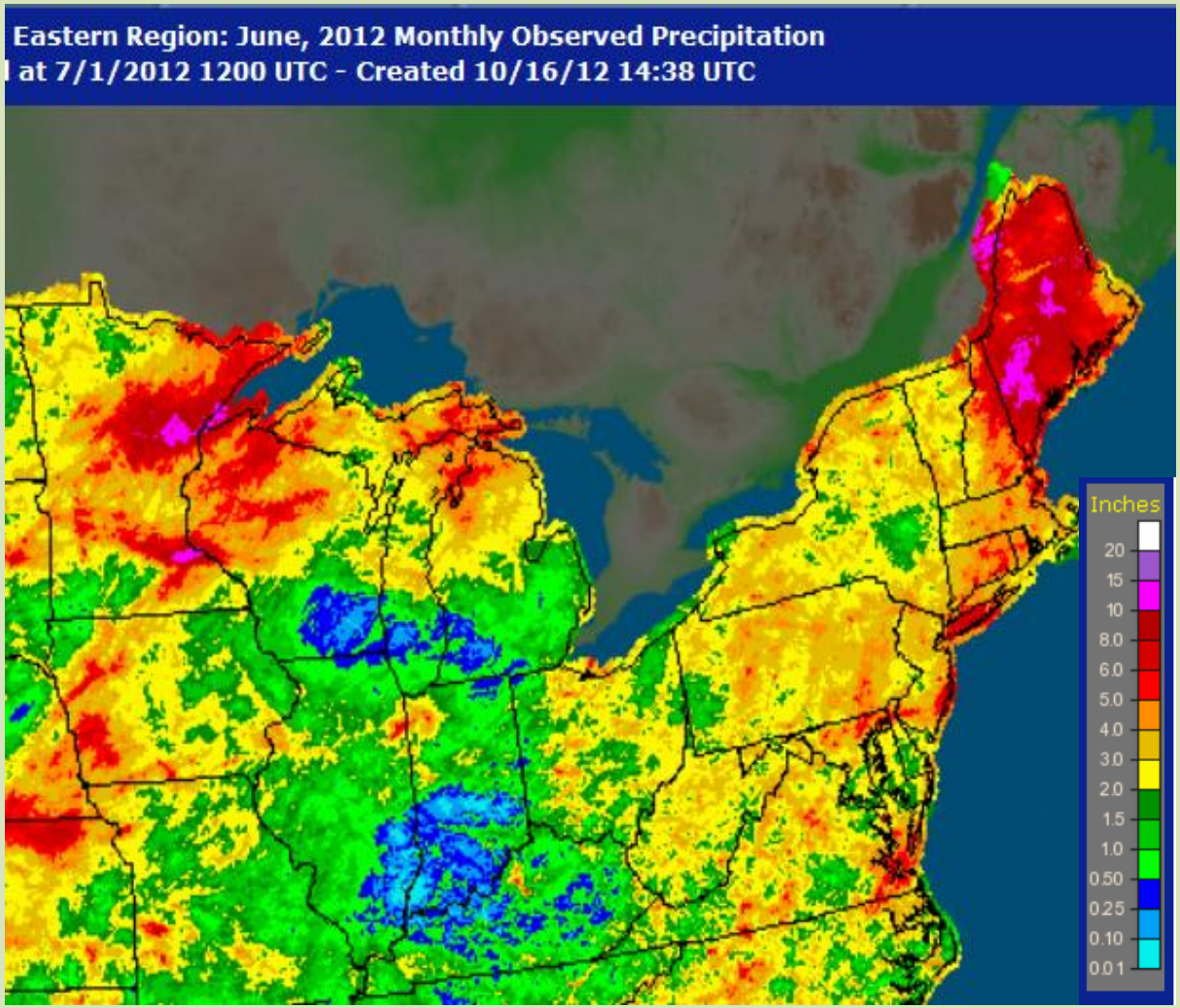
A tool for adaptive nitrogen management in corn

- **User-friendly Web Interface**
  - Designed as *management* tool
  - Provides N recommendation at sidedress
  - Server-based “cloud computing”
- **At core: PNM model**
  - Built from well-calibrated dynamic simulation models based on decades of research
  - Simulates crop and soil processes using field-specific info provided by user
- **High Resolution Weather Data:**
  - daily, 3x3mi, near-real time weather data
  - Critical input: highly localized & seasonal

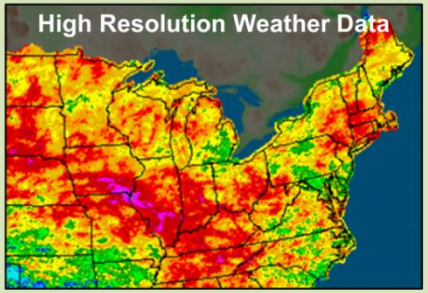


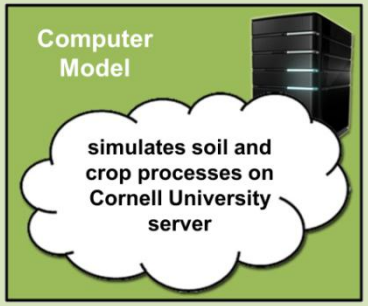
High Resolution Climate Data (3x3mi) Critical Input to Adapt-N Tool

Precipitation is highly localized and seasonal….



Adapt-N Infrastructure





Adapt-N

A tool for adaptive nitrogen management in corn

- Simulates crop and soil processes
  - Crop management, rotation, tillage, soil type, OM, organic/inorganic nutrient additions, etc.
- Field or subfield management scale
- Incorporates fertilizer grain-price ratio, and uncertainty corrections
- Provides additional information on:
  - Environmental impact - nitrate leaching and (soon) N_2O losses
  - uncertainty estimates for recommended N rate
  - Additional diagnostic information

Adapt-N Interface: Managing Locations

Adapt-N: ***A tool for adaptive nitrogen management in corn production.***

Login | Mineral Nitrogen/Cultivar | Soil/Tillage | Manure/Sod/Soybean | Add Application | Results | **Manage Locations**

Adapt-N Home

○ **Select Location**

○ **Modify Location**

● **Set Up New Location**

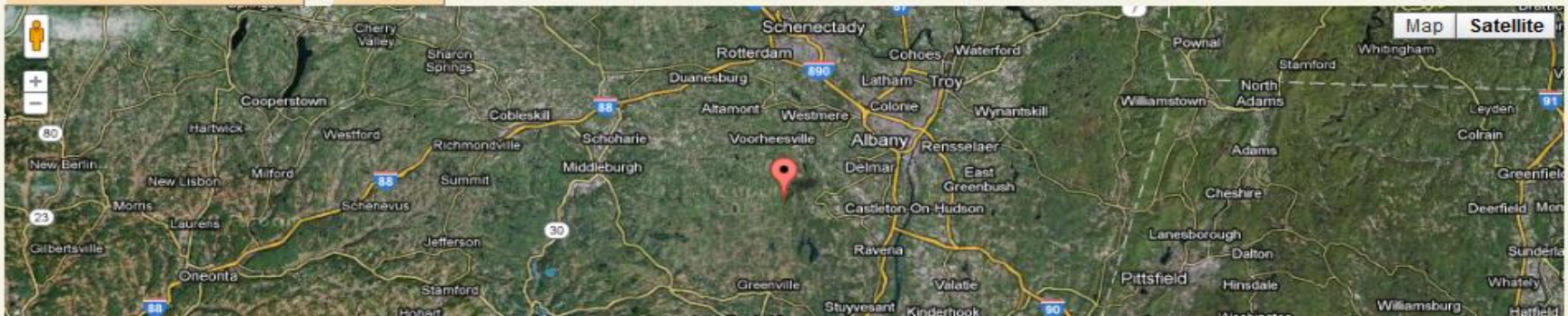
Please identify the region,the season and the location name. You may also identify the group name if you wish.

Northeast | 2011 | Select Group (optional) | Location Name

Please identify the latitude and longitude. You can use the map to do this; If you wish to enter latitude and longitude without using the map, you can click on the clear Lat./Lon. button to remove any information provided by the map.

Latitude (e.g. 42.443) 42.55644705C Longitude (e.g. -76.502) -73.99192535 clear Lat./Lon.

Submit New Location | Cancel



Adapt-N Interface: entering Mineral N/Cultivar Info

(2011 version)

Adapt-N: ***A tool for adaptive nitrogen management in corn production.***

Login | Manage Locations | Alert Settings | N Rec. Alerts | Mineral Nitrogen/Cultivar

Soil/Tillage | Manure/Rotations | Irrigation | Add Application | Results

Season End Date

Adapt-N Home

Nitrogen Fertilizer Applications for this Growing Season

Application	Name	lbs N/acre	Placement Depth	Date	Delete Button	Edit Button
starter (fertilizer banded with seed)	monoammonium phosphate	30	2"-4"	n/a	Delete	Edit
preplant/sidedress	urea	100	2"-4"	04/10/2012	Delete	Edit

You may enter one starter and up to four preplant/sidedress applications. Preplant applications can start as early as 10/1/2011. Select Fertilizer Application

Crop Information

Grains: 110 d crm

Planting Date 04/15/2012 32,500 plants/acre

Grain Cultivars: Expected Yield (bu/acre) 190 - 210

Adapt-N Results Page

(2011 version)

Adapt-N: ***A tool for adaptive nitrogen management in corn production.***

Login | Manage Locations | Alert Settings | N Rec. Alerts | Mineral Nitrogen/Cultivar | Soil/Tillage | Manure/Rotations | Irrigation | Add Application | Results

Adapt-N Home

Sidedress Nitrogen Recommendation for IA Storm Lake: 115 lbs N/Acre (101 - 128 lbs N/Acre)

This recommendation is based on an "Expected Yield" entry that is assumed to be the economically optimum yield for this field. The recommended range reflects the uncertainty with post-application fertilizer losses for the remainder of the growing season due to unknown future weather events.

1. Calculation of Sidedress N Rate

Sidedress N rate estimated by AdaptN = $CropN_{Harvest}$ - $CropN_{Current}$ - $SoilN_{Current}$ - $SoilN_{postsidedress}$ - $SoybeanN_{Credit}$ + $Loss_{postapplication}$ - $Correct_{profit}$

$CropN_{Harvest}$	205 *(lbs N/acre)*
$CropN_{Current}$	65 *(lbs N/acre)*
$SoilN_{Current}$	28 *(lbs N/acre)*
$SoilN_{postsidedress}$	7 *(lbs N/acre)*
$SoybeanN_{Credit}$	0 *(lbs N/acre)*
$Loss_{postapplication}$	17 *(lbs N/acre)*
$Correct_{profit}$	8*(lbs N/acre)*

Root Zone Crop Available Water

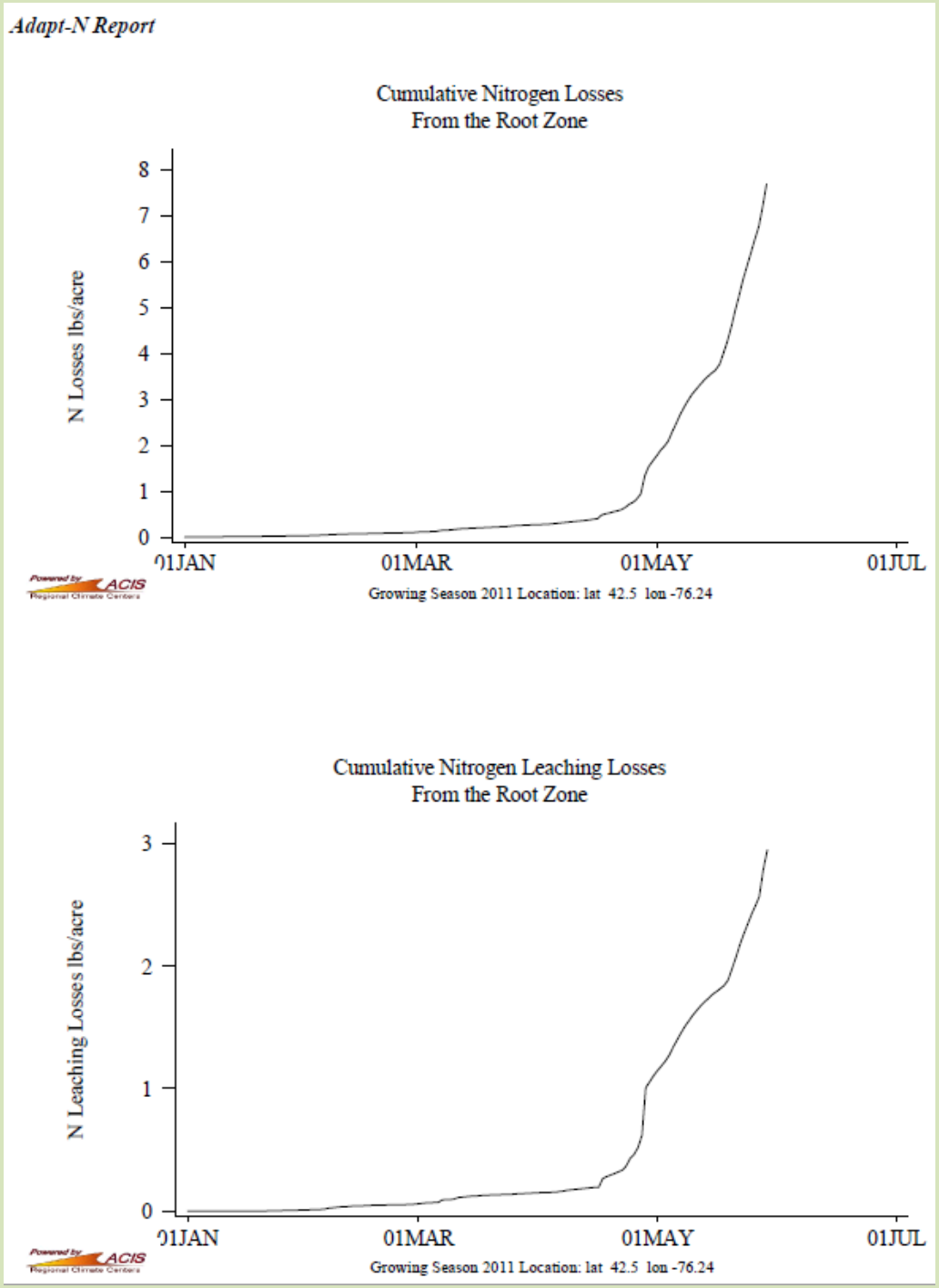
Note that these estimates are for non-irrigated corn production.

Current root zone crop available water:	**0 *inches***
Crop available water at field capacity	6 *inches*

- Full Report and Graphs (pdf file)
- Sidedress N Definitions

Downloadable pdf

Adapt-N Graphs



(2011 version)

Daily N recommendations automatically available

Adapt-N: *A tool for adaptive nitrogen management in corn production.*

Login | Manage Locations | Alert Settings | N Rec. Alerts | Mineral Nitrogen/Cultivar | Soil/Tillage | Manure/Rotations | Irrigation

Add Application | Results

Adapt-N Home

Summary of Adapt-N Simulation Results: 6/22

Group	Location	N Recommendation[1] *lbs. N/Acre*	Crop Available Water[2] *inches*	Leaf Growth Stage	Soil N[2] *lbs. N/Acre*	details
Ungrouped	Aldrich East 24-1	135(124 - 148)	5	5	46	Report & Graphs (pdf file)
	Aldrich East 24-11	100(92 - 108)	5	5	70	Report & Graphs (pdf file)
	Aldrich East 24-13	115(105 - 123)	5	5	64	Report & Graphs (pdf file)
	Aldrich East 24-14	135(124 - 148)	5	5	46	Report & Graphs (pdf file)
	Aldrich East 24-4	145(133 - 159)	5	5	42	Report & Graphs (pdf file)
	Aldrich East 24-5	115(112 - 122)	3	5	46	Report & Graphs (pdf file)
	Aldrich East 24-7	110(106 - 115)	3	5	53	Report & Graphs (pdf file)
	Aldrich East 24-8	65(60 - 71)	5	5	93	Report & Graphs (pdf file)
	Aldrich East 24-9	115(107 - 125)	5	5	61	Report & Graphs (pdf file)
	Aldrich West 25-2	140(127 - 152)	5	5	43	Report & Graphs (pdf file)
	Aldrich West 25-3	115(109 - 119)	3	5	48	Report & Graphs (pdf file)
	Aldrich West 25-7	125(112 - 133)	5	5	55	Report & Graphs (pdf file)
	Doane 4-10	130(128 - 139)	3	5	30	Report & Graphs (pdf file)
	Doane 4-13	150(138 - 166)	5	5	31	Report & Graphs (pdf file)
	Doane 4-16	115(114 - 124)	3	5	37	Report & Graphs (pdf file)
	Doane 4-2	150(135 - 162)	5	5	34	Report & Graphs (pdf file)
	Doane 4-3	155(142 - 172)	5	5	27	Report & Graphs (pdf file)
	Doane 4-4	120(110 - 129)	5	5	52	Report & Graphs (pdf file)

N Recommendation Methodology: deterministic-stochastic mass balance at sidedress

Input:
Expected Yield

Near-Real-Time Simulation at Sidedress

$$\mathbf{SidedressNrate = CropN_{Harvest} - CropN_{Current} - SoilN_{Current} - SoilN_{postsidedress} - SoybeanN_{credit} + NLoss_{postapplication} - Correct_{profit}}$$

Now: simulated & partial fixed credit

Probabilistic simulations

Question: Does Adapt-N work?

- **Agronomic:** Does Adapt-N provide an accurate N recommendation at sidedress time?
- **Economic:** Can Adapt-N save growers money in comparison to their current practices?
- **Environmental:** Can Adapt-N decrease N losses?

- **Model/Interface:** What changes need to be made for improved performance?

2011 & 2012 Strip Trial Collaborators

New York

- Keith Severson, Cayuga County
- Kevin Ganoe, Central NY
- Chuck Bornt, Capital Region
- Sandy Menasha, Long Island
- Eric Young, Miner Institute
- Michael Davis, Willsboro Research Farm
- Anita Deming, Essex County
- Eric Bever & Heather Robinson, Champlain Valley Agronomics
- David Shearing and David DeGolyer, WNYCMA
- Peg Cook, Cook's Consulting
- Joe Lawrence, Jefferson County
- Mark Ochs, Benn Lott; Ochs Consulting

Iowa

MGT Envirotec:

- Shannon Gomes, NE Iowa
- Frank Moore, NE Iowa
- Michael McNeill, NC Iowa
- Hal Tucker, W Iowa

Maine

- Ellen Mallory, Erin Roche

Vermont

- Heather Darby

Minnesota

- Kevin Kuehner

2011 Strip Trials

Agronomic, Economic & Environmental Performance

- **NY: 14 strip trials**
  - Grain (Corn-Corn, Soy-Corn)
  - Silage
- **IA: 9 trials**
  - All Grain
- **N Management**
  - Fall/Spring manure
  - Spring fertilizer N
  - IA: Fall anhydrous ammonia

Strip Trial Layout

- 2+ N treatments:
  - "Grower-N" rate – current practice (various methods)
  - Adapt-N recommended N rate
  - Sometimes: Zero, mid-range, high or low N rate

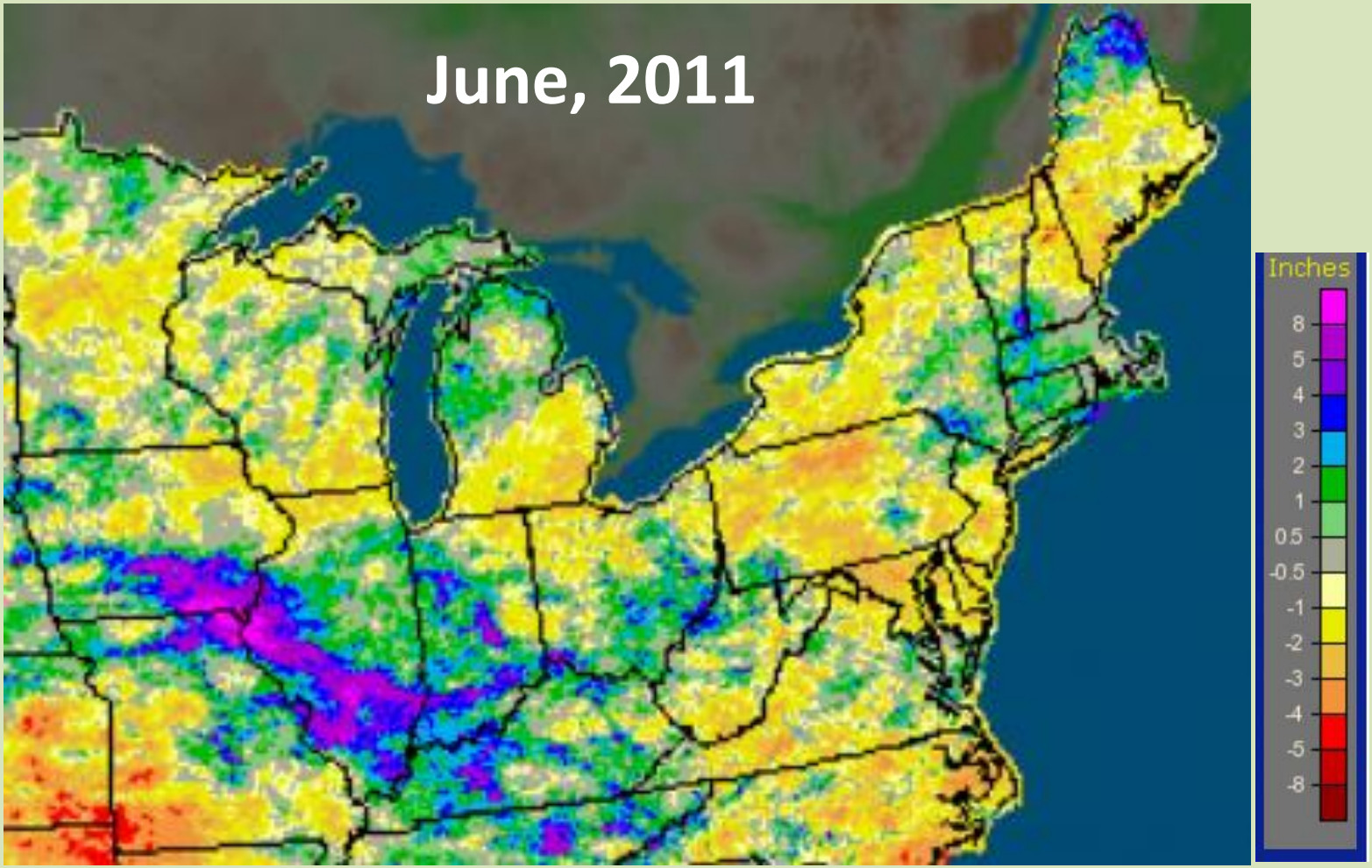
- Spatially balanced design* with 4 replications
  - Some varied # reps and designs

C1
A1
A2
C2
A3
C3
C4
A4

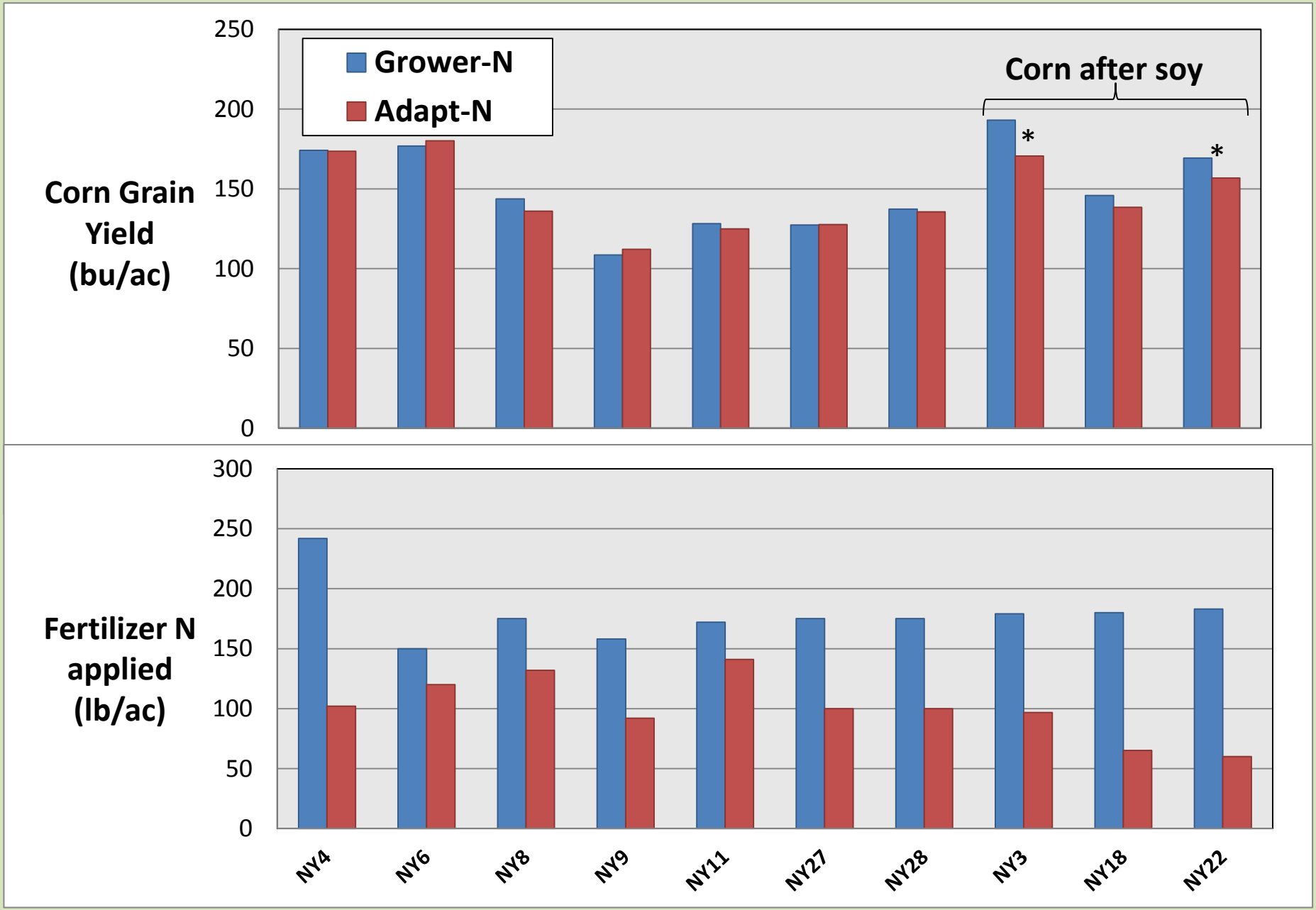
**van Es et al. 2007. Spatially-Balanced Complete Block designs for field experiments. Geoderma 140: 346–352*; Some trials were more or less replicated with some varied layouts.

Interpreting recommendations in context of the growing season

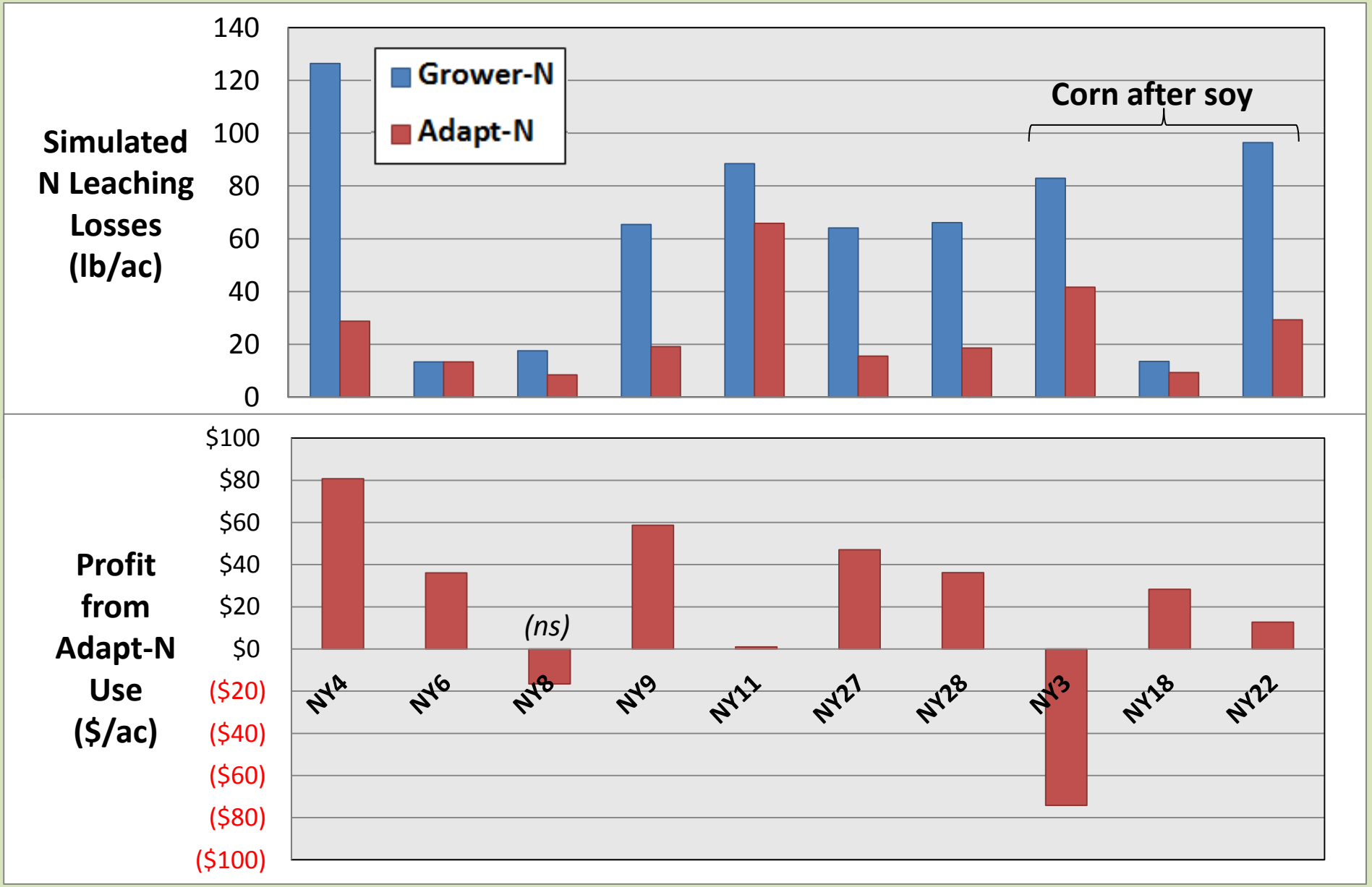
Departure from Normal



NY 2011: Agronomic Performance in Grain



NY 2011: Environmental and Economic Performance in Grain



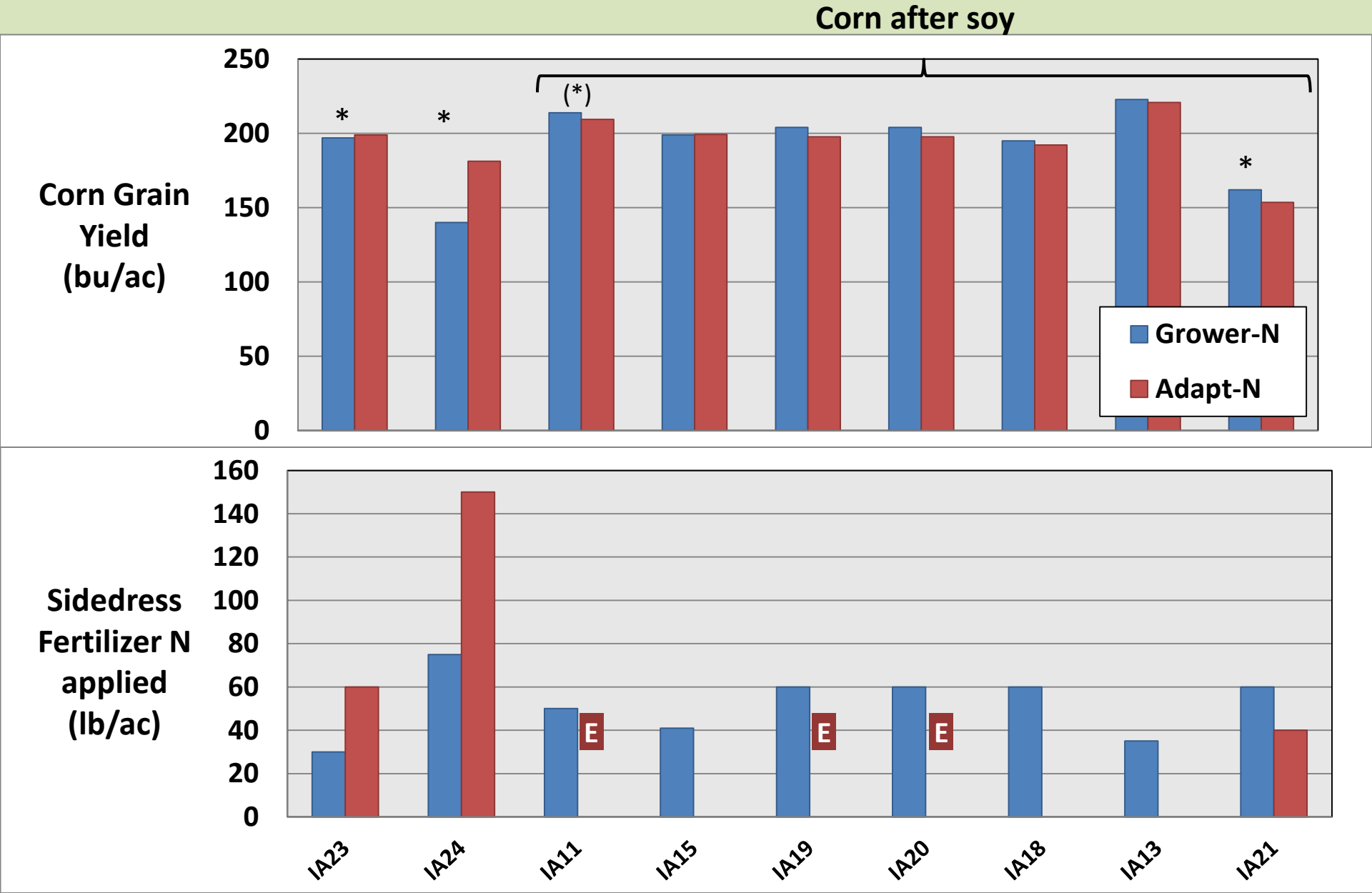
NY 2011: Agronomic, Economic & Environmental Performance

	NY grain	NY grain	NY silage
	corn-corn n=7	soy-corn n=3	corn-corn n=4
N fertilizer input (lb/ac)	**-66**	**-107**	**-37**
Yield (grain: bu/ac; silage:T/ac)	**-1**	**-14**	**0.3**
Simulated N leaching losses (lb/ac)	-39	-38	-11
Simulated total N losses (lb/ac)	-52	-69	-19
Profit ($/ac)	**$35**	**-$11**	**$39**

Average Adapt-N profit gain: $26/acre

* p < 0.05, (*) p < 0.10

IA 2011: Agronomic Performance



IA 2011 : Agronomic & Economic Performance

Adapt-N Impact, IA	IA grain (Adapt-N < Grower-N)	IA grain (Adapt-N > Grower-N)
	Soy-corn, n=7	Corn-corn, n=2
N fertilizer input (lb/ac)	-47	53
Yield (bu/ac)	-4	22
Profit ($/ac)*	$8	$87

*$0.60/lb N, $5.50/bu corn ($6.50/bu - $1/bu for drying, storing trucking)

Average profit gain from Adapt-N: $26/acre

Summary of 2011 Adapt-N Results

Agronomic:

- N rates reduced by avg 60 lb/ac (NY), 45 lb/ac (IA)
- Limited yield loss.
- IA: higher Adapt-N rates justified by higher yields

Economic:

- Grower profits increased by avg $26/ac (NY), $25/ac (IA)
- Adapt-N increased grower profits in 86% (NY), 78% (IA) of cases

Environmental:

- N losses decreased (5-120 lb/ac)
- **Provides strong incentive to sidedress**

Model/Interface:

- Minor adjustments incorporated into 2012 version of Adapt-N
- Requires accurate inputs

2012 Season

Model/Interface Improvements:

- Soybean credit: Residue N immobilization & partial empirical 'credit'
- Soil type, previous crop, and irrigation inputs
- Alert system
- Expanded availability: Now Northeast, Iowa, Minnesota, Wisconsin, Illinois and Indiana

2012 season trials:

- > 70 replicated trials (IA, NY, ME, VT, MN)
- Over 7000 acres implementing recommendations

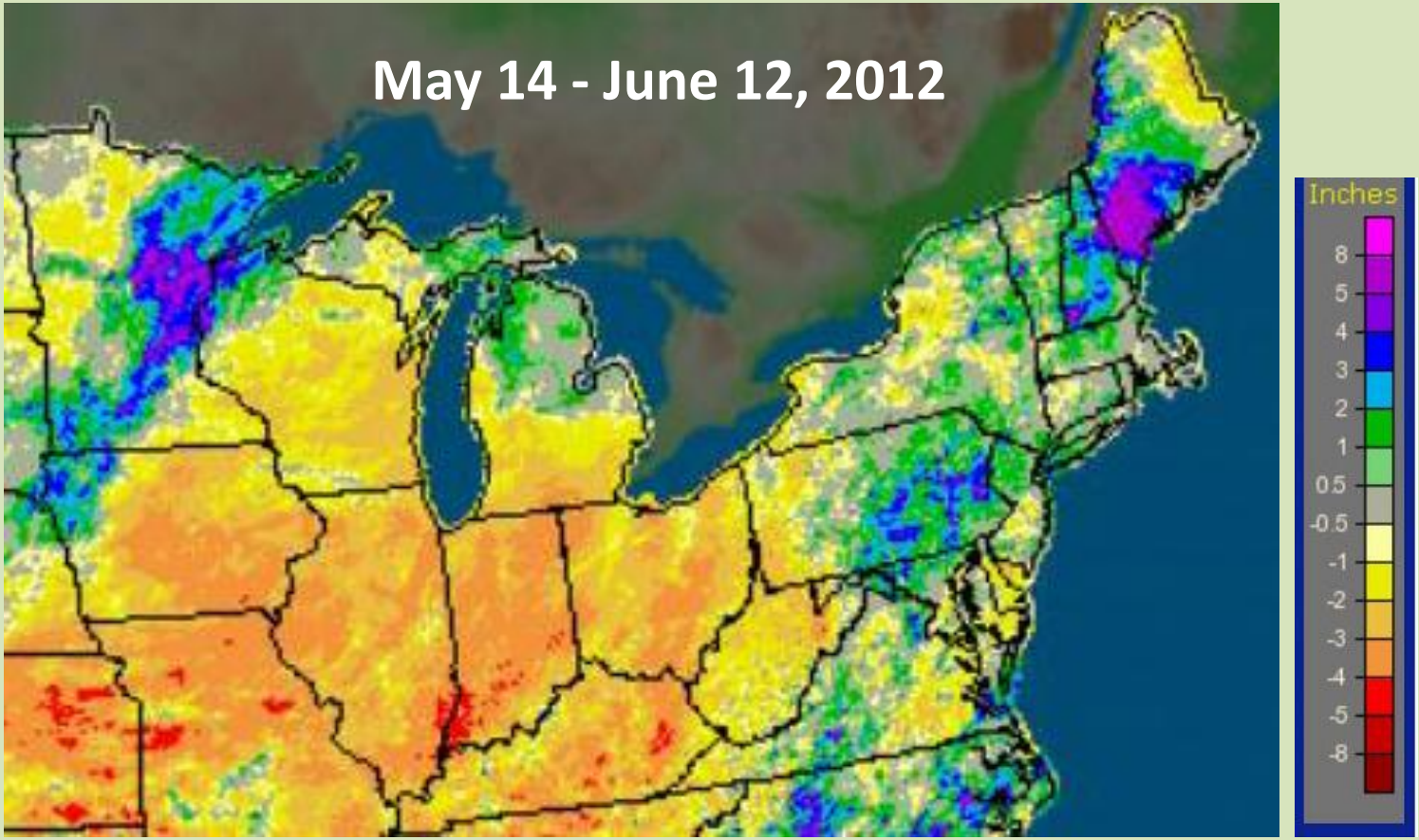
Adapt-N featured in *Corn and Soybean Digest* and *Successful Farming* this season, gaining national attention.

Environmental and Corporate interests:

- BMP Challenge Collaboration
- NRCS at the national level is very excited about the tool
- Environmental Defense Fund
- Foundations

Interpreting recommendations in context of the growing season

Departure from Normal



Adapt-N Replicated Strip Trials
Iowa 2012 - Preliminary

Iowa 2012 - Western

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	95	196 a	
Adapt-N	57.5 (-37.5)	198 a	$31

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	140	187 a	
Adapt-N	100 (-40)	180 a	-$18

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	80	153 a	
Adapt-N	40 (-40)	150 a	$3

Iowa 2012 - Western

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	76	152 a	(sidedressed 10lb too little for Adapt-N)
Adapt-N	36 (-40)	146 a	-$5


	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	158	209 a	Exceed exp yield
Adapt-N	95 (-63)	194 b	-$50*

Iowa 2012 – North Central

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	65	213 a	
Adapt-N	35 (-30)	211 a	$12

Grower-N	80	142 a	
Adapt-N	60 (-20)	141 a	$12

Minnesota 2012 – Southeast

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	230	204 a	
Adapt-N	130 (-100)	207 a	$81

Iowa 2012 – North East

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	160	173 a	
Adapt-N	80 (-80)	174 a	$62

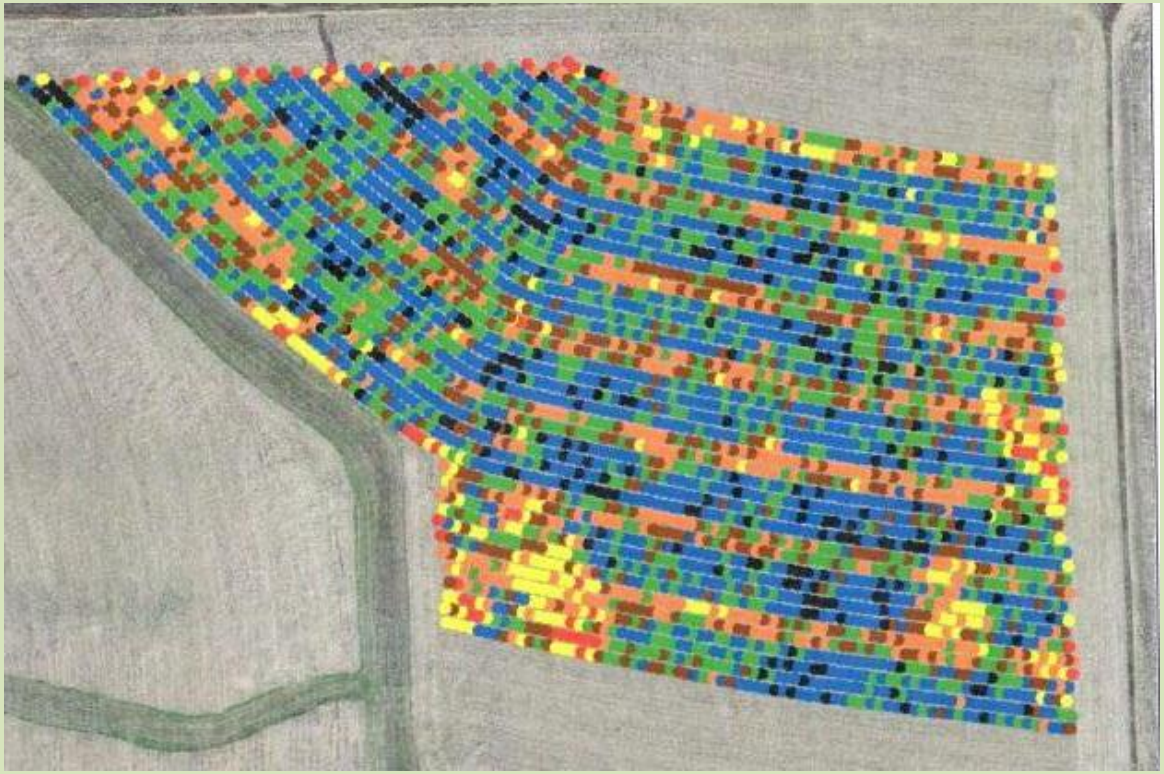
	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	140	145 a	
Adapt-N	95 (-45)	144 a	$20

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	75	124 a	
Adapt-N	65 (-10)	123 a	$3

	N (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	165	114 a	
Adapt-N	135 (-30)	116 a	$30

Northeast Iowa

	SidedressN (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N 1	75	159	
Adapt-N	0 (-75)	150	$1



Iowa 2012 Adapt N Benefits (Preliminary)

- 10 out of 13 performed well
- Average N input reduction: 47 lbs/ac
- Average yield reduction: 2.9 bu/ac
- Average profit gain: $14/ac

Adapt-N Replicated Strip Trials
New York 2012 - Preliminary

Western NY 2012

	N rate (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N1	178	239 a	Exceed exp yield
Adapt-N	114 (-64)	233 a (no sidedress)	$12

Grower-N	177	204 a	
Adapt-N	145 (-32)	215 a	$82

Grower-N	173	164 a	
Adapt-N	153 (-20)	167 a	$25

Grower-N	164	171 a	
Adapt-N	197 (+33)	177 a	$15

Grower-N	126	185 a	
Adapt-N	149 (+24)	191 a	$21

Cayuga County, NY 2012

One farm with >900 acres of implementation saved ~ $30,000+

	N rate (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	222	200 a	
Adapt-N	162 (-60)	206 a	$68
Grower-N	222	149 a	
Adapt-N	152 (-70)	152 a	$61
Grower-N	258	235 a	Exceeded exp yld
Adapt-N	187 (-71)	227 a	-$8
Adapt-N & Grower-N	143	174 a	$0
Plus 30lb	173 (+30)	183 a	(-$36)




Cayuga County, NY - 2012

	N rate (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	181	198 a	
Adapt-N	156 (-25)	197 a	$9

Grower-N	228	229 a	
Adapt-N	178 (-50)	224 a	$0

Grower-N	224	163 a	
Adapt-N	178 (-46)	172 a	$84

Grower-N	224	216 a*	Exceed exp yield
Adapt-N	177 (-47)	203 a	-$53

Grower-N	116	150 a	
Adapt-N	146 (+30)	156 a	$18

Central NY

	N rate (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	189	161 a	
Adapt-N	89 (-100)	158 a	$80

Grower-N	189	199 a	
Adapt-N	129 (-60)	197 a	$24

Long Island

	N rate (lb/ac)	Yield (bu/ac)	Profit Gain
Grower-N	113	146 a	
Adapt-N	68 (-45)	156 a	$95

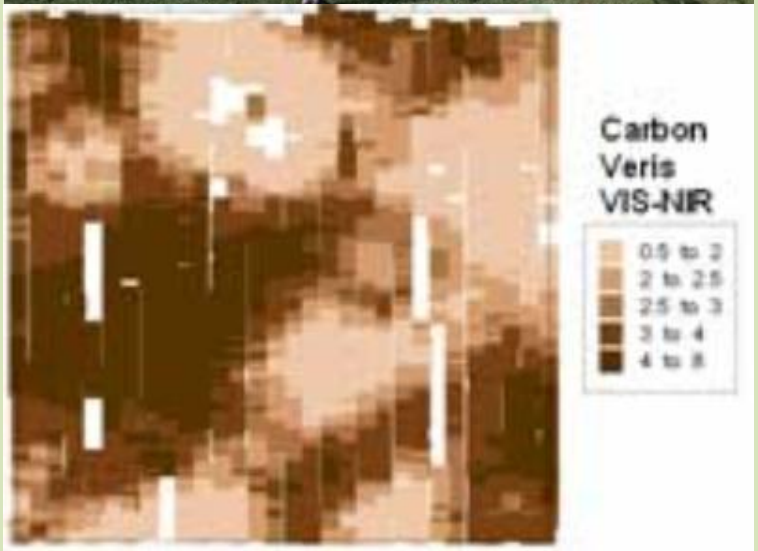
Grower-N	149	140 a	
Adapt-N	109 (-40)	140 a	$24

NY Grain Adapt-N benefits (Preliminary)

- **15 out of 18 performed well**
- **Average N input reduction: 38 lbs/ac ***
- **Average yield gain: 2.0 bu/ac**
- **Average profit gain: $29/ac**

Effective use of Adapt-N

- requires accurate inputs:
  - Representative organic matter test
  - Good soil and crop info
- requires good estimates of expected yields (don't underestimate)
- benefits/accuracy will increase with later N application (as long as crop does not run out)
- Opportunity for site-specific management
- Complements new technologies



2013 Developments

- Batch upload capability
- Cover crop N credits
- N_2O emission estimates
- Other minor upgrades
- Possibly expansion to additional states

Summary

- Adapt-N tool allows for more precise N management in corn production, and helps farmers manage risk
- Tool is available for 18 states, currently at no cost
- Two years of strip trials show very encouraging results:
  - Adapt-N increases farm profits by average of $24 per acre
  - Adapt-N significantly reduces N inputs and environmental impacts
- Adapt-N needs further testing and adoption

In-Depth Training Webinar 2013

When: March 21, 2013

Where: multiple host sites in the Northeast and Midwest

What:

- N concerns and tools
- Adapt-N inner workings
- How to use Adapt-N effectively
- Hands-on training on Adapt-N

To Attend: get on our mailing list by getting an Adapt-N account

To Host a Training: contact Bianca bnm5@cornell.edu

Want to learn more TODAY?

Special Session: Adapt-N Hands-On Training,

Orient Building, Room 237, 1:15 - 2:00 PM

This session will guide growers through using the online Adapt-N tool

There will be computers available, but please feel free to bring your own (laptop, tablet, iPad, Smartphone…)

Thank you!
Questions?

Bianca Moebius-Clune: bnm5@cornell.edu

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- USDA-NIFA Agriculture and Food Research Initiative
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- Northern NY Agricultural Development Program
- International Plant Nutrition Institute