Adapt-N
Comparing Static and Adaptive N Rate Tools for Corn Production

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Presenter

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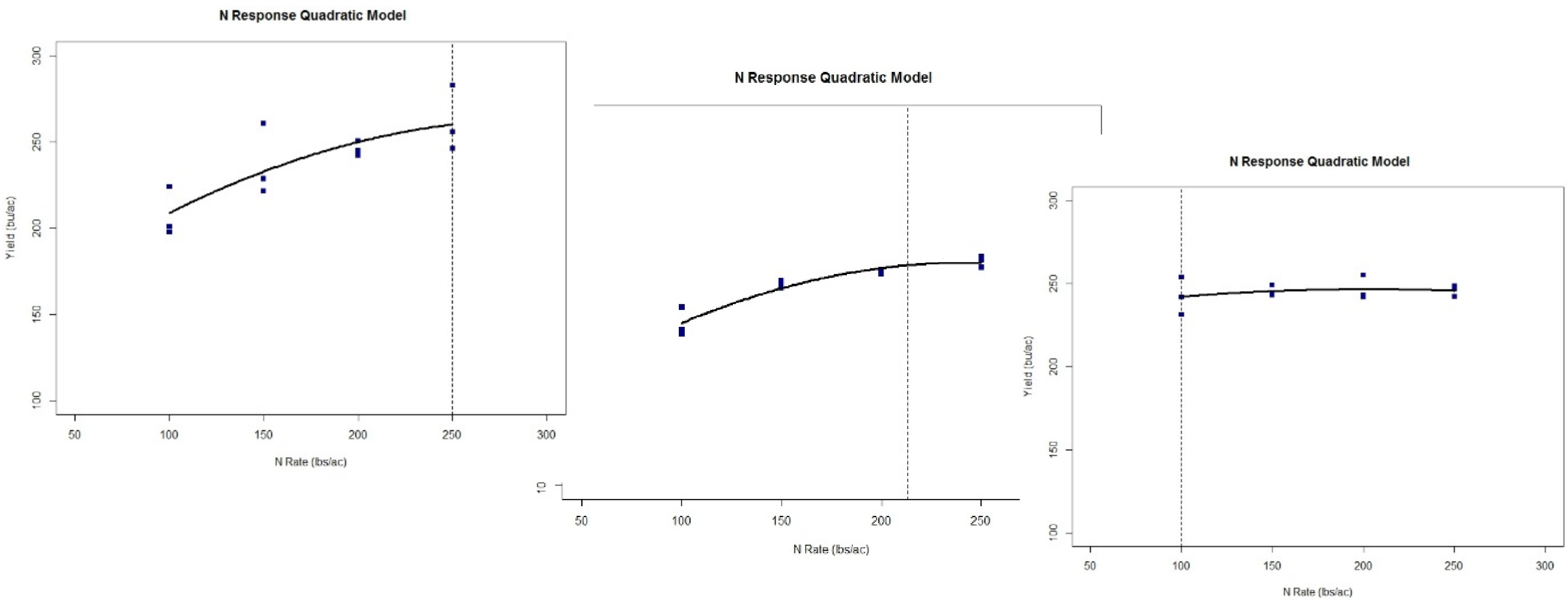
- Maize N management in the US is often inefficient, with N recovery efficiency (the proportion of applied N taken up by the crop) estimated at 37% (Cassman et al., 2002).
- N availability is spatially and temporally variable (Scharf et al., 2005; Kitchen et al., 2010; van Es et al., 2007) and defining a economically optimum N rate (EONR) for a particular production environment (location, time, management) is challenging.



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Comparing N Recommendation Approaches
Static vs Adaptive

	Static	Adaptive
	Cornell N Calc	**Adapt-N**
Basic approach	Stanford-based mass balance. Regionally generalized.	Dynamic simulation model. Highly location-specific.
Variables	Expected yield, soil type, previous crop	Multitude of soil and crop management factors, weather, risk.

Cornell N Calculator (CNC)
(Ketterings et al., 2003; based on Stanford, 1973)

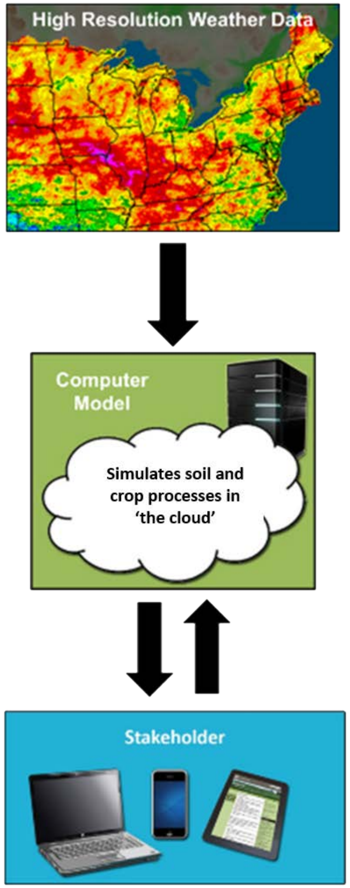
$$N_{Required} = (YP_{corngrain} * 1.2 - N_{soil} - N_{sod})/\left(\frac{F_{eff}}{100}\right)$$

$YP_{corngrain}$, N_{soil}, and F_{eff} are available from tabular values based on soil type

Can use default value or based on grower supplied yield estimates

Adapt-N – an adaptive nitrogen management tool for Maize

- Commercial cloud-based dynamic simulation model, which provides in-season N recommendations
- Combines soil, crop and management information with near real-time weather data
- Uses grower estimated yield
- Recently successfully validated in 113 strip trials in IA and NY (Sela et al. 2016, *Agronomy Journal*)



The engine of the Adapt-N tool is the PNM model

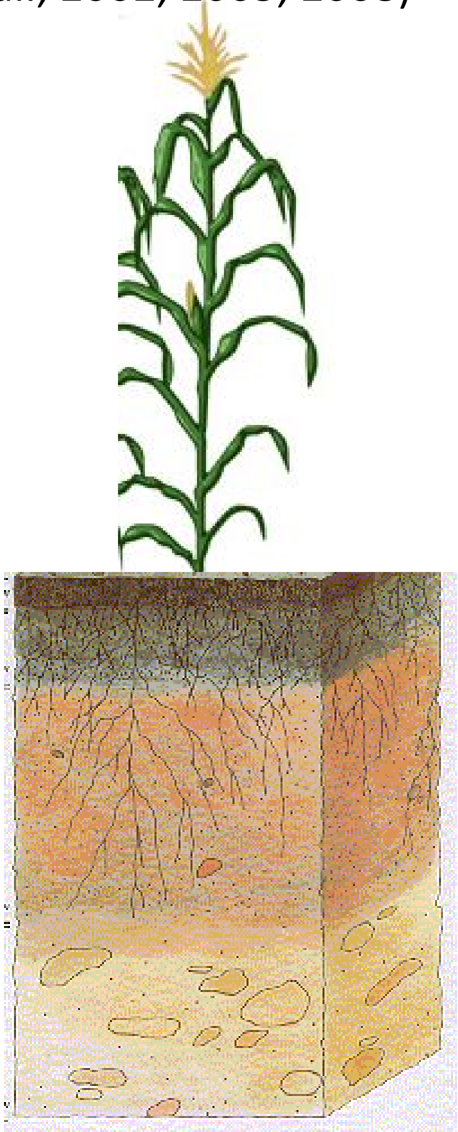
(Melkonian et al., 2002, 2005, 2008)

Dynamic mass balance approach

Soil Hydrology and Chemistry Model (LEACH-N)

Crop growth model

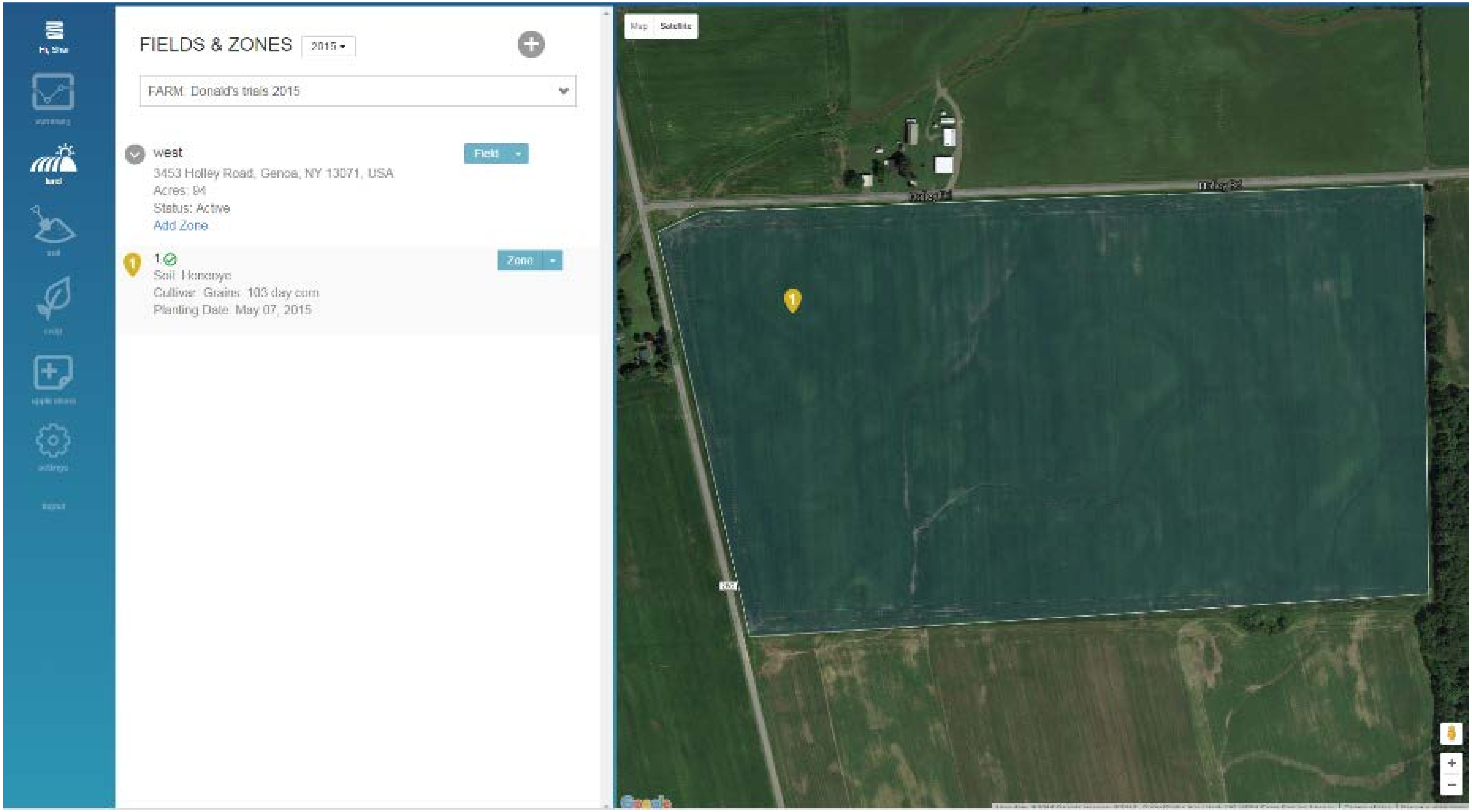
Simulates water and nutrient availability and uptake based on the plant growth stage



Summary of features and inputs for Adapt-N tool

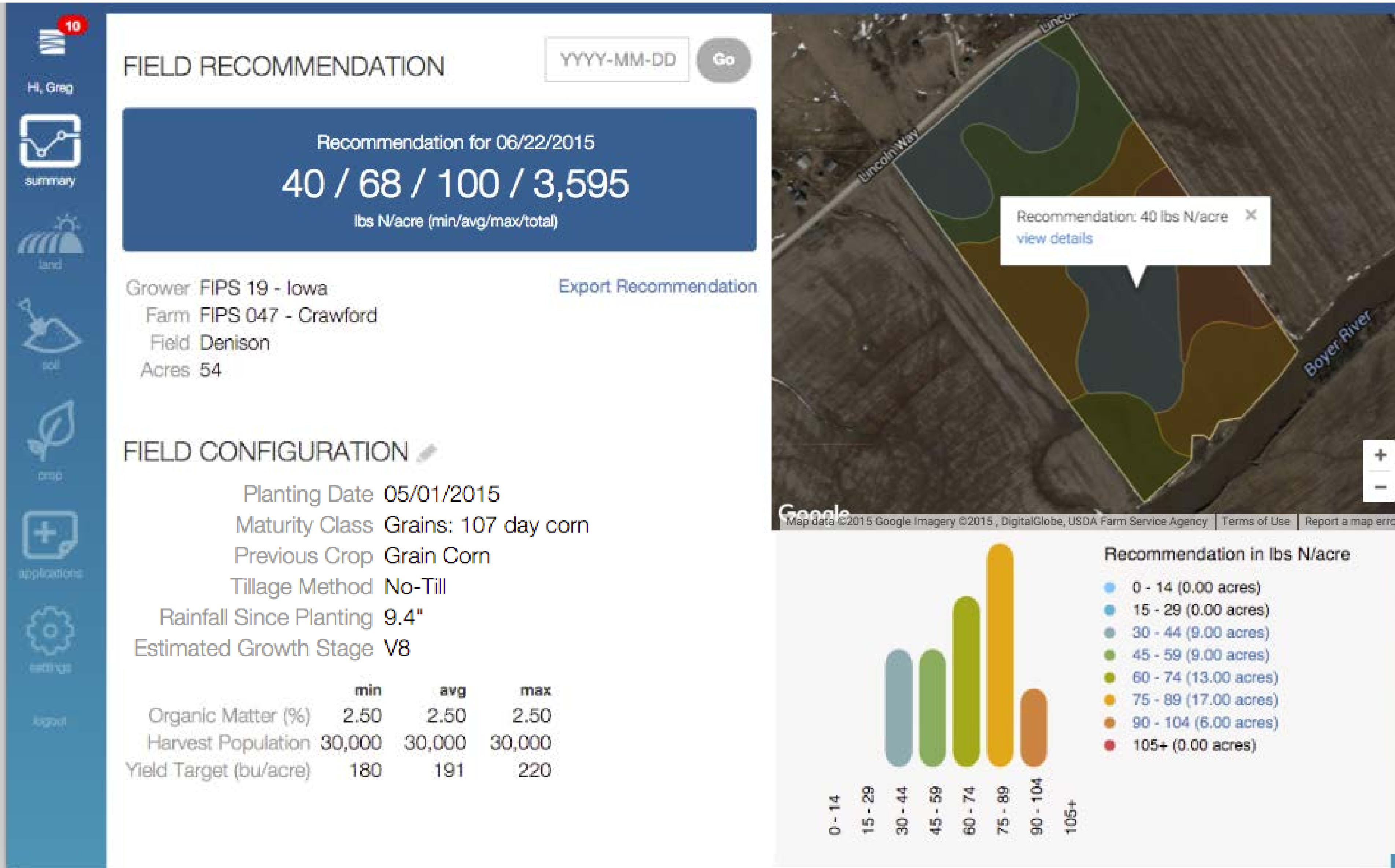
Feature	Approach
Simulation time scale	Daily time-step. Historical climate data for post-date estimates
Optimum N rate estimation	Mass balance: deterministic (pre) and stochastic (post) with grain-fertilizer price ratio and risk factors
Weather inputs	Near-real time: Solar radiation; max-min temperature; precipitation
Soil inputs	Soil type or series related to NRCS database properties; rooting depth; slope; SOC; artificial drainage
Crop inputs	Cultivar; maturity class; population; expected yield; crop price;
Management inputs	Tillage (type, time, residue level); irrigation (amount, date); manure applications (type, N & solid contents, rate, timing, incorporation method); previous crop characteristics; cover crop (2016)
N Fertilizer inputs	Multiple: Type, rate, time of application, placement depth; fertilizer price; enhanced efficiency compounds (inhibitors, slow-release).
Graphical outputs	N contributions and uptake; N losses (total, NO_3 leaching and gaseous); N content dynamics; crop development; weather inputs; site-specific fertilizer maps (advanced)
Other	Web accessible; option for automatic daily updates by email or text message; batch data upload capability. Available for 95% of US corn acres.

Adapt-N User interface



Flexible Zone Creation Modes

Point-Based	Polygon-Based VRT	Gridded VRT
Fast, easy, N recommendations either flat rate or by manual zone	Fast, powerful VR rec using user-defined management zones	Comprehensive 60x60 ft gridded VR prescriptions with unlimited geometries


10
Hi, Greg
summary
land
soil
crop
applications
settings
logout
FIELD RECOMMENDATION
YYYY-MM-DD
Go
Recommendation for 06/22/2015
40 / 68 / 100 / 3,595
lbs N/acre (min/avg/max/total)
Grower FIPS 19 - Iowa
Farm FIPS 047 - Crawford
Field Denison
Acres 54
Export Recommendation
FIELD CONFIGURATION
Planting Date 05/01/2015
Maturity Class Grains: 107 day corn
Previous Crop Grain Corn
Tillage Method No-Till
Rainfall Since Planting 9.4"
Estimated Growth Stage V8
min avg max
Organic Matter (%) 2.50 2.50 2.50
Harvest Population 30,000 30,000 30,000
Yield Target (bu/acre) 180 191 220
Lincoln Way
Boyer River
Recommendation: 40 lbs N/acre
view details
Google
Map data ©2015 Google Imagery ©2015 , DigitalGlobe, USDA Farm Service Agency
Terms of Use
Report a map error
Recommendation in lbs N/acre
0 - 14 (0.00 acres)
15 - 29 (0.00 acres)
30 - 44 (9.00 acres)
45 - 59 (9.00 acres)
60 - 74 (13.00 acres)
75 - 89 (17.00 acres)
90 - 104 (6.00 acres)
105+ (0.00 acres)
0 - 14
15 - 29
30 - 44
45 - 59
60 - 74
75 - 89
90 - 104
105+

Detailed support for all recommendations gives users key insights into our modeling results so ground observations and other tools can be used in complement.

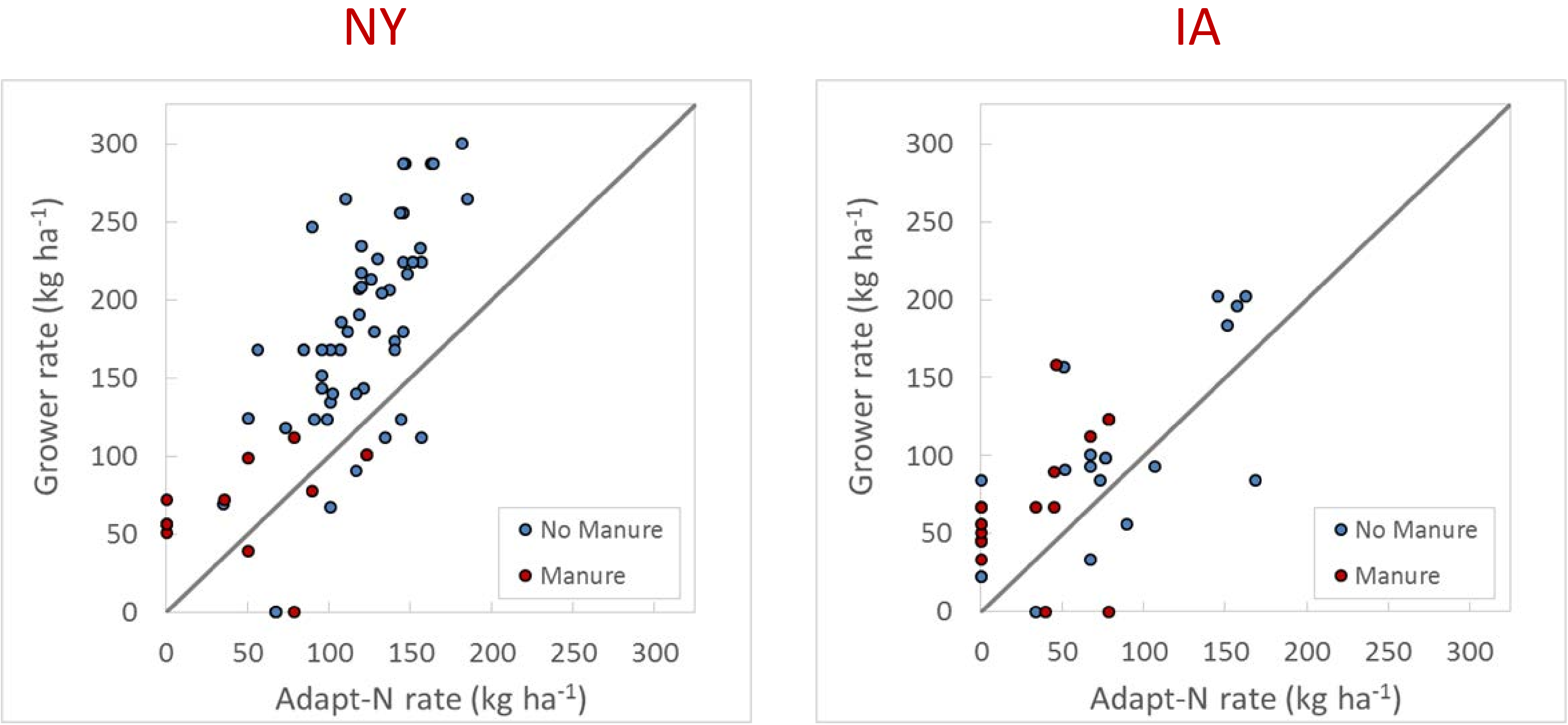
The Adapt-N tool generates N recommendations based on a dynamic-probabilistic mass balance approach

$$N_{rec} = N_{exp\_yld} - N_{crop\_now} - N_{soil\_now} - N_{rot\_credit} - N_{fut\_gain-loss} - N_{profit\_risk}$$

- Where N_{rec} is the N rate recommendation (kg ha^{-1});
- $N_{\exp\_yld}$ is the crop N content needed to achieve the expected yield;
- N_{crop_now} and N_{soil_now} are the N content in the crop and soil as calculated by the PNM model for the current simulation date;
- N_{rot_credit} is a credit for soil N available from crop rotations
- $N_{fut\_gain-loss}$ is a probabilistic estimate of future N gains minus losses until the end of the growing season, based on model simulations with historical rainfall distribution functions;
- and N_{profit_risk} is an economic adjustment factor that integrates corrections for fertilizer and grain prices, as well as the relative profit risk of under-fertilization vs. over-fertilization.

The Adapt-N tool was extensively validated against field data

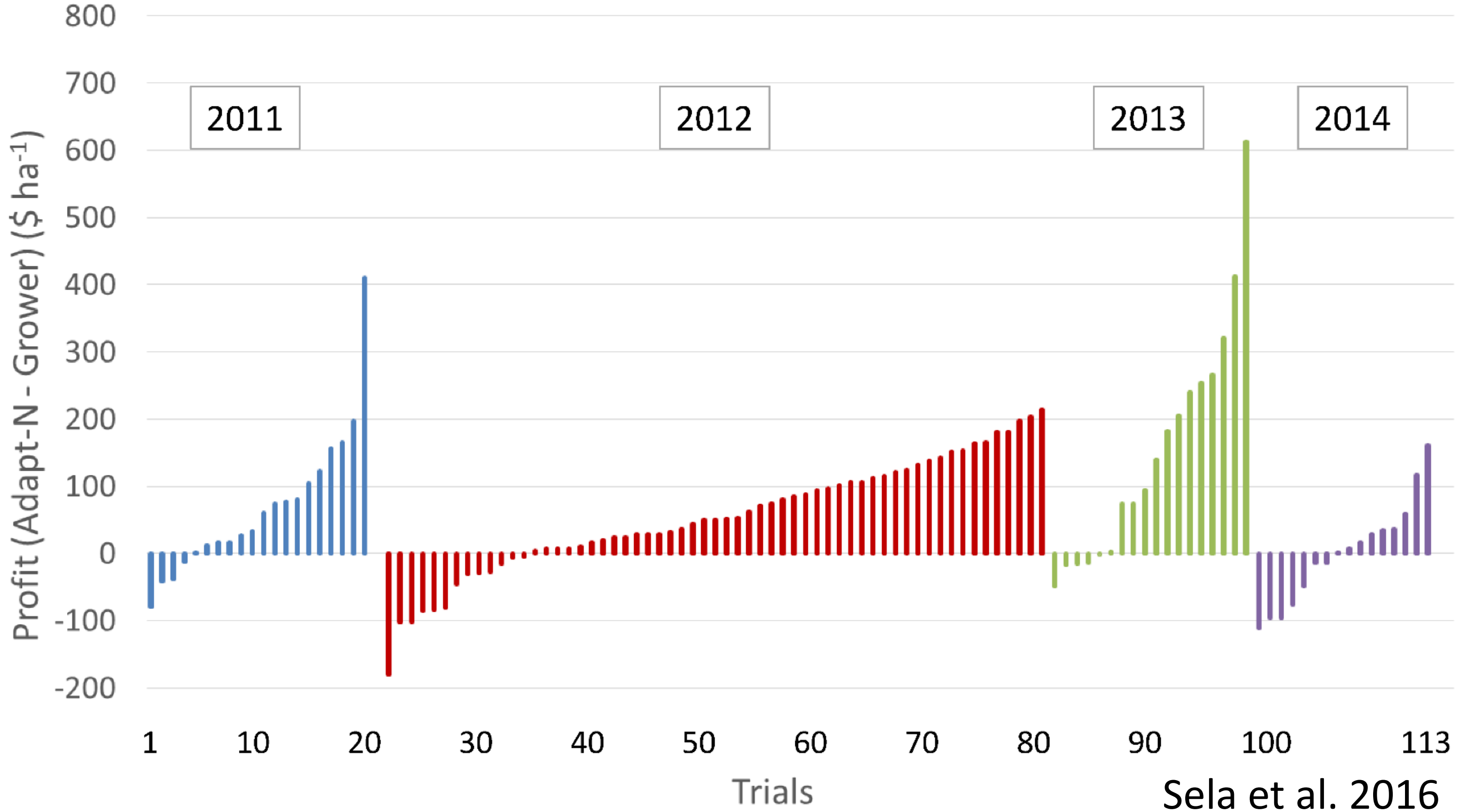
In 83% of all 113 trials the Adapt-N tool recommended lower N application than the respective Grower rate with an average reduction of 45 kg/ha ha-1 (40 lbs/ac) (34%)



Sela et al. 2016

The Adapt-N tool was extensively validated against field data
Profit

Avg profit increase of $65/ha ($26/ac)

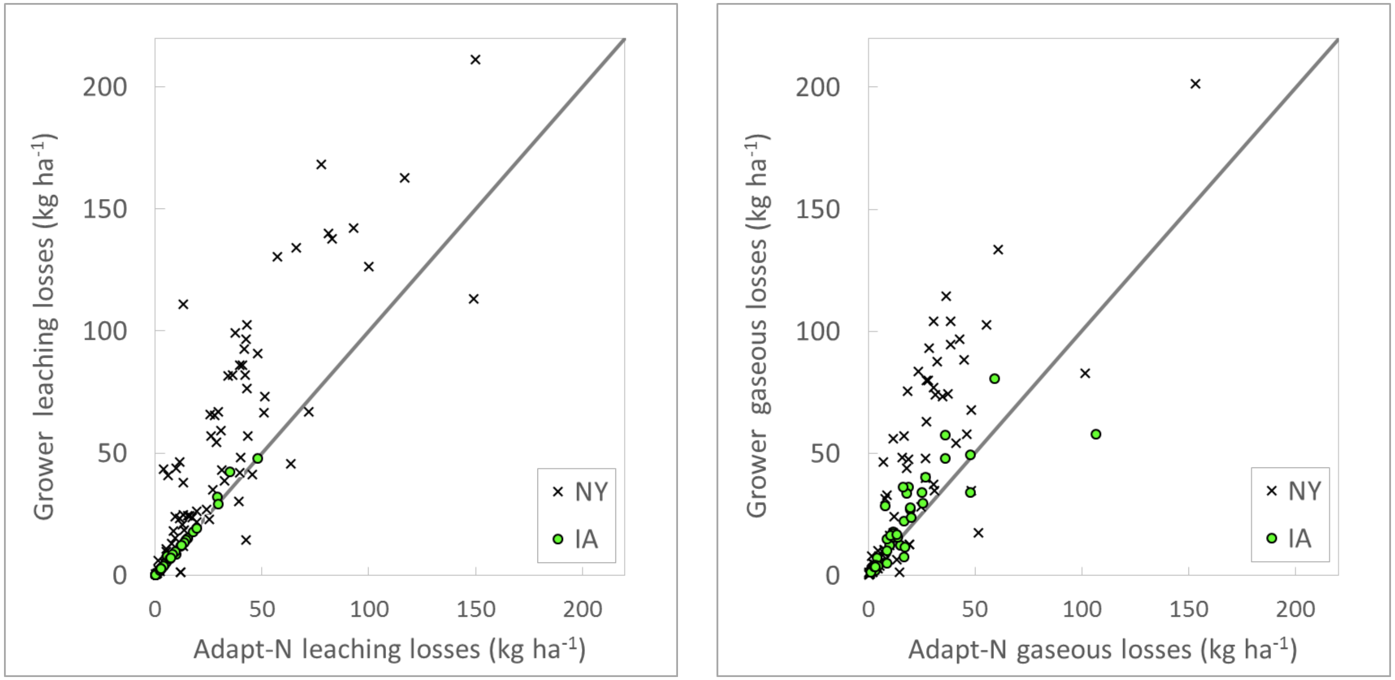


Sela et al. 2016

The Adapt-N tool was extensively validated against field data
Environmental Losses

Avg. reduction in simulated leaching losses of 12 lbs/ac (36%)

Avg. reduction in simulated gaseous losses of 12 lbs/ac (39%)



Sela et al. 2016

Objectives of the study:

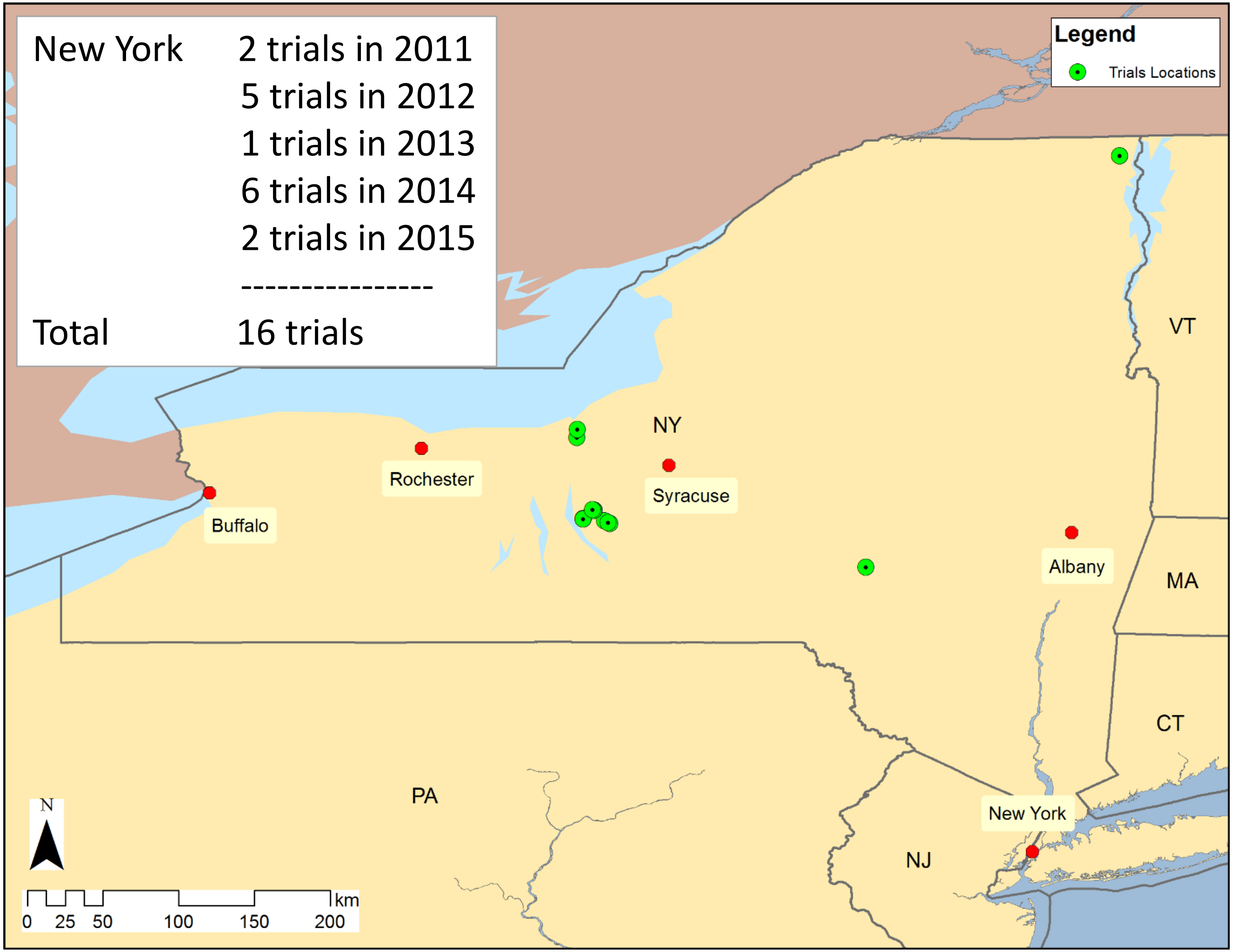
1. To compare measured yields to the default yields at the CNC (Cornell N calculator) database

2. To compare N rates of a Static (CNC) and an adaptive approach (Adapt-N) against the measured EONR

3. To compare the environmental fluxes resulting from each approach

New York	2 trials in 2011
	5 trials in 2012
	1 trials in 2013
	6 trials in 2014
	2 trials in 2015

Total	16 trials



Calculating EONR

1) A quadratic model was used to fit yield vs N rate data

2) The EONR of each trial was calculated using an R code
EONR (Yield, N rate)

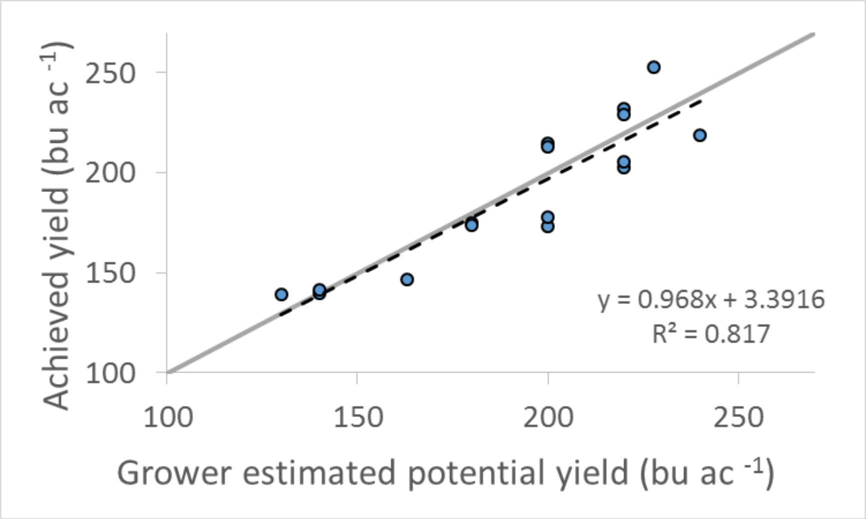
3) EONR determined at the end of the growing season

4) EONR does not equal AONR

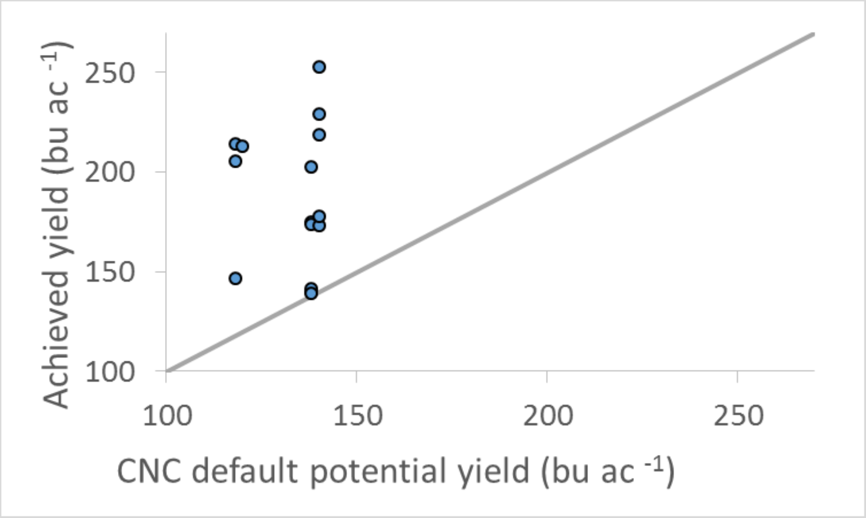
5) The CNC (New York) and Adapt-N were compared to the EONR

Comparison of achieved with estimated potential yields

The growers estimated their field yield potential remarkably well
(~ 3 bu/ac)



The CNC default potential yields significantly underestimated the achieved ones (~62 bu/ac)



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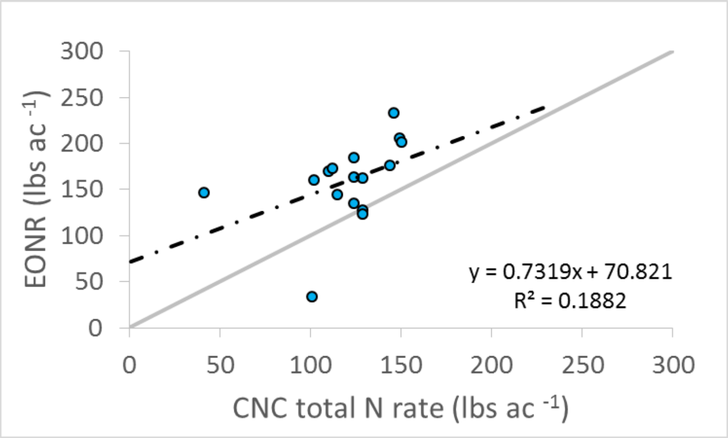
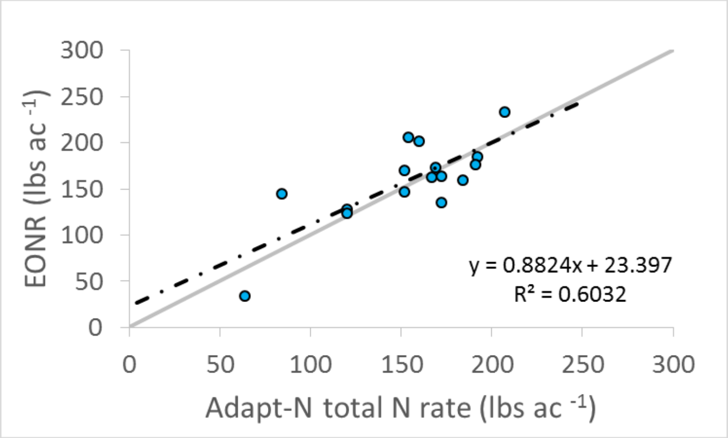
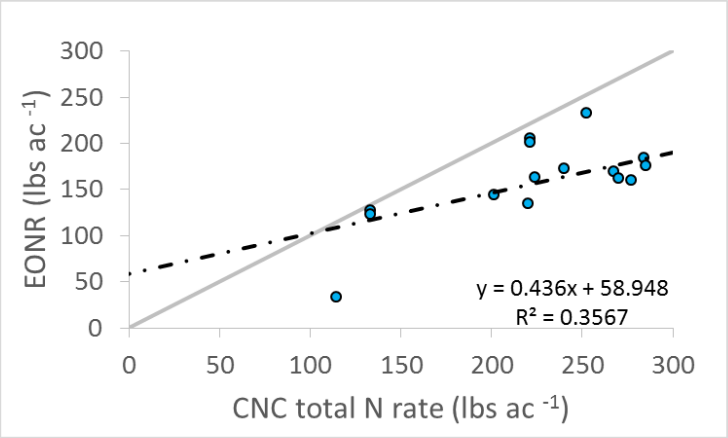
EONR, Adapt-N and Cornell N Calc NY trials

Default potential yields in the CNC database under predicts the EONR (RMSE of 55 lbs/ac)





Grower potential yields in the CNC database over predicts the EONR (RMSE of 85 lbs/ac)



Adapt-N successfully predicts the EONR in the different production environments (RMSE of 28 lbs/ac)

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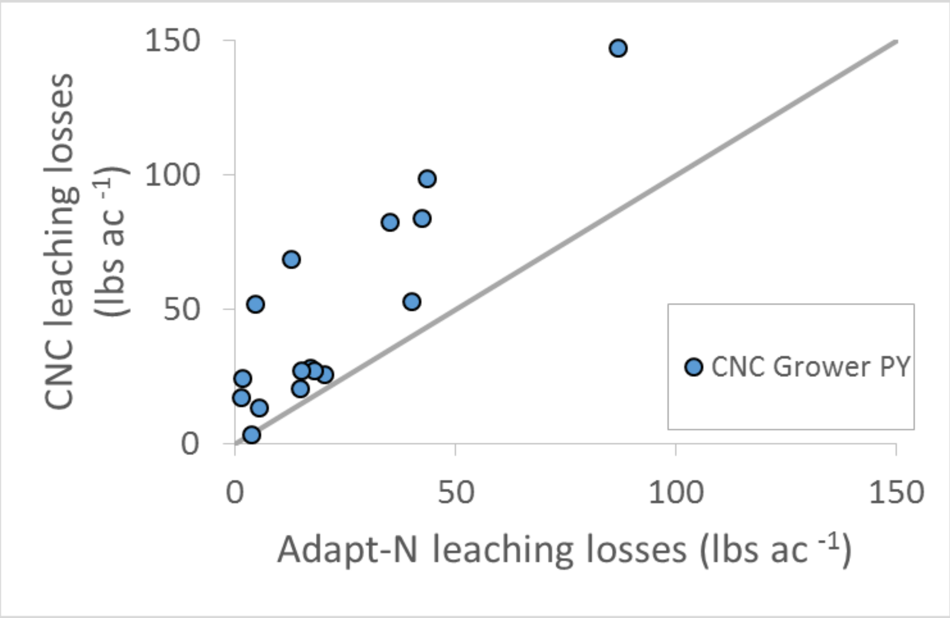
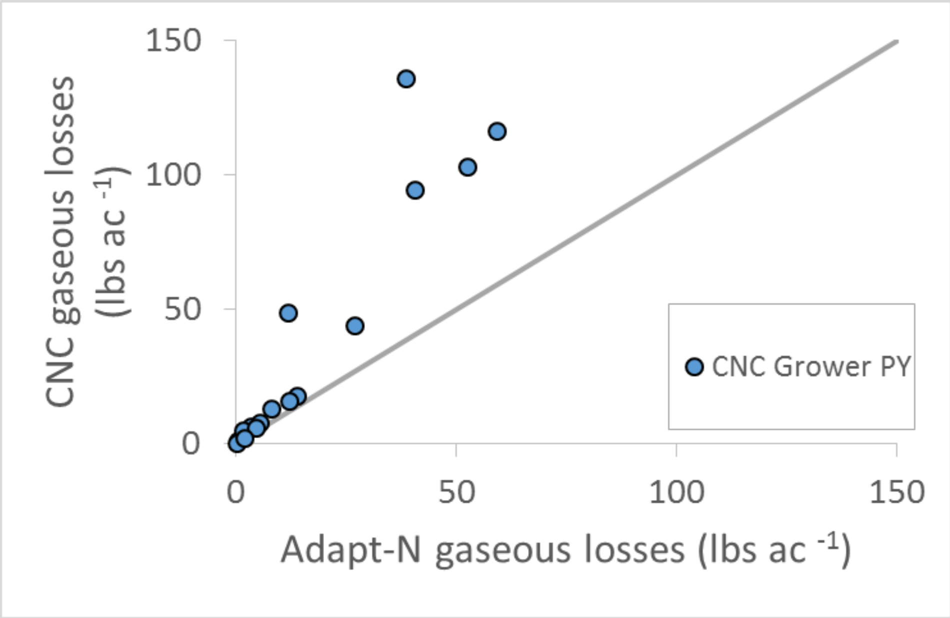
Environmental losses Adapt-N vs Cornell N Calc New York

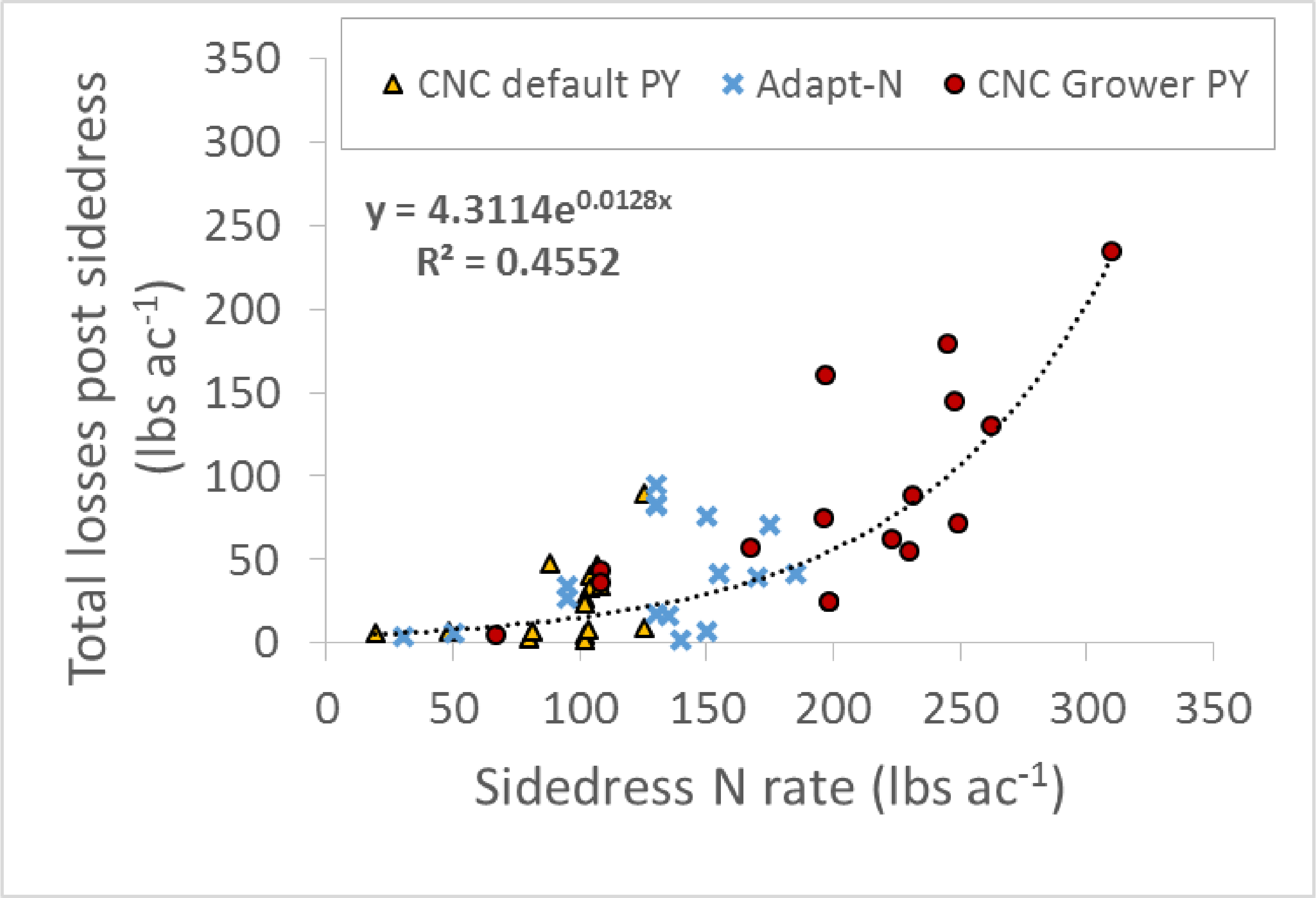
Adapt-N reduces simulated leaching losses by 26 lbs/ac (53%) compared with CNC grower PY



Adapt-N reduces simulated gaseous losses by 21 lbs/ac (55%) compared with CNC grower PY



Exponential relationship between SD N rates and environmental N losses



Conclusions

- The CNC potential yield database is outdated and underestimates achieved yields
- An adaptive approach for N recommendation outperforms a static one for NY trials
- Adapt-N achieves better correlation with the EONR while reducing environmental losses

Acknowledgements

This work was supported by funding from the USDA-NRCS Conservation Innovation Program grant number 69-3A75-10-157, New York Farm Viability Institute, USDA-NIFA WQ grant number 2013-51130-21490, the Northern New York Agricultural Development Program, USDA-Sustainable Agriculture Research and Extension grant number LNE13-328, the International Plant Nutrition Institute and the Atkinson Center for a Sustainable Future at Cornell University.

We are grateful for the cooperation from Paul Cerosaletti and Dale Dewing of Cornell Cooperative Extension.
We also are thankful for the cooperation of the many farmers who implemented these trials on their farms. Lindsay Fennell is thanked for help with data analysis.