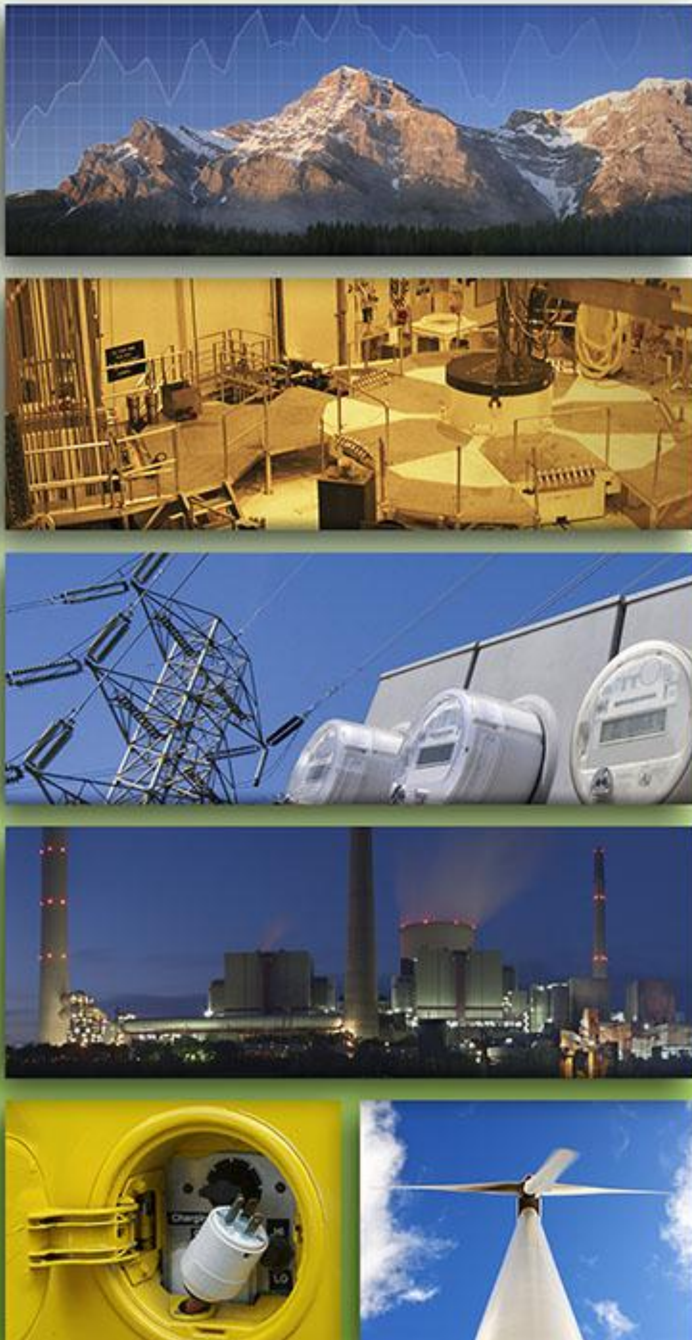

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Overview of the EPRI-MSU Nitrous Oxide (N_2O) Emissions Reduction Offsets Methodology

Adam Diamant
Senior Project Manager
EPRI Global Climate Program

C-AGG Workshop
Sacramento, CA
March 29, 2011

EPRI-MSU N_2O Offsets Collaboration

- Electric Power Research Institute (EPRI)
  - U.S. non-profit "501(c)(3)" scientific research consortium founded 1973 to perform objective electricity research for the public benefit
  - EPRI has more than 450 participants in more than 40 countries around the world. In the U.S., participants include companies who generate more than 90% of electricity delivered in the U.S.
- Michigan State University (MSU)
  - Major U.S. land grant university
  - Respected for high-quality research in agriculture, agronomy, crop sciences and related fields
  - Key personnel include Dr. Phil Robertson and Dr. Neville Millar, other MSU scientists and other collaborators.

Why Nitrous Oxide (N_2O)?

- Major GHG emitted by agriculture in U.S. and globally
- Agriculture accounts for ~70% of total U.S. N_2O emissions
- GWP (CO_2e) = ~300 → "low hanging fruit"
- High climate change mitigation "payback" for N_2O emissions reductions
- In practice, farmers often fertilize in excess of the "economic optimum," so there is an opportunity to reduce N_2O without adversely affecting crop yields.

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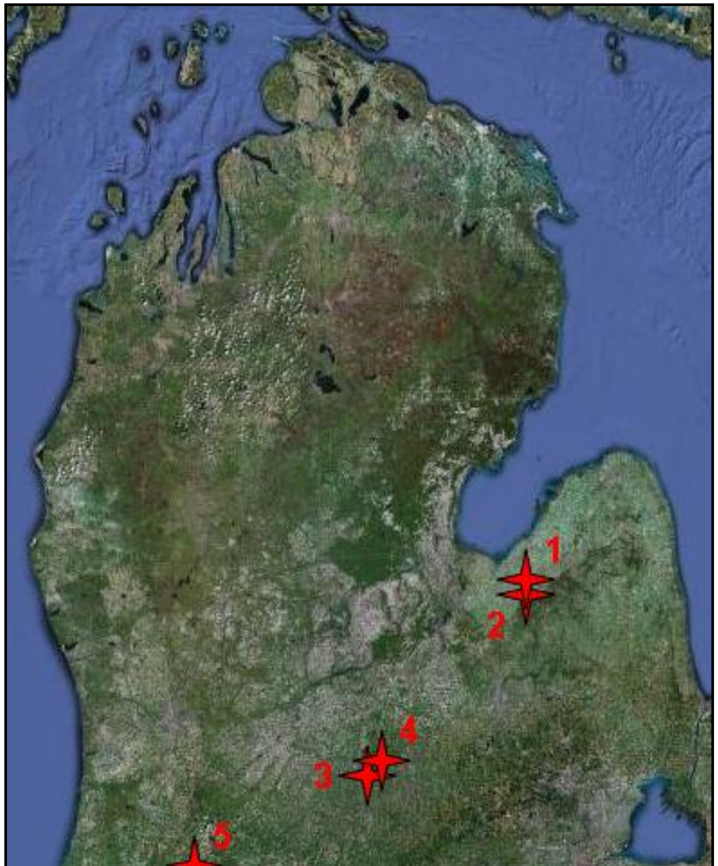
N_2O Flux Response Demonstrated on Commercial Farms in MI over 3 Years



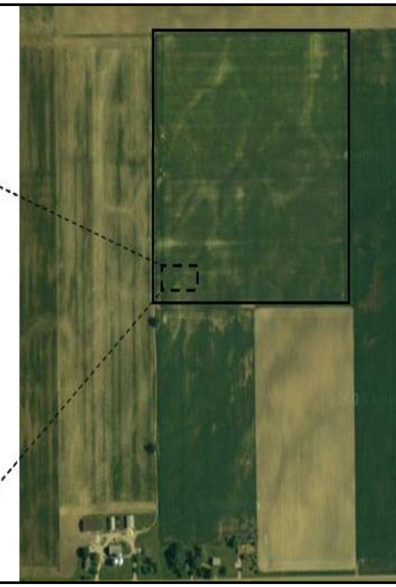
Rep 1	Rep 2	Rep 3	Rep 4

Nitrogen Rate (kg N ha^{-1})

0	135	180	45
90	225	225	0
180	180	90	90
225	0	45	135
135	45	0	225
45	90	135	180

35 m

60 m



- Five sites (8 site years)
- Commercial corn– soybean
- Conventional tillage

Confirmed that N_2O flux can be reduced by reducing N fertilizer inputs without a significant impact on crop yield and profitability.

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EPRI-MSU N_2O GHG Offsets Protocol Based on Recent Scientific Literature

Global Change Biology (2010), doi: 10.1111/j.1365-2486.2010.02349.x

Nonlinear nitrous oxide (N_2O) response to nitrogen fertilizer in on-farm corn crops of the US Midwest

J. P. HOBEN*, R. J. GEHL†, N. MILLAR‡, P. R. GRACE§ and G. P. ROBERTSON*‡

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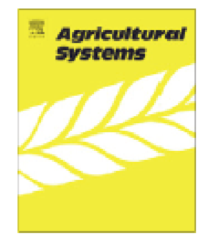

Short Communication

The contribution of maize cropping in the Midwest USA to global warming: A regional estimate

Peter R. Grace[a,b,*], G. Philip Robertson[b,c], Neville Millar[b], Manuel Colunga-Garcia[d], Bruno Basso[a,b,e], Stuart H. Gage[a,b], John Hoben[f]

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EPRI-MSU N_2O GHG Offsets Accounting Approach Published in Scientific Literature

Mitig Adapt Strateg Glob Change (2010) 15:185–204
DOI 10.1007/s11027-010-9212-7

ORIGINAL ARTICLE

Nitrogen fertilizer management for nitrous oxide (N_2O) mitigation in intensive corn (Maize) production: an emissions reduction protocol for US Midwest agriculture

Neville Millar • G. Philip Robertson • Peter R. Grace • Ron J. Gehl • John P. Hoben

http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s11027-010-9212-7

This published scientific peer-reviewed article provides a solid foundation for the MSUI-EPRI N_2O offsets protocol to be validated under existing offsets standards, such as ACR, CAR and VCS.

EPRI-MSU N_2O Offset Protocol
Guiding Principles

- ✓ **Simple** to understand and to implement
- ✓ **Transparent**
- ✓ **No gaming** opportunities
- ✓ **Flexible** – Allows farmers latitude to implement creative solutions based on their specific situation
- ✓ **Scientifically robust** – Based on peer-reviewed scientific literature and accepted understanding of N_2O flux
- ✓ Based on a **standardized performance** approach to additionality and baselines
- ✓ **Widely applicable** to different climates, soils, crops

EPRI-MSU N_2O Offset Protocol
Project Additionality

Additionality assessed using a Performance Benchmark.
Under both the ACR and VCS, two tests must be passed:

1. Regulatory Surplus

- No mandatory laws or regulations at the local, state, or federal level that requires farmers to reduce N fertilizer rate below BAU rates.

2. Performance Standard

- Exceeds a performance threshold that represents BAU rate
- “Common practice” threshold used that is identical to calculated N rate baseline value, irrespective of whether Approach 1 or 2 is used.

EPRI-MSU N_2O Offset Protocol
Project Baseline & Emissions Reductions

- Baseline N_2O emissions are the emissions that would be emitted without the project.
  - N fertilizer is assumed to be applied at the BAU rate.
  - Baseline scenario equals "common practice" application of N-fertilizer based on USDA yield-goal recommendations.
- Project Activity: Reducing N-fertilizer application to a level below the BAU baseline rate (e.g., to the MRTN level recommended for the specific crop and region).
- Emissions Reductions: Avoided N_2O emissions from reduced application of N fertilizer in crop production.

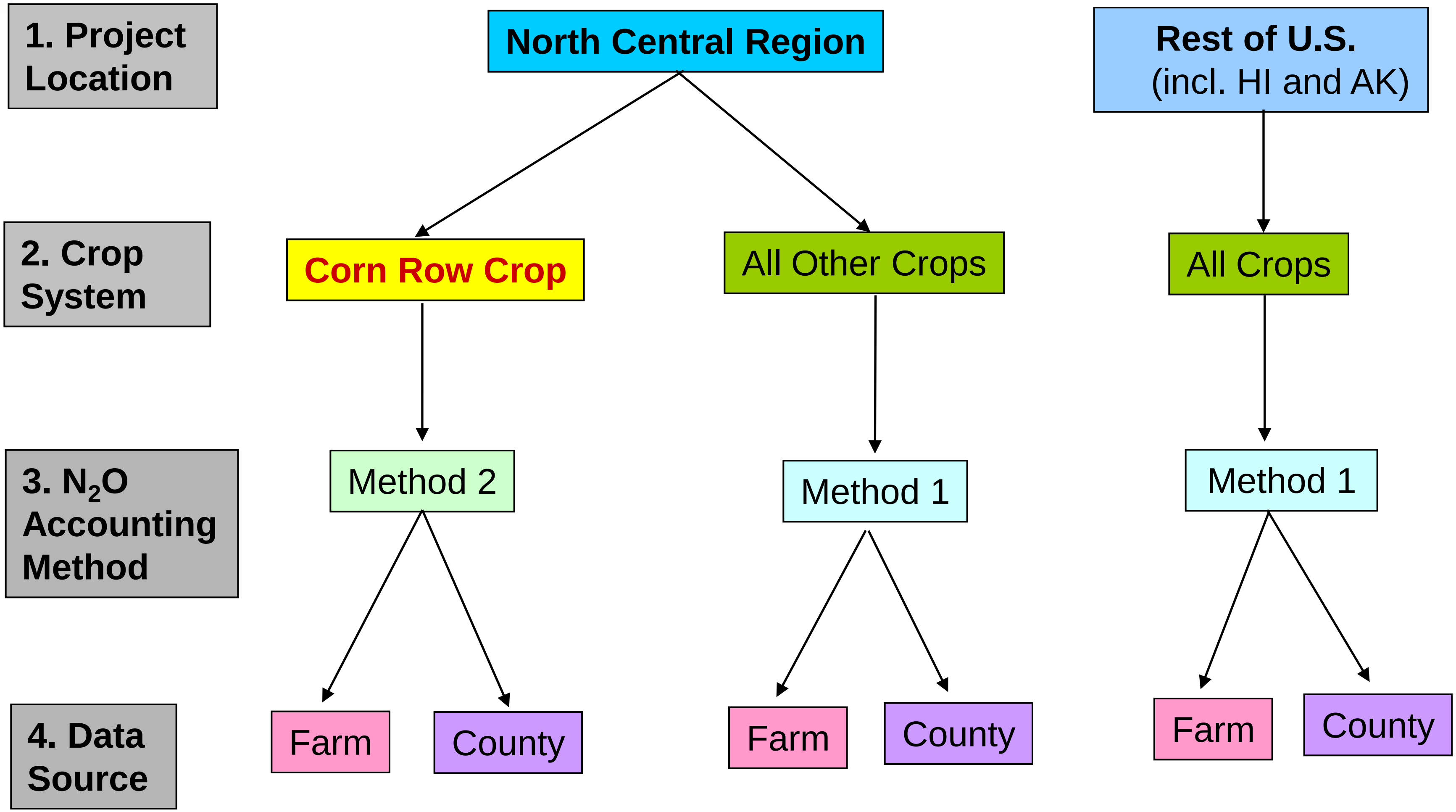
$$N_2O_{PR,\,t} = (N_2O_{B\ total,\,t} - N_2O_{P\ total,\,t}) * A_P$$

$N_2O_{PR,\,t}$	$(N_2O_{B\ total,\,t}$	$- N_2O_{P\ total,\,t})$	$* A_P$
Project emissions reductions	Total baseline emissions	Total project emissions	Project area

EPRI-MSU N_2O Offset Protocol
Eligibility and Coverage

- All N inputs deliberately and directly applied to the soil as external source are equal on a mass basis
  - Includes synthetic and organic sources of N
  - N applied throughout entire cropping cycle (year agnostic).
  - Project proponent must adhere to regional BMPs.
- Geographic Location and Calculation Methods
  - **Method 1: Direct N_2O emissions (Tier 1 – IPCC)** applies to cropland throughout the U.S. Eligible for all agricultural systems.
  - **Method 2: Direct N_2O emissions (Tier 2 – MSU/EPRI)** applies to corn row–crop systems in the U.S. North Central Region (NCR).
  - Same Method to be used for both Baseline and Project Emissions
  - “Organic” soils are ineligible (e.g., wetlands, peat, etc…)

MSU-EPRI N_2O Project Flowchart



EPRI-MSU N_2O Offset Protocol
Covered GHG Emission Sources

- Direct – N_2O emissions produced on–site by soil within the defined project boundary.
- Indirect – GHG emissions generated beyond the project boundary that result from the project. Includes N_2O produced in waters and soils from NO_3 leaching NH_3 volatilization.
- Increased CH_4 and CO_2 emissions and reductions in soil carbon considered negligible, based on long-term field studies and scientific literature.
- Excludes emissions associated with farm fuel.

EPRI-MSU N_2O Offset Protocol
Permanence and Leakage

Permanence

- Avoided N_2O emissions occur immediately. They are irreversible and permanent.
- **No permanence concerns.**

Leakage

- Cropland is maintained for crop production after implementation of the N_2O offset project.
- Project does not cause crop yields to decline so yield losses do not lead to increased production and N use elsewhere.
- **No market leakage concerns**

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Technical Potential for N_2O Emissions Reductions in U.S. Agriculture

Geographic Area	Technical Mitigation Potential	
	N_2O-N (Gg)	***CO_2e (MMT)***
California	12.4	5.81
North Central Region (NCR)	142	66.7
Contiguous US*	6.1	3.10
Total	**161**	**76**

Notes: Gg = Gigagram (10^9 g) = 1000 metric tons; MMT = million metric tons.
N2O-N = mass of nitrogen associated with N_2O emissions reductions.
CO_2e = carbon dioxide equivalent based on GWP of N2O = 298.
*Contiguous U.S. excludes California and North Central Region and is only applicable here because it only includes corn and wheat acreage.

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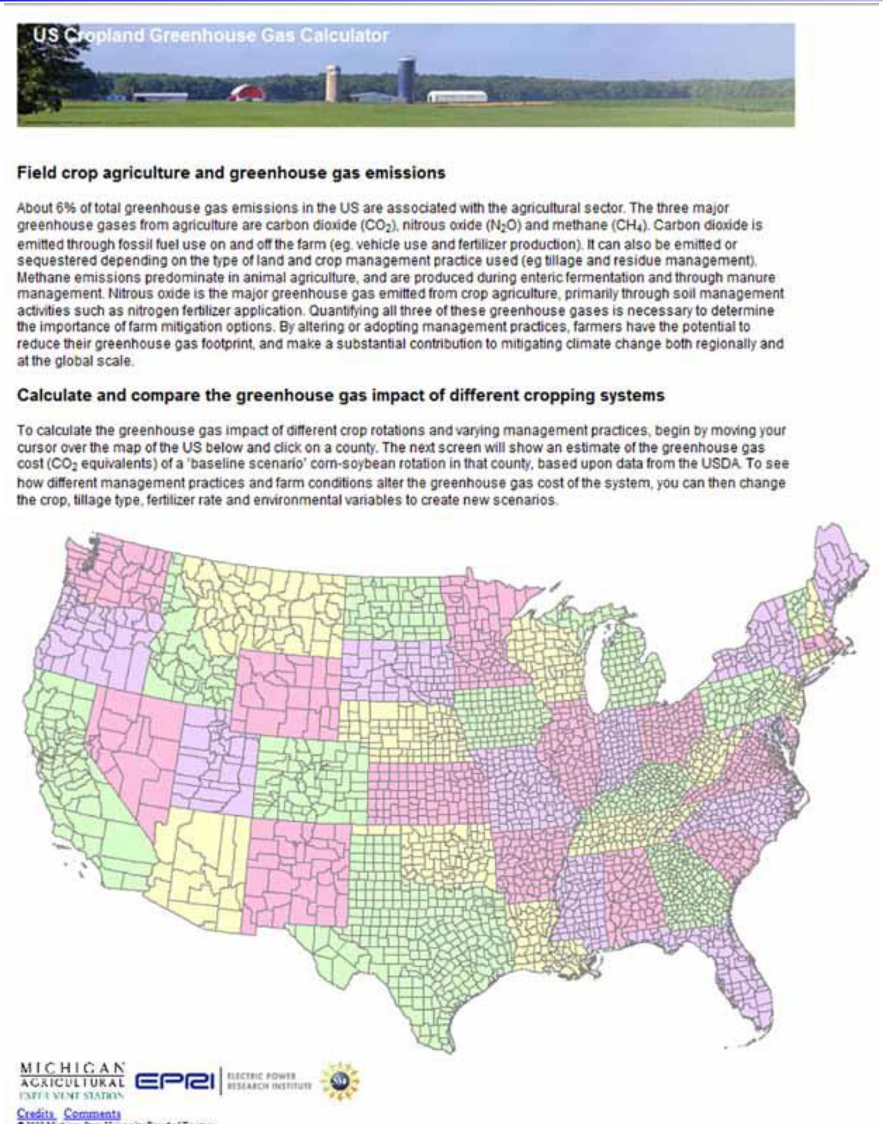
MSU Web-based Decision Support System: N_2O GHG Calculator



- N_2O calculator allows offset project developers, electric companies, and others to quantify potential N_2O offsets and identify the best locations to implement them.
- Calculator makes use of existing USDA and other data.
- Provides comparative CO_2e "costs" of N_2O, soil carbon change, fuel, and fertilizer;
- Allows comparison of different scenarios based on crop, tillage, and fertilizer decisions

www.kbs.msu.edu/ghgcalculator

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The MSU–EPRI N_2O Offsets Protocol
Methodology Validation Status

VCS Validation:

- Submitted to VCS : 17th August 2010
- VCS website posting : 8th Sept. 2010
- Public consultation completed : 10th October 2010
- 1st Validation Completed : 2nd February 2011
- 2nd Validation Started : 23rd February 2011

ACR Verification:

- Submitted to ACR : 3rd March 2011
- Public comment / Peer review : 2nd Quarter 2011

EPRI-MSU N_2O Offset Protocol
Next Steps

- Continue VCS 2nd methodology validation
- ACR public comment period and peer-review expected to occur in the next 2-3 months
- Now preparing Project Design Document for a "pilot" N_2O offsets project in MI
- Continue ongoing interaction with Climate Action Reserve (CAR) as they move forward to develop a "nutrient management" offsets protocol
- Exploring potential use of MSU-EPRI N2O protocol in Australia as part of the Carbon Farming Initiative (CFI)

Thank You

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Additional Slides

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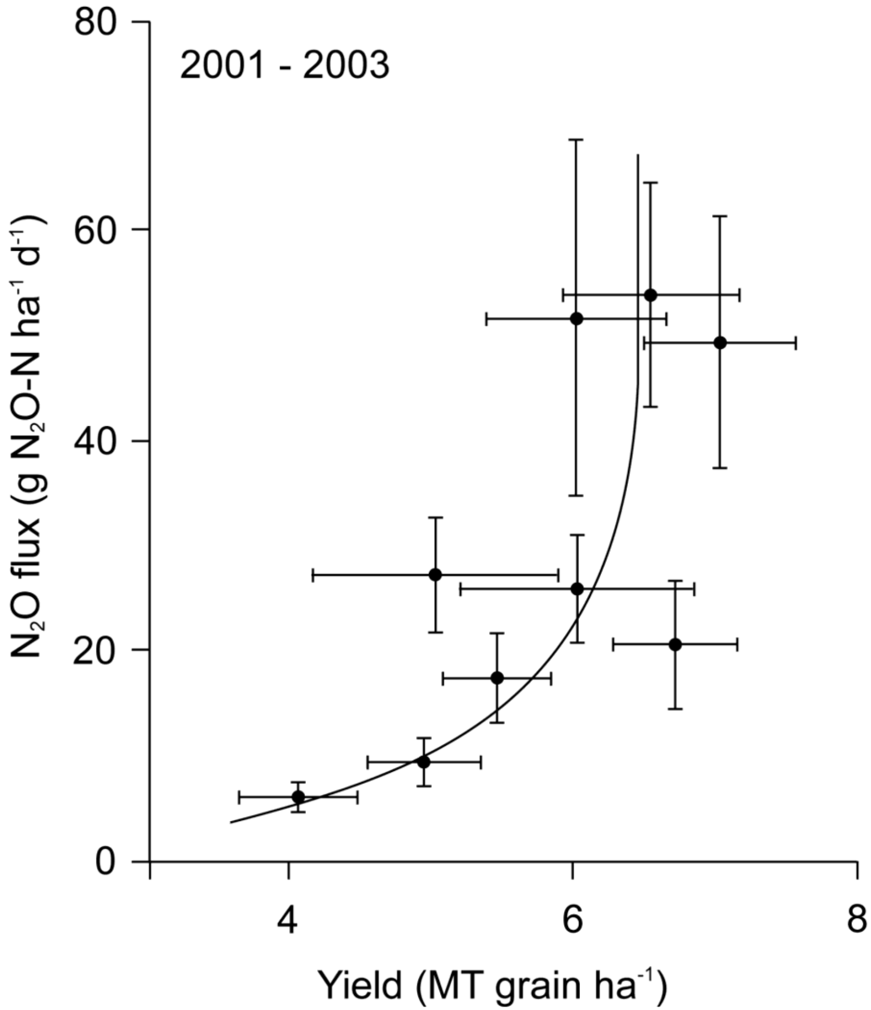
N_2O "Flux" Versus Crop Yields

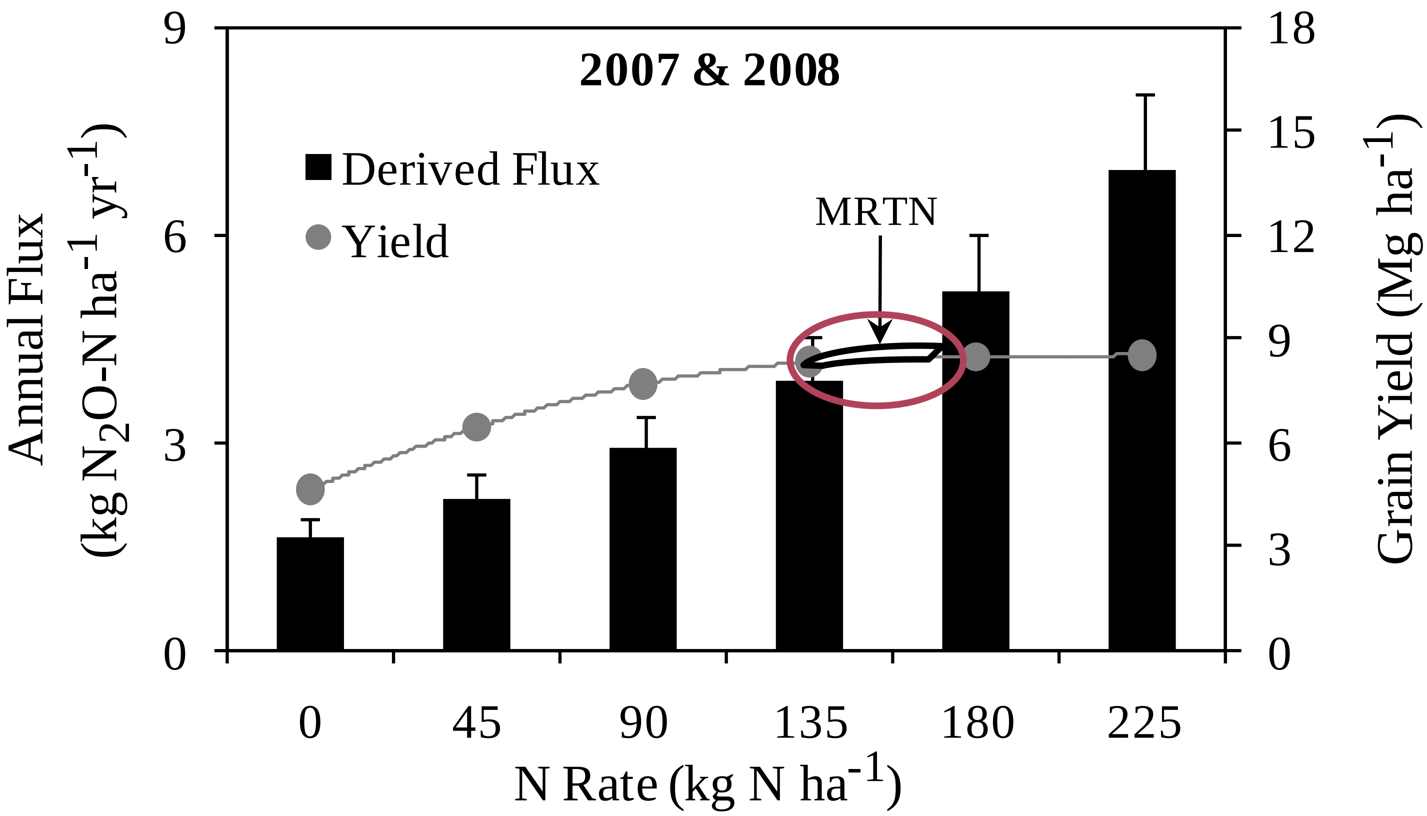


- **N$_2$O flux increases exponentially** as N-fertilizer increases beyond crop yield increase.
- Implication – N_2O emissions can be reduced dramatically with little or no impact on total crop yield.

N_2O flux as a function of yield (nitrogen availability) in continuous corn at a site in southwest Michigan. Results suggest that a significant decrease in N_2O flux could be achieved with little yield impact.

Source: McSwiney & Robertson, *Global Change Biology*, 2005.

N_2O Flux Increases Exponentially as N Rate Increases Beyond Yield Increase



MRTN = 153 kg N ha^{-1} ($1 range =135-173 kg N ha^{-1}). *MRTN (Maximum Return to Nitrogen) is the recommended N rate based on fertilizer cost versus corn price.*

N_2O emissions can be reduced with no impact on crop yield.