Methodology for Quantifying Nitrous Oxide (N_2O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops

Webinar
November 15, 2012

Outline

- ACR background and N_2O emissions from corn
  - *Nicholas Martin, American Carbon Registry*
- EPRI support for reducing N_2O emissions from agriculture
  - *Adam Diamant, Electric Power Research Institute*
- Key points of the MSU/EPRI methodology
  - *Phil Robertson and Neville Millar, Michigan State University*
- Q&A

Webinar logistics

- To ask questions:
  - During presentation, type questions into '**Chat**' box near bottom of your webinar pane. Please include name and organization.
  - Or '**Raise Hand**' (in vertical bar at left of your webinar pane) to hold your place in line to ask a question verbally
  - As a participant, your microphone will be muted until the organizers un-mute you
- Q&A period at end: we will direct written questions to appropriate person, and call on anyone with hand raised
- Webinar will be recorded and posted shortly to www.americancarbonregistry.org

Winrock International Institute for Agricultural Development

Non-profit organization that works in the U.S. and around the world to empower the disadvantaged, increase economic opportunity, and sustain natural resources

- 1985 merger of Winrock Int'l Livestock Research & Training Center, International Ag Development Service, and Ag Development Council
- Rockefeller family tradition of agricultural research and extension, yield improvement, global food security
- Seeking ways to connect farmers and ranchers to new markets, enhance competitiveness, maintain/increase yields

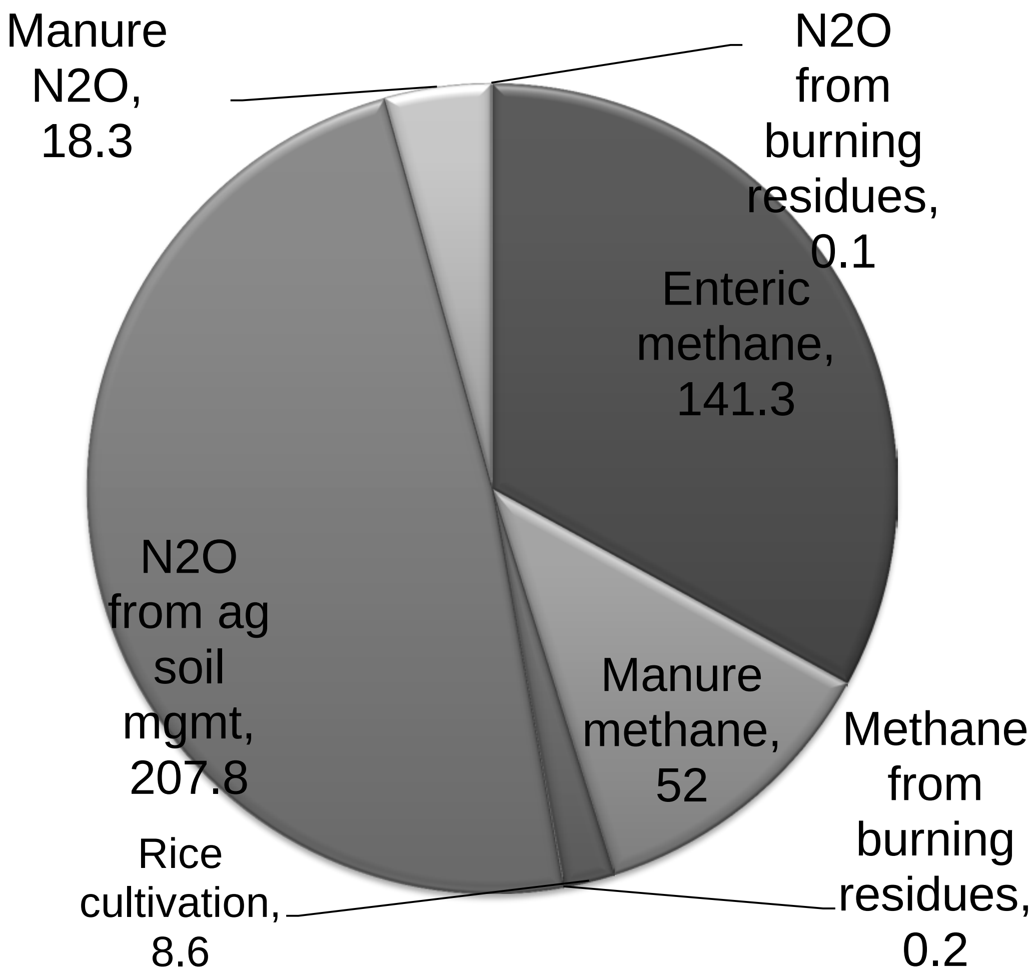
American Carbon Registry

- First U.S. voluntary carbon registry
  - 37.5 MMT CO_2e verified carbon reductions since 1996
  - Non-profit organization
- Registry roles:
  - Develop and approve carbon protocols
  - Review and register projects
  - Oversee independent verification
  - Transparently track transactions and retirements
  - Support California compliance market, both as OPR and with new protocols
- 2011: 2.9 million ERTs sold, retired or contracted at average price of $5.51/tCO2e (range $1-14)
- Most widely used forest carbon standard in North America in 2011 (2012 *State of the Forest Carbon Marke*t report)

ACR focus on agricultural GHG mitigation

- Crop agriculture:
  - N_2O emission reductions through changes in fertilizer management
  - N_2O emission reductions through fertilizer rate reduction
  - Voluntary emission reductions in CA and Midsouth rice
  - Afforestation/reforestation of degraded lands
- Livestock and grazing lands:
  - ARB Compliance Offset Protocol – Livestock Biogas
  - Grazing Land and Livestock Management modular methodology
  - BIGGS: Carbon Intensity of Fed Cattle, Dairy Carbon Intensity, Reduced Age at Harvest
  - Compost Additions to Grazed Rangelands
  - Panda Standard - Revegetation of Degraded Grasslands in China

Methane and N_2O emissions from U.S. agriculture (MMT CO_2e, 2010)



- Agriculture = 428 MMT CO_2e or 6.3% of US GHG emissions
- Leading sources are N_2O from fertilizer and methane from livestock

N_2O from fertilizer

- Annual emissions of 208 $MMTCO_2e$ – half of agriculture total, and >3% of US total
- Corn is among most intensive fertilizer users
- 80% of corn for grain is grown in North Central Region
- Potential to increase competitiveness for farmers, achieve GHG reductions at reduced cost, mitigate climate change and improve water quality

STATE	ACRES
Iowa	12,522,638
Illinois	11,126,533
Nebraska	8,561,006
Minnesota	6,746,774
Indiana	5,064,288
South Dakota	4,466,561
Kansas	3,758,622
Wisconsin	3,406,333
Missouri	2,765,287
Ohio	2,739,173
Texas	2,381,378
North Dakota	2,033,928
New York	1,321,142
Colorado	1,057,354
Pennsylvania	966,934
Kentucky	945,890
North Carolina	940,710
Georgia	382,628

N_2O emissions from corn

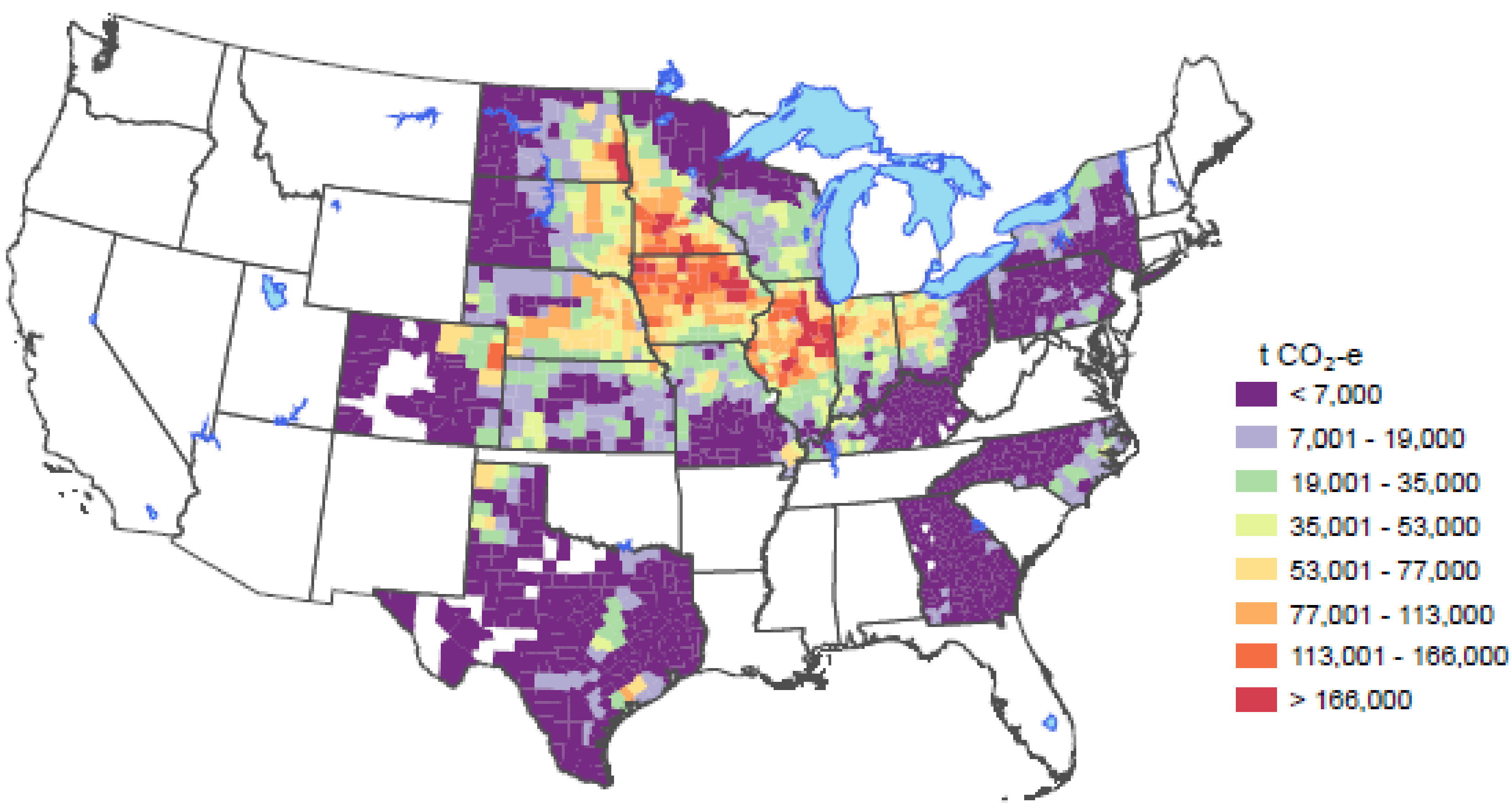


Figure 8. Estimated cumulative county-level annual emissions from corn fields for anhydrous ammonia fertilizer

Why two fertilizer methodologies?

- Both based on strong science, vetted via public consultation and peer review
- Both account for and deduct for uncertainty to ensure conservative crediting
- MSU initially limited to rate reduction on corn in NCR (though designed to expand), but far simpler to apply
- DNDC methodology applies to any practice, any crop and region for which DNDC cal/val meets criteria
- Useful for different project types
- Useful input to CARB compliance protocol
  - ACR MSU/EPRI methodology generally similar to CAR *Nitrogen Management Project Protocol*
  - ACR DNDC methodology broader and applicable in CA

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EPRI's Engagement in Developing GHG Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Crop Production

Adam Diamant
EPRI Energy and Environmental Analysis Program

American Carbon Registry Webcast
November 15, 2012

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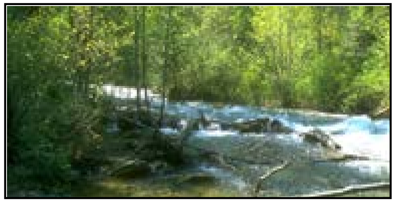
Together…Shaping the Future of Electricity



- **EPRI is a non-profit “501(c)(3)”** scientific research consortium founded in 1973 to perform objective research and development relating to the generation, delivery and use of electricity for the benefit of the public.
- EPRI has **450+ participants in more than 40 countries** around the world.
- In the U.S., EPRI participants generate **more than 90% of electricity delivered**.
- **Principal locations** — Palo Alto, CA, Charlotte, NC and Knoxville, TN

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EPRI's Greenhouse Gas Emissions Offsets Research Program (EPRI P102)

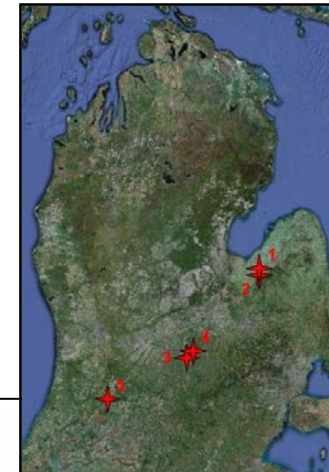
1. **Development of New Types of Offsets**
   - Identify promising new offset "technologies"
   - **Facilitate development of new offset methodologies (e.g., N_2O Offsets)**
2. **Offsets Education & Communication**
   - Hosted 13 offsets policy workshops since 2008 (e.g., Offset Credit Stacking, November 9, 2012)
   - Ongoing monitoring and reporting on the operation of offsets programs around the world.
3. **Quantitative Analysis of Offsets**
   - Examine the role of offsets in proposed federal legislation.
   - Analyze land-use competition, and interactions between biofuels, agricultural production and forest carbon sequestration.
   - Analyze potential "sectoral" offsets (e.g., China electric sector; REDD)
   - Reassess potential domestic & international offset supplies

Benefits of N_2O Emissions Reductions in Agricultural Production

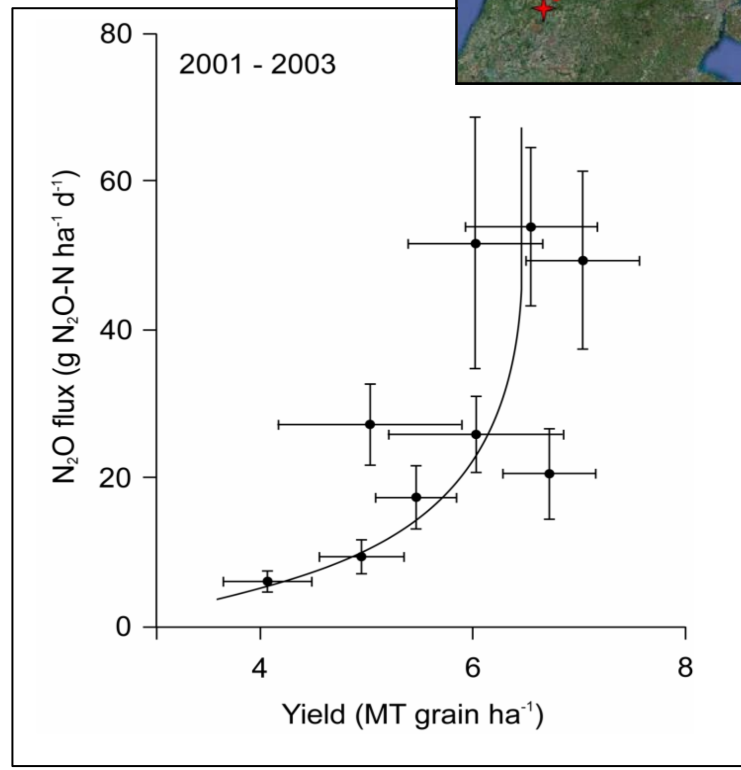
- Reducing N fertilizer application in crop production can reduce N_2O emissions, particularly in NCR corn.
- N_2O reductions are permanent and there is no saturation.
- N_2O reductions do not cause leakage.
- N_2O reductions can be implemented across a wide range of crops and geographic areas in the U.S. and abroad. Initial focus on corn production in the NCR.
- N_2O reductions can be achieved at low cost.
- N_2O reductions in crop production provide ancillary co-benefit of improved water quality.

EPRI's Partnership with Michigan State University (MSU)

- MSU has unique, critical technical capabilities for understanding N_2O flux in crop production, particularly NCR Corn.
- MSU is one of only several U.S. institutions capable of measuring N_2O "flux" in field samples. This was a critical element of this project.
- MSU has developed key field testing infrastructure that made it possible to leverage existing relationships with farmers to facilitate field testing.
- Agronomic results developed in MI often can be generalized more broadly across crop types, soils and climatic regimes of the larger NCR.



MICHIGAN STATE UNIVERSITY



Source: McSwiney, C.P., and G. P. Robertson, 2005.

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Phase 1 N_2O Offset Project (2006-2009)
Scientific Research

Developing GHG Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production

Row crop ecosystems, such as this corn crop in the United States, contribute about 50% of anthropogenic N_2O emissions.

- **Evaluated technical potential and economic cost** to offset GHG emissions by reducing N_2O emissions in crop production.
- **Conducted field testing** that confirmed N_2O emissions can be reduced by lowering N input with no reduction in crop yield.
- **Developed quantitative models** to predict the relationship between N_2O flux and crop yields.
- **Conducted socio-economic analysis** to identify factors that may promote or inhibit farmer acceptance of this approach.
- **Published key findings and a proposed new N_2O offsets methodology** in peer-reviewed scientific literature.

Phase 2 N_2O Offset Project (2010-12)
Methodology Development

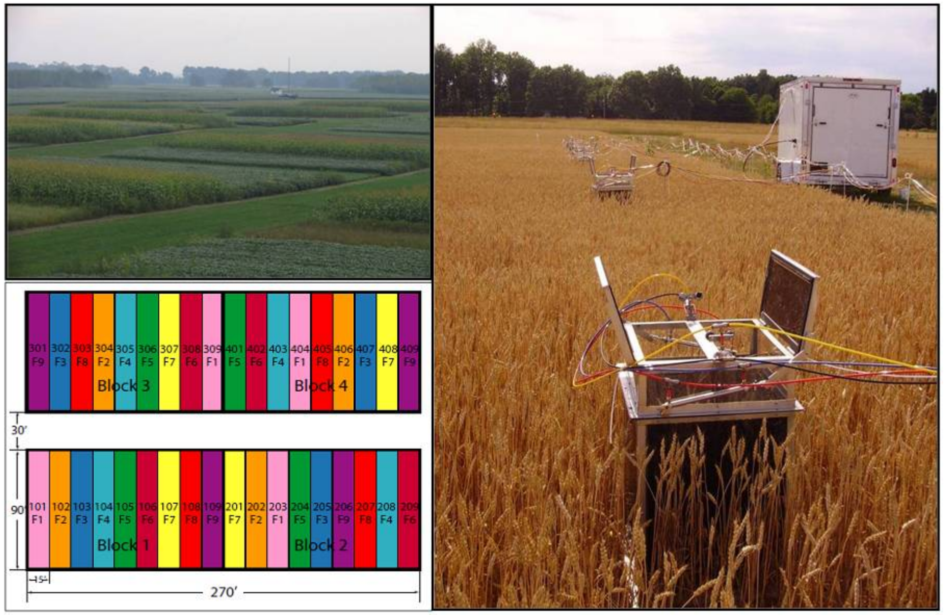
Developing GHG Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production

N_2O offset projects on agricultural lands could be an important component of efforts to reduce GHG emissions.

- **Validated MSU-EPRI N_2O Offsets Methodology** for use in multiple existing high-quality GHG offsets standards and programs, including the American Carbon Registry (ACR)
- **On-Farm Demonstration Project** – Developed and implemented a pilot N_2O offsets demonstration project on a working farm.

EPRI N_2O Project Participants

- EPRI Participants
  - Investor Owned Utilities (8)
  - Cooperatives (3)
  - Public power (2)
- R&D Organizations
  - EPRI
  - Michigan State University (MSU)
- Methodology Validators
  - Environmental Services Inc.
  - Det Norske Veritas (DNV)
- Offset Standards
  - American Carbon Registry (ACR)
  - Climate Action Reserve (CAR)
  - Verified Carbon Standard (VCS)



Row crop ecosystems, such as corn grown in the U.S., contribute about 50% of global anthropogenic N_2O emissions. These emissions can be lowered by reducing the amount of Nitrogen fertilizer used in crop Production.

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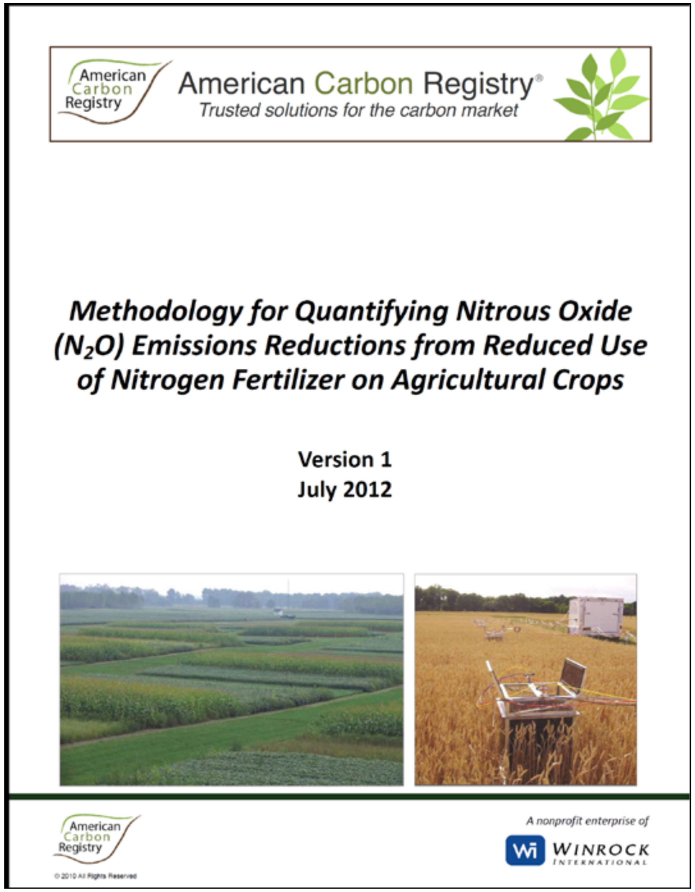
Status of MSU-EPRI N_2O Offsets Protocol

- **American Carbon Registry (ACR)** *Methodology for Quantifying Nitrous Oxide (N_2O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Lands v.1* (Approved July 2012)
- Climate Action Reserve (CAR) *Nitrogen Management Project Protocol (Approved June 2012)*
  - Incorporates MSU-EPRI "Tier 2" N_2O emissions quantification & other features
- Verified Carbon Standard (VCS)
  - Completed Double Approval
  - Final approval expected Q4, 2012


American Carbon Registry®
Trusted solutions for the carbon market

Methodology for Quantifying Nitrous Oxide (N_2O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops

Version 1
July 2012

A nonprofit enterprise of WINROCK INTERNATIONAL

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Thank You

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MSU-EPRI Methodology

MICHIGAN STATE UNIVERSITY

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A nonprofit enterprise of
Wi WINROCK INTERNATIONAL

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Thanks to:

Suzanne Sippel, Iurii Shcherbak

Michigan State University AgBioResearch

KBS LTER Kellogg Biological Station Long-term Ecological Research

NSF

Protocol based on Peer Reviewed Science

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

Offsets Protocol

Global Change Biology

Global Change Biology (2011) 17, 1140–1152, 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*‡

Field Research

Agricultural Systems 104 (2011) 292–296

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

ELSEVIER

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]

Modeling

Guiding Principles

PROTOCOL

- Robust science
- High environmental integrity
- Transparent
- Non-prescriptive

PROJECT

- Low effort and cost
- Simple to verify
- Quick adoption potential
- Widely applicable

In short, easy to use and verify

Benefits

Environmental

- Reduction in agricultural GHG footprint
- Reduction in reactive N in environment

Financial

- Reduced farm (fertilizer) costs
- No productivity penalty
- Financial reward (carbon market)
- Delivers sought-after offset credits

Eligibility Requirements (1 of 3)

Farmers who use external sources of nitrogen

Fertilizer Type

- Synthetic N (e.g. urea, anhydrous ammonia)
- Organic N (e.g. manure, compost)

Fertilizer Management

- Applied any time during cropping cycle
- Must adhere to Best Management Practices for region

Eligibility Requirements (2 of 3)

Nitrous Oxide Emissions

- Direct: Emitted on-site
- Indirect: Emitted off-site

Includes N_2O produced downstream and downwind in waters and soils as a result of nitrate (NO_3^-) leaching and ammonia (NH_3) volatilization

Eligibility Requirements (3 of 3)

Geographic Location / Categories

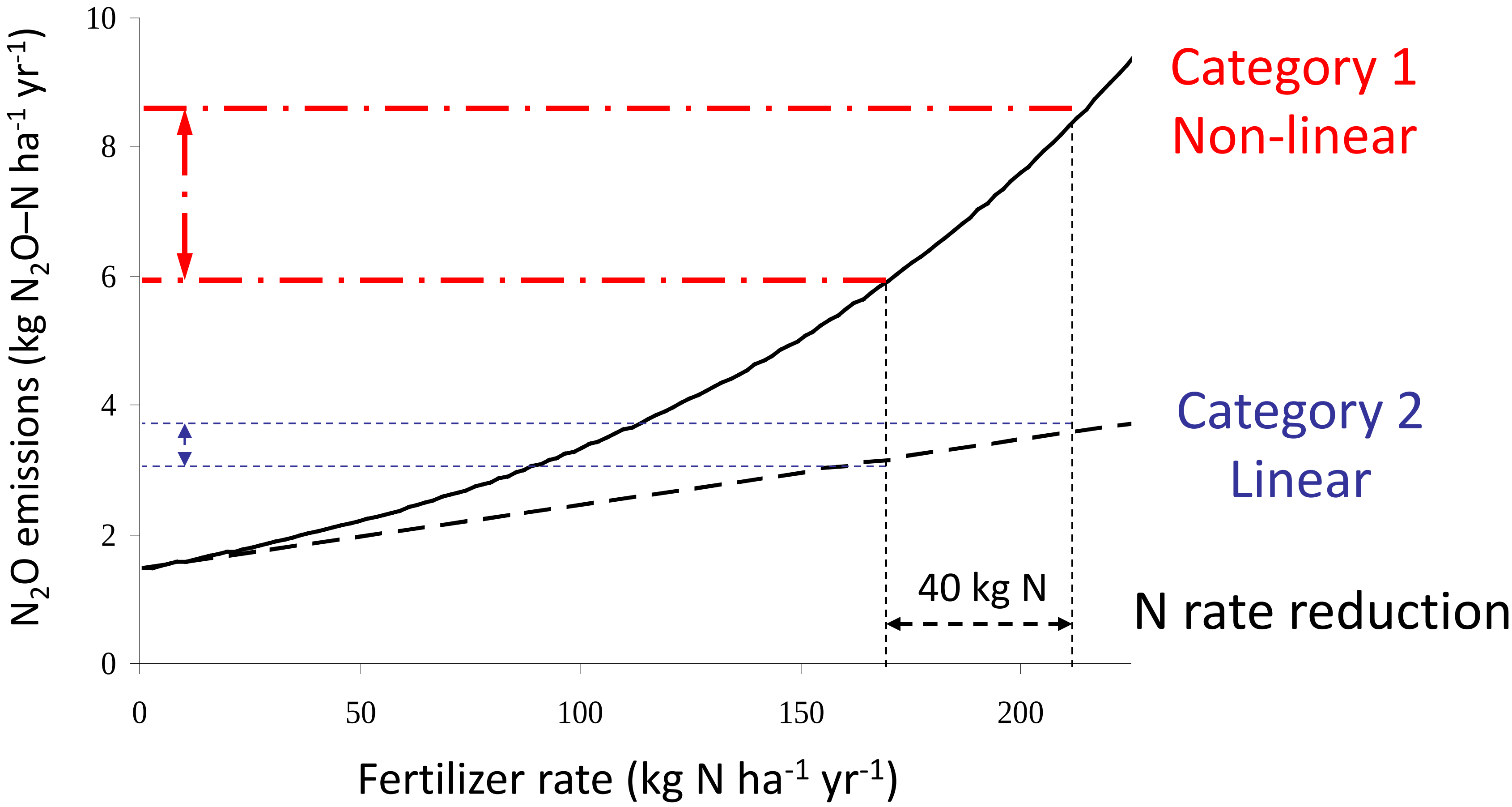
Category 1: Projects located in US *North Central Region (NCR)*
(ND, SD, NE, KS, MN, IA, MO, WI, IL, MI, IN, OH)
Corn in row-crop systems
MSU-EPRI Tier 2 method (non-linear)

Category 2: Projects located *worldwide*
Tier 1 – IPCC 'global' method (1% of N inputs, linear)
Approval based on peer-reviewed data

Category 3: Projects located *worldwide*
Tier 2 - new project-specific method (linear or non-linear)
Approval based on peer-reviewed data

Protocol Accounting

Category 1 vs. Category 2 Method



Millar et al. 2010 MASGC, Hoben et al. 2011. GCB

Provides Flexibility for Farmers

Farmers have multiple routes to reduce N rate

- More accurate estimates of N need (e.g. MRTN)
- Timing of N application (e.g. spring vs. fall)
- Source of fertilizer (e.g. formulation)
- Placement of fertilizer (e.g. precision agriculture)
- Cover crops use

N rate reduction is the integrated result

Key Issues

- Baseline Determination
- Proving Additionality
- Dealing with Permanence and Reversal
- Proving No Project Leakage
- Dealing with Uncertainty

Baseline Determination

Baseline N rate determined from:

Site Specific Records - Approach 1 *(worldwide)*

N fertilizer purchase and application rate data

County Level Records - Approach 2 (*U.S. only*)

Yield data and equations based on yield goal estimates

Approach 1 preferred due to:

Finer spatial resolution and more potential offsets

Approach 2 can be used if:

Records are not available or verifiable for Approach 1

Proving Additionality

Additionality assessed using:

- Performance Benchmark (*U.S. only*)
- ACR 'Three-Prong Test' (*worldwide outside U.S*.)

Performance Benchmark

Regulatory Surplus

No existing laws or other regulatory frameworks that require farmer to reduce N fertilizer rate below BAU

Performance Standard

Farmers must reduce N fertilizer rate to below a threshold that represents the BAU rate

Dealing with Permanence and Reversal

N_2O emissions avoided are:

- Immediate
- Irreversible
- Permanent

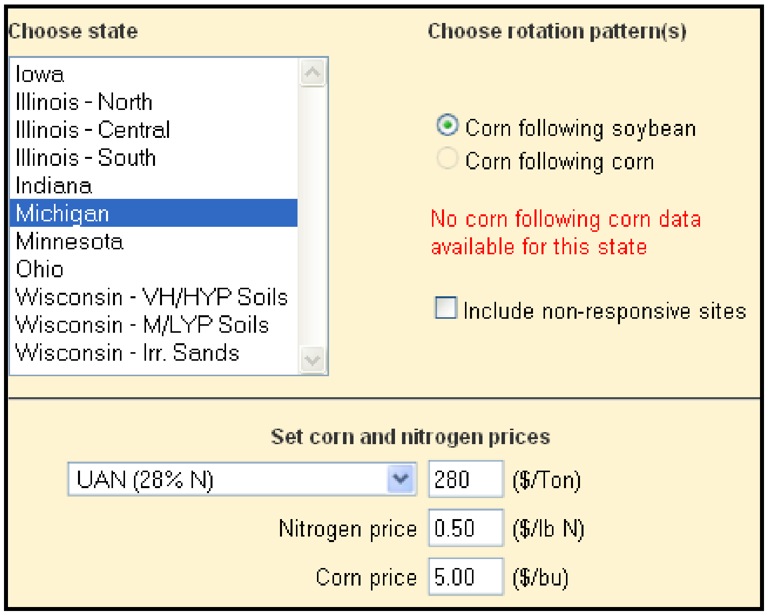
There are no permanence or reversal concerns

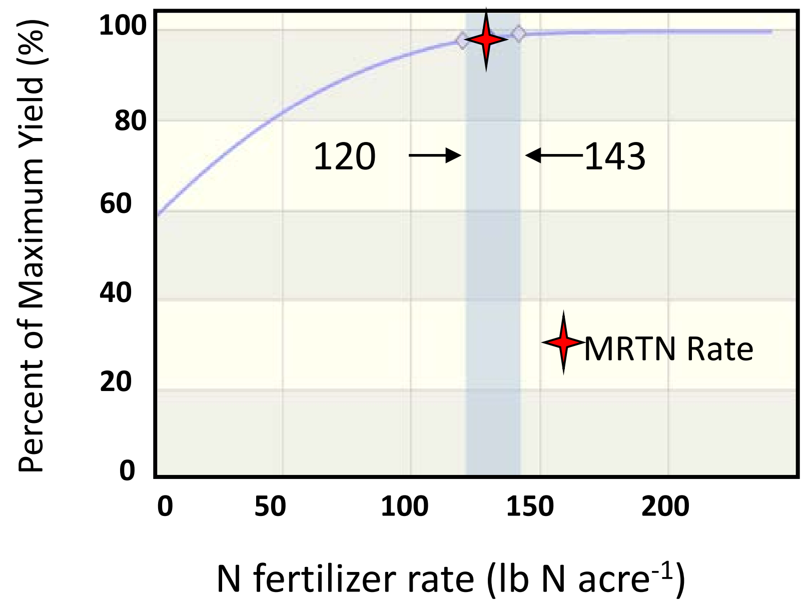
Demonstrating no Project Leakage (1 of 2)

- For project eligibility land must have been maintained in crop production for 5+ years prior to implementing project
- In the absence of the project, continuation of crop production using BAU management practices is the most realistic and credible baseline scenario
- No crop yield reductions are expected due to project activity, so there is little likelihood for *Market leakage or Activity shifting*

Demonstrating no Project Leakage (2 of 2)

Calculators are available for better economic estimate





No yield reductions, therefore no yield compensation

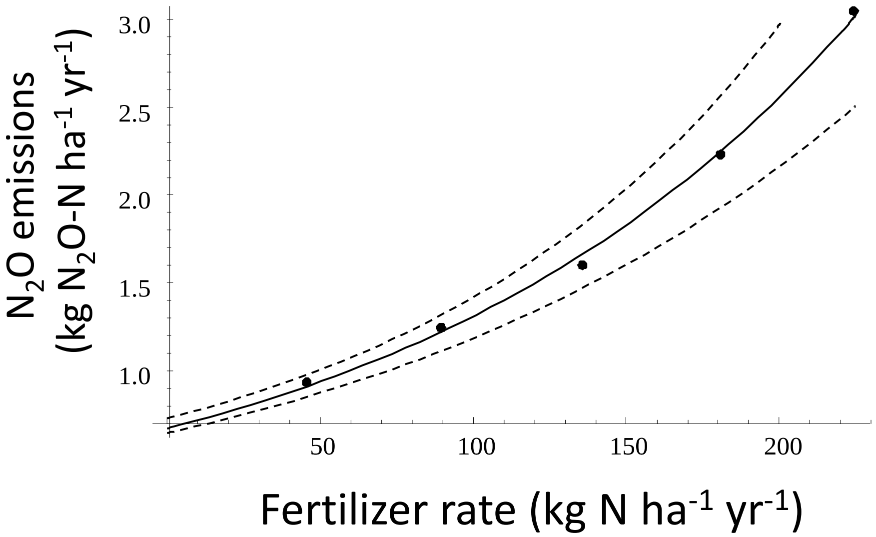
No additional N use, therefore no added N_2O emissions

ISU Agronomy Extension http://extension.agron.iastate.edu/soilfertility/nrate.aspx

Discounting for Uncertainty (1 of 2)

$$N_2O_{PR,\,t} = [(N_2O_{B\ total,\,t} - N_2O_{P\ total,\,t}) * AP] * [1-\textcolor{red}{UNC}]$$

- $N_2O_{PR,\,t}$ → Project emissions reductions
- $N_2O_{B\ total,\,t}$ → Total baseline emissions
- $N_2O_{P\ total,\,t}$ → Total project emissions
- AP → Project area
- UNC → Uncertainty deduction



- Greater uncertainty around N_2O emissions at higher N rates
- This uncertainty can be quantified using statistical techniques

Discounting for Uncertainty (2 of 2)

- The uncertainty percentage is related to a set of IPCC conservativeness factors
- Based on these factors the uncertainty deduction can be applied to discount the number of N_2O offset credits

Uncertainty range at 95% confidence level of project emissions reductions	Conservativeness factor	Uncertainty deduction
< ± 15%	1.000	0.000
> ± 15% ≤ ± 30%	0.943	0.057
> ± 30% ≤ ± 50%	0.893	0.107
> ± 50% ≤ ± 100%	0.836	0.164

Key Insights

MSU-EPRI protocol

- High environmental integrity
- Generates fungible offset credits
- Scientifically robust
- Non-prescriptive and flexible
- Transparent and straightforward to understand and use
- Suitable for project aggregation
- Potential for credit stacking
- Potential for adaption and extension

Thank you for listening

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Questions?

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