Overview of the EPRI-MSU Nitrous Oxide (N\textsubscript{2}O) Emissions Reduction Offsets Methodology

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EPRI-MSU N₂O 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$_2$O)?

• Major GHG emitted by agriculture in U.S. and globally
• Agriculture accounts for ~70% of total U.S. N$_2$O emissions
• GWP (CO$_2$e) = ~300 → “low hanging fruit”
• High climate change mitigation “payback” for N$_2$O emissions reductions
• In practice, farmers often fertilize in excess of the “economic optimum,” so there is an opportunity to reduce N$_2$O without adversely affecting crop yields.
N\textsubscript{2}O Flux Response Demonstrated on Commercial Farms in MI over 3 Years

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

Confirmed that N\textsubscript{2}O flux can be reduced by reducing N fertilizer inputs without a significant impact on crop yield and profitability.

Nonlinear nitrous oxide (N$_2$O) 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*‡

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

Nitrogen fertilizer management for nitrous oxide (N$_2$O) 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


This published scientific peer-reviewed article provides a solid foundation for the MSUI-EPRI N$_2$O offsets protocol to be validated under existing offsets standards, such as ACR, CAR and VCS.
EPRI-MSU N$_2$O 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$_2$O flux

✓ Based on a **standardized performance** approach to additionality and baselines
✓ **Widely applicable** to different climates, soils, crops
EPRI-MSU N₂O 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 $\text{N}_2\text{O}$ Offset Protocol

Project Baseline & Emissions Reductions

• **Baseline $\text{N}_2\text{O}$ 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 $\text{N}_2\text{O}$ emissions from reduced application of N fertilizer in crop production.

\[
\text{N}_2\text{O}_{\text{PR, t}} = \frac{(\text{N}_2\text{O}_{\text{B, total, t}} - \text{N}_2\text{O}_{\text{P, total, t}}) \times A_P}{\text{Project area}}
\]

- Project emissions reductions
- Total baseline emissions
- Total project emissions
- Project area
EPRI-MSU N\textsubscript{2}O 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\textsubscript{2}O emissions (Tier 1 – IPCC) applies to cropland throughout the U.S. Eligible for all agricultural systems.
  – Method 2: Direct N\textsubscript{2}O 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 $\text{N}_2\text{O}$ Project Flowchart

1. Project Location
   - North Central Region
   - Rest of U.S. (incl. HI and AK)

2. Crop System
   - Corn Row Crop
   - All Other Crops

3. $\text{N}_2\text{O}$ Accounting Method
   - Method 2
   - Method 1

4. Data Source
   - Farm
   - County

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EPRI-MSU N\textsubscript{2}O Offset Protocol
Covered GHG Emission Sources

- **Direct** – N\textsubscript{2}O 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\textsubscript{2}O produced in waters and soils from NO\textsubscript{3} leaching NH\textsubscript{3} volatilization.

- Increased CH\textsubscript{4} and CO\textsubscript{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 N₂O Offset Protocol
Permanence and Leakage

**Permanence**
- Avoided N₂O emissions occur immediately. They are irreversible and permanent.
- **No permanence concerns.**

**Leakage**
- Cropland is maintained for crop production after implementation of the N₂O 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**
## Technical Potential for N$_2$O Emissions Reductions in U.S. Agriculture

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>Technical Mitigation Potential</th>
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<tbody>
<tr>
<td></td>
<td>$N_2O$-N (Gg)</td>
<td>$CO_2$e (MMT)</td>
</tr>
<tr>
<td>California</td>
<td>12.4</td>
<td>5.81</td>
</tr>
<tr>
<td>North Central Region (NCR)</td>
<td>142</td>
<td>66.7</td>
</tr>
<tr>
<td>Contiguous US*</td>
<td>6.1</td>
<td>3.10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>161</strong></td>
<td><strong>76</strong></td>
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</tbody>
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**Notes:**
- Gg = Gigagram ($10^9$ g) = 1000 metric tons; MMT = million metric tons.
- N$_2$O-N = mass of nitrogen associated with N$_2$O emissions reductions.
- $CO_2$e = carbon dioxide equivalent based on GWP of N$_2$O = 298.
- *Contiguous U.S. excludes California and North Central Region and is only applicable here because it only includes corn and wheat acreage.
MSU Web-based Decision Support System: N$_2$O GHG Calculator

- N$_2$O calculator allows offset project developers, electric companies, and others to quantitatively potential N$_2$O offsets and identify the best locations to implement them.

- Calculator makes use of existing USDA and other data.

- Provides comparative CO$_2$e “costs” of N$_2$O, soil carbon change, fuel, and fertilizer;

- Allows comparison of different scenarios based on crop, tillage, and fertilizer decisions.

www.kbs.msu.edu/ghgcaculator
The MSU–EPRI N₂O 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$_2$O Offset Protocol

Next Steps

• Continue VCS 2$^{nd}$ 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$_2$O 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
N$_2$O “Flux” Versus Crop Yields

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

N$_2$O 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$_2$O flux could be achieved with little yield impact.

N$_2$O 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$_2$O emissions can be reduced with no impact on crop yield.