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Materials will be available at:
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Fertile Ground for Reform: A Research Roadmap for Agricultural Nitrogen Pollution

Thursday, July 16, 2026

About EESI

EESI
Environmental and Energy Study Institute

Nonpartisan Educational Resources for Policymakers

A bipartisan Congressional caucus founded EESI in 1984 to provide nonpartisan information on environmental, energy, and climate policies

Direct Assistance for Equitable and Inclusive Financing Program

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop “on-bill financing” programs

Commitment to Diversity, Equity, Inclusion, and Justice

We recognize that systemic barriers impede fair environmental, energy, and climate policies and limit the full participation of Black, Indigenous, people of color, and legacy and frontline communities in decision-making

Sustainable Solutions

Our mission is to advance science-based solutions for climate change, energy, and environmental challenges in order to achieve ***our vision of a sustainable, resilient, and equitable world***

Policymaker Education

Briefings and Webcasts

Live, in-person and online public briefings, archived recordings, and written summaries

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Bi-weekly newsletter with everything policymakers and concerned citizens need to know, including a legislation and hearings tracker

Fact Sheets and Issue Briefs

Timely, objective coverage of environmental, clean energy, and climate change topics

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Upcoming Briefings

EESI
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Rapid Readout: Impacts of Severe Drought
Friday, July 24, 12-12:30 PM EDT

Sign up for our *Climate Change Solutions* newsletter here: eesi.org/signup

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What did you think of the briefing?

Please take 2 minutes to let us know at:
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Thursday, July 16, 2026

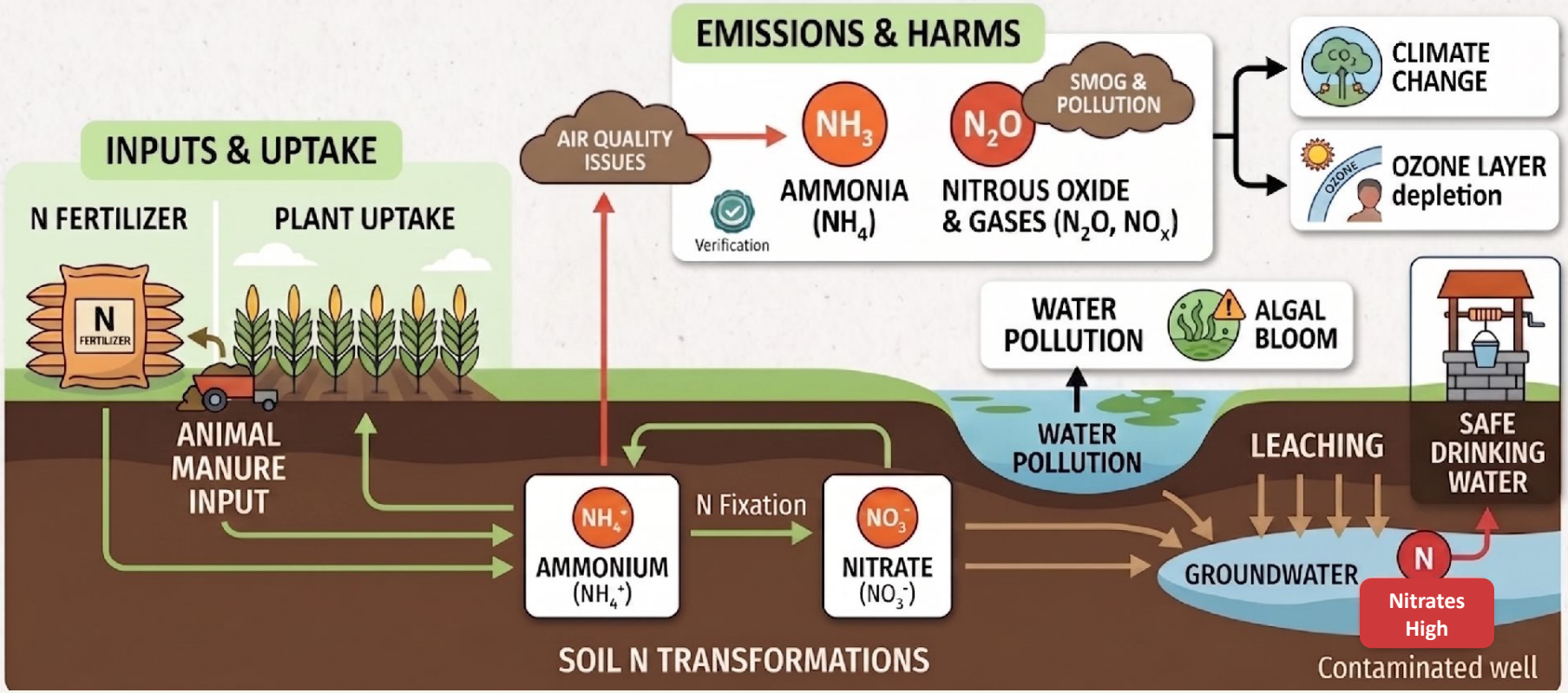
TAYLOR GEOSPATIAL · NRDC

Fertile Ground for Reform: A Research Roadmap for Agricultural Nitrogen Pollution

doi:10.17605/OSF.IO/RT63B

2026

OVERVIEW: AGRICULTURAL N CYCLE & HARMS



How Agricultural Nitrous Oxide (N_2O) Affects Business and People

N_2O

A potent greenhouse gas

273× WARMING **POTENTIAL** VS **POTENTIAL** VS CO_2 *(verified)*

~80% **OF ANTHROPOGENIC N_2O** FROM AG**RICULTURE**

GROWING THREAT: Projected growth without intervention

BUSINESS IMPACT: Nitrogen Inefficiency

N_2O emissions signal **excessive nutrient loss** and **fertilizer use inefficiency**, indicating **higher costs** for agricultural businesses.

Wasted capital

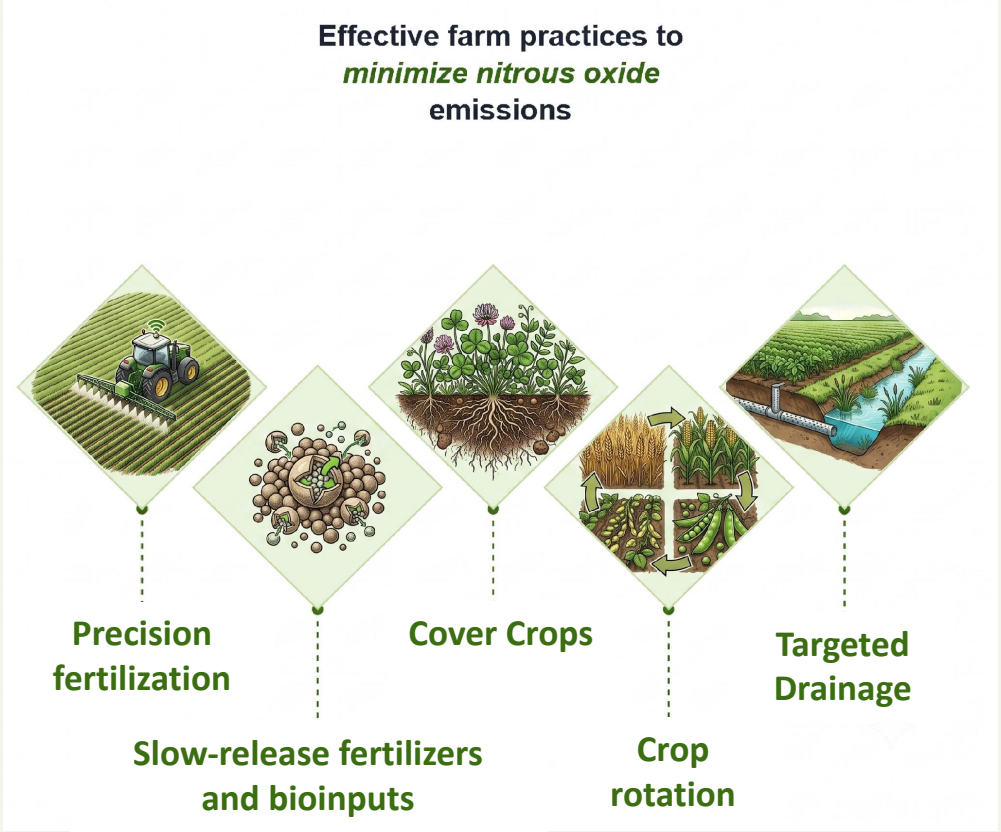
PUBLIC IMPACT: Climate, Ozone & Health

Direct links to increased global temperatures, ozone layer depletion, and public health risks such as higher **skin cancer incidence**.

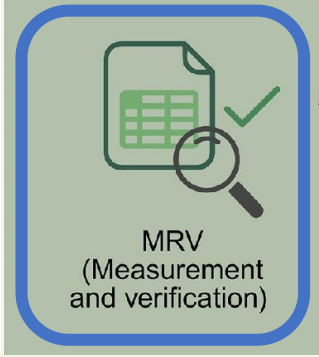
Long-term trends

BACKGROUND

Opportunities to reduce N2O emissions

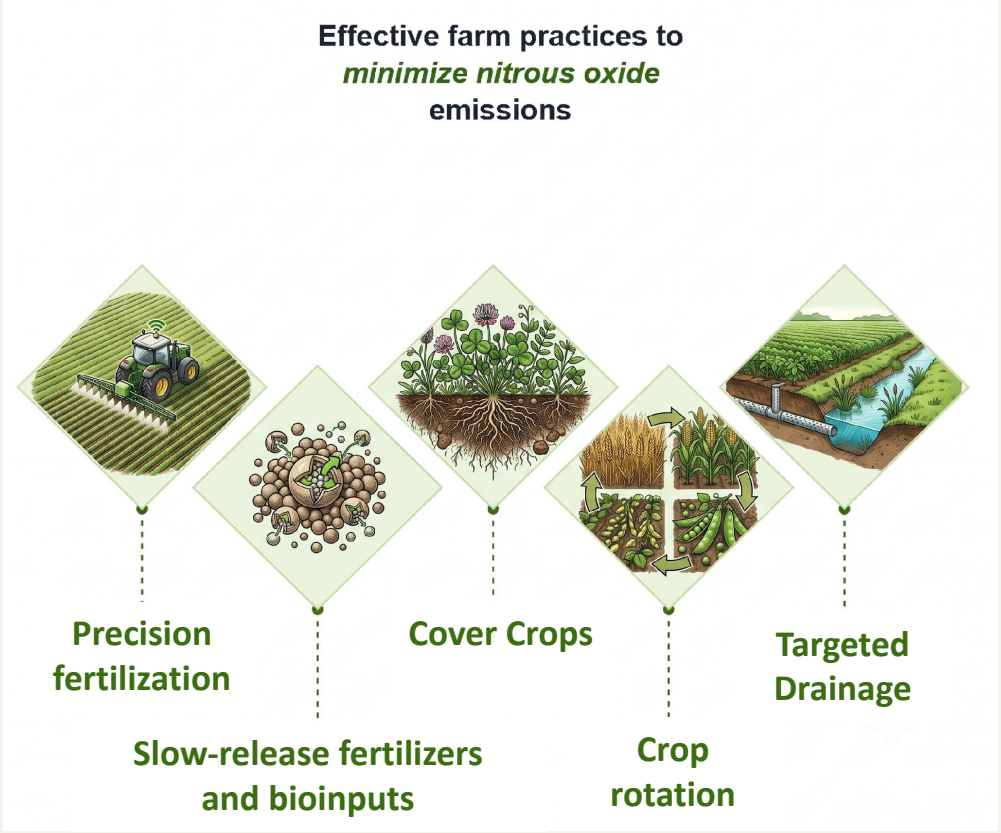


Measurement and modeling help us understand which interventions and practices are succeeding in different places and to predict what is likely to work well.

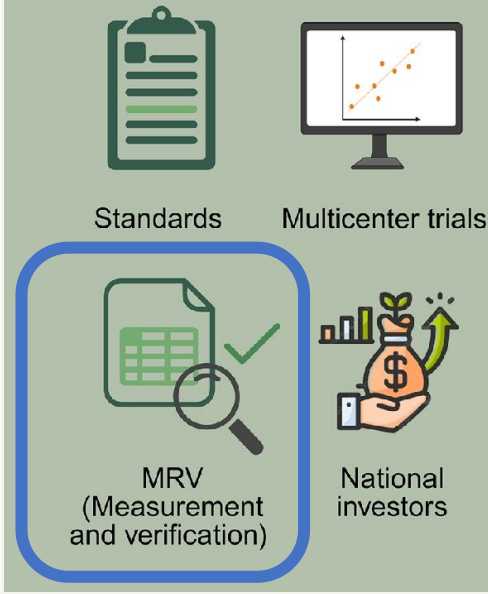


BACKGROUND

Opportunities to reduce N2O emissions



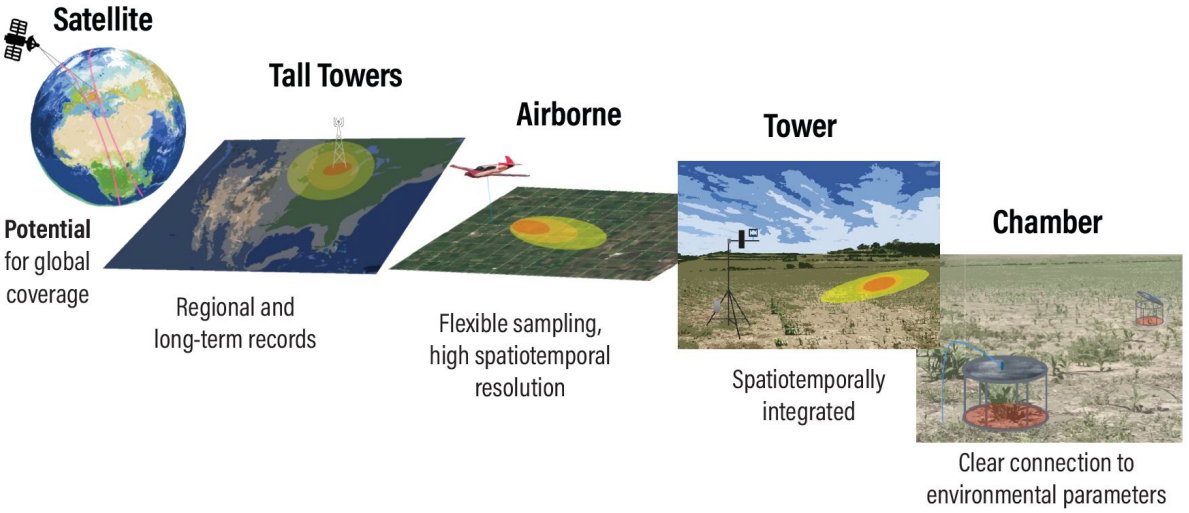
MRV is necessary to demonstrate practices meet standards, align across trials, and create confidence in investments.



BACKGROUND

How we can assess N2O emissions

Measurement and Monitoring Technologies (MRV)



Physical Process-based Modeling Technologies

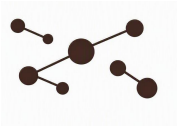
Knowledge Guided Machine Learning and GeoAI Integration

CHALLENGE

N_2O Measurement Challenges

Low Atmospheric Concentrations

Very low atmospheric concentrations make N_2O detection difficult with standard instruments



Episodic Emissions

Hot spots & hot moments dominate — emissions are patchy and hard to capture continuously

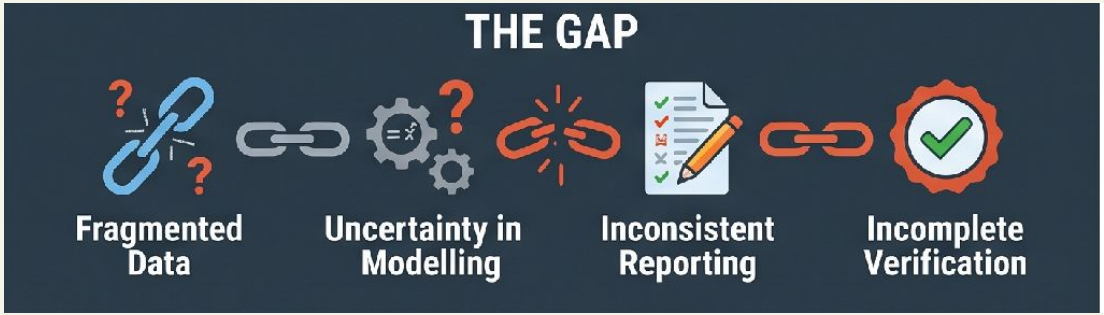
Costly Sensors and Instruments

Current instrumentation is expensive, fragile, and difficult to deploy at scale in field conditions

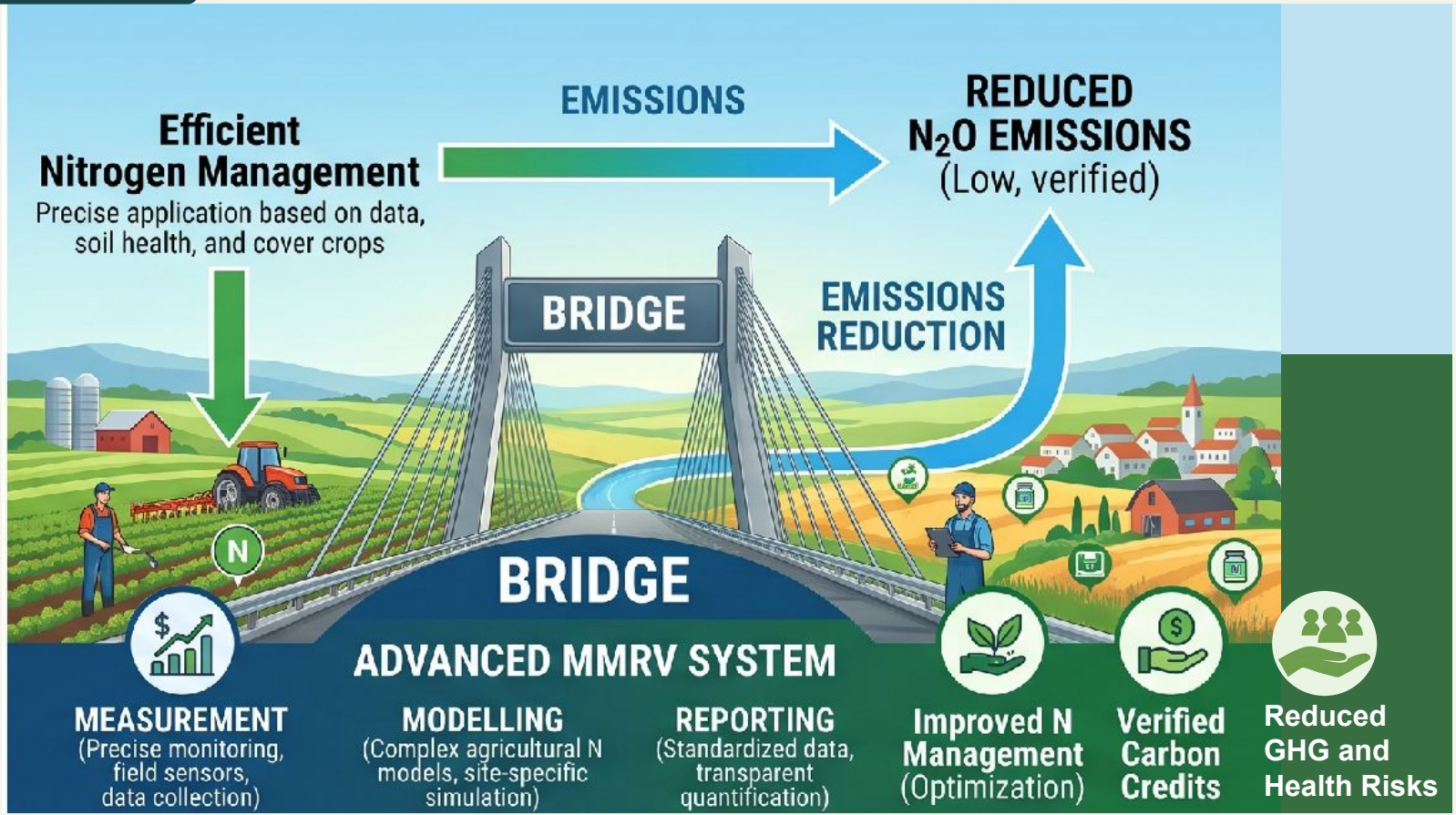
Sparse Monitoring Networks

Sparsely located long-term monitoring networks limit our understanding of spatial and temporal variability across regions

Measurement challenges create Modeling challenges



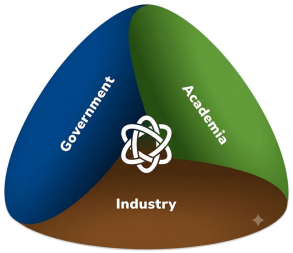
The Gap We're Addressing



Building the Roadmap

01

Convened science, industry, and government stakeholders to scope the research needed to transform N2O MMRV and Modeling



02

25+ Scientists and Experts focused on developing a roadmap during 1 year of Collaboration

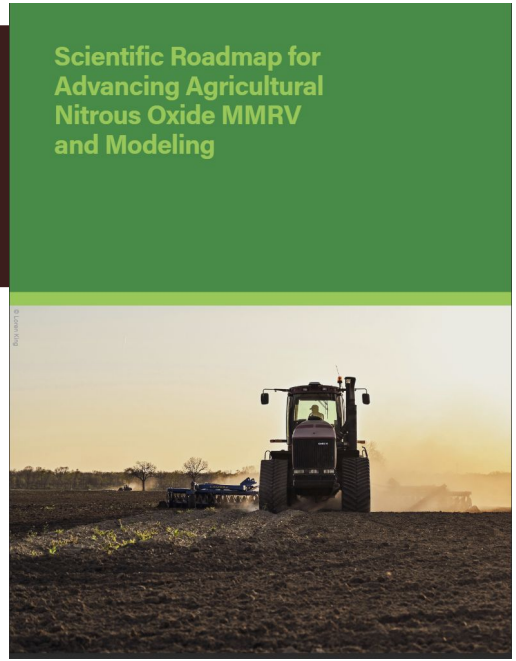
03

Critical feedback to refine the roadmap was gathered through open comment sessions

AVAILABLE NOW

What Research Needs to Happen?

Scientific Roadmap for Advancing Agricultural Nitrous Oxide MMRV and Modeling



Citation:

Rath, Daniel, Rachel Opitz, Matt Kaplan, Alex Woodley, Alexandra Huddell, Brian Buma, Ayesha Riaz, et al. 2026. "Scientific Roadmap for Advancing Agricultural Nitrous Oxide MMRV and Modeling." OSF. May 13. doi:10.17605/OSF.IO/RT63B.

https://doi.org/10.17605/OSF.IO/RT63B // https://osf.io/rt63b/files/vkepc

Improved Sensors and Models

Key Bottleneck: Sensor Cost and Reliability

Need: Sensor Improvements Across Multiple Platforms

Potential Solution: Emerging Technologies at Lower Costs

Key Bottleneck: Uncertainty

Need: Better Representation of Soil Processes in Process Models

Potential Solution: Hybrid AI and Process Models may help lower uncertainty

SENSORS

Improved Measurement Coordination and Data Infrastructure

Key Bottleneck: Lack of Coordinated Measurement

Need: Measurement Campaigns that bridge Plots, Fields, Landscapes and Regions

Potential Solution: Convenor of cross-scale measurement programs

Key Bottleneck: Lack of Agreement on Vocabularies and Data Governance

Need: Data Pipelines that link to decision support tools and models

Potential Solution: Using FAIR Data Principles

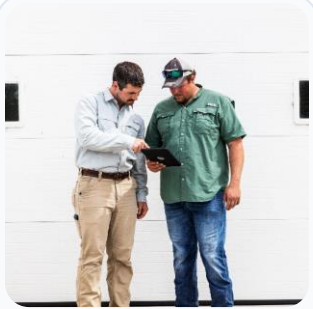
SPARK
CLIMATE SOLUTIONS

Challenges and opportunities for nitrogen management

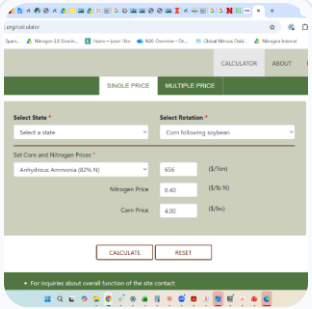
Maria Bowman, Ph.D.
Director, Agricultural Nitrogen Transformation Program
Spark Climate Solutions

What tools do farmers use for nutrient management?

Experience



Trusted relationships



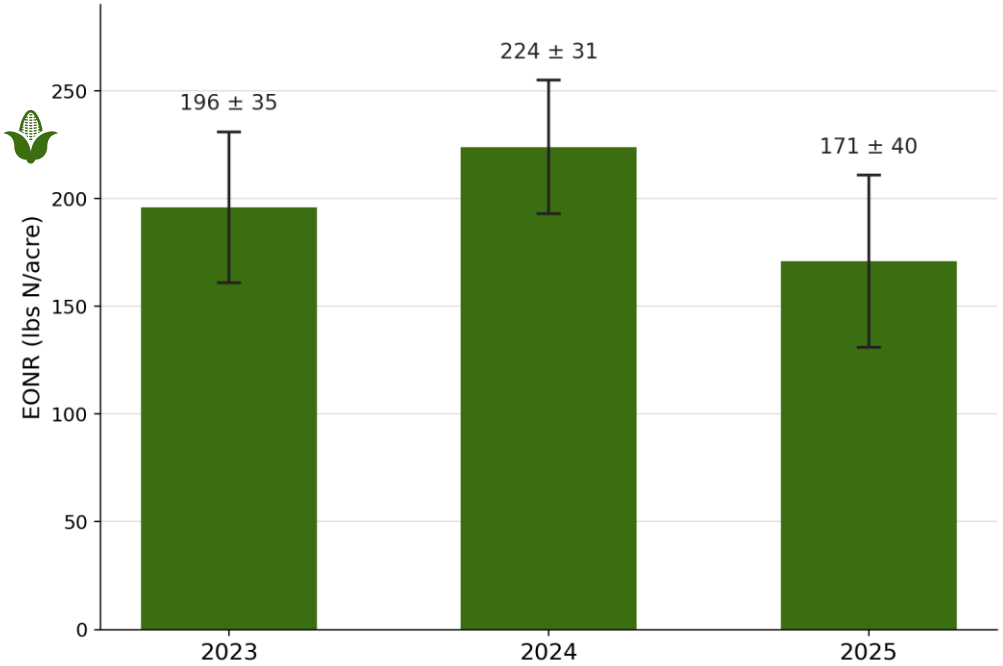
N rate calculators

Soil testing

Specialized equipment

Images: (2) United Soybean Board; (4) Dianne Johnson, USDA; (5) Jason Johnson, Iowa NRCS

Challenge: the “right” nitrogen rate varies widely from year to year



Source: Iowa Nitrogen Initiative trial data: https://n-fact.ag/
Ranges represent variability in the EONR across fields.

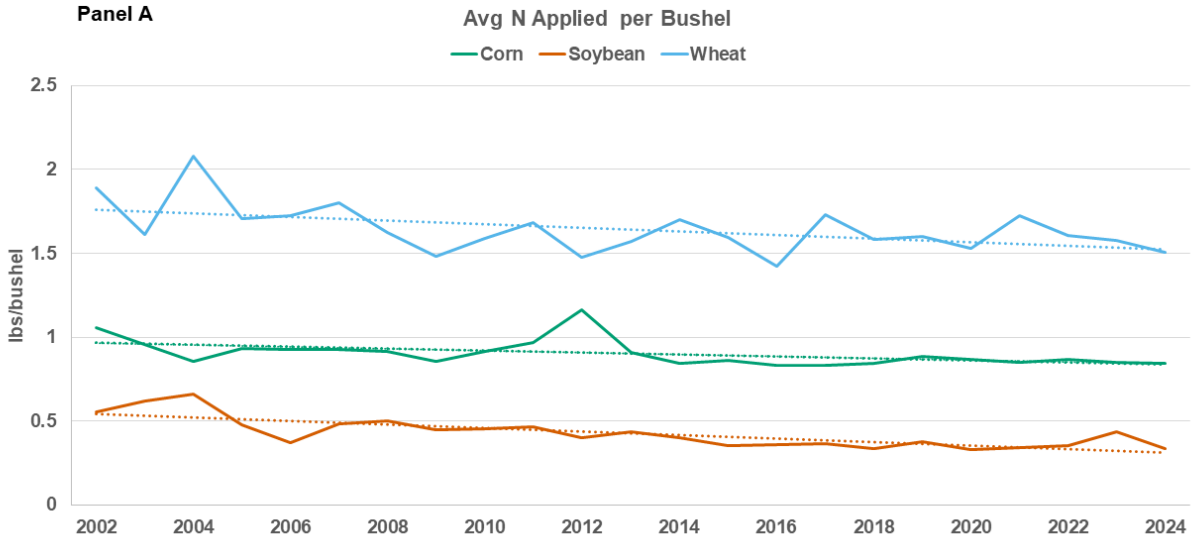
Over just 3 years the Economically Optimal N Rate (EONR) for trials in the Iowa Nitrogen Initiative differed by 53 lbs./acre

Most of this variability is due to **weather** which means that a farmer doesn’t know ahead of time how much N to apply

Better data, models, and decision tools can reduce this uncertainty!

Fertilizer Use Efficiency has increased

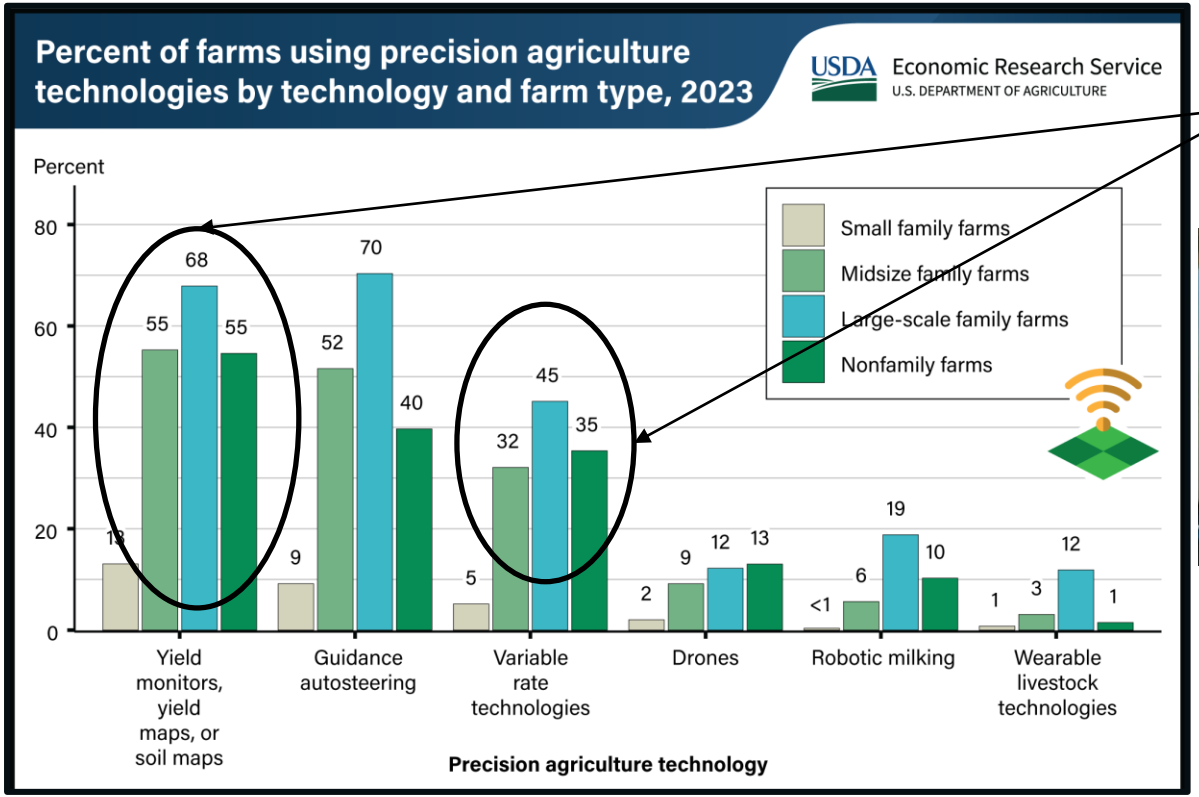
Figure 3. Estimated Fertilizer Use Efficiency (lbs/bushel) by Nutrient Type and Crop, 2002-2024



However….roughly ¼ of nitrogen inputs to cropland are still lost as pollution to air (nitrous oxide) and water (nitrate)

Monaco, H., N. Paulson and G. Schnitkey. "Trends in Fertilizer Use and Efficiency in the U.S." *farmdoc daily* (15):98, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 29, 2025

Precision Ag use has increased – but plenty of room to grow



Increasing use of precision agricultural technologies and yield/soil mapping make it easier to vary fertilizer rates within and across fields

Still, more than half of farms do not use variable rate technologies for nutrient management

Source: USDA, Economic Research Service (ERS) using USDA, National Agricultural Statistics Service and ERS 2023 Agricultural Resource Management Survey (ARMS) data

Emerging innovations can help reduce N losses

Development of new crop varieties could improve nitrogen use efficiency, and reduce fertilizer inputs and nitrogen losses

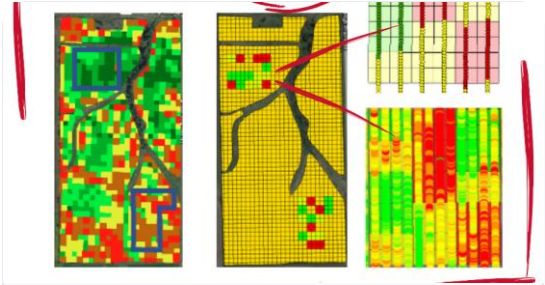
Changing livestock diets to feed more digestible N directly to animals can reduce the amount of N lost in manure

Improved manure recycling could allow manure to substitute for 6% of fertilizer demand with existing technology & another 22% with technological innovations (Wang et al., 2026)

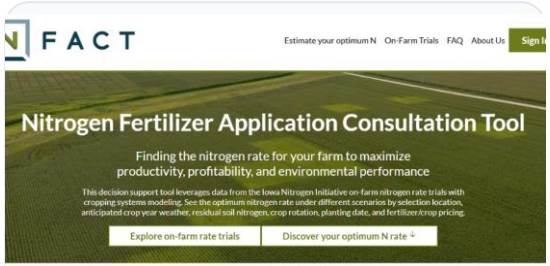
Better data, models, and tools to support the innovation process

SPARK CLIMATE SOLUTIONS

The more we understand about the system – the better we understand its agronomic, economic, and environmental performance.



Coordinated, on-farm research networks



Improved models and decision-support tools

Trialing of new innovations to improve NUE, reduce nitrogen losses, and measure outcomes (MMRV)

Innovations and tools need to deliver **value to the farmer** in order to be adopted

Images: Iowa Nitrogen Initiative and Kansas State University

Thank you

SPARK
CLIMATE SOLUTIONS

Facebook Twitter (X) Substack Threads Bluesky

Minnesota State Rep. Rick Hansen

State Representative Rick Hansen represents Minnesota House District 53B, a working-class district split by the Mississippi River. He has served in the Minnesota House since 2005. A lifelong advocate for conservation and the outdoors, he co-chairs the House Agriculture Committee. He also serves on the Environment and Capital Investment Committees and on the Legislative Audit Commission.

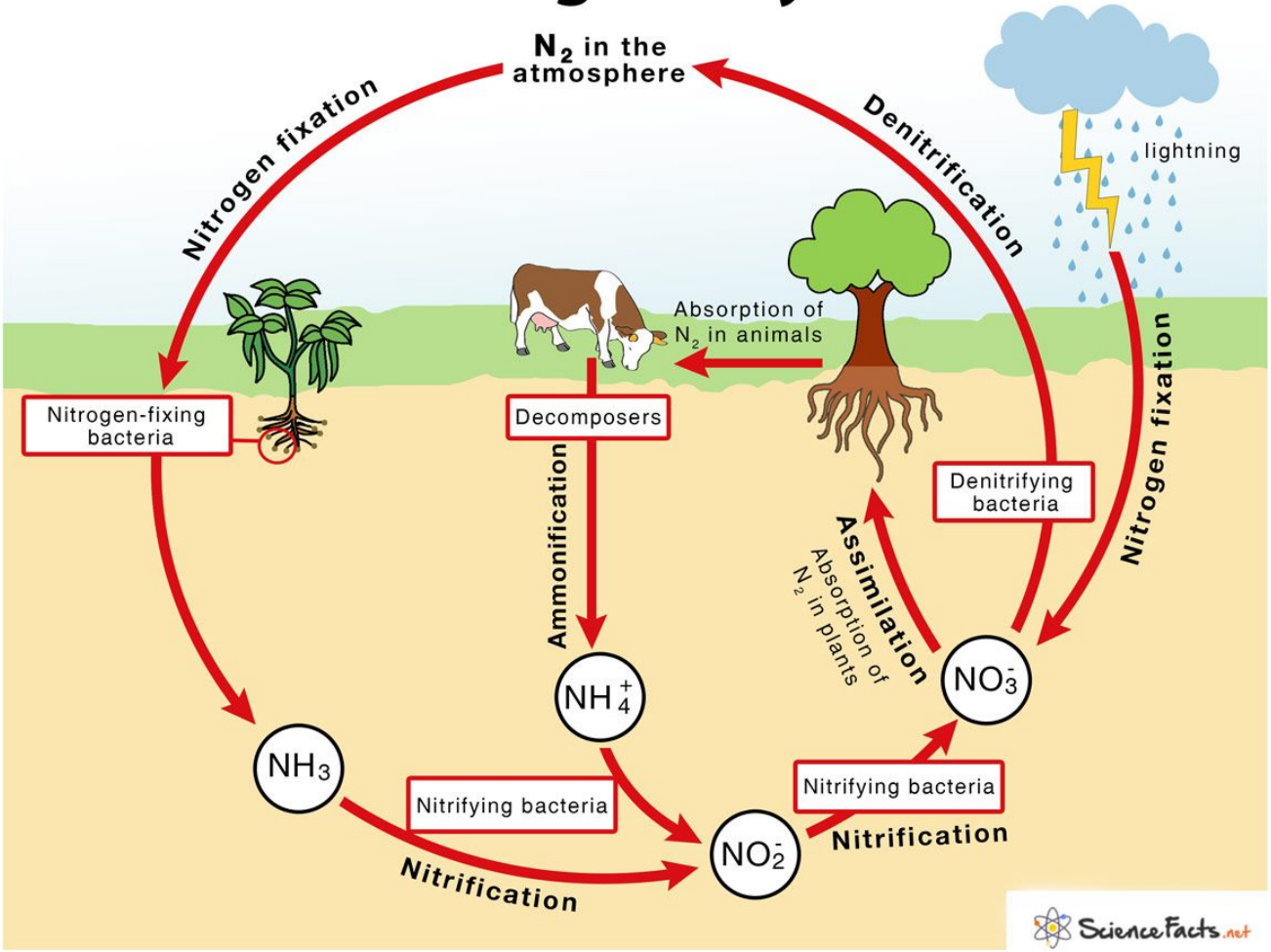
651-296-6828
rep.rick.hansen@house.mn.gov

Recommendations
Of The
Nitrogen Fertilizer Task Force
On

THE NITROGEN FERTILIZER MANAGEMENT PLAN

To The
Minnesota
Commissioner of Agriculture

Nitrogen Cycle



Nitrous Oxide: No Longer the Forgotten Super Pollutant

Matthew Kaplan— NRDC, Senior Attorney

Why Nitrous Oxide MMRV Matters

Carbon Markets Rely on Accurate Nitrous Oxide Measurements

Maximizing Farmer Profit Means Understanding Nitrogen Losses

Global Corporations Need To Track Emissions

Tracking The Environmental Impacts Of Nitrogen Pollution

Long Term Nitrous Oxide Goals

1. Develop Scientific Consensus
2. Identify High Value Scientific Questions
3. Build National MMRV Community
4. Identify Areas of Policy Innovation
5. Develop Long Term Science Strategies

What do we do with this roadmap?

Implementing the Roadmap Through Policy

Take Lessons from the Carbon and Methane Measurement Initiatives

Success involves tracking long term goals, creating scope three measurement technologies, fostering industry investment and marketplace adoption of measurement techniques.

Coordinate Nitrous Oxide Research

Inform funding decisions with roadmap conclusions

Unpack the Roadmap for Policy Makers

Marshalling State and Federal Science Infrastructure

What do we do with this roadmap?

The Different Levers for Policy Making

Federal Science Policy

Federal Agency Research Budgets and Funding Mechanisms

State Policy

Governors, State Agencies, State Land Grants, State Innovation Agenda

Philanthropy

Independent Research and Policy Making Functions

Business

Regulatory Compliance, Research and Development, Implementation

Federal Policy Goals

Research Coordination and Funding

Coordinating between primary funding agencies, data coordination, priority technologies, common modeling tools

Strategic Partnerships

Integrating science policy making by the Office of Science Technology Policy (OSTP) and facilitated by the National Academies or in partnership with National Laboratories.

Integrated Business and Farmer Stakeholder Engagement

Bringing in multinational food companies, philanthropies and non-profits active in agriculture, food systems, climate resilience

Bringing the Roadmap to Federal Policy Makers

Coordinate Research and Funding Among Federal Agencies

- Department of Energy
- National Science Foundation
- Department of Agriculture
- Office of Science and Technology
- NIST (Commerce)

Integrate Policy Changes Into Funding Decisions

Coordinating Federal Science Policy around nitrogen through funding MMRV science (**annual appropriations**) and through **annual authorizations** e.g.., Farm Bill, NSF, DOE,

Examples of Funded MMRV Programs

- NASA Farm Flux
- ARPA-E ITAR Network
- National Science Foundation (e.g. NEON, quantum network, Internet of Things)
- Department of Agriculture, Agricultural Research Service (e.g. LTAR Sites)

What Do We Need: State Policy

Create an Innovation Pipeline

Utilizing state innovation and technology hubs to create a business ecosystem for N_2O measurement; industry depends on sensors, measurement and modeling tools

Marshal State Resource and Research Agencies

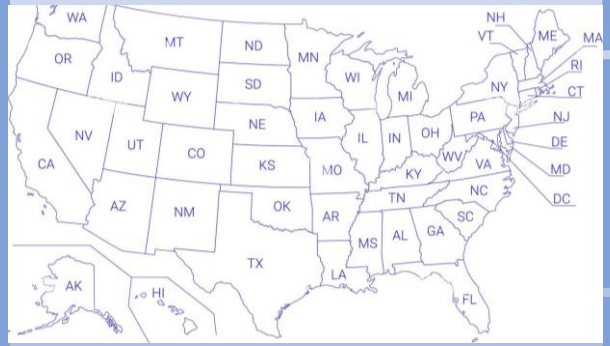
Marshalling state agencies (Departments of Agriculture and Natural Resources) to fund and utilize high value N_2O research tools

Coordinate Among States

Developing N_2O research collaboration tools for state legislatures, governors and state participants in climate negotiations

Policy Asks

Bringing the Roadmap to State Policy Makers



Engage with State-Level Policy Makers

State-level engagement, targeting agricultural and environmental agencies in key states where conditions are ripe for action on data coordination.

Broad Interest Across Numerous State Agencies

- Departments of Natural Resources
- Departments of Environment
- Departments of Agriculture
- Climate Policy Office
- Office of Job Creation/Innovation

Develop policy briefs for individual states

Policy briefs tailored to individual state contexts are in development to support these conversations.

California | Maryland | Delaware | Wisconsin | Minnesota

Conclusion

Share the Roadmap: Connect the Nitrous Oxide MMRV Research Community to Policy Makers, Philanthropy and the Private Sector

Volunteer: Tailor Nitrous Oxide Roadmap Recommendations to your State, Local or Federal Policy Contexts

Activate the Private Sector: Connect with Industry Organizations in your State, Local or Federal contexts to share their needs

Thank You

Access the Roadmap:

https://doi.org/10.17605/OSF.IO/RT63B

Contact:

mkaplan@nrdc.org