TAYLOR GEOSPATIAL · NRDC

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

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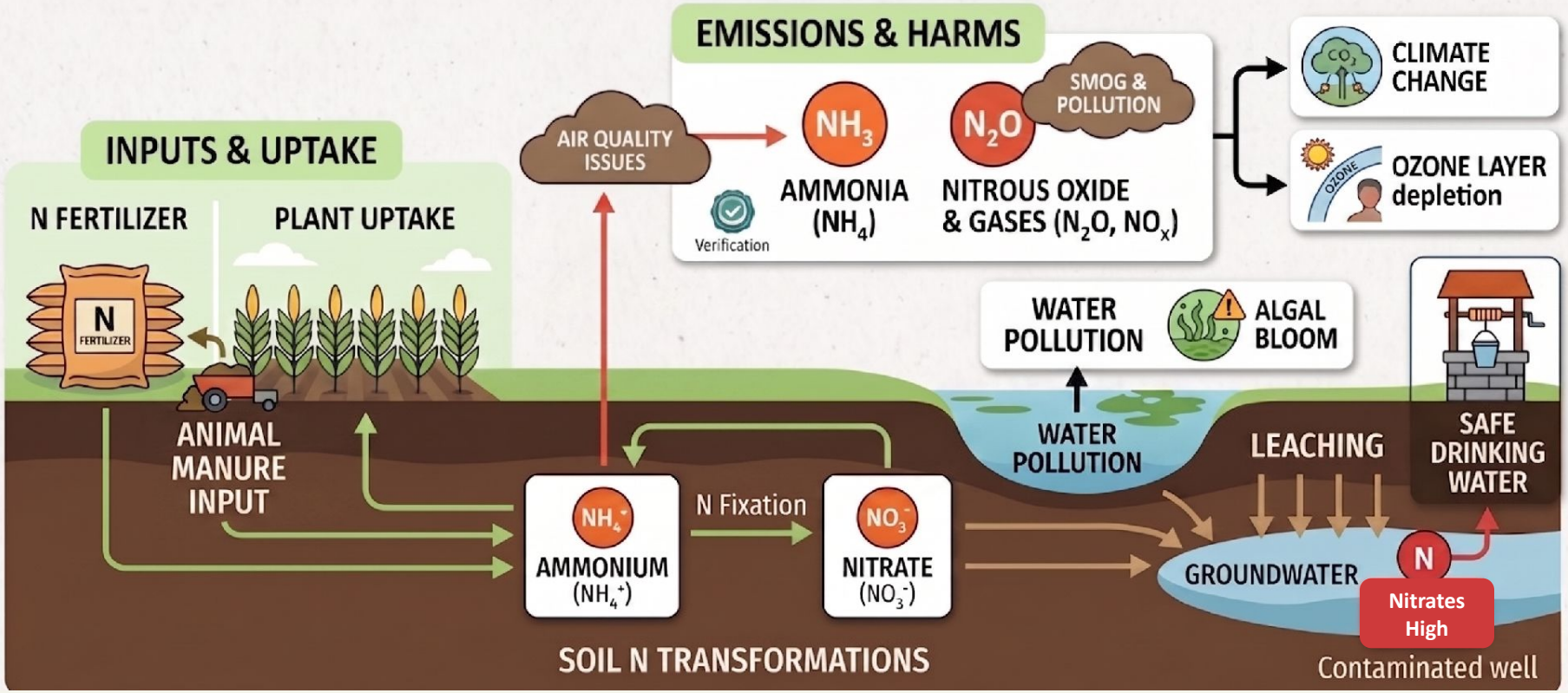
2026

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

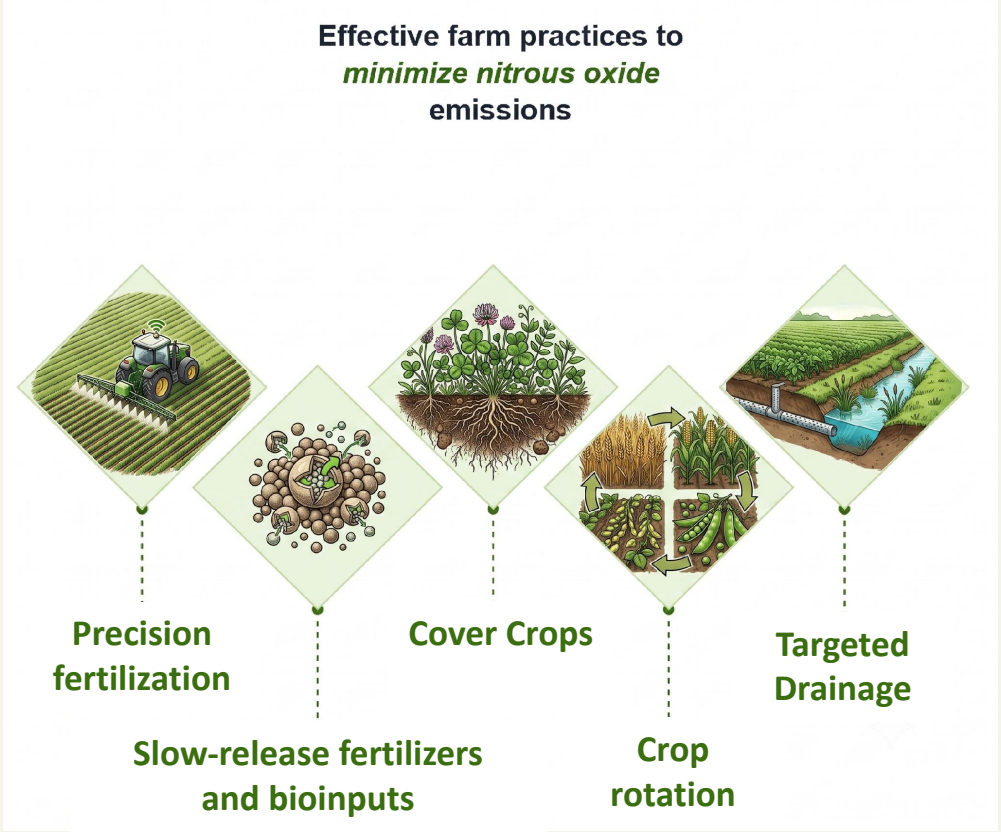
PUBLIC IMPACT: Climate, Ozone & Health

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

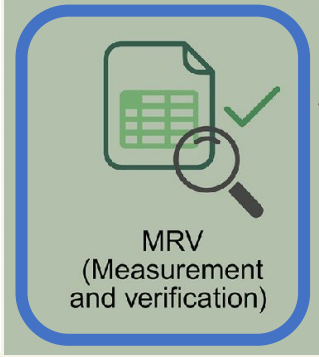
Long-term trends

BACKGROUND

Opportunities to reduce N2O emissions

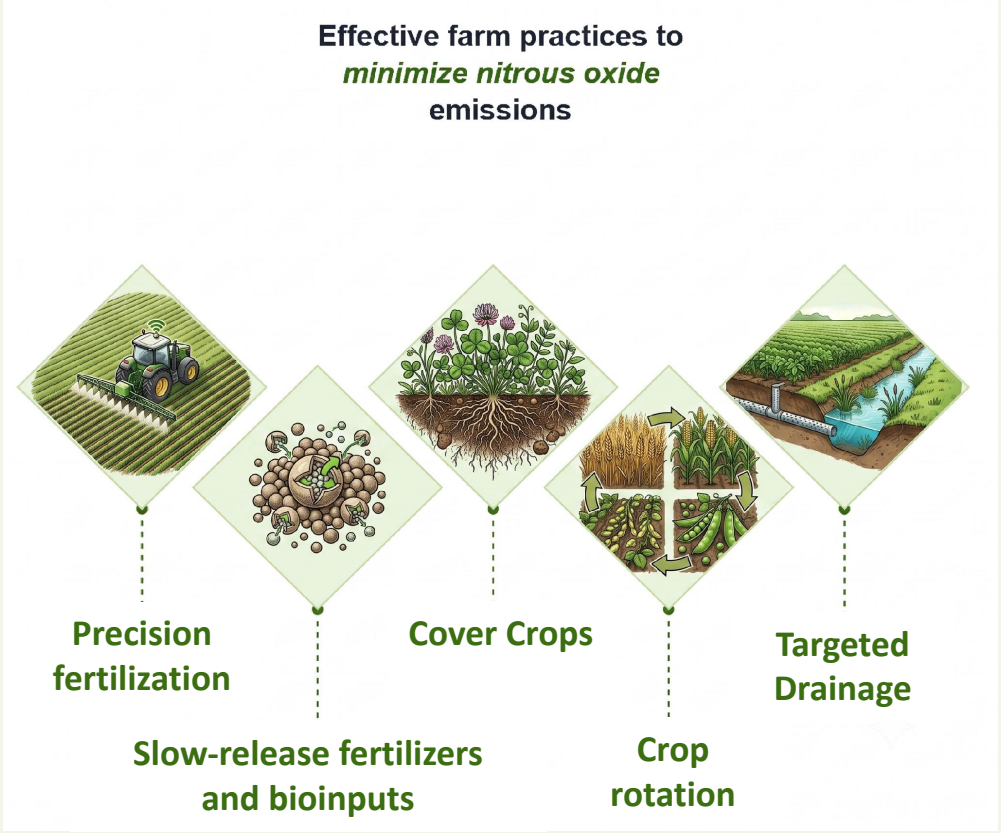


Measurement and modeling help us understand which interventions and practices are succeeding in different places and to predict what is likely to work well.

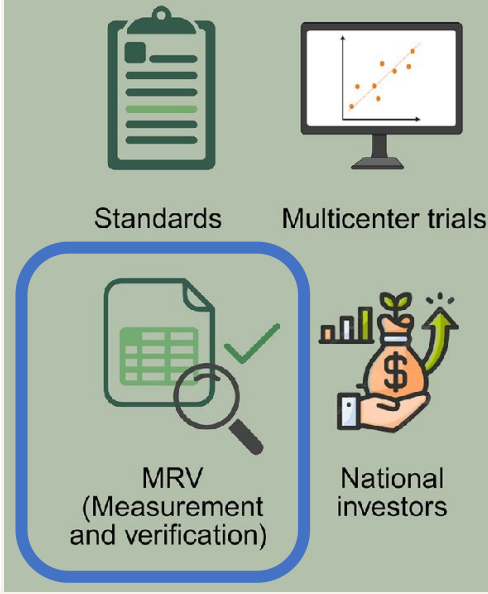


BACKGROUND

Opportunities to reduce N2O emissions



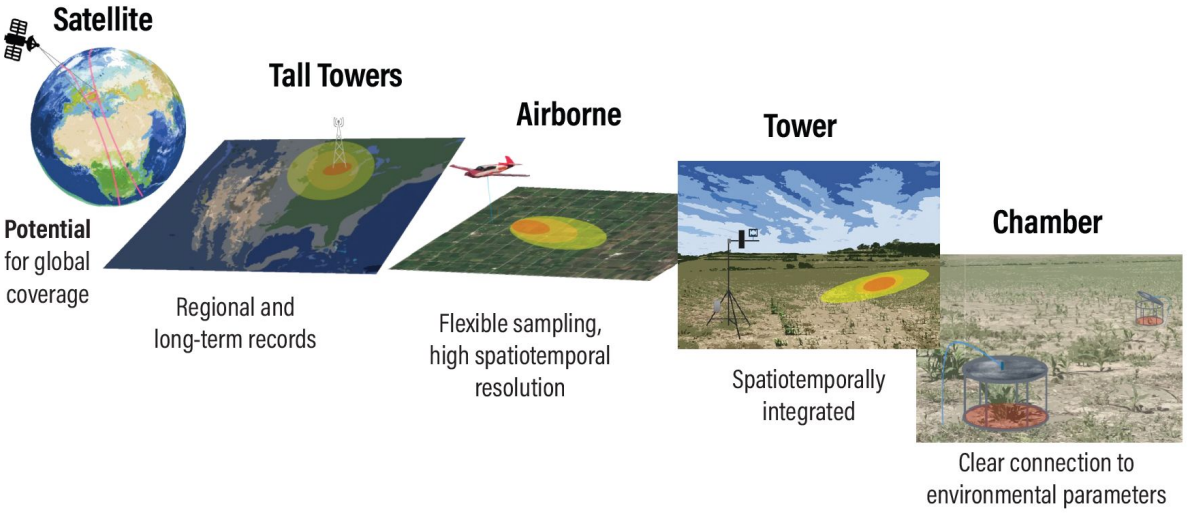
MRV is necessary to demonstrate practices meet standards, align across trials, and create confidence in investments.



BACKGROUND

How we can assess N2O emissions

Measurement and Monitoring Technologies (MRV)



Physical Process-based Modeling Technologies

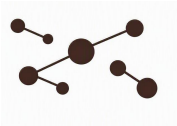
Knowledge Guided Machine Learning and GeoAI Integration

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

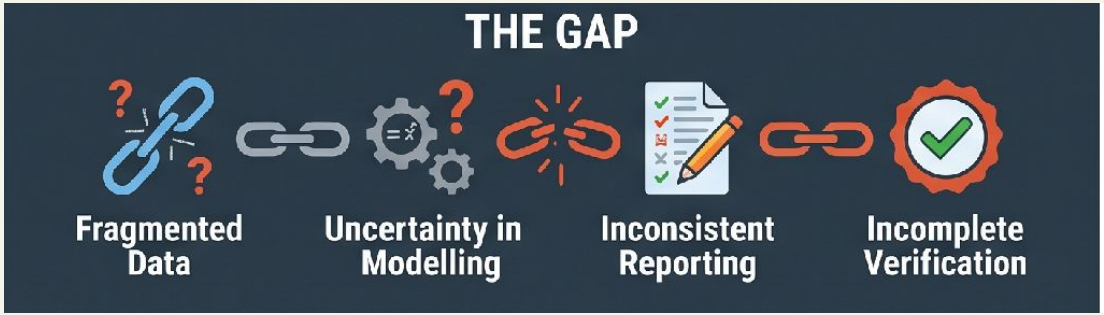
Costly Sensors and Instruments

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

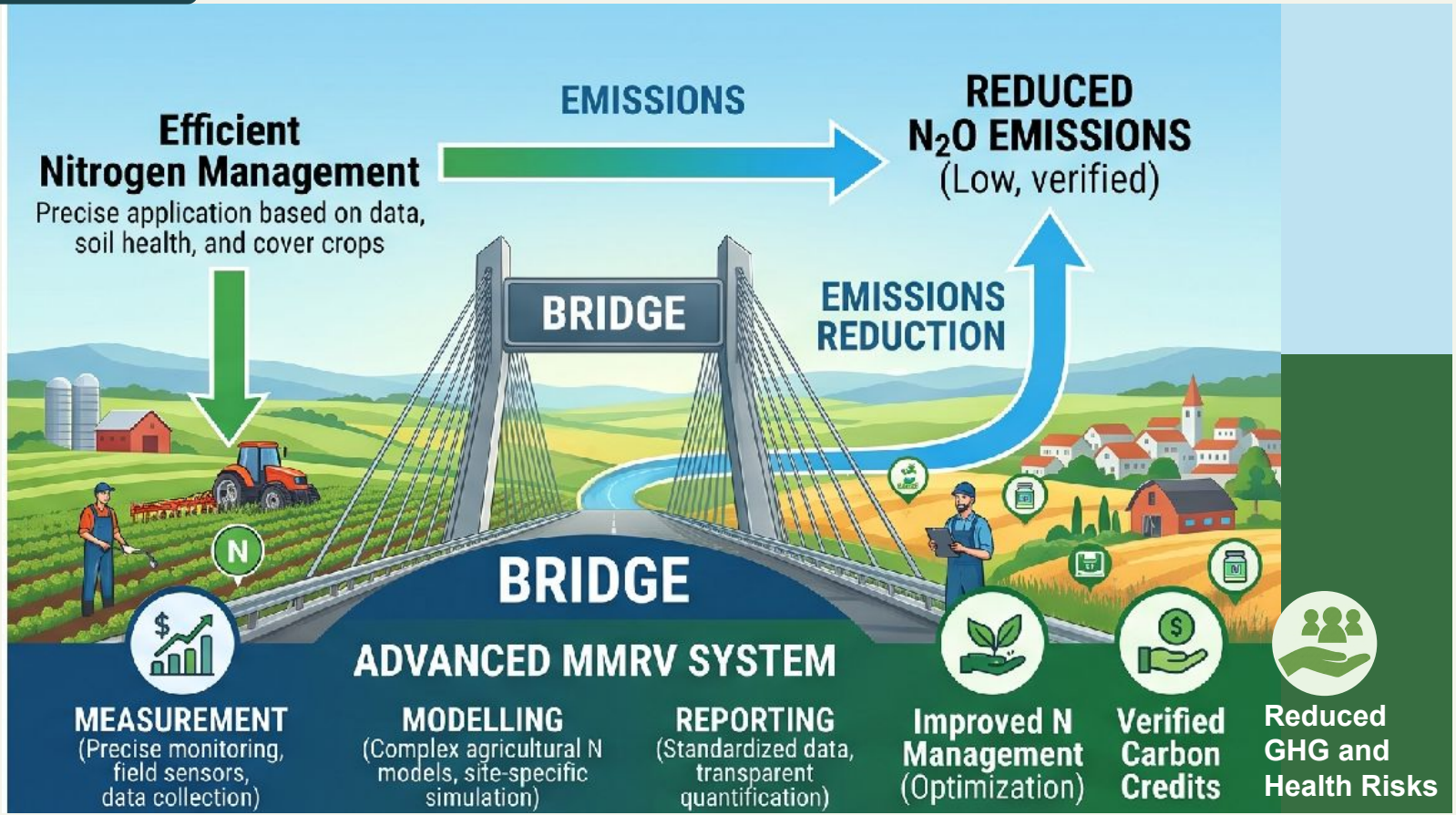
Sparse Monitoring Networks

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

Measurement challenges create Modeling challenges



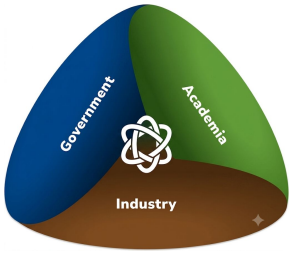
The Gap We're Addressing



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

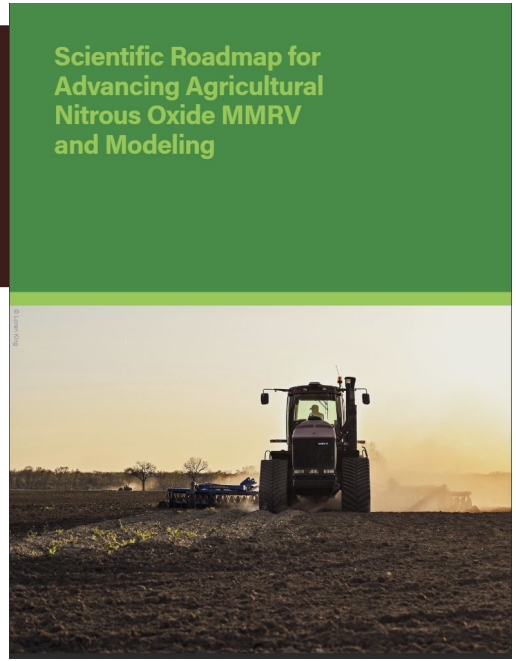
03

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:

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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