# NITROGEN SURPLUS: AN ENVIRONMENTAL PERFORMANCE INDICATOR FOR SUSTAINABLE FOOD SUPPLY CHAINS

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# SUPPLY CHAIN DEMAND FOR SUSTAINABLY PRODUCED GRAINS



**FARMERS**
Increase adoption of sustainable practices at scale

**AG RETAILERS**
Engage farmers via education and data collection

**RETAILERS**
Send demand signal to food companies

**TOOLS AND TECH**
Increase confidence in precision ag tools

**FOOD COMPANIES**
Send demand signal to aggregators and ag retailers

**Driving farm management change at scale**

# ACCOUNTABILITY: THE NEED FOR AN ENVIRONMENTAL PERFORMANCE INDICATOR

**How to measure environmental performance?**
- **Direct measurement of losses by N species?**
- **Simulate impact of conservation practices via models?**
- **A robust "proxy" indicator of N losses from the farm?**
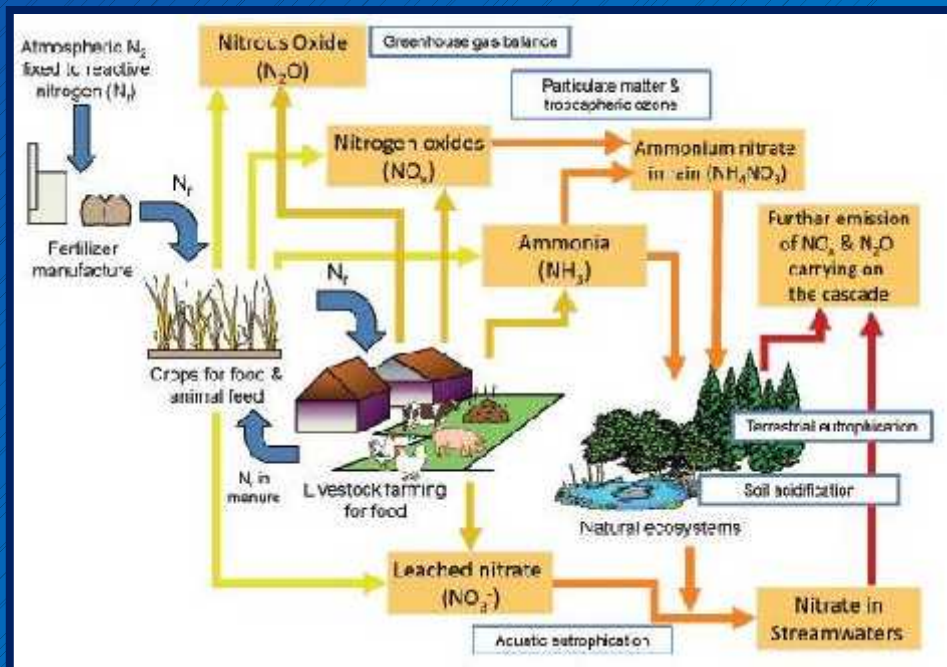


**The nitrogen cascade: need to consider all N species in an integrated way**

# NITROGEN SURPLUS AS AN ENVIRONMENTAL PERFORMANCE INDICATOR

N surplus = (N inputs to the crop) – (N removed in harvested materials*)

* including grain, seed, tubers, hay and forage

**Characteristics of a suitable indicator:**
- Simple (easily collected field-level data)
- Robust (directly related to environmental outcomes)
- Meaningful to producers (related to other aspects of sustainability)
- Scalable (from field to sourcing region)

# RELATIONSHIP BETWEEN N SURPLUS AND ENVIRONMENTAL OUTCOMES
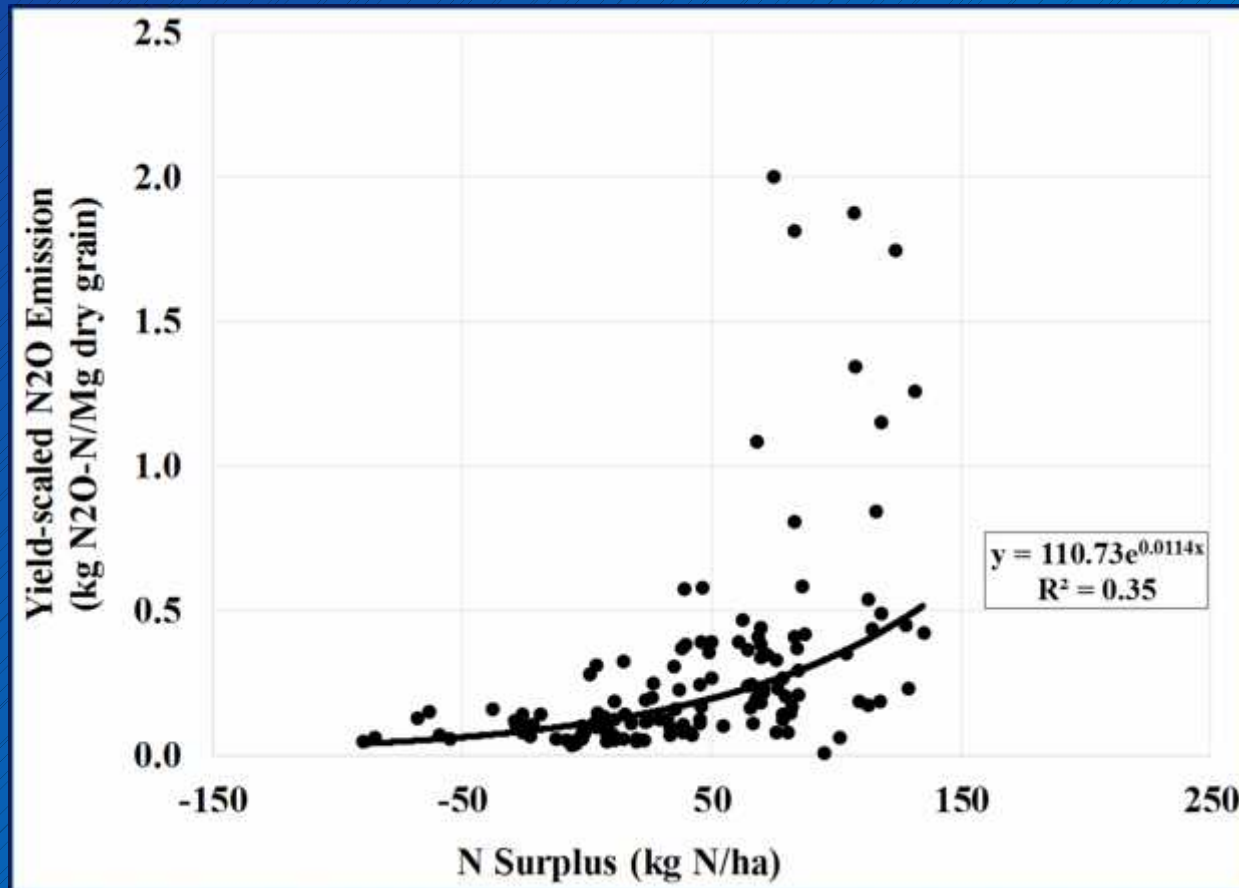


**Empirical relationship between N surplus and yield-scaled $N_2O$ losses based on data from 12 field studies with maize in the U.S.**

# RELATIONSHIP BETWEEN N SURPLUS AND ENVIRONMENTAL OUTCOMES, cont'd
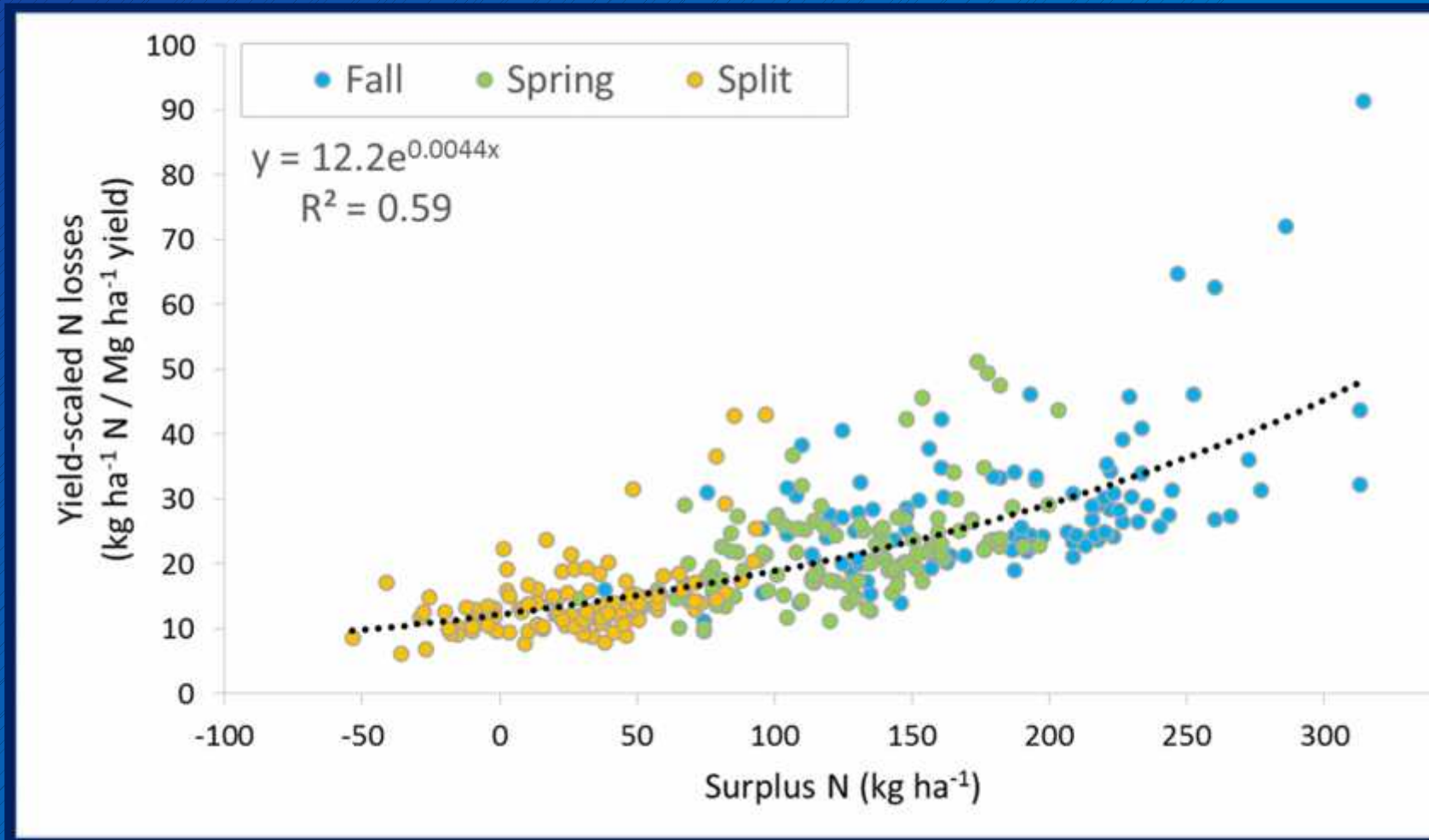


**Results from Adapt-N model simulations showing the relationship between N surplus and yield-scaled total nitrogen losses.**

# WHAT DO WE LEARN FROM THESE ANALYSES?

- **Strong relationship between N surplus and yield-scaled N losses in U.S. maize systems**
- **Opportunity for farmers to reduce N losses by reducing N surplus** *

- **Possible threshold for these systems at N surplus   50 kg N/ha, above which N losses increase dramatically**
- **Greatest environmental benefit from targeting farmers and cropping systems with current large N surplus values** *

- **Models can be used to identify on-farm opportunities to reduce N surplus**
- **In U.S. maize systems, the biggest opportunities to reduce N losses are shifting fertilizer application from Fall to Spring, and applying N in split applications more synchronous with plant uptake***

# AN N SURPLUS FRAMEWORK TO IMPROVE N MANAGEMENT IN FOOD SUPPLY CHAINS

**RETAILERS**

↓

**FOOD COMPANIES**

↓

**GRAIN BUYERS**

↓

**FARMERS**

**Commit to reducing supply chain N losses**

**Set performance goals related to the N surplus of the grain they buy**
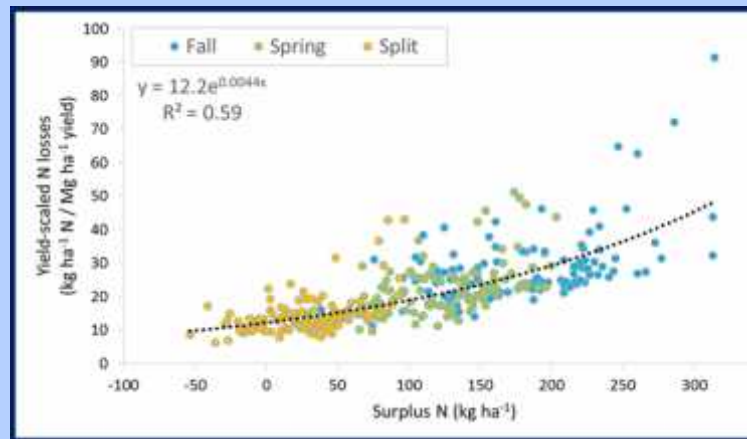
**Incentivize production of grain with acceptable N surplus**

**Improve N management on farm to reduce N surplus within acceptable range**

# HELPING FARMERS REDUCE N SURPLUS IN CROP PRODUCTION

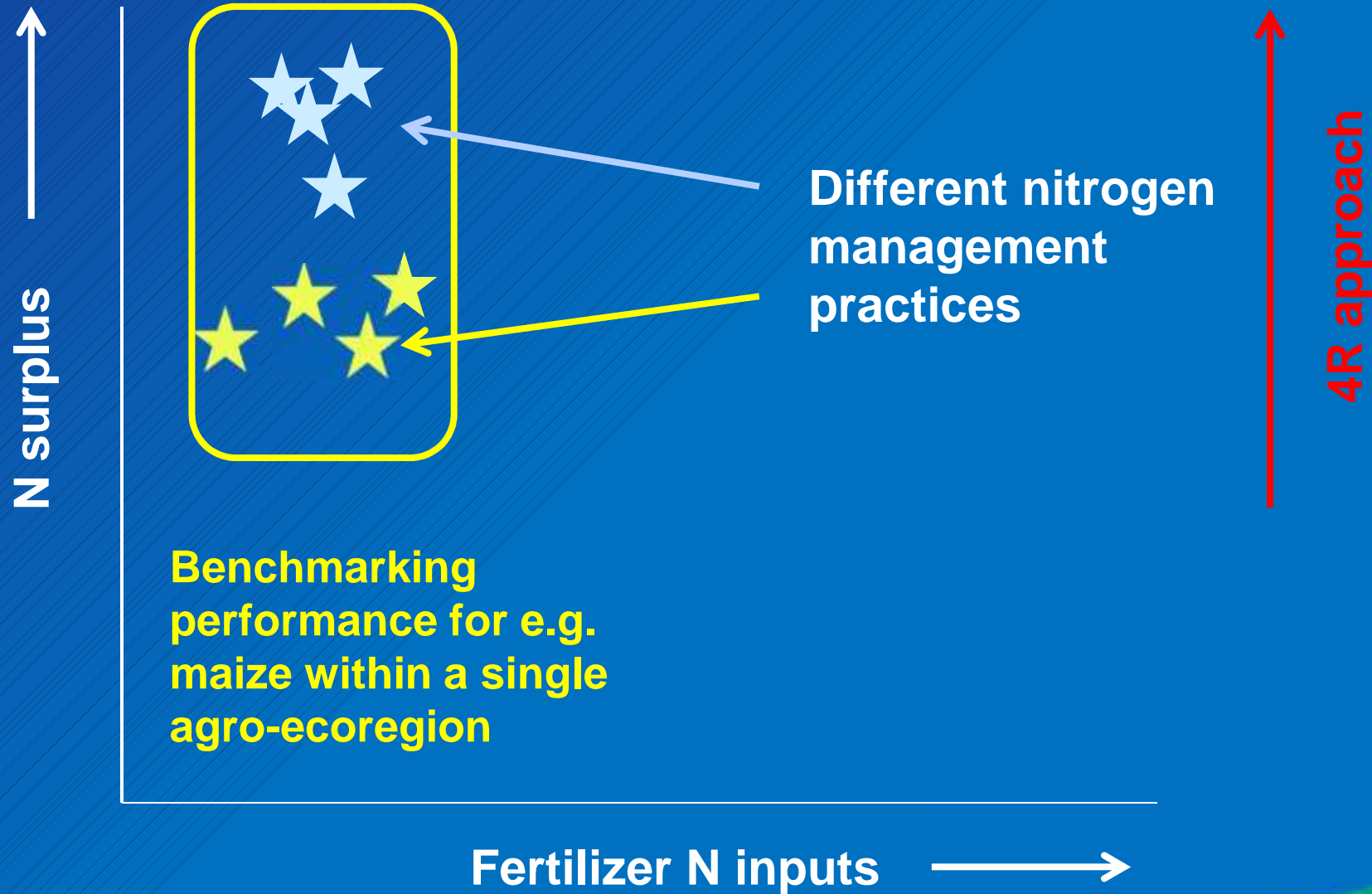**Model simulations of the impacts of various conservation practices**



**On-farm adaptive management in a social learning context**



General guidance

Model suitability

Applicability of model outcomes across large areas

Farm-specific guidance

Social capacity to engage farmers

Upscaling community engagement

# HOW MIGHT ON-FARM ADAPTIVE MANAGEMENT WORK?
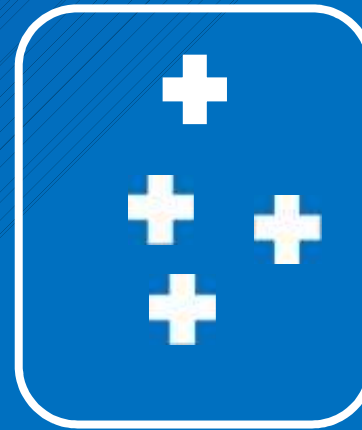


**N surplus**

**Fertilizer N inputs**

**4R approach**

**Different nitrogen management practices**

**Benchmarking performance for e.g. maize within a single agro-ecoregion**

# HOW MIGHT ON-FARM ADAPTIVE MANAGEMENT WORK?

**N surplus** (y-axis)

**Fertilizer N inputs** (x-axis)

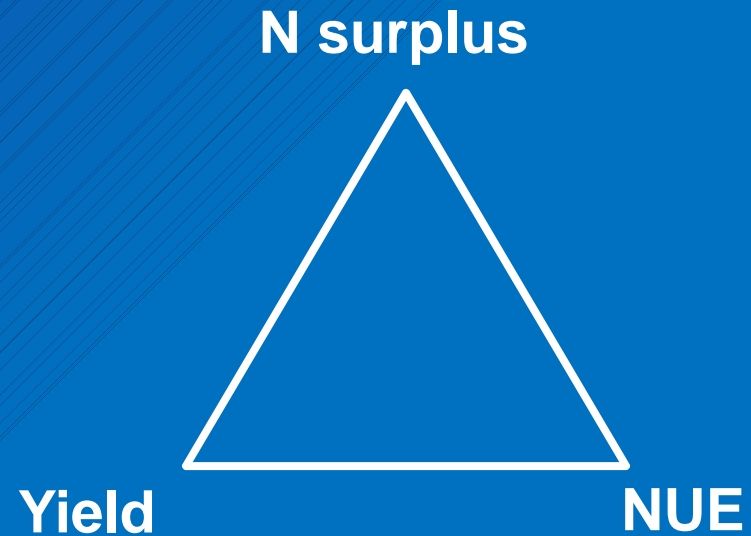**Benchmarking performance for e.g. maize within a single agro-ecoregion**

**Comparing performance across different farming systems or agro-ecoregions**

# THE BENEFITS OF AN N SURPLUS FRAMEWORK

**Farmers:**
**Increased sustainability**
**Increased public support for**
**farming operations**

**N surplus**

**Yield**                    **NUE**

**Food companies and retailers:**
**Credible sustainability claims**
**Reduced supply chain risk**

QUESTIONS?

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