N2010 – 5th International Nitrogen Conference
New Delhi, India
3-7 December 2010

IPNI
International Plant Nutrition Institute

Fertilizer Management and Nitrogen Use Efficiency

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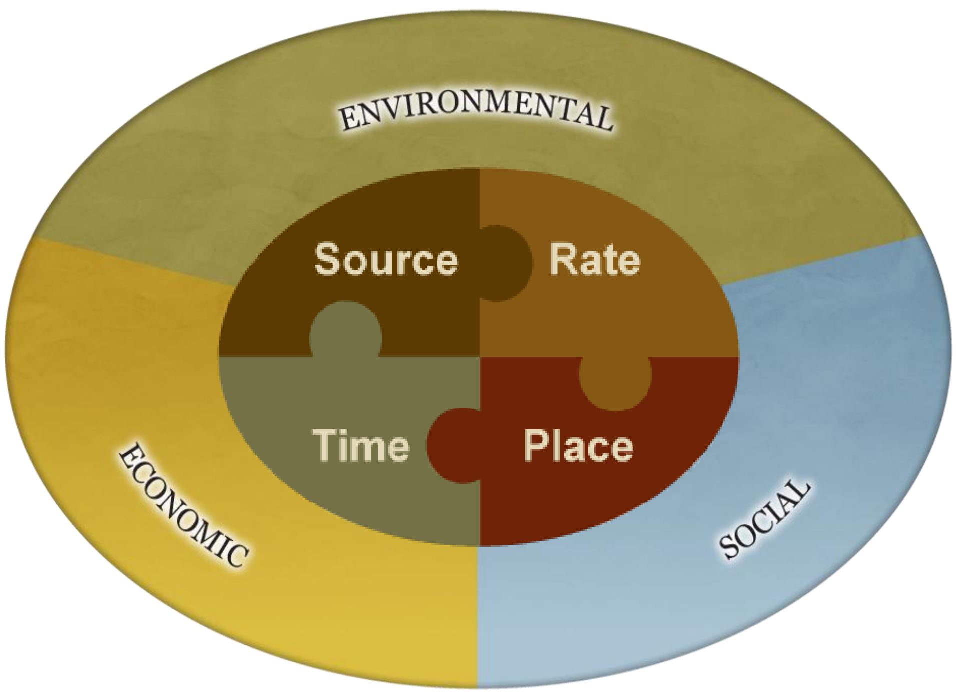
Outline

- Nutrient Stewardship for N Management
- Nitrous Oxide Emission Reduction Protocol (NERP)
  - Eastern Canada
- N use efficiency
- Benefits to society

Principles of 4R Nutrient Stewardship

- Stakeholders choose goals
- Producers choose practices (S-R-T-P)
- Practices to achieve goals are specific to site, crop and weather
- Science links practices to goals



The basic scientific principles of managing crop nutrients are universal

1. Supply plant-available forms
2. Suit soil properties
3. Recognize synergisms
4. Blend compatibility

1. Assess soil supply
2. Assess indigenous sources
3. Assess plant demand
4. Predict fertilizer use efficiency

1. Assess timing of crop uptake
2. Assess dynamics of soil supply
3. Recognize timing of weather
4. Evaluate logistics of operations

1. Recognize root-soil dynamics
2. Manage spatial variability
3. Fit needs of tillage system
4. Limit off-field transport

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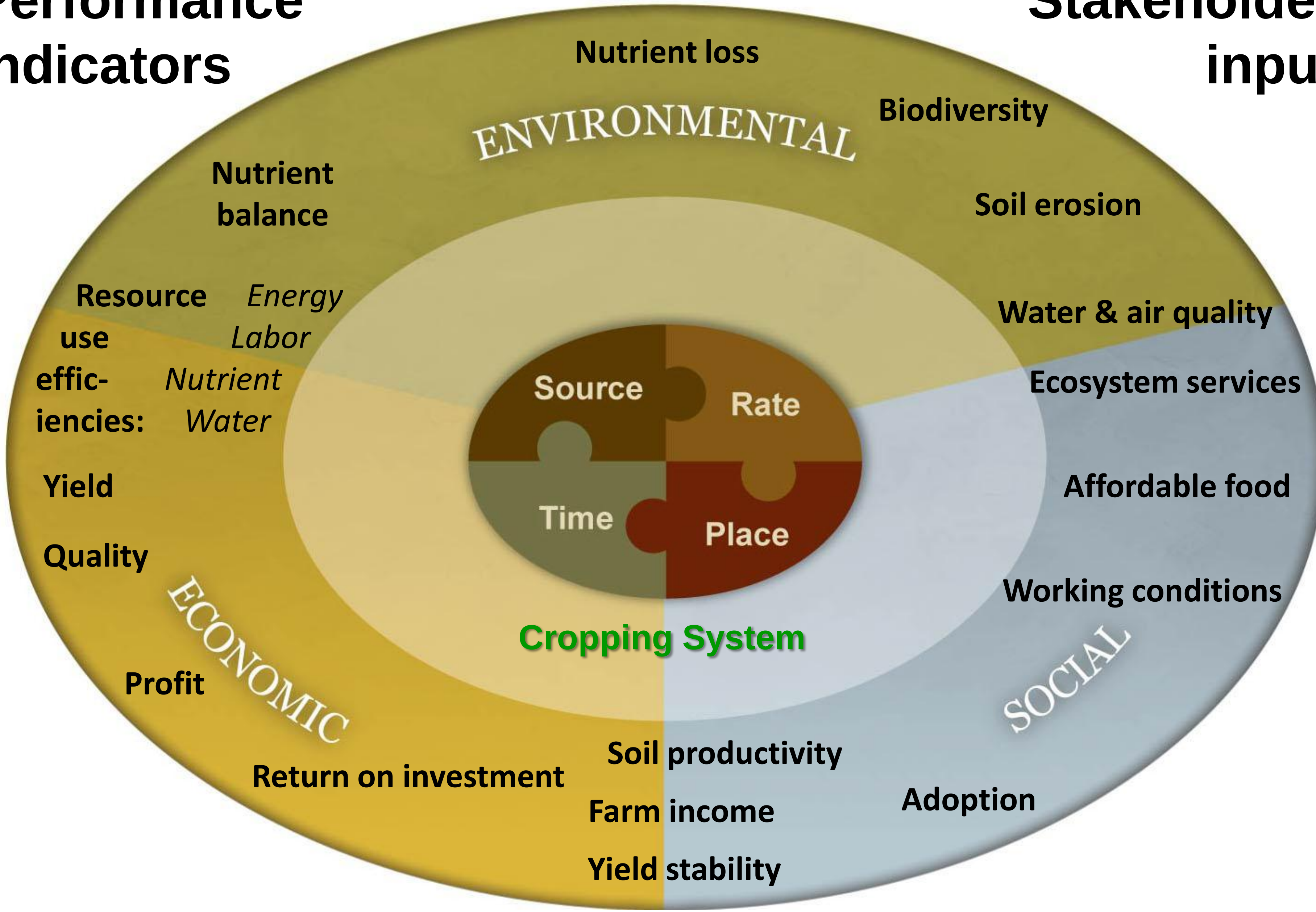
Performance indicators

Stakeholder input



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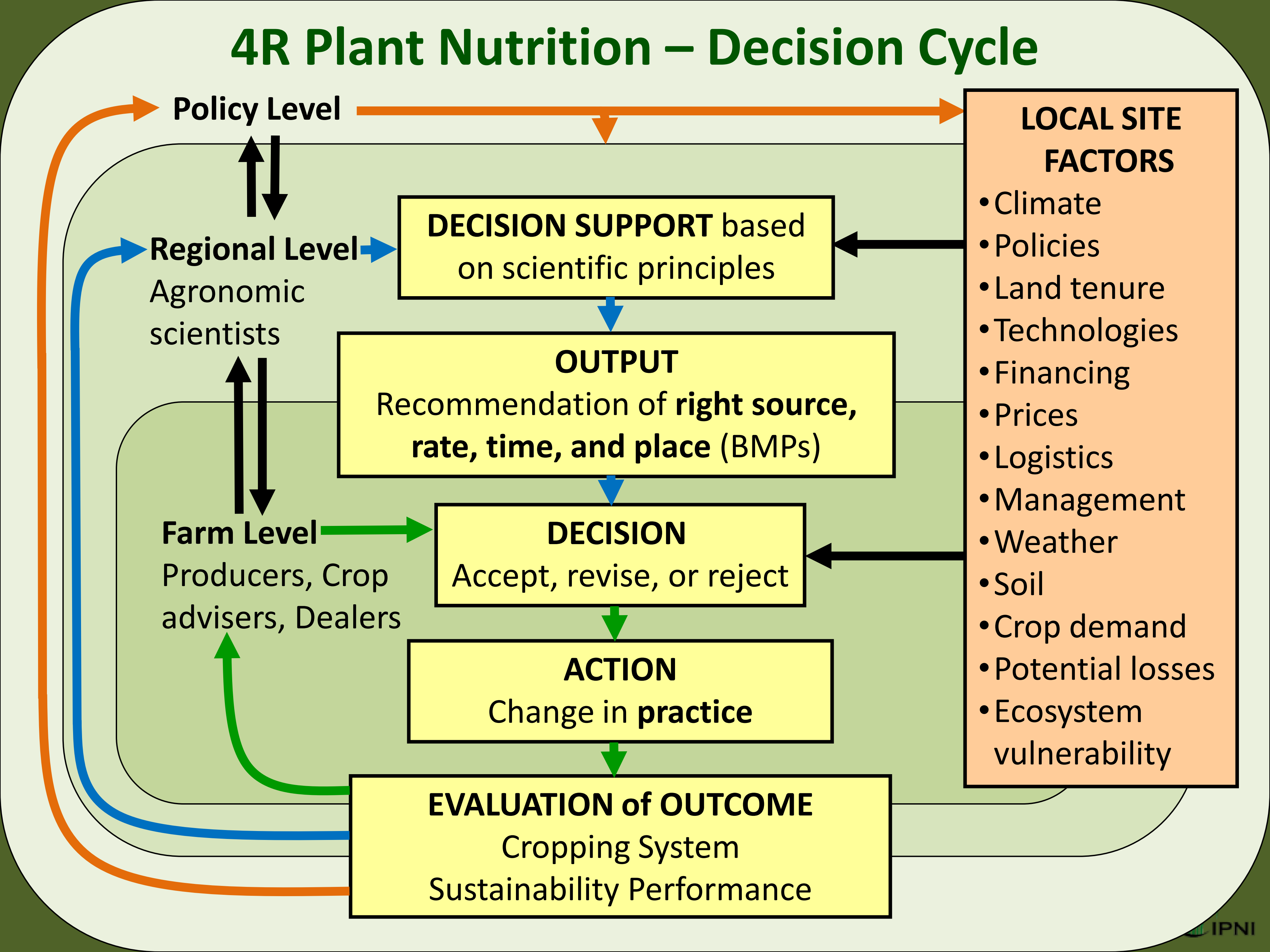
4R Plant Nutrition – Decision Cycle
Policy Level
Regional Level
Agronomic scientists
Farm Level
Producers, Crop advisers, Dealers
DECISION SUPPORT based on scientific principles
OUTPUT
Recommendation of right source, rate, time, and place (BMPs)
DECISION
Accept, revise, or reject
ACTION
Change in practice
EVALUATION of OUTCOME
Cropping System Sustainability Performance
LOCAL SITE FACTORS
• Climate
• Policies
• Land tenure
• Technologies
• Financing
• Prices
• Logistics
• Management
• Weather
• Soil
• Crop demand
• Potential losses
• Ecosystem vulnerability
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Understanding

NERP

and what it can mean to you

Nitrous oxide Emission Reduction Protocol

CANADIAN FERTILIZER INSTITUTE

INSTITUT CANADIEN DES ENGRAIS

Benefits

Farmers

- Offset credit for reduced GHGs

Government

- Tool to meet emission reduction targets
- ISO 14064-2 criteria for "real, measurable, additional, verifiable"
- Approved October 2010 by Alberta Environment

Researchers

- Advance science relating farm practices to N_2O emissions

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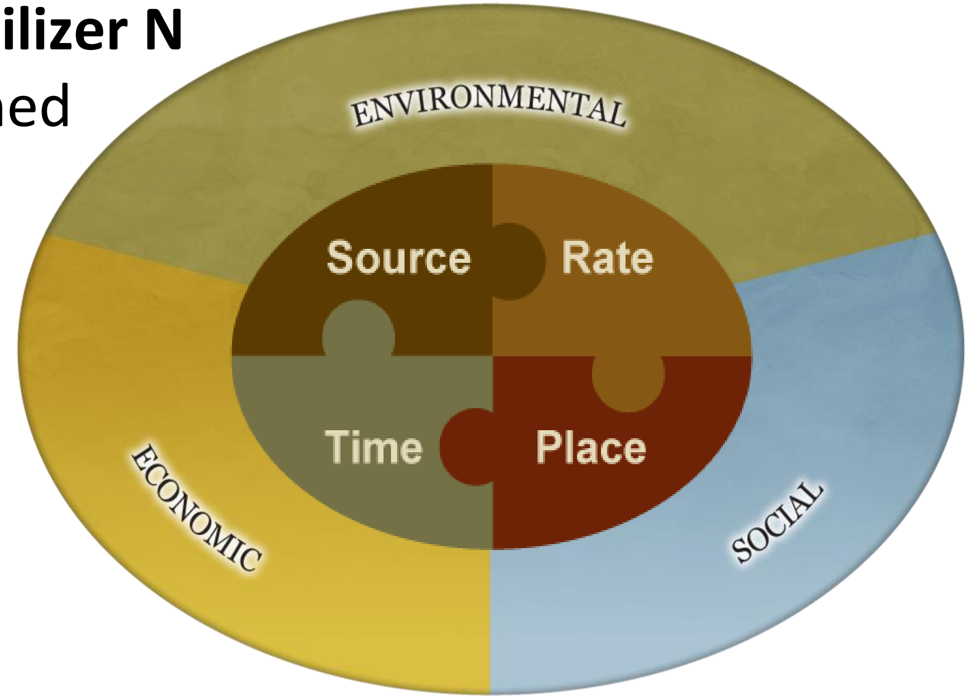
Eastern Canada meta-analysis for NERP

Objective:

- To quantify the impact of fertilizer management practices – source, rate, time, and place – on N_2O emission.
- Analyze aggregated data on N_2O **emission response to fertilizer N application**, for all published research conducted in Eastern Canada (ON, QC, NB, NS).
- Emissions summed on a site-year basis



Eastern Canada meta-analysis for NERP

Focus

- 20 studies on S-R-T-P with rate-effect comparisons at constant source, time and place

Hypotheses:

- Source, rate, time, place influence fertilizer-induced N_2O emission (FIE) over a growing season

$$FIE = \frac{E_f - E_c}{N_f - N_c} \quad (\text{kg } N_2O\text{-N kg } N^{-1})$$

Crop, soil and site characteristics in 20 studies furnishing 197 observations of FIE in Eastern Canada

Year (18)	1978 1979 1992 1993 1994 1995 1996 1997 1998 2000 2001 2002 2003 2004 2005 2006 2007 2008
Province (4)	QC-57%, ON-29%, NB-9%, NS-5%
Crop (6)	Corn (60%), Forage (29%), Fallow (4%) Cereal (3%), Potato (3%), Soybean (1%)
Soil texture	Median 30% sand, range 7-85%
Soil pH	Median 6.4; Range 5.1-7.7
Source (7)	AN (34%), urea (20%), manure (20%) UAN (13%) NH4 (10%) nitrate (3%) EEF (2%)
Rate	Median 142; range 20-400 kg N ha^{-1}
Time (4)	Split (35%) May (34%) June (22%) Other (9%)
Place (4)	BR-SUR-T (41%), BR-INC-T (26%), BAND (24%), BR-SUR-NT (8%)

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Mixed linear model – FIE

Effect	Estimate	se	df	t	p
Sand	-1.71	0.4	181	-4.6	<.0001
Soil pH	-0.37	0.1	181	-2.7	0.0070
Type 3 Tests of Fixed Effects			**df**	**F**	**p**
Source		6	181	3.1	0.007
Time		3	181	5.9	0.001
Place		3	181	2.1	0.101

- Preliminary analysis
- SAS PROC MIXED restricted maximum likelihood (REML); years random; N=197; adapted from Stehfest & Bouwman, 2006
- Further analysis ongoing for specific SRTP for specific crops

Direct and indirect emissions

- **Direct:**
  - FIE median, mean, lsmean = 6, 11, 15 g N_2O-N kg N^{-1}
  - FIE (rate effect) modified by source-time-place practices
- **Indirect:**
  - Larger than direct?
  - A function of rate? of N losses? of N use efficiency?
- **Emission per unit of yield**

Potential ROI: Ontario corn N management research

	CURRENT	OPTIMUM	FUTURE
N applied (kg/ha)	146	100	144
Yield (kg/ha)	8440	8390	10980
Partial N Balance (PNB)	72%	105%	95%
Recovery Efficiency (RE)	30%	43%	55%
NET SOCIETAL BENEFIT ($M)			

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Annual Benefits to Ontario:				
Yield benefit from N use ($M)	389	382		809
Cost of N fertilizer ($M)	168	115		166
Net Return To Grower ($M)	221	267	46	644
NET SOCIETAL BENEFIT ($M)				

Assumes: 1M ha, $165/t corn, $1.15/kg N, $30/t CO_2-eq, 1%-2% N_2O-N loss, $0.50/lb N loss

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GHG emission cost ($M)	-70	-45		-52
Nitrate loss cost ($M)	-24	-15		-12
Ammonia detriment cost ($M)	-18	-11		-9
NET SOCIETAL BENEFIT ($M)	108	197	**89**	571

Assumes: 1M ha, $165/t corn, $1.15/kg N, $30/t CO_2-eq, 1%-2% N_2O-N loss, $0.50/lb N loss

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Managing Crop Nitrogen for Weather

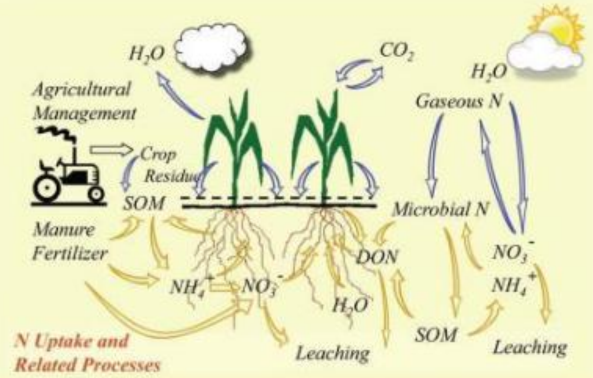
Proceedings of the Symposium
"Integrating Weather Variability into Nitrogen Recommendations"

Sponsored by
the Soil Science Society of America

Edited by: T.W. Bruulsema

Published by
the International Plant Nutrition Institute

Quantifying and Understanding Plant Nitrogen Uptake for Systems Modeling



Edited by
Liwang Ma
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CRC Press
Taylor & Francis Group

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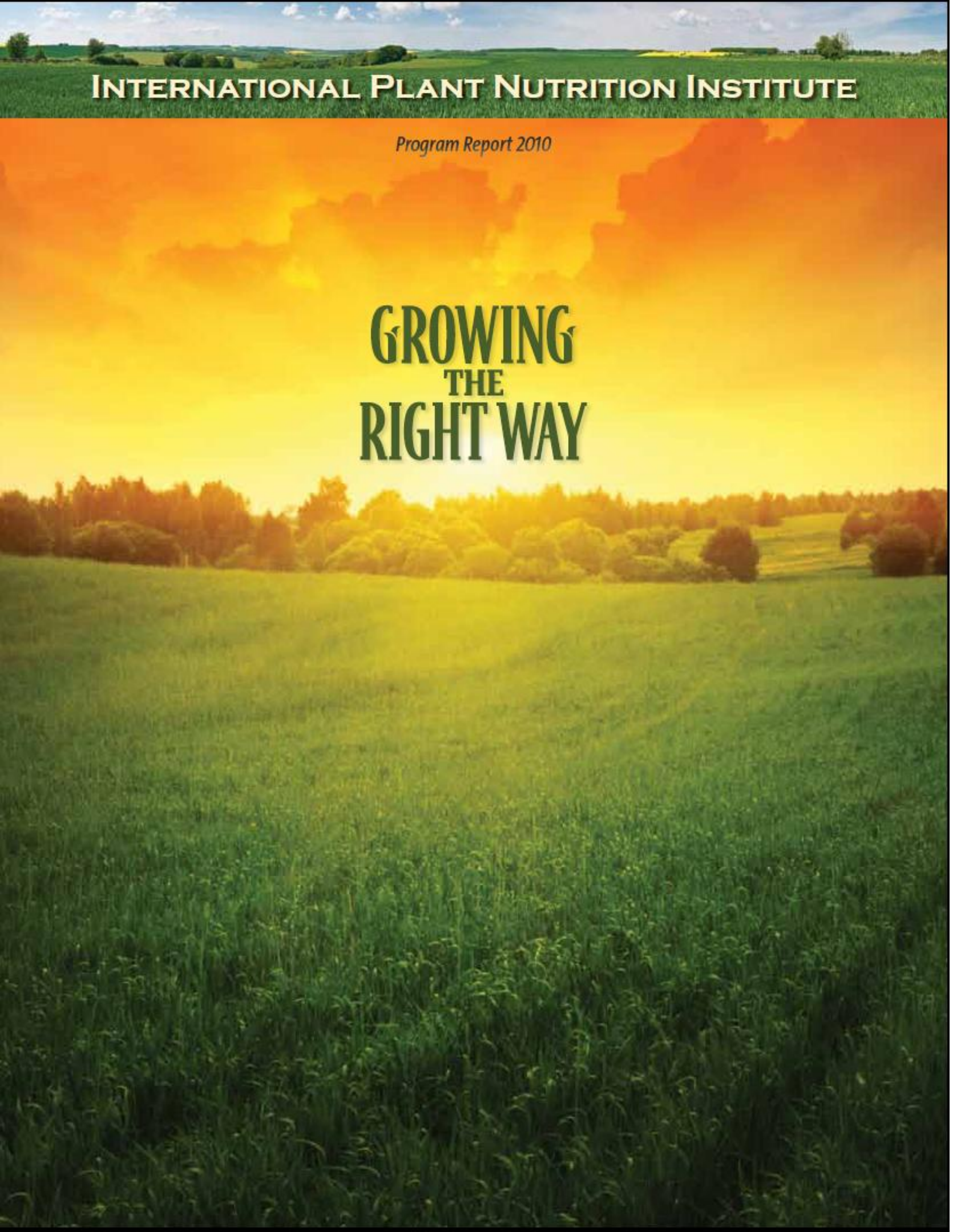
Summary

1. **Source, time and place impact N_2O emissions induced by fertilizer N.**
2. **Protocols such as NERP provide context for scientists to shape the future.**
3. **Societal benefits justify larger investments in research to adapt N management to weather and improve N efficiency.**



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Acknowledgments

Canadian Fertilizer Institute

Ontario Agri-Business Association

Ontario Soil & Crop Improvement Association