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Furthering 4R Nutrient Stewardship for Future Farming

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Linkages

- Plant Nutrition Canada supports the Nutrient Stewardship programs of Fertilizer Canada, The Fertilizer Institute in the USA and the International Fertilizer Association.



- Its partners include African Plant Nutrition Institute, Scientific Panel on Responsible Plant Nutrition, and 4R Solution Project.





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SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

A NEW PARADIGM FOR PLANT NUTRITION

Issue Brief, November 2020



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KEY POINTS

Nutrient inputs play a critical role in raising crops and livestock for food security, human nutrition and other uses in the bioeconomy. Their production and management must change to more effectively nourish crops, reduce harmful environmental impacts caused by nutrient losses and contribute to restoration of soil health. A new paradigm for plant nutrition follows a food system approach in which multiple socioeconomic, environmental and health objectives must be achieved (Fig. 1).

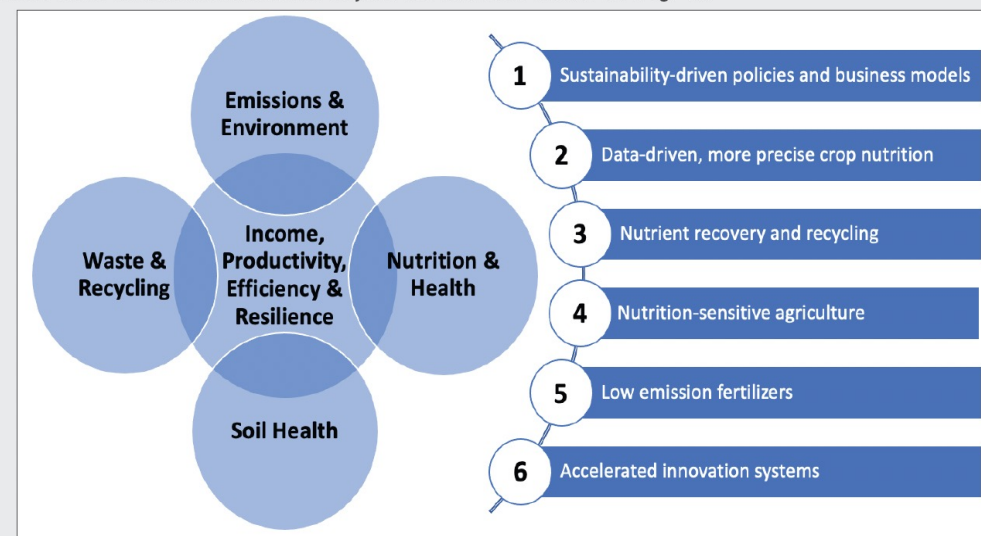


Figure 1. The five interconnected aims of responsible plant nutrition, and six key actions to take.

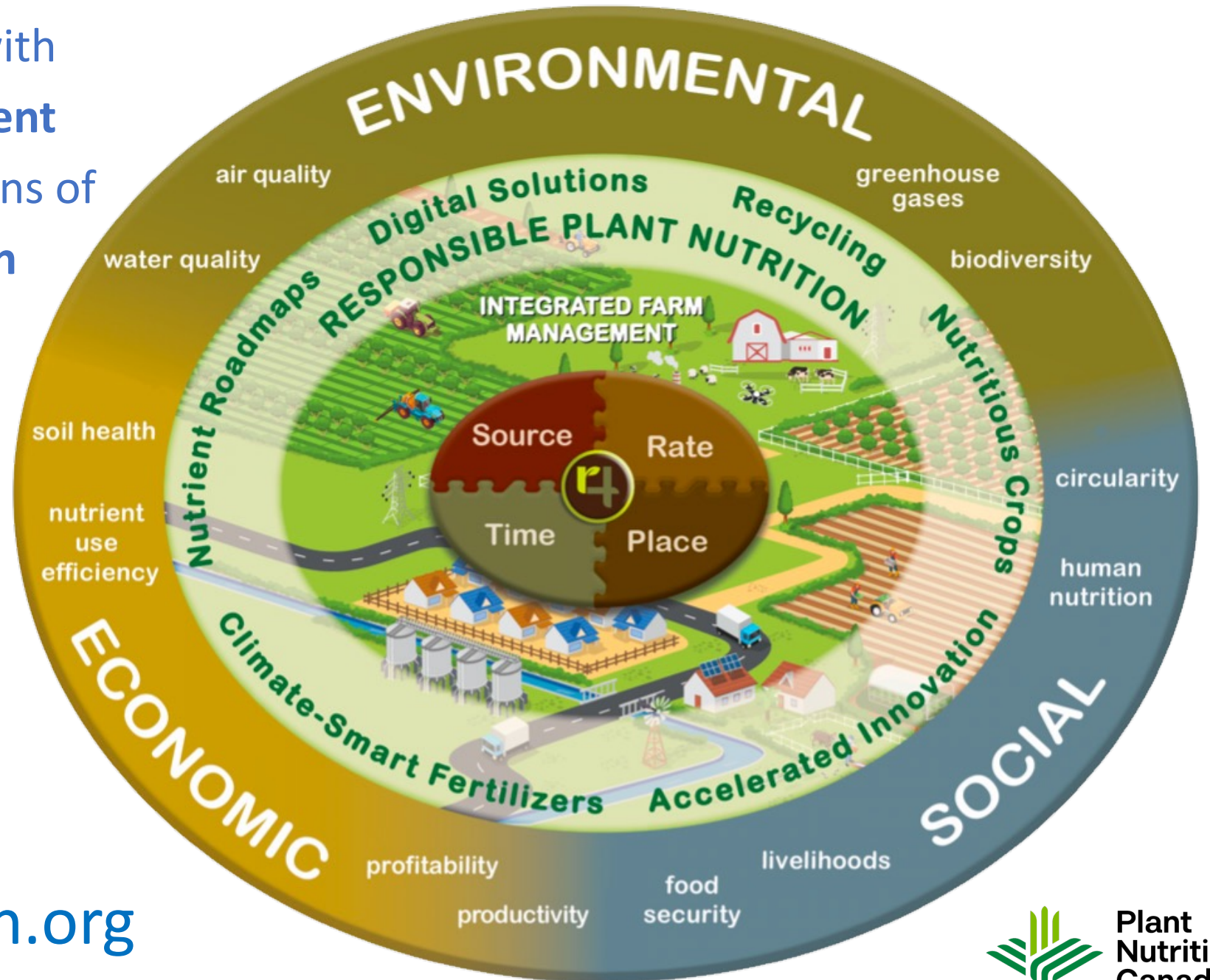
4R Nutrient Stewardship with integrated farm management supports the 6 critical actions of **Responsible Plant Nutrition** to deliver multiple sustainability outcomes.



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4R Framework & Principles: What needs to change?

1. FUTURE FARMING SYSTEMS INTEGRATION

- Digital solutions, adaptive management

2. NEW CORE PRINCIPLES

- Source, rate, time, and place

3. CONTRIBUTE TO SUSTAINABILITY PERFORMANCE REPORTING

- Track practices and performance at the farm level

Future Farming Systems Integration

- Farming systems in transition – regenerative, circular, nature-based
 - Soil conservation
 - Integration with livestock
 - Mechanization, irrigation, fertigation → sustainable intensification
 - Better human nutrition → biofortification, better diets
- Data-driven digital solutions
 - GPS guidance
 - Decision support tools
- Adaptive management for accelerated innovation
 - Weather-responsive sensing tools and crop models

Principles for Right Source

- 1. Supply nutrients in quantifiable and available forms.**
- 2. Use climate-smart forms.**
- 3. Use recycled forms where feasible.**
- 4. Consider biological inoculants.**
5. Suit soil physical and chemical properties.
6. Recognize synergisms among nutrient elements and sources.
7. Recognize blend compatibility of materials.
8. Recognize benefits and sensitivities to associated elements.
9. Control effects of non-nutritive elements.

New principles
added to the
paradigm
“furthering 4R”

Original



New source principle #2: Use climate-smart forms.

Climate-smart fertilizers reduce greenhouse gas emissions.

Three attributes:

1. Lower manufacturing CO₂ emissions
 - “green” and “blue” ammonia
2. Inhibit loss of nitrous oxide (N₂O)
 - nitrification inhibitors and polymer coated urea
3. Improve nitrogen use efficiency (NUE)
 - controlled-release, stabilized, “smart fertilizers”



Photo credit:
TFI, 2022

Principles for Right Rate

1. Address variability in crop response. } New

2. Assess plant nutrient demand.

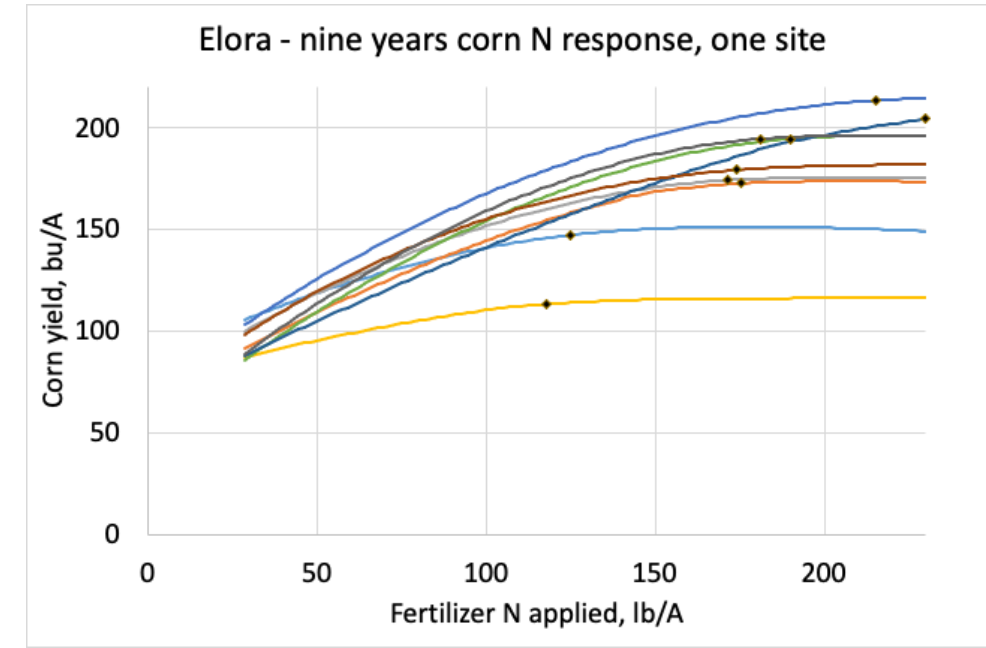
3. Assess soil nutrient supply.

4. Predict fertilizer use efficiency.

5. Consider soil resource impacts.

6. Consider economics and the law of diminishing returns.

Original



Principles for Right Time

1. **Address changes in nutrient need through the growing season.**

New

2. Assess timing of plant uptake.

3. Assess dynamics of soil nutrient supply.

4. Recognize dynamics of soil nutrient loss.

5. Evaluate logistics of field operations.

Original



Principles for Right Place

1. Place nutrients to avoid loss.

} New

2. Consider where plant roots are growing.

3. Consider soil chemical reactions.



4. Suit the goals of the tillage system.

5. Manage spatial variability.

} Original

PLATO, the Phosphorus Loss Assessment Tool for Ontario

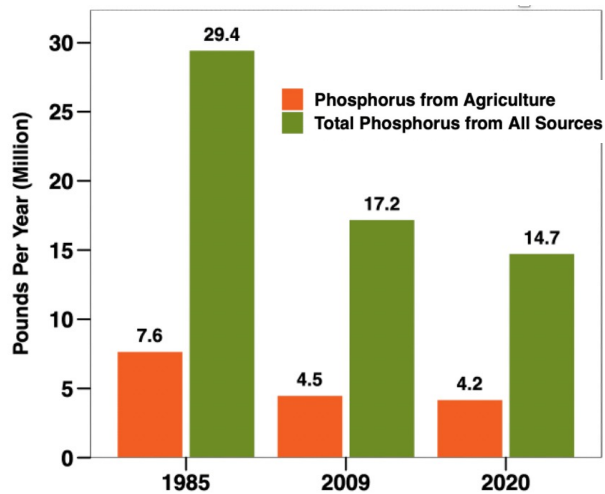
Summary

Field characteristic index	79.6		
Application loss index	0.4		
Total phosphorus index	80.1		

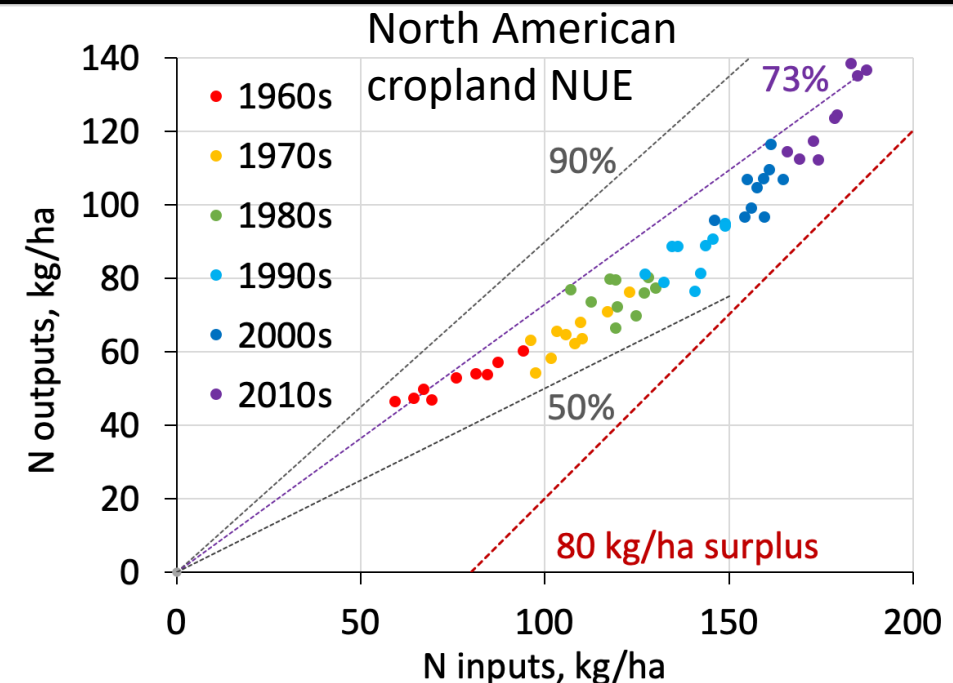
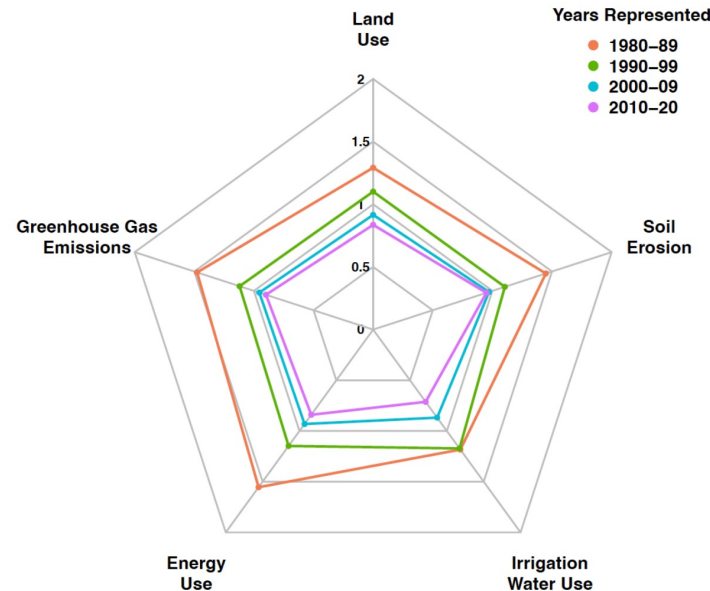


Sustainability Performance Reporting

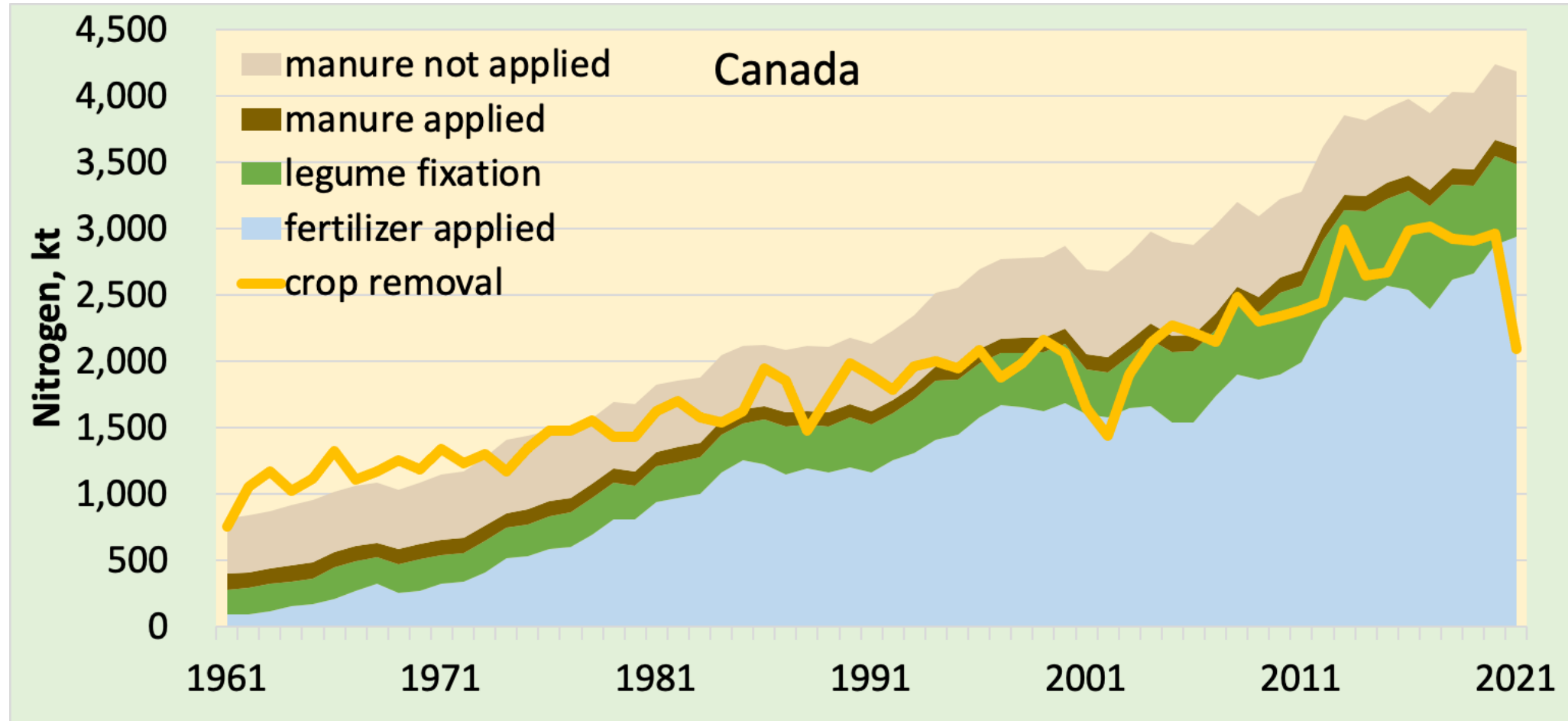
- Track practices at farm level
- Share tracked data to report performance
- Economic, environmental and social sustainability



-----Field to Market 2021 Indicators Report-----



Cropland nitrogen balance



Crop removal includes all crops and harvested forage. Data sources: Statistics Canada fertilizer shipments, livestock inventories, crop production.

4R Nutrient Stewardship challenges:

1. Integrate with Future Farming Systems.
2. Adopt New Core Principles.
3. Contribute To Sustainability Performance Reporting.



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FURTHERING 4R NUTRIENT STEWARDSHIP

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<https://www.sprpn.org/issue-briefs>