36th Annual Soil Fertility Seminars

4R Practices, Real Outcomes

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Portage la Prairie, MB

3 March 2026

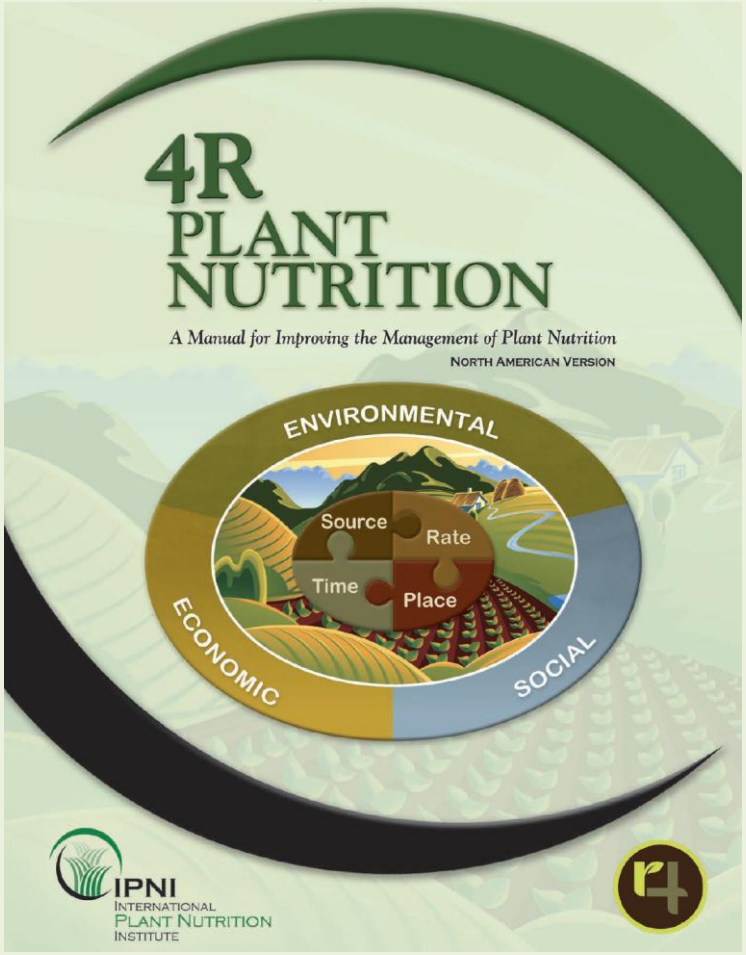
Outline

4R Practices, Real Outcomes

1. 4R Principles – genesis & recognition
2. 4R Practices – defining, tracking & reporting
3. Outcomes – nutrient balances, soil test trends
4. Linking to sustainability & credits

4R Principles

IPNI, 2012-2016



SPRPN, 2022

SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

https://www.sprpn.org

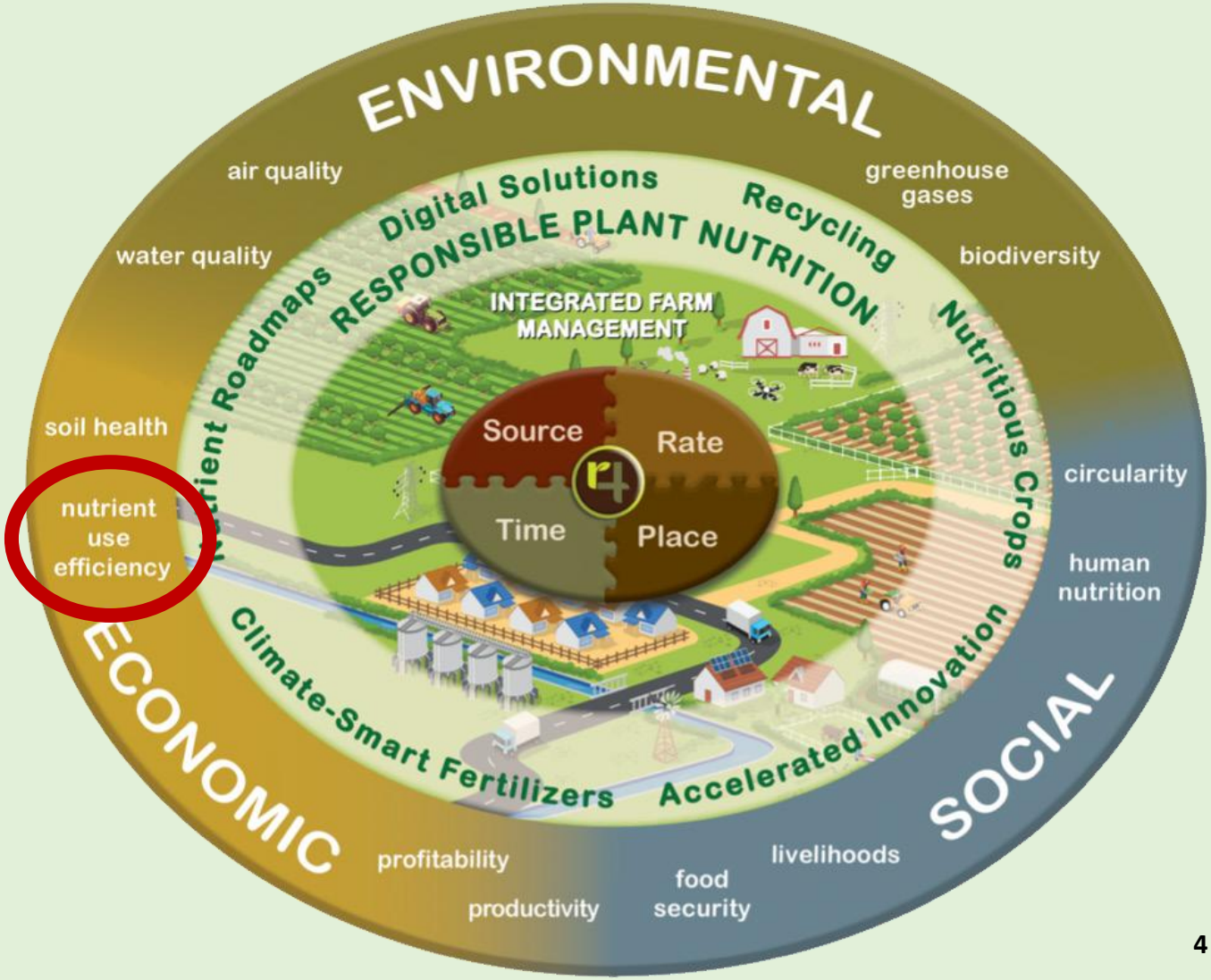
Furthering 4R

Relevant to the aims and actions of responsible plant nutrition.

Connected to outcomes, including NUE and N balance.

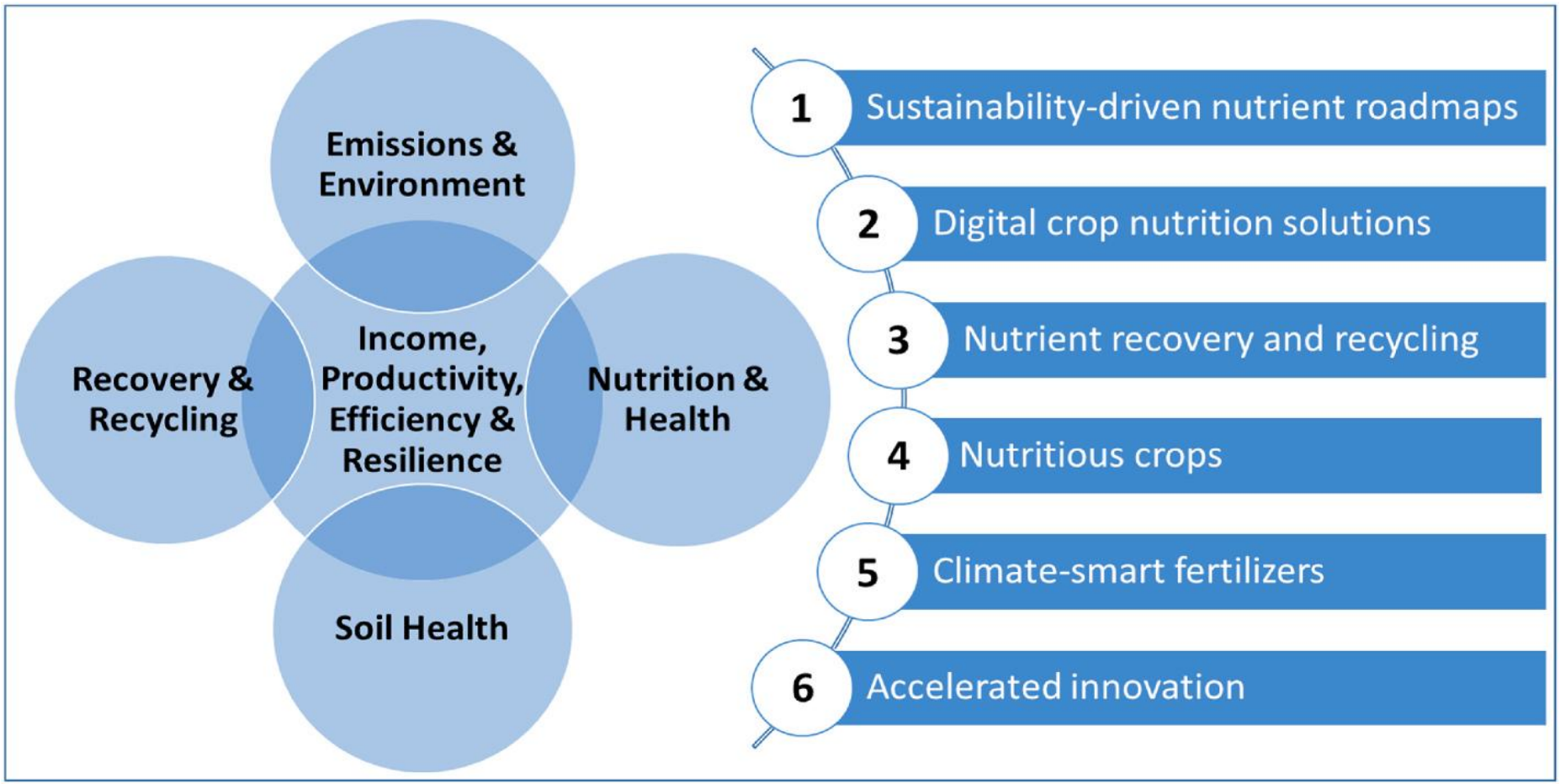
Recognized principles.

Site-specific practices.



SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

Responsible Plant Nutrition – 5 aims, 6 actions



Dobermann, et al., 2022. Global Food Security 100636.

SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

4R Framework & Principles: What needs to change?

nutrient stewardship

FUTURE FARMING SYSTEMS INTEGRATION

- Integrate with farming systems in transition
- Use data-driven digital solutions to support decisions
- Innovate using adaptive management

NEW CORE PRINCIPLES

- Source, rate, time, and place

CONTRIBUTE TO SUSTAINABILITY PERFORMANCE REPORTING

- Track practices and economic performance at the farm level
- Share tracked data to report performance

Future Farming Systems Integration

Farming systems in transition – regenerative, circular, nature-based

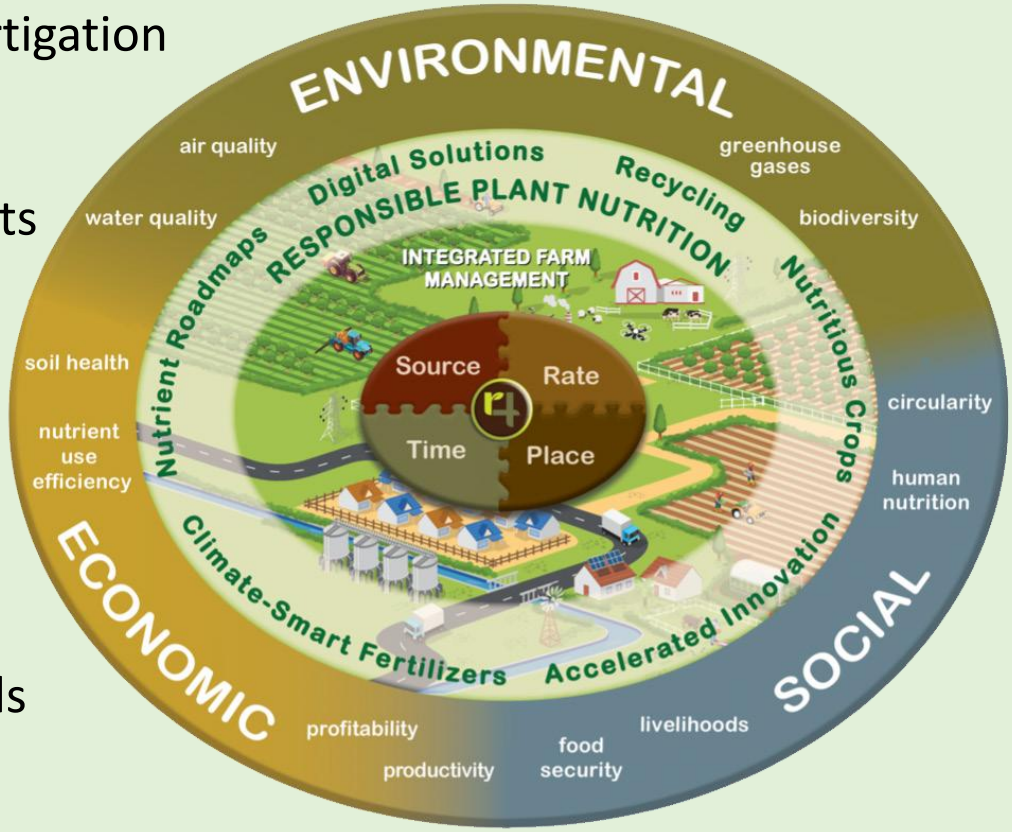
- Soil conservation
- Integration with livestock
- Mechanization, irrigation, fertigation
  → sustainable intensification
- Better human nutrition
  → biofortification, better diets

Data-driven digital solutions

- GPS guidance
- Decision support tools

Adaptive management for accelerated innovation

- Weather-responsive sensing tools and crop models



New Core Principles

RIGHT SOURCE

- Use climate-smart forms
- Use recycled forms where feasible
- Consider biological inoculants
- Supply nutrients in quantifiable available forms

RIGHT RATE

- Address variability in crop response

RIGHT TIME

- Address changes in nutrient need through the growing season

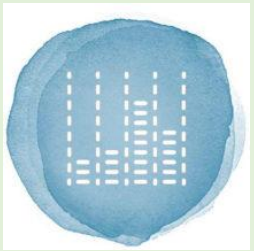
RIGHT PLACE

- Place nutrients to avoid loss

Sustainability Performance Reporting

1. Track practices at farm level
2. Share tracked data to report performance
3. Economic, environmental and social sustainability

4R nutrient stewardship



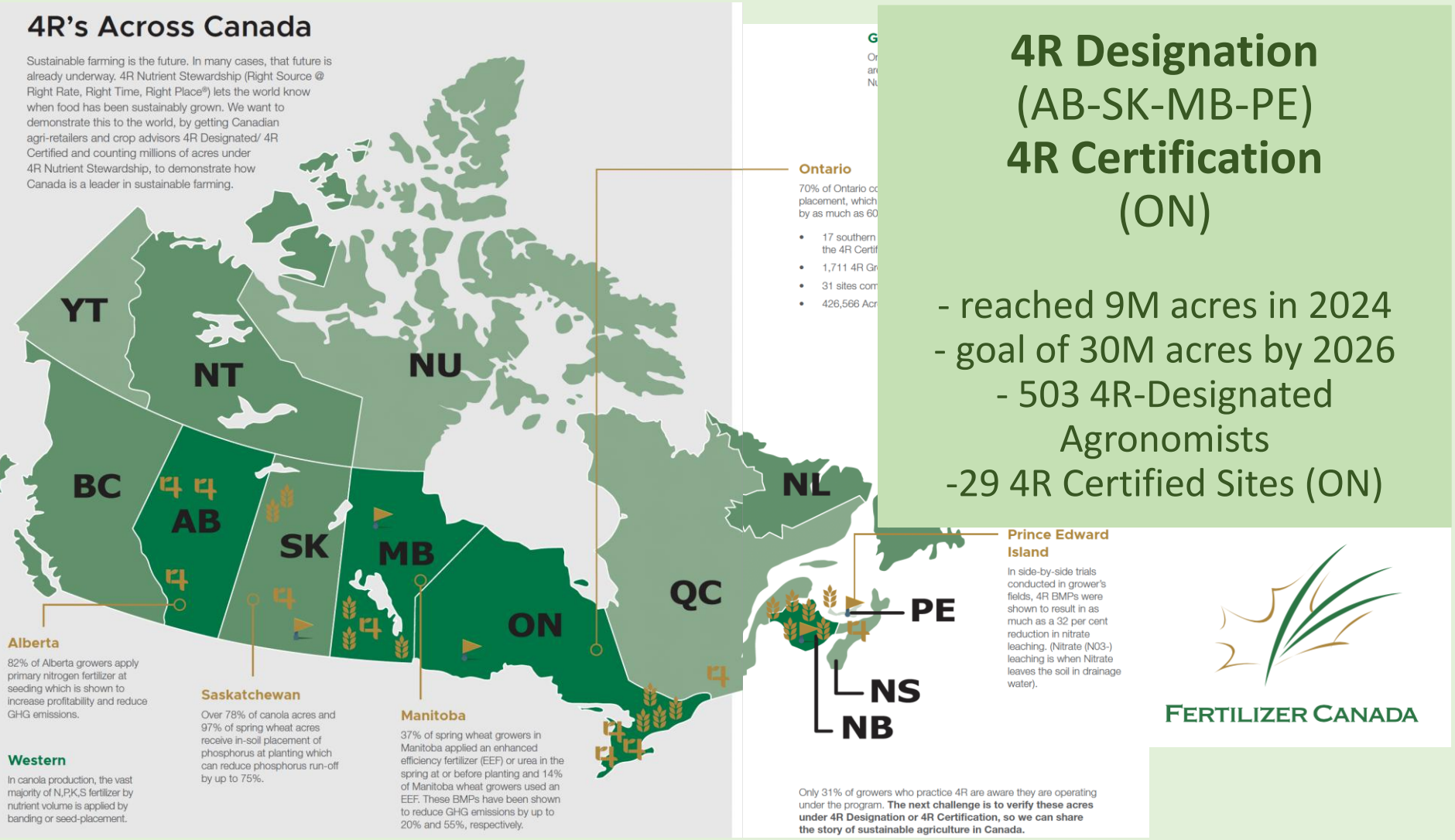
Land Use Efficiency

Soil Erosion Risk

Greenhouse Gas Emissions

Energy Use

Fertilizer Canada 4R Programs



4R Designation
(AB-SK-MB-PE)
4R Certification
(ON)

- reached 9M acres in 2024
- goal of 30M acres by 2026
- 503 4R-Designated Agronomists
-29 4R Certified Sites (ON)

4R Guidance Tables, 4R eLearning, 4R Fertilizer Use Survey

4R Designated Acre Reporting

Acre Recording Form – 4R Designated Agronomist: please use this form to record the number of crop acres that you verified to be 4R over the 2025 growing season.		
Name Today's Date Province Agri-Retail/Consulting Location Email	# Acres Perennial Forages # Acres Wheat # Acres Canola # Acres Corn # Acres Barley # Acres Soybeans	# Acres Oats # Acres Lentils # Acres Field Peas #Acres Flaxseed # Acres Potatoes # Acres OTHER

I agree that information provided on this form is accurate to my best knowledge – SIGNATURE

By signing this form and based on my professional judgement as P.Ag and/or CCA, I verify that the principles of the 4R Nutrient Stewardship have been reviewed and the grower's nutrient management as discussed is consistent with the the principles of 4R Nutrient Stewardship.

nutrient stewardship

4R Nutrient Stewardship Planning Guide

1. Introduction
2. Farm Information
3. Sustainability Goals and Indicators
4. Production Information
5. Nutrient Balance
6. Planned Nutrient Application

FERTILIZER CANADA
FERTILISANTS CANADA

4R Nutrient Stewardship Management Plan

Many details to track.

Reporting: Only 4R acres.

Moving toward reporting of 4R basic, intermediate, advanced.

4R Practices
Guidance Document

FERTILIZER CANADA

2026 update

A - 4R Excluded Nitrogen and Phosphorus Fertilizer Practices

B - 4R Nitrogen and Phosphorus Practices for Annual Crops in Western Canada

C - 4R Nitrogen and Phosphorus Practices for Annual Crops in Eastern Canada

D - 4R Nitrogen and Phosphorus Practices for Annual Legumes in Canada

E - 4R Nitrogen and Phosphorus Practices for Intensive Potato Production

F - 4R Practices for Potassium Fertilizer Management

G - 4R BMPs for Sulphur Fertilizer Management

H - 4R Practices for Manure Use in Annual Crop Rotations

4R Nitrogen Practices for Annual Crops in Western Canada

BMPs for Spring Cereal and Oilseeds in Dry Regions

Table B1. 4R Nitrogen Practices for Spring Cereal and Oilseeds in Dry Regions – Prairies and Boreal Plain.

Level	Right Source	Right Rate	Right Time	Right Place
Basic	Ammonium-based formulation for fall (except UAN).[1] Any N fertilizer source in spring or in season.	Set field scale N rates using a recognized N calculator or recommendation system that accounts for realistic yield goal, soil N supply characteristics, previous legume crops, and previous manure applications[2] as well as annual weather variations.[3] Soil test every 4 years or less to assess residual N at depth.[4]	Apply N after soil cools in fall.[5] Apply N in spring before seeding.	Broadcast and incorporate within 24 hours using tillage to a minimum depth of 2 inches.[6] Fall broadcast for spring seeded crops of primary N source must be EENF.[7] Fall or early spring broadcast of NP or NS sources is allowed at P rate and/or S rate for planned crop.[8]
Inter-mediate	*EEF*	*Variable rate - qualitative*	*+*	*+*
Ad-vanced	*EEF+*	*Variable rate - quantitative*	*++*	*++*

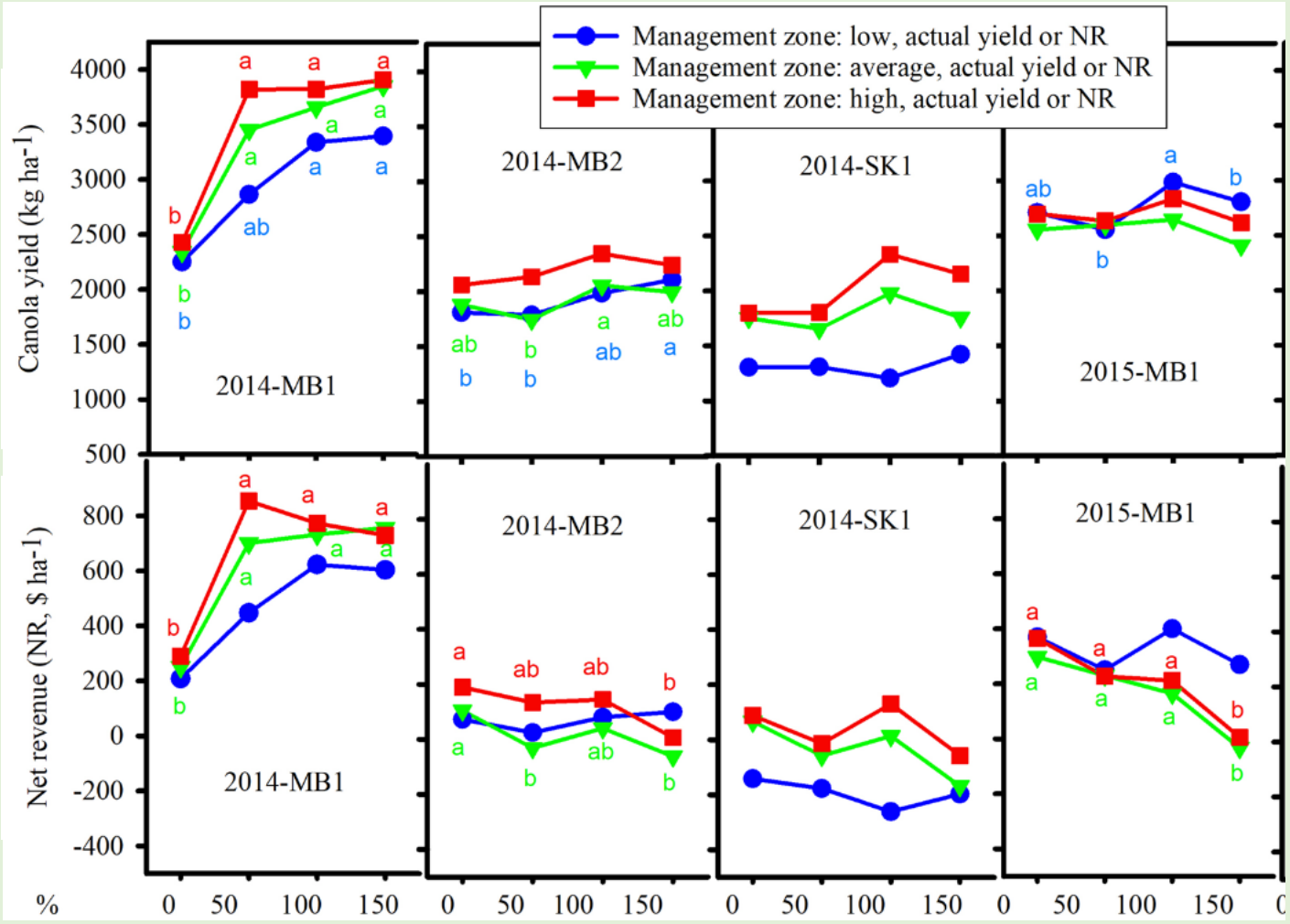
4R Phosphorus Practices for Annual Crops in Western Canada

Table B2. 4R Phosphorus BMPs for Spring Cereal and Oilseeds in Dry Regions – Prairies and Boreal Plain.

Level	Right Source	Right Rate	Right Time	Right Place
Basic	Use P fertilizer with guaranteed analysis.	Use recent soil test (4 years or less) to establish P baseline.[1]	Apply P in fall or co-apply with N after soil cools.[2]	Broadcast and incorporate to a minimum depth of 2 inches.[3]
	Use P sources capable of enhancing P availability to level of crop demand in current growing season.[4]	Set field specific rates considering differences in yield potential and soil test values among fields.[5]		
Intermediate	Use P fertilizer with guaranteed analysis.	Assess in-field variability in P availability through zone, grid or benchmark sampling (4 years or less).	Apply P in spring before seeding.	Band/inject or co-band in fall or in spring prior to seeding or mid-row band at seeding (with consideration for mobility issues if banded with high rates of N or in cool soils).[6]
	Use P sources capable of enhancing P availability to level of crop demand in current growing season.	Vary P in-field in relation to yield potential variations and/or N rates and/or differences in soil test P.[7]		
Advanced	Use P fertilizer with guaranteed analysis.	Assess in-field variability in P availability through benchmark, zone or grid sampling.	Apply P in spring at seeding.	Place with seed at safe rates based on crop, seed bed utilization, and total product load.[8]
	Use P sources capable of enhancing P availability to level of crop demand in current growing season.	Vary P by management zone independently from N.		Side-band at seeding.

Variable-rate N could increase net revenue from canola by $11 to $26 per acre.

Connects to agronomic efficiency.



Khakbazan, Moulin & Huang, 2021. Scientific Reports.

FERTILIZER CANADA

Fertilizer Canada's e-learning

Fertilizer Canada's e-learning courses cover essential topics, including 4R Nutrient Stewardship and Safety and Security best practices across the fertilizer industry—from manufacturing to handling, storage, application and transportation safety.

Who is Fertilizer Canada e-learning for?

- Farmers
- Agri-retailers
- Fertilizer industry employees

Certified Crop Advisors (CCAs) have the opportunity to obtain Continuing Education Credits (CEUs)

FERTILIZER CANADA

Nutrient Stewardship Courses

Fertilizer Canada's Nutrient Stewardship training courses help you understand the economic, social and environmental advantages of 4R practices and how these can be implemented on Canadian farms.

4R Essentials – A short Course in 4R Nutrient Stewardship

4R Nutrient Stewardship Training – Part 1

4R Nutrient Stewardship Training – Part 2

4R Nutrient Stewardship Training – Part 3

4R Nutrient Stewardship – Manitoba

4R Nutrient Stewardship – New Brunswick

4R Nutrient Stewardship – Ontario

4R Nutrient Stewardship – Prince Edward Island

4R Nutrient Stewardship – Saskatchewan

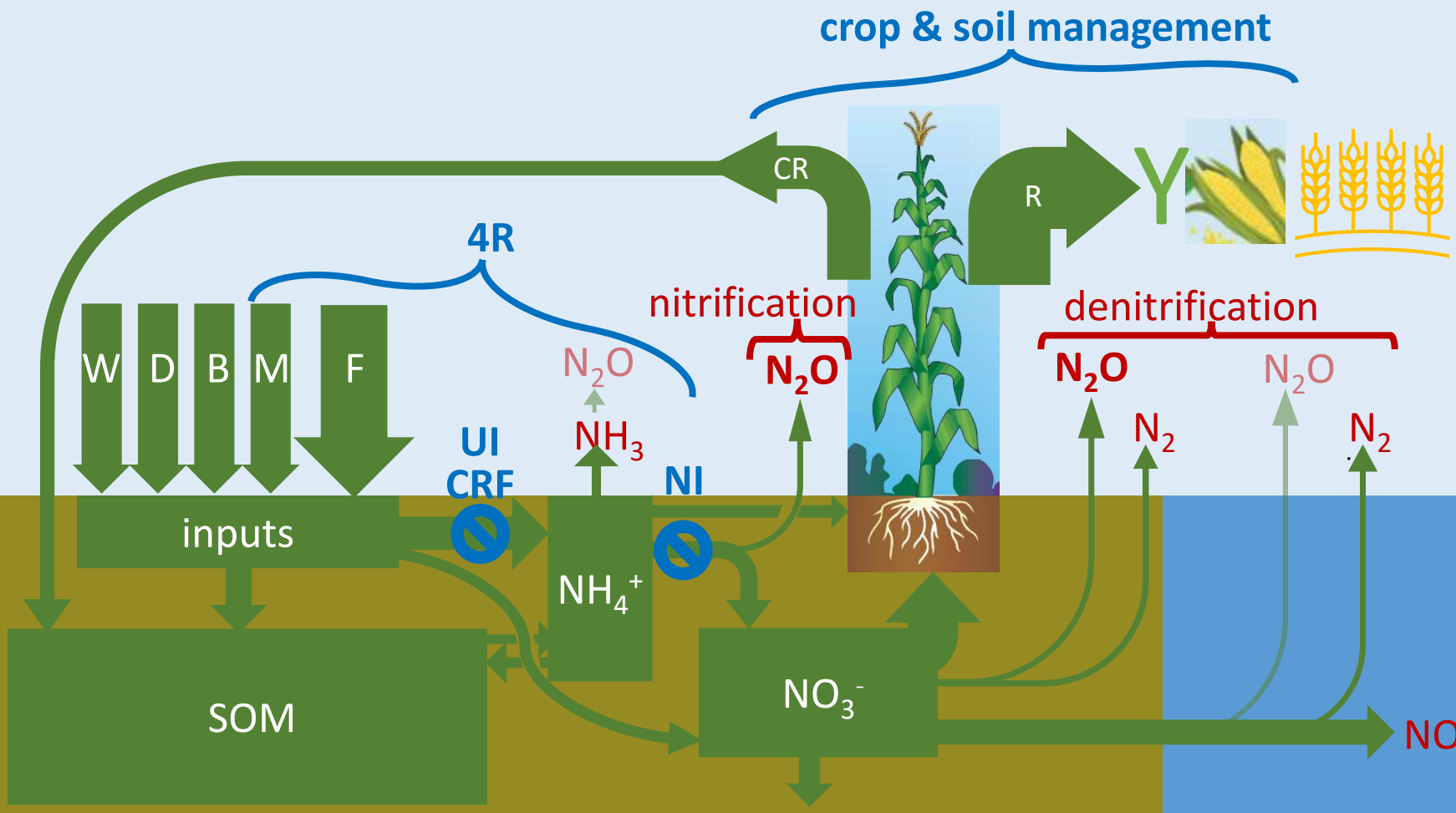
4R Nutrient Stewardship – Reducing Green House Gas

NERP

NERP Lite

Updates and changes to come in 2026

Responsible Plant Nutrition: ↑NUE & ↓N_2O



Relative changes due to 4R Practices – Global

Practice	N_2O emission, % decrease	Crop yield, % increase
Fertilizer rate	9	-4
Fertilizer timing	0	4
Fertilizer placement	14	5
EEF source	35	6
Cover cropping	5	12
Biochar	40	13

Young, Ros, and de Vries. 2021. Impacts of agronomic measures on crop, soil, and environmental indicators: A review and synthesis of meta-analysis. Agriculture, Ecosystems & Environment 319: 107551.

Fan, D. et al. 2022. Global Change Biology
Grados, D. et al. 2022. Environmental Research Letters
Thapa, R. et al. 2016. Soil Science Society of America Journal
Yao, Z. et al. 2024. Global Change Biology

Specific Outcomes of 4R EEF Source Practices

Practice	N_2O	NH_3	Yield
Fertilizer source ("EEF"):			
Nitrification Inhibitor, NI	-50	+20	+2
Urease Inhibitor, UI	-10	-50	+6
UI&NI	-30	-38	+3
Controlled-Release, CRF	-19 to -33	-65	-3

EEF – environmental benefit bigger than agronomic

N_2O Emission Reduction Factors, %
specific to Canada

EEF	HOLOS v 4.0	Sokolov et al, 2026
UI	+4	+9
CRF	-14	-6
NI	-28	-23
UI+NI	**-31**	**-15**

Holos Version 4.0 Algorithm Documentation, Table 13
[Courtesy of Samantha Earl-Goulet, CanN_2ONet]

Sokolov, V.K., D.E. Pelster, A. Khorsandi, B.C. Liang, and H. Asgedom. 2026. Meta-Analysis: Effect of Improved Nitrogen Management Practices on Nitrous Oxide Emissions in Canadian Studies. Can. J. Soil. Sci. doi: 10.1139/cjss-2025-0036.

If 4R practices can be reported – specific to the ecodistrict and cropping system – credits can be recognized and rewarded.

FERTILIZER CANADA

Our Focus | About | Membership | Resources | News & Events | Contact | FR

OUR FOCUS > STEWARDSHIP

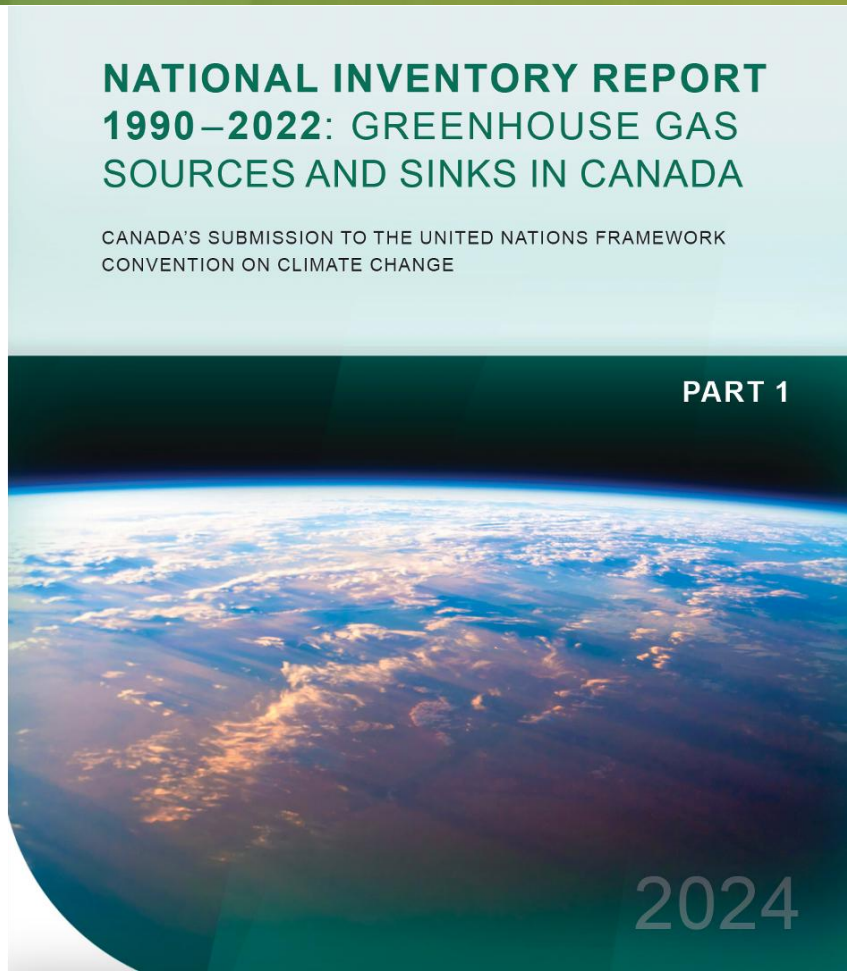
Fertilizer Use in Canada

4R Nutrient Stewardship Grower Adoption

Recognizing 4R practices

- Regulatory reporting of fertilizer shipments to agricultural markets
- Census – amounts spent on fertilizer and lime
- **Fertilizer Use Survey – industry supported**

https://fertilizercanada.ca/our-focus/stewardship/fertilizer-use-survey/



Stratus AG RESEARCH

Real Story. Better Decisions.

4R FERTILIZER USE SURVEY

4R Fertilizer Use Survey Committee members:

Fertilizer Canada

Ontario Agri Business Association

Grain Farmers of Ontario

canola council of Canada

Réseau végétal Québec

CCGA Canadian Canola Growers Association

Pulse Canada

University of Saskatchewan

Manitoba

Alberta Grains

Christian Farmers Federation of Ontario CFFO

University of Manitoba

Sask Wheat Development Commission

Manitoba Crop Alliance

OFA Ontario Federation of Agriculture

University of Guelph

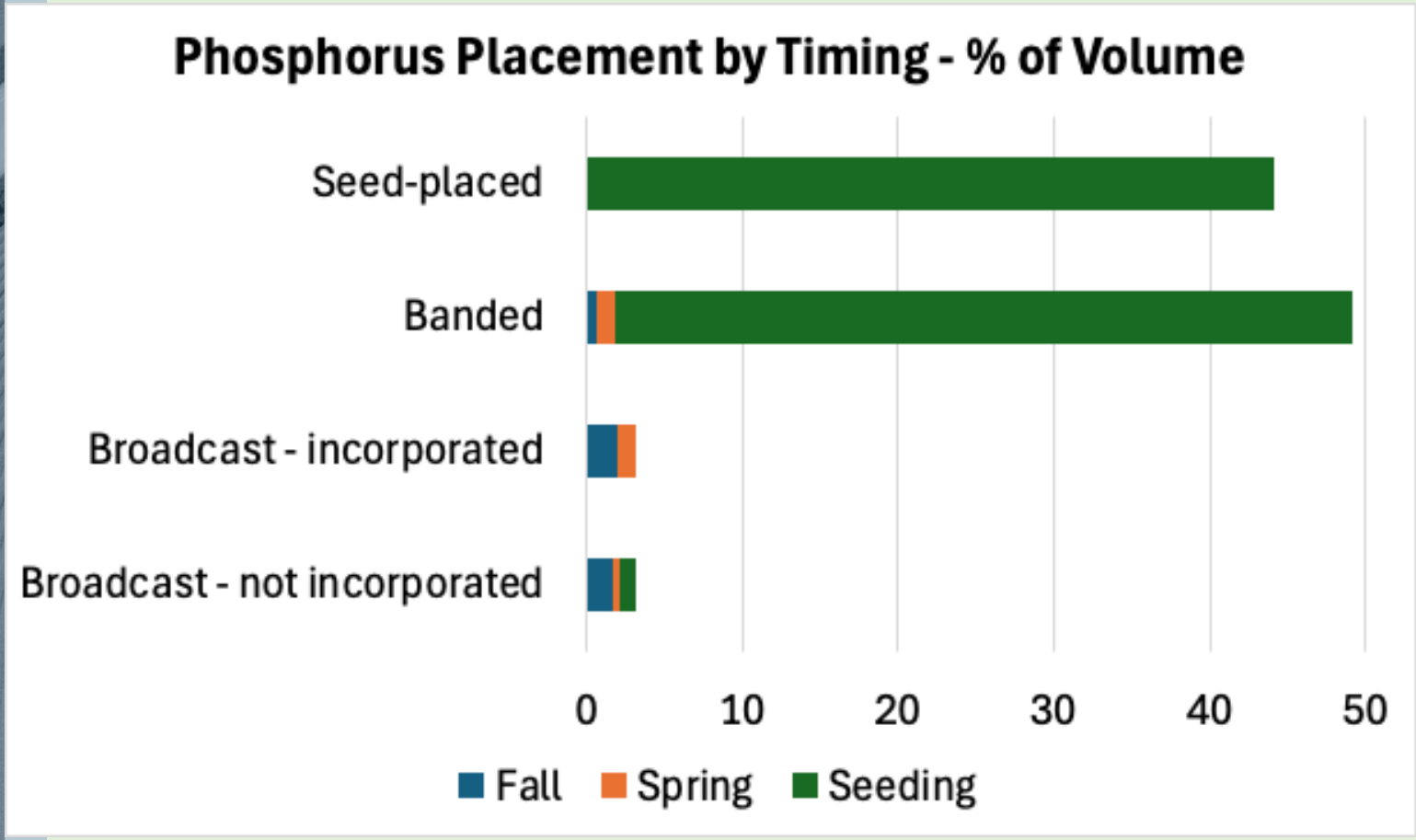
FERTILIZER USE

Western Canada
CDN 2024

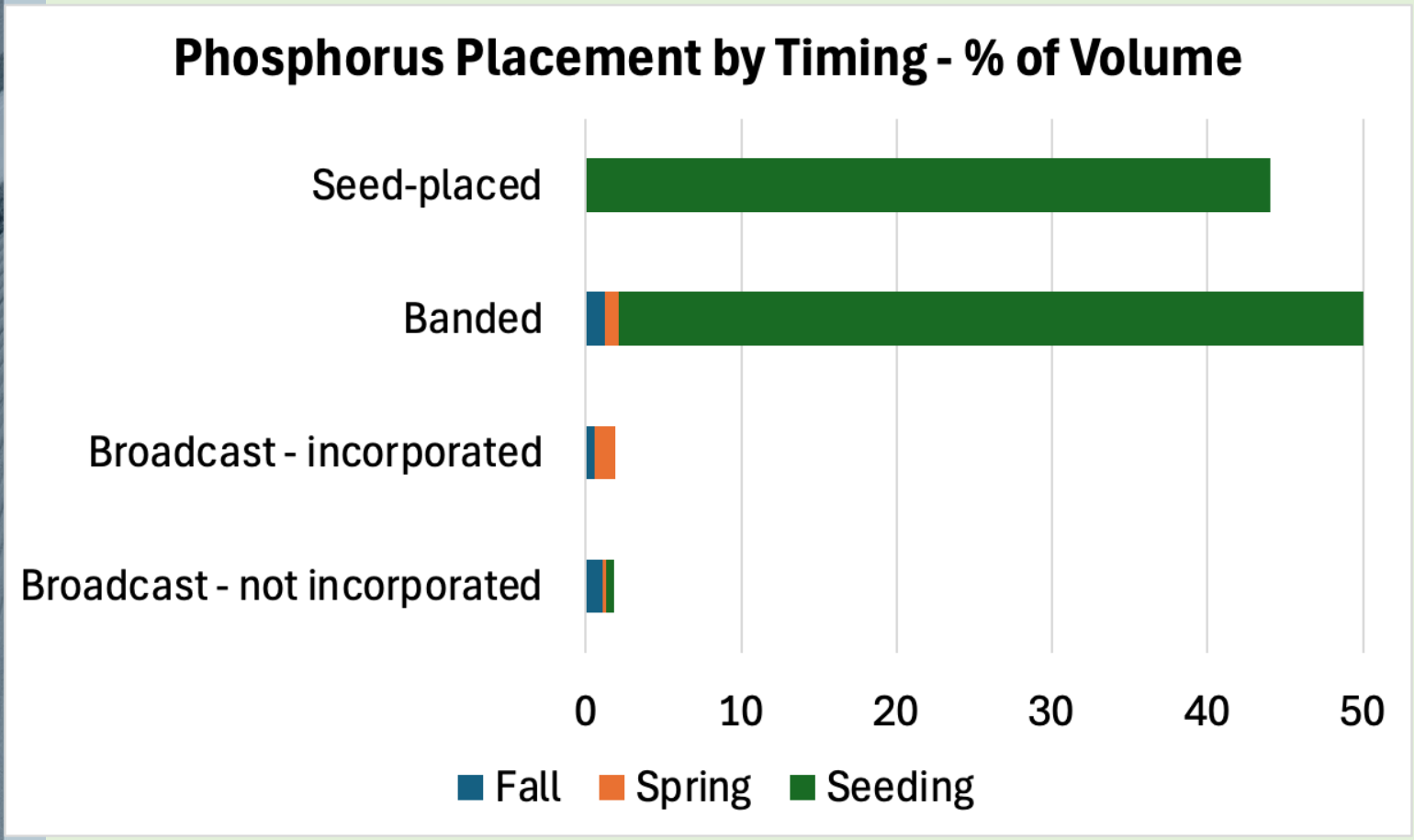
Stratus
AG RESEARCH

Navigation

Canola: fertilizer P is applied subsurface at seeding.



Wheat: fertilizer P is applied subsurface at seeding.



More growers are working with a 4R Designated Agronomist.

FERTILIZER USE

Western Canada
CDN 2024

General Fertilizer Practices

4R Summary ▶

Stratus AG RESEARCH

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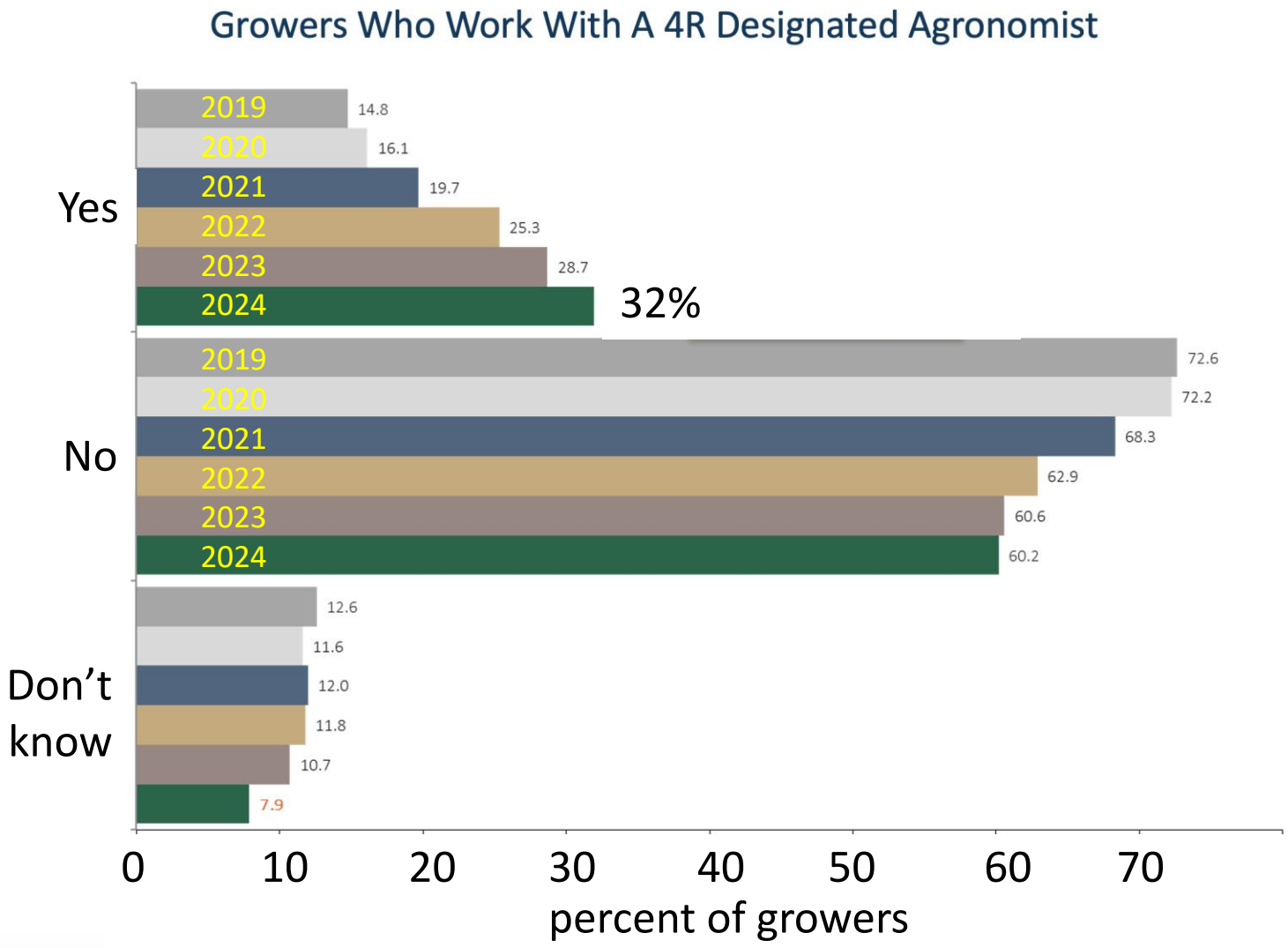
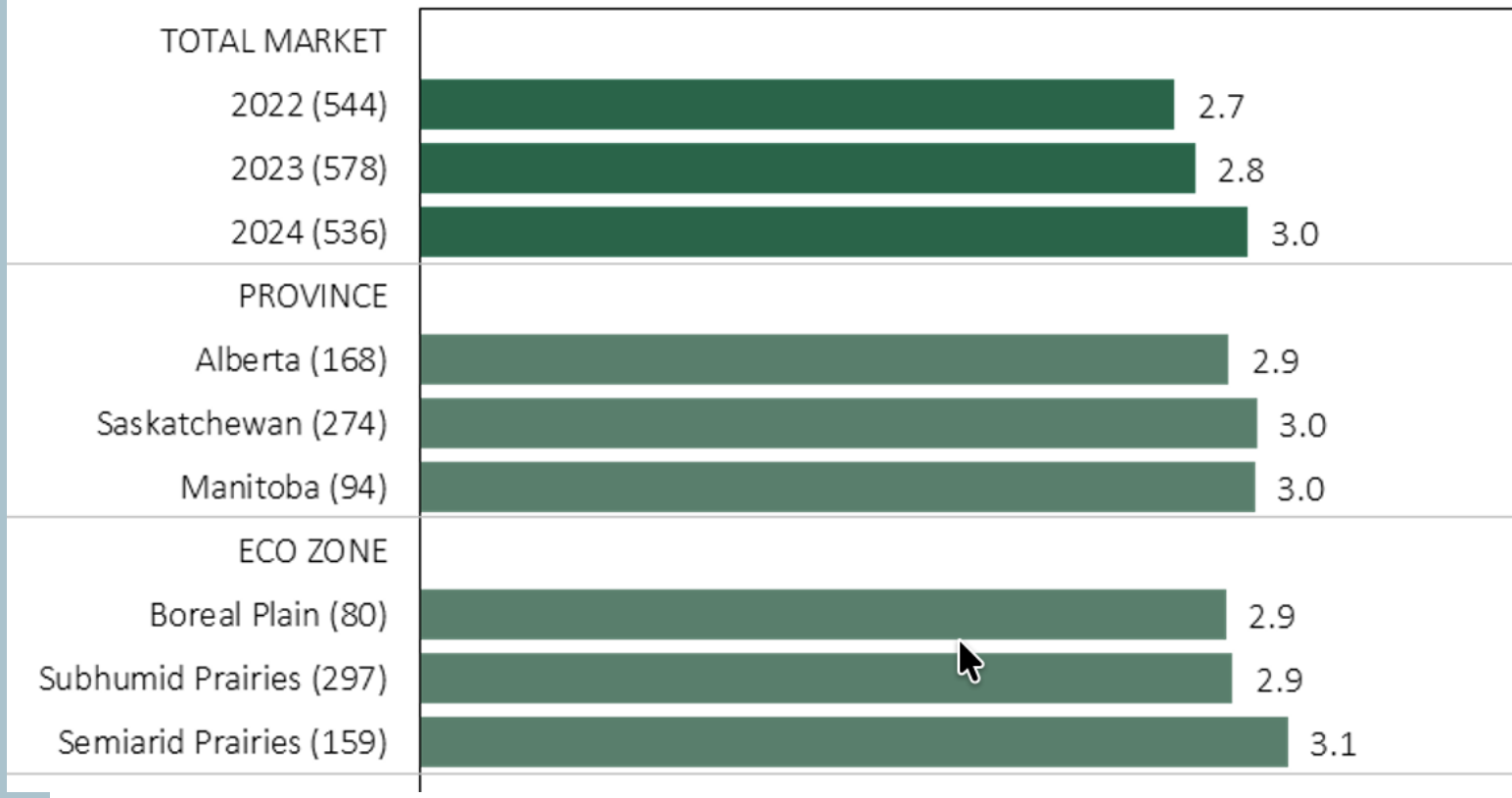


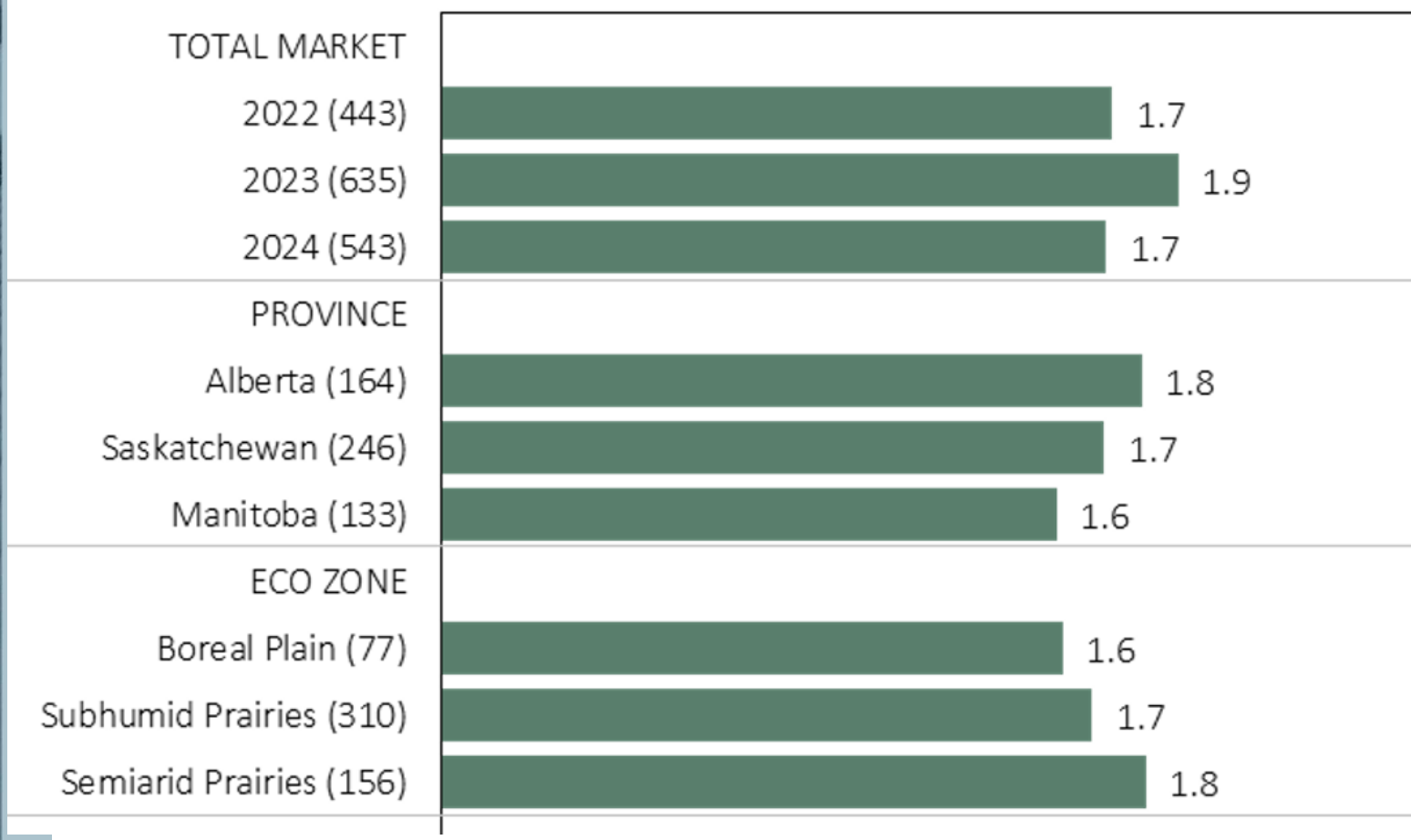
Nitrogen Use "Footprint" for Canola increased slightly 2022 - 2024



Pounds of fertilizer N per bushel of yield

(footprint = lb/bu; efficiency = bu/lb)

Nitrogen Use "Footprint" for Spring Wheat declined in 2024



Pounds of fertilizer N per bushel of yield
(footprint = lb/bu; efficiency = bu/lb)

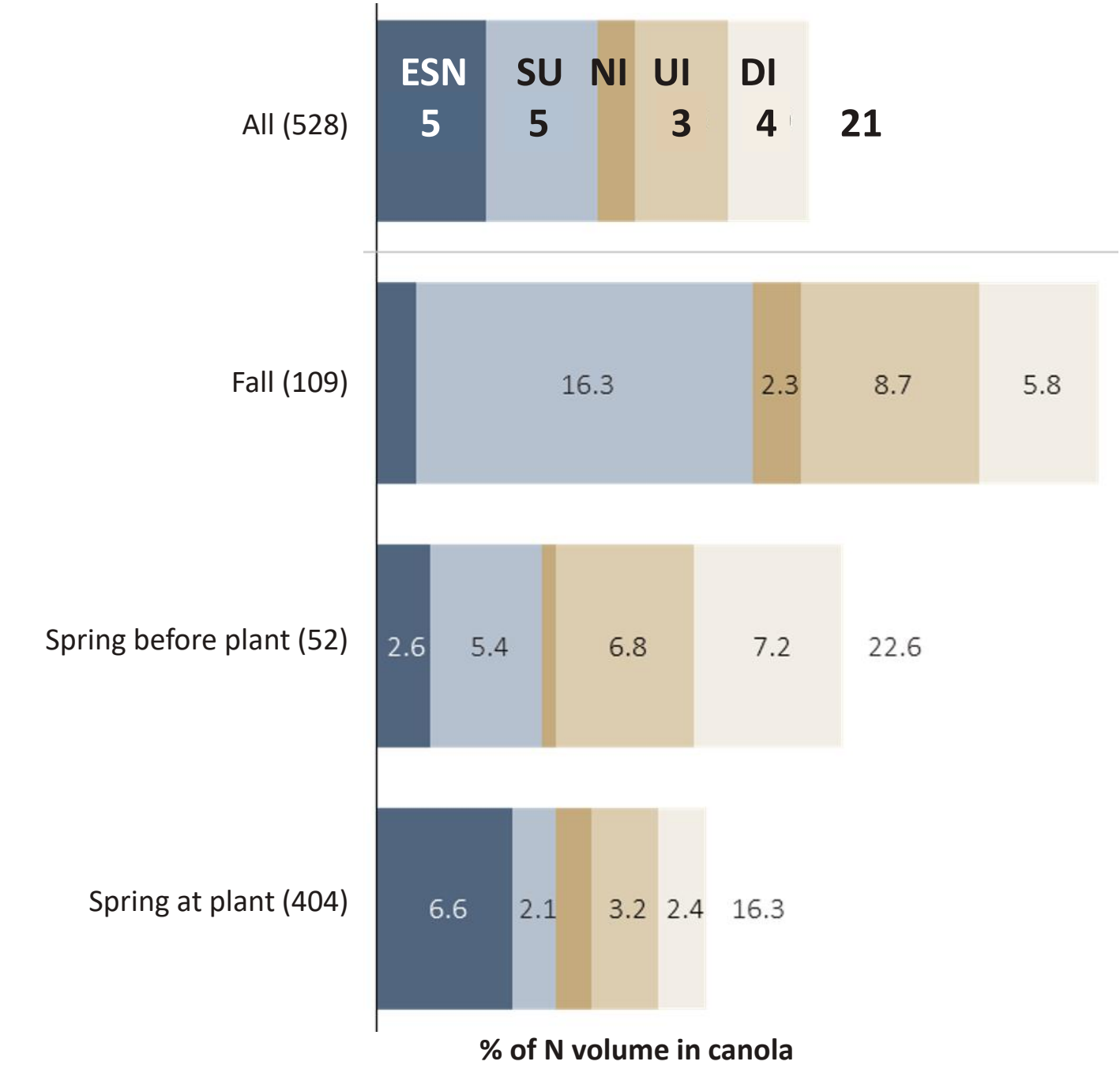
Stratus AG RESEARCH

FERTILIZER USE

Western Canada
CDN 2024

Canola

Use of EEFs in Canola – 21 % of Nitrogen Volume



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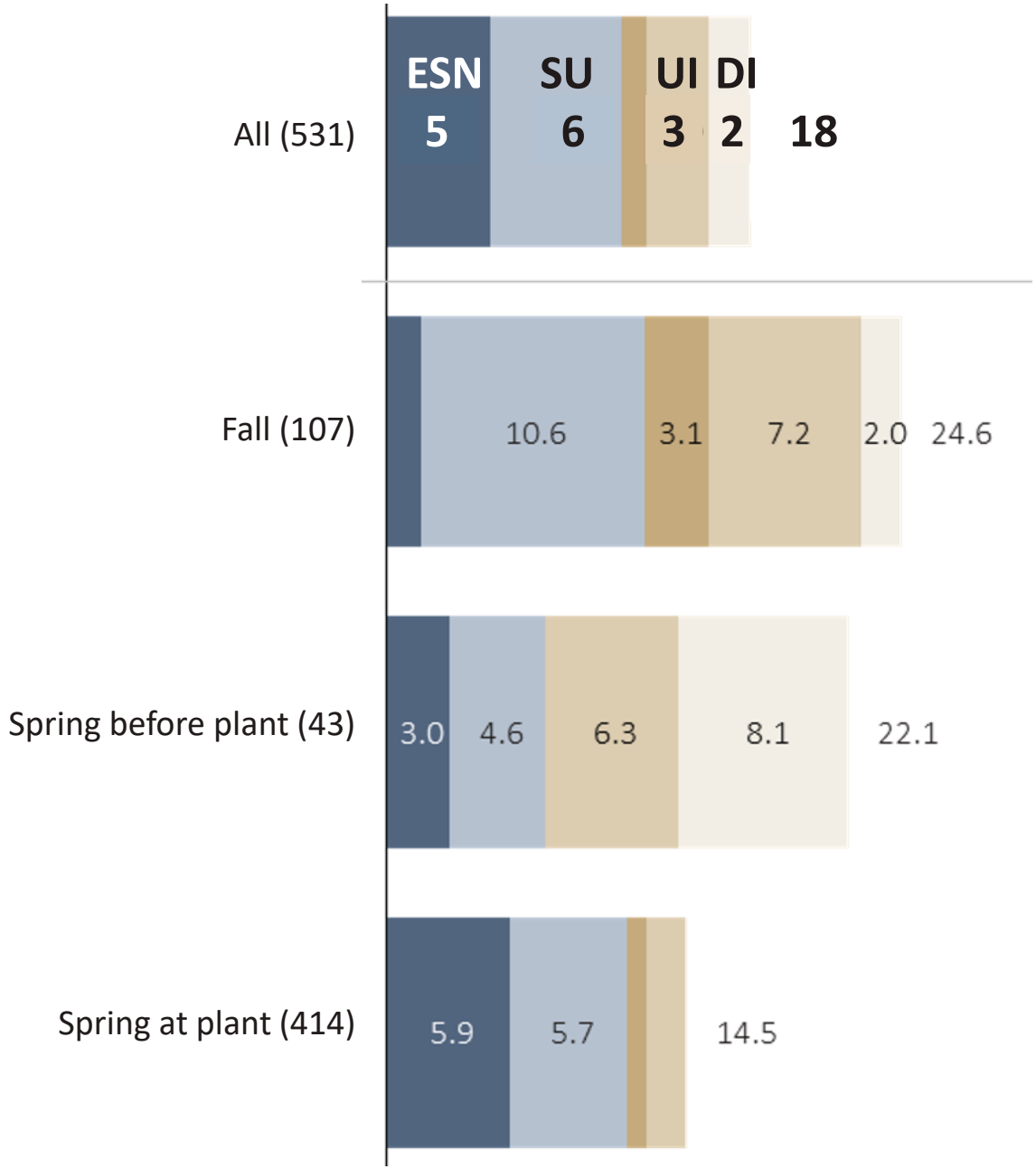
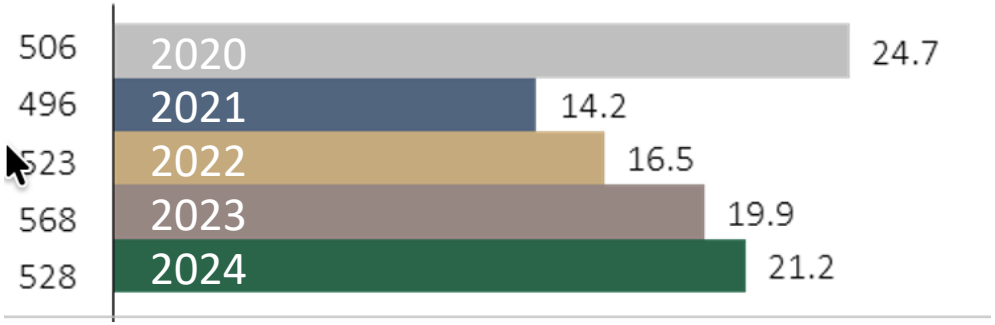
Use of EEFs in Wheat – 18% of Nitrogen Volume

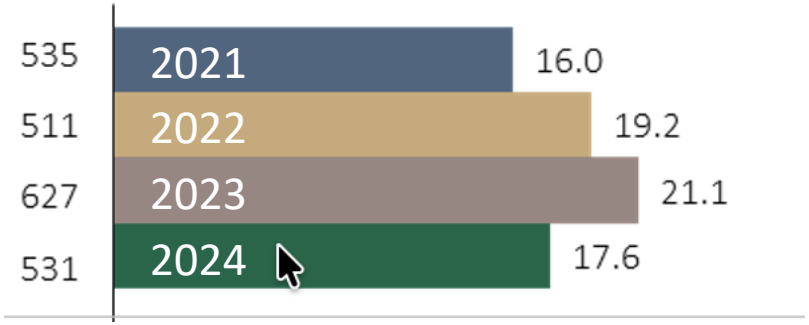


Trend in Use of EEFs
% of N Volume increased modestly

Canola



Wheat

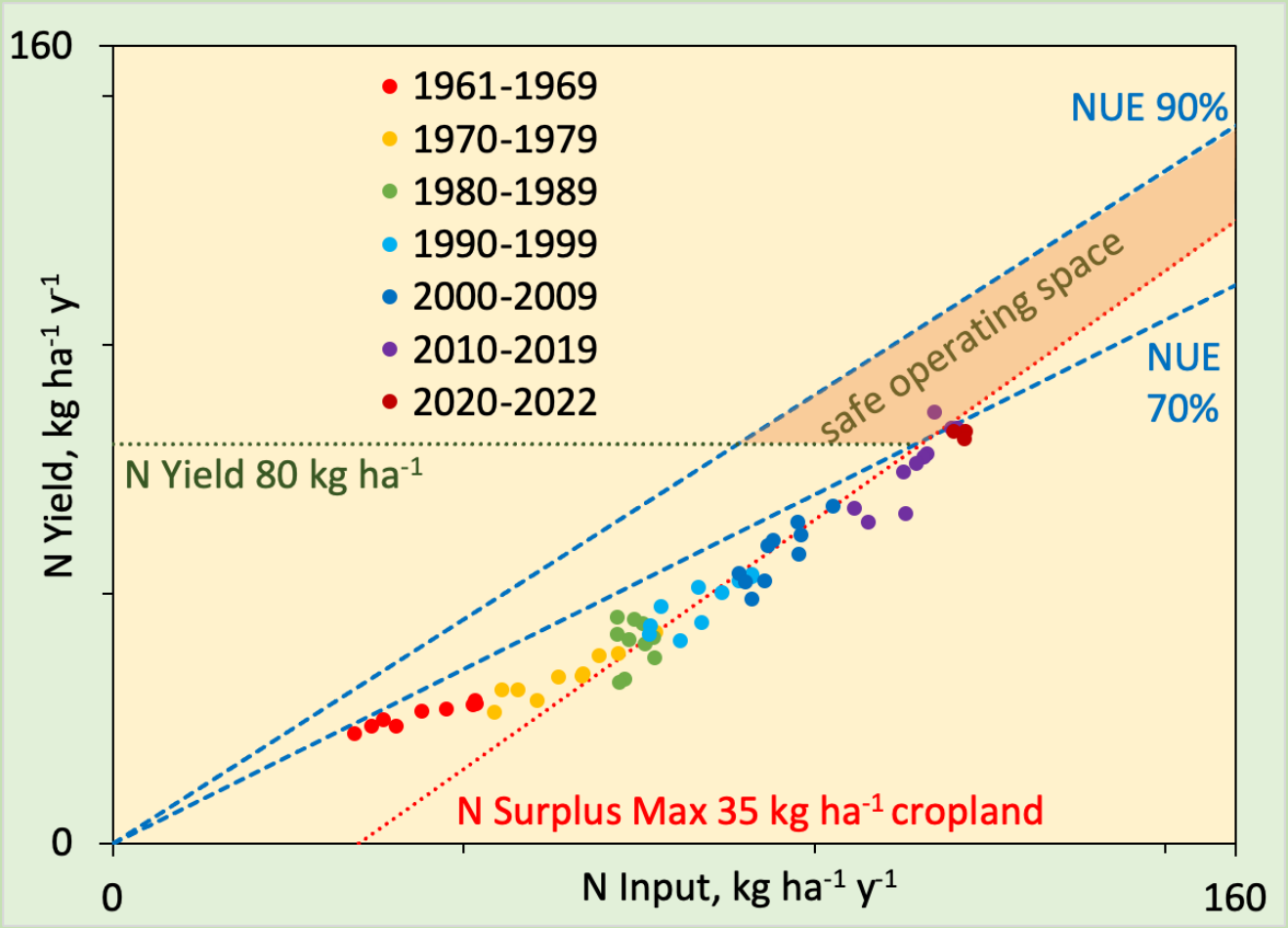


General Performance Outcomes

Nutrient Balances

Soil Test Summaries

NUE in North American cropland



NUE = Crop N yield / N inputs

N Inputs: Fertilizer + manure applied + biological fixation + atmospheric deposition

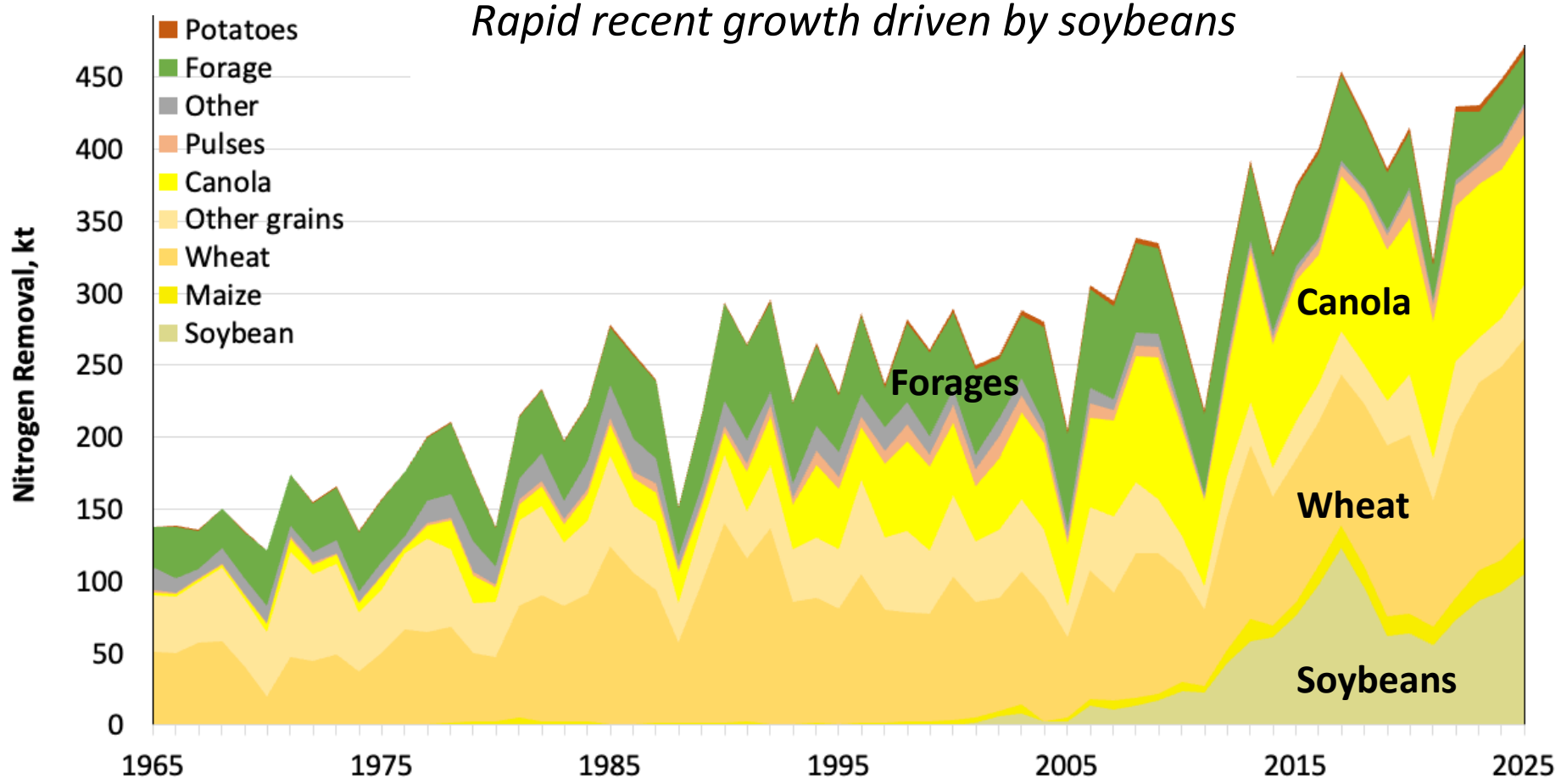
Data Sources:

FAOSTAT Crop Nutrient Budgets

N Max: Regional Planetary Boundary – Schulte-Uebbing et al., 2022 Nature 610:507-512.

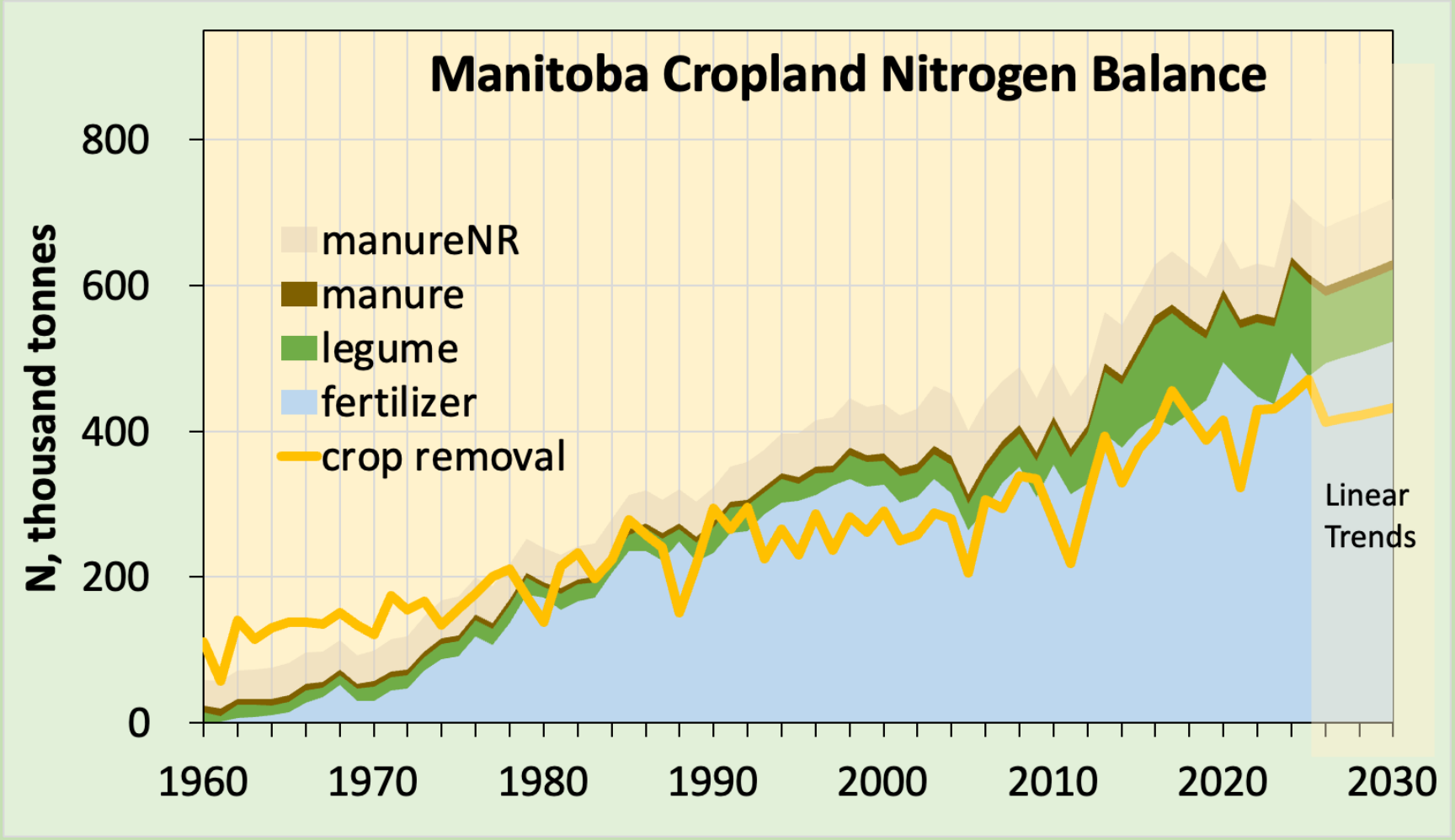
Manitoba Crop Nitrogen Removal

Rapid recent growth driven by soybeans



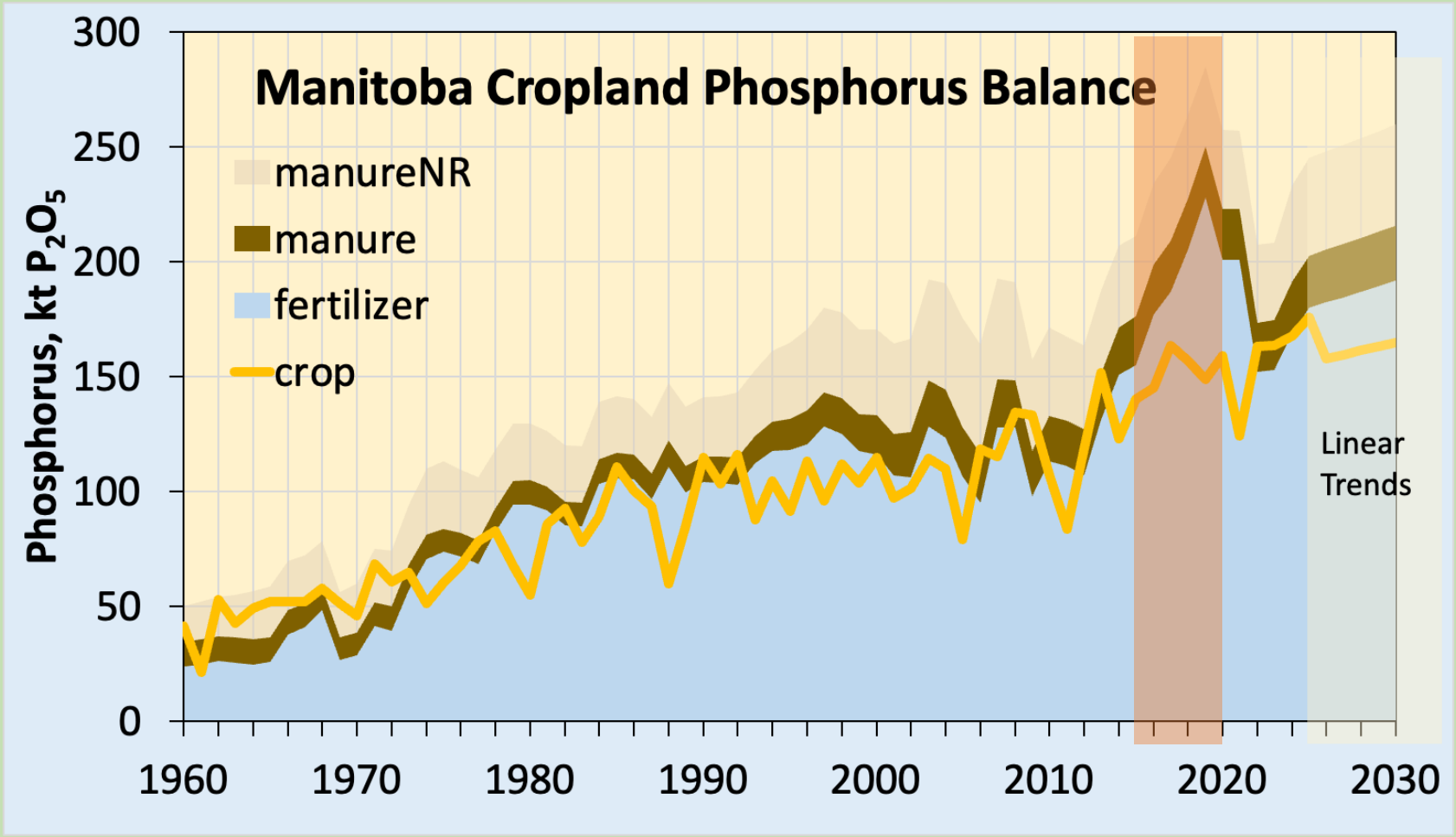
Crop removal includes all field crops and harvested forage.

Data sources: Statistics Canada crop production.



Crop removal includes all crops and harvested forage.

Data sources: Statistics Canada fertilizer shipments, livestock inventories, crop production.



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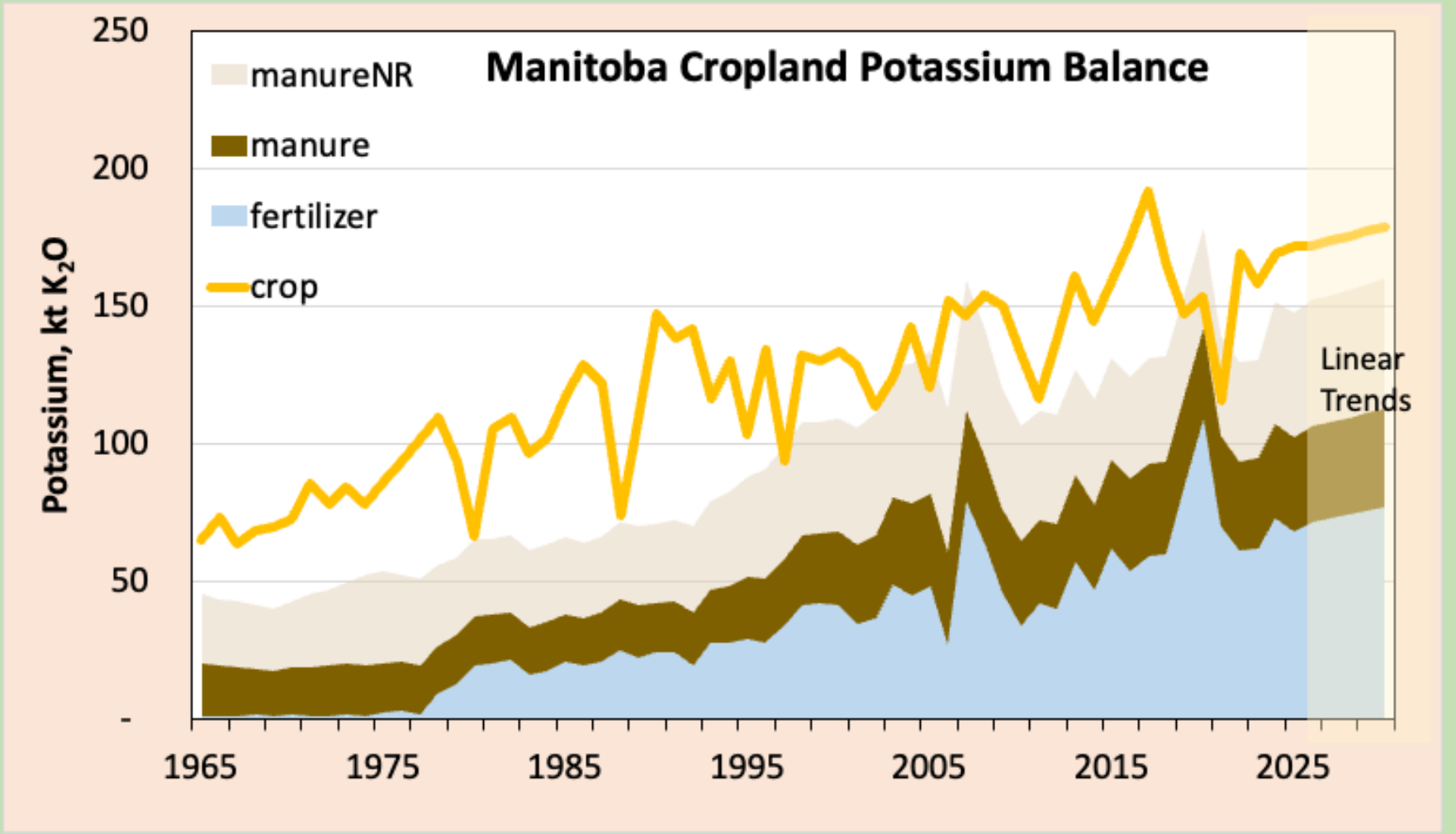

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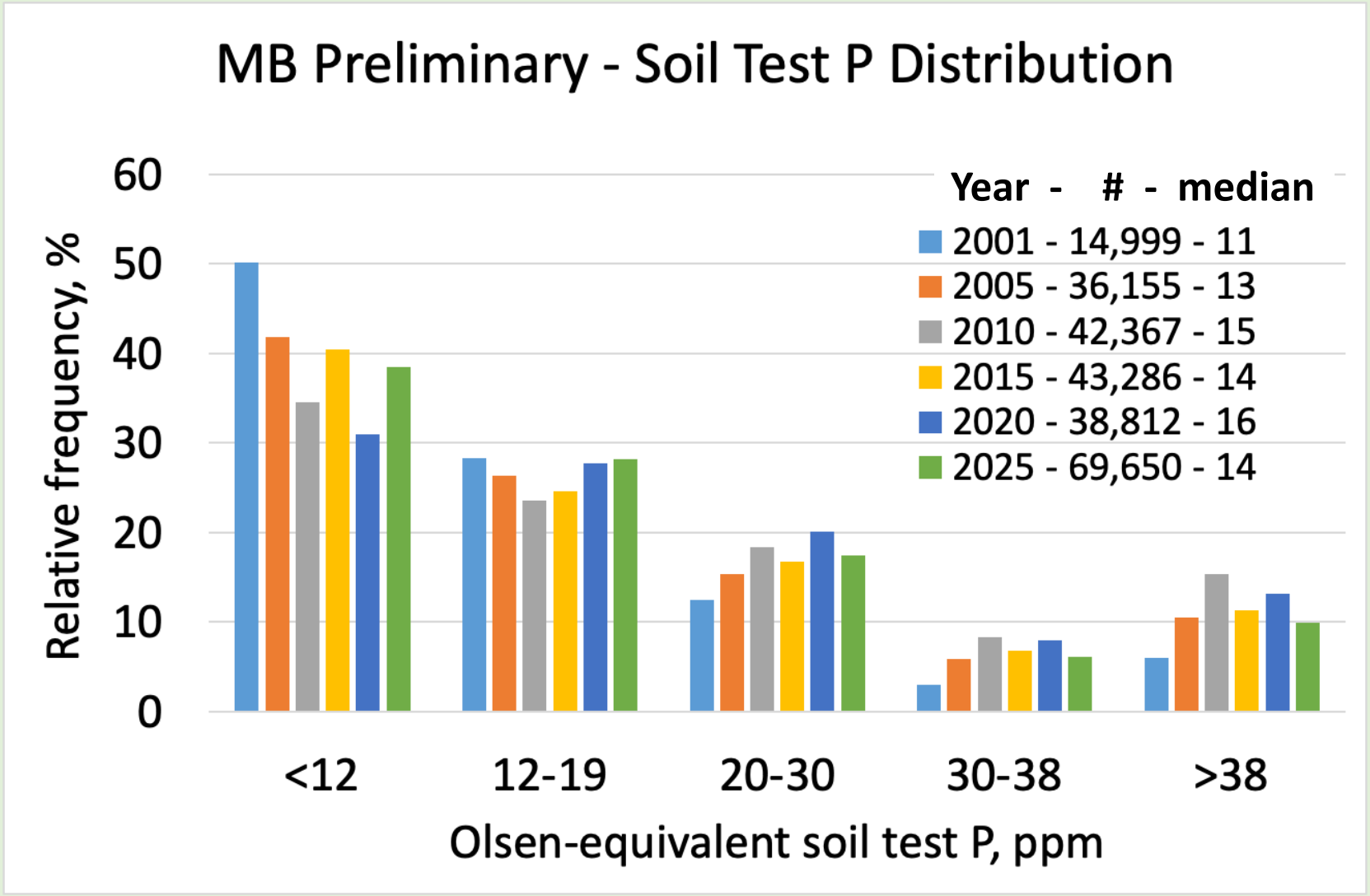
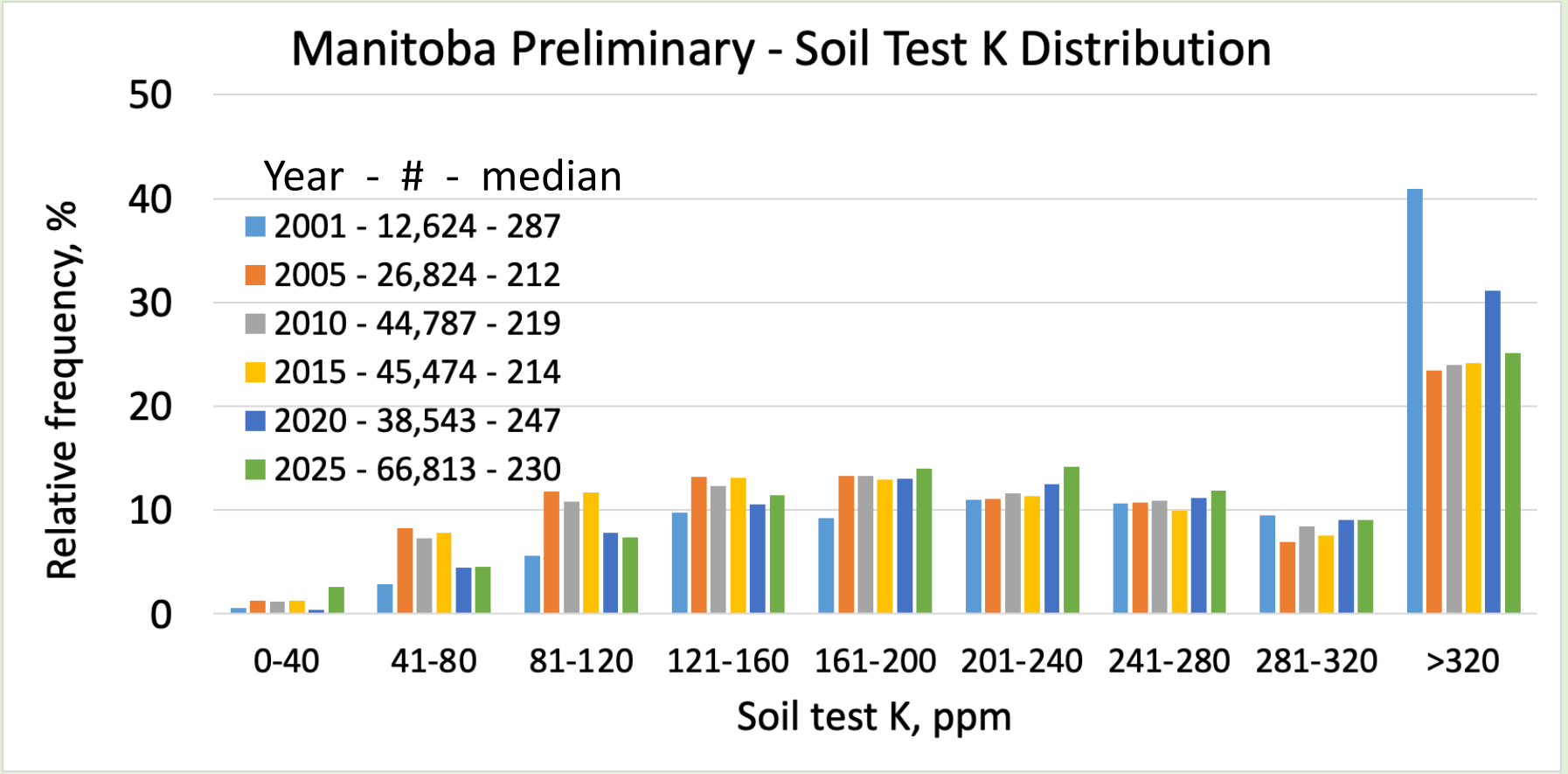


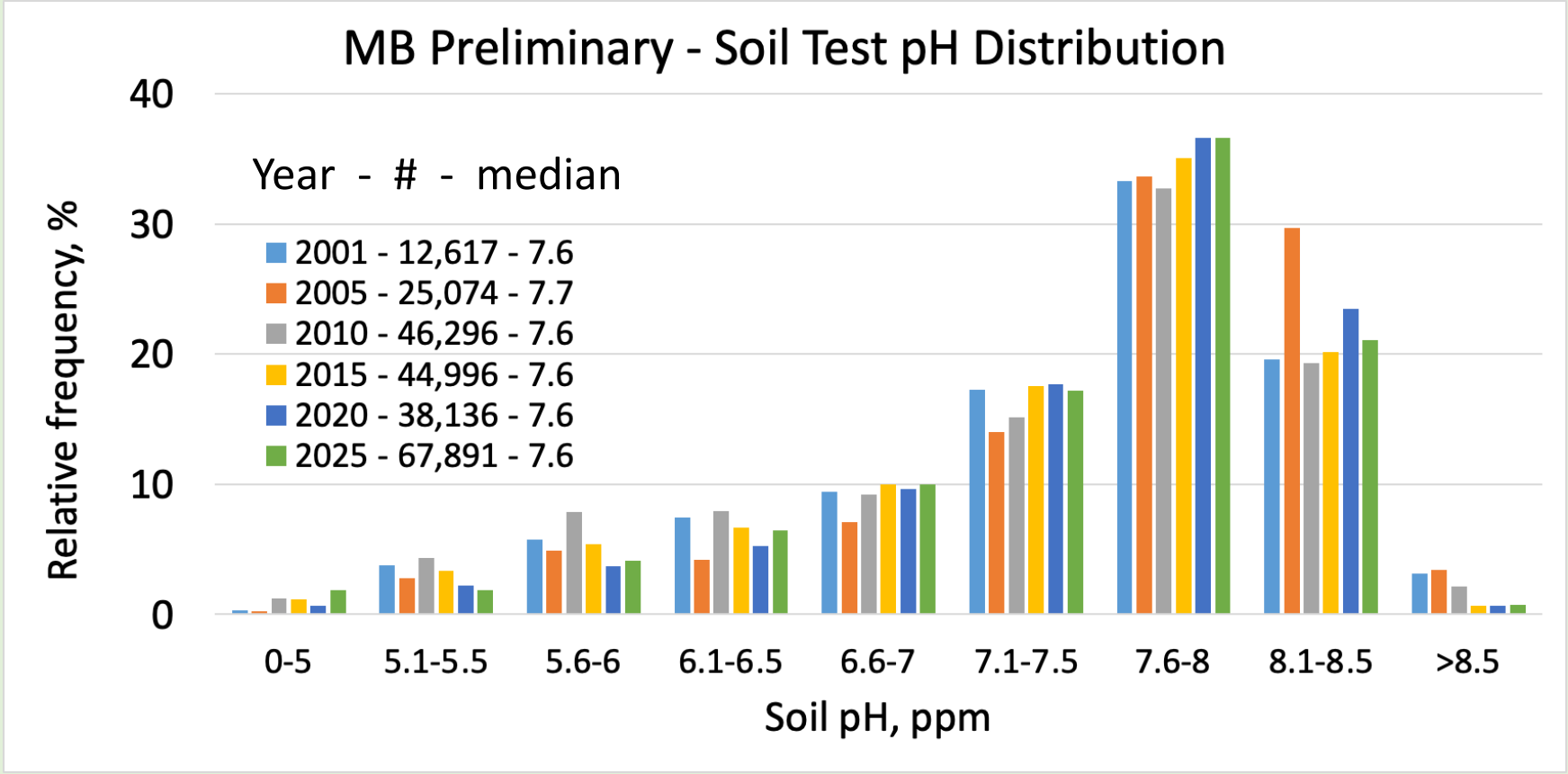
Soil test P increased from 2001 to 2020, but declined since.
38% below 12 ppm, 67% below 19 ppm.

THE FERTILIZER INSTITUTE sts soil test summary



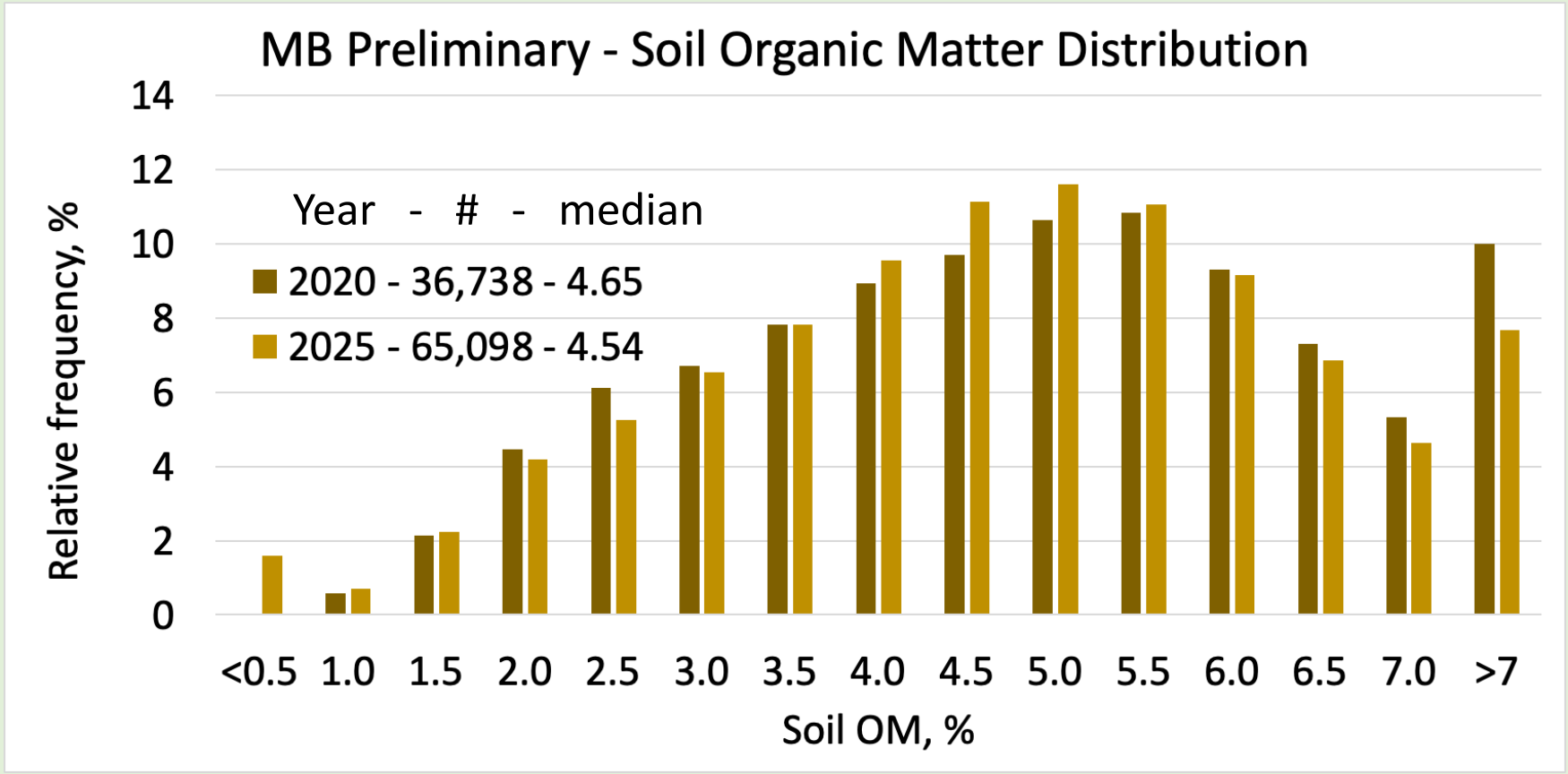
Soil test K increased from 2005 to 2020, but declined since.
14% below 120 ppm, 67% below 200 ppm.

THE FERTILIZER INSTITUTE sts soil test summary



No hint of any acidification trend.

THE FERTILIZER INSTITUTE sts soil test summary



Slight decline in soil organic matter since 2020.

THE FERTILIZER INSTITUTE sts soil test summary

General Performance Outcomes

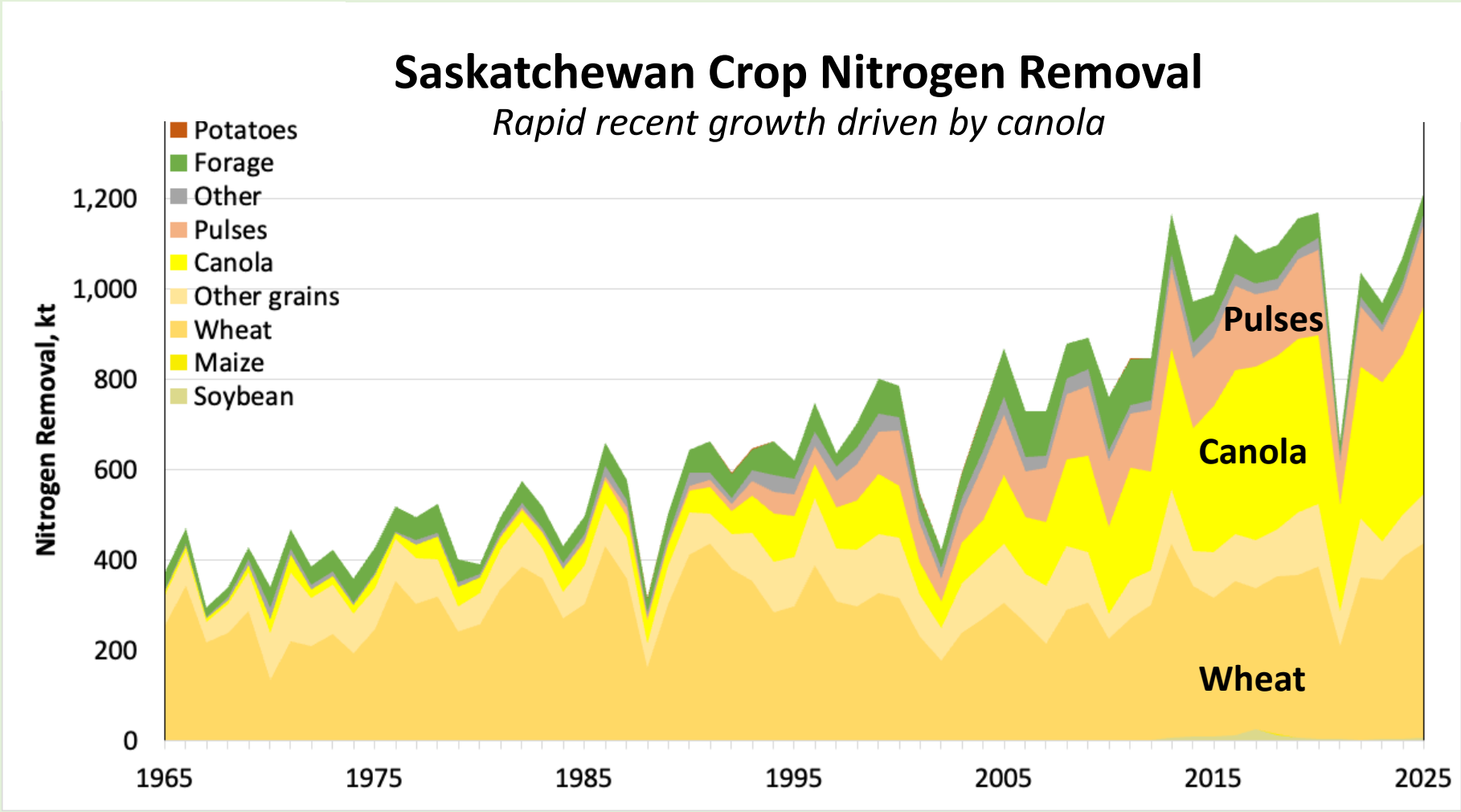
Nutrient Balances

N – surplus, P – balanced to surplus, K – deficit

Soil Test Summaries

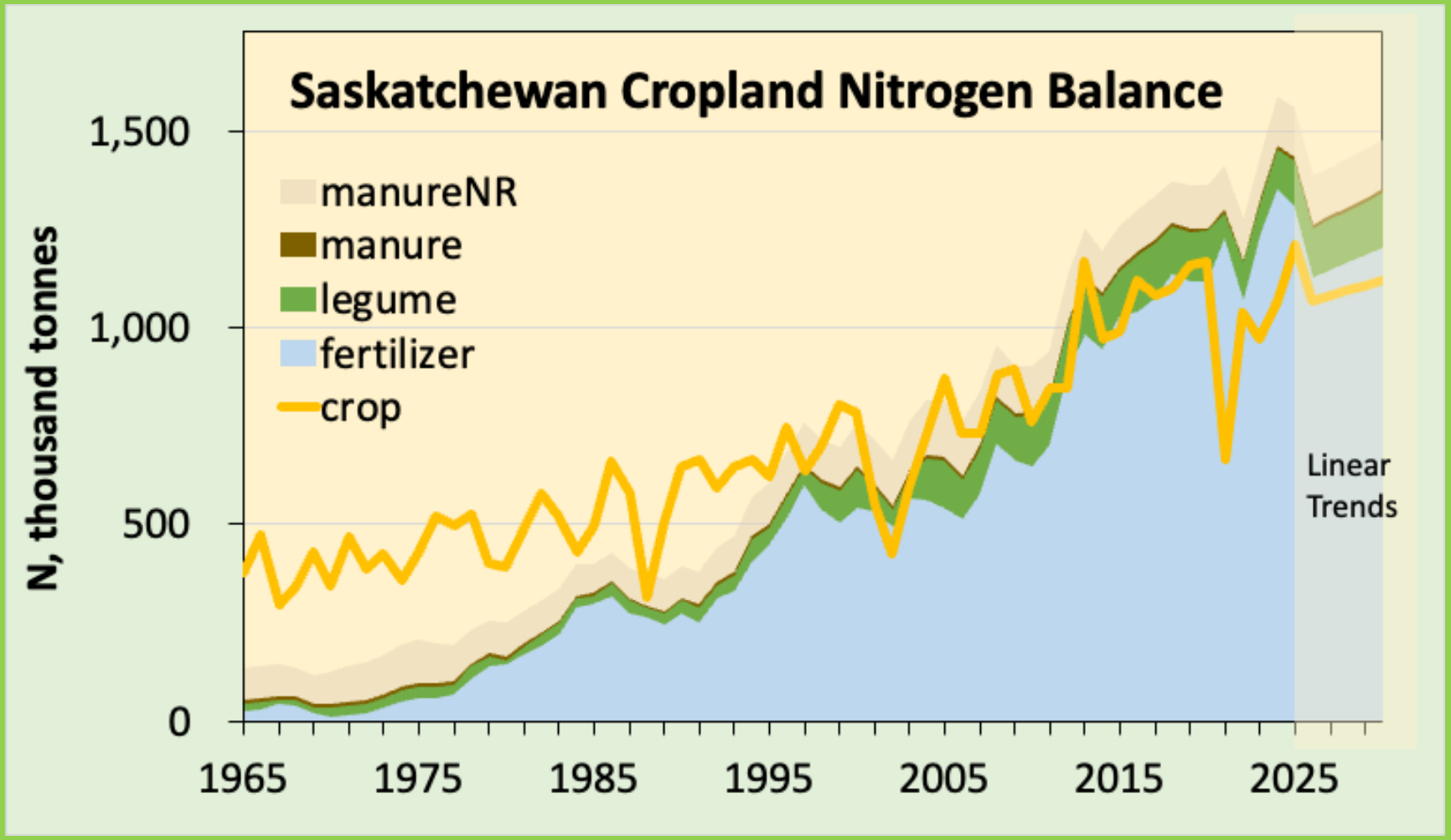
N – not acidifying, P & K – down a bit in past 5 years

SOM – slight decline?



Crop removal includes all field crops and harvested forage.

Data sources: Statistics Canada crop production.



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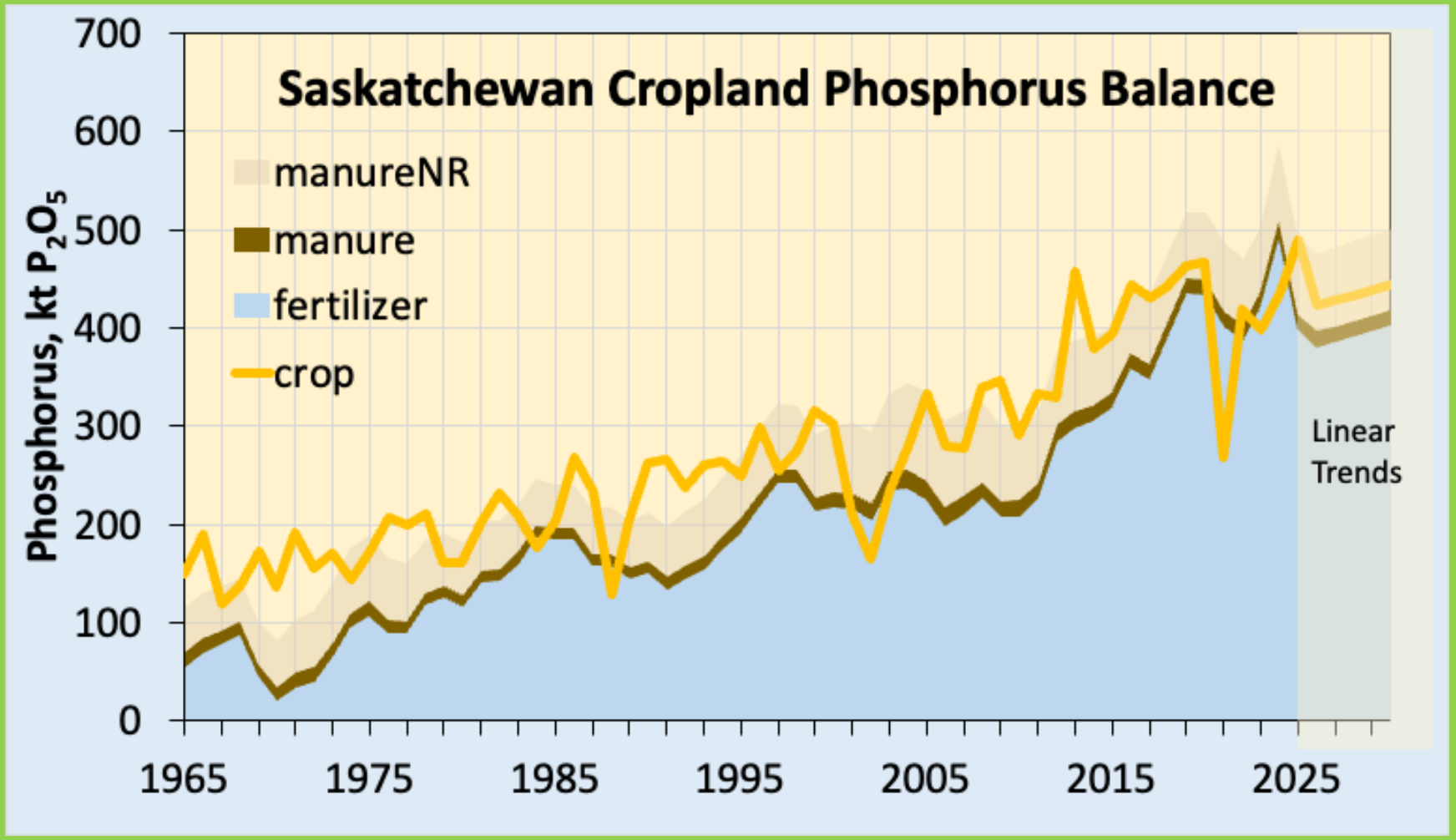

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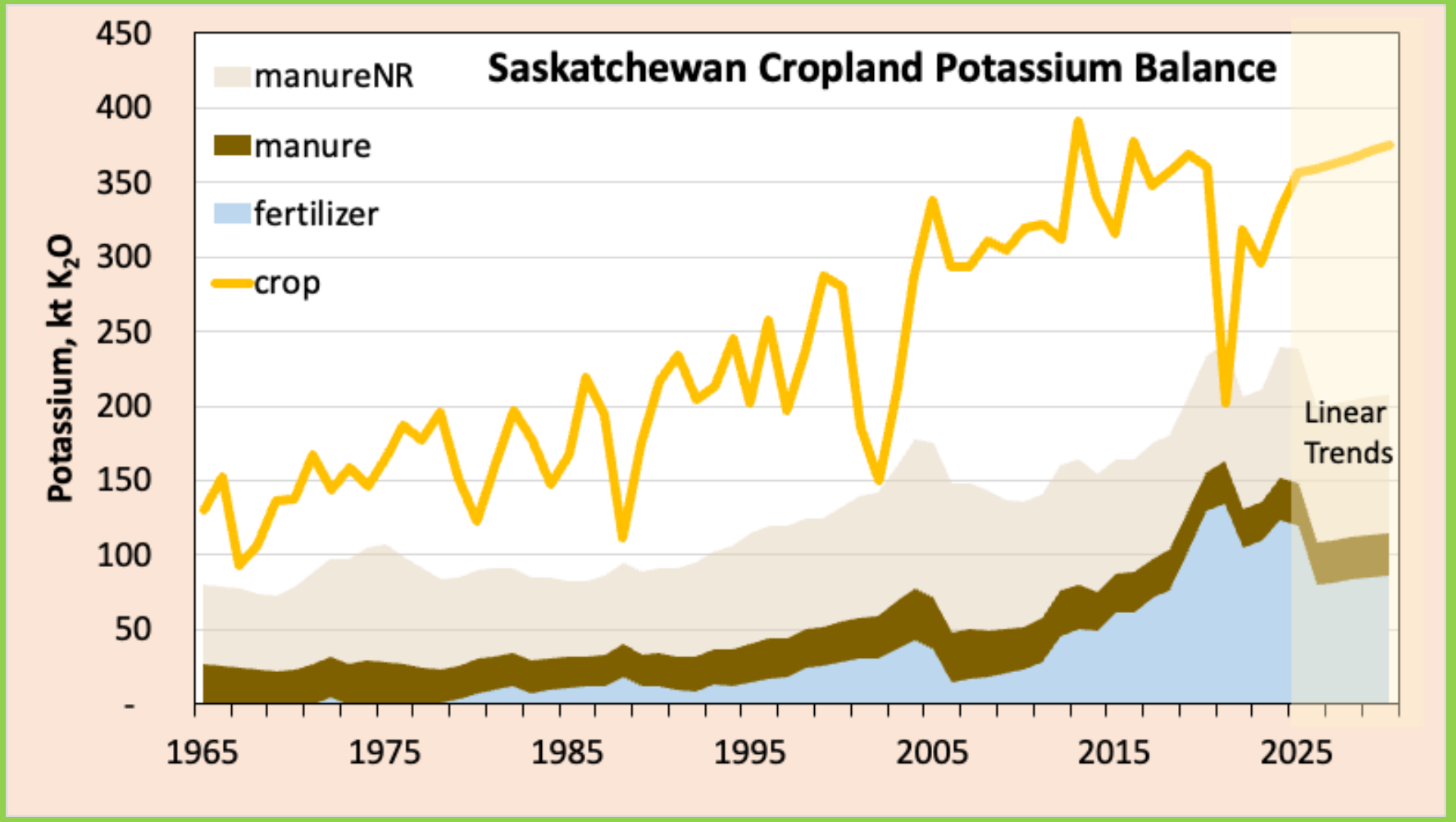
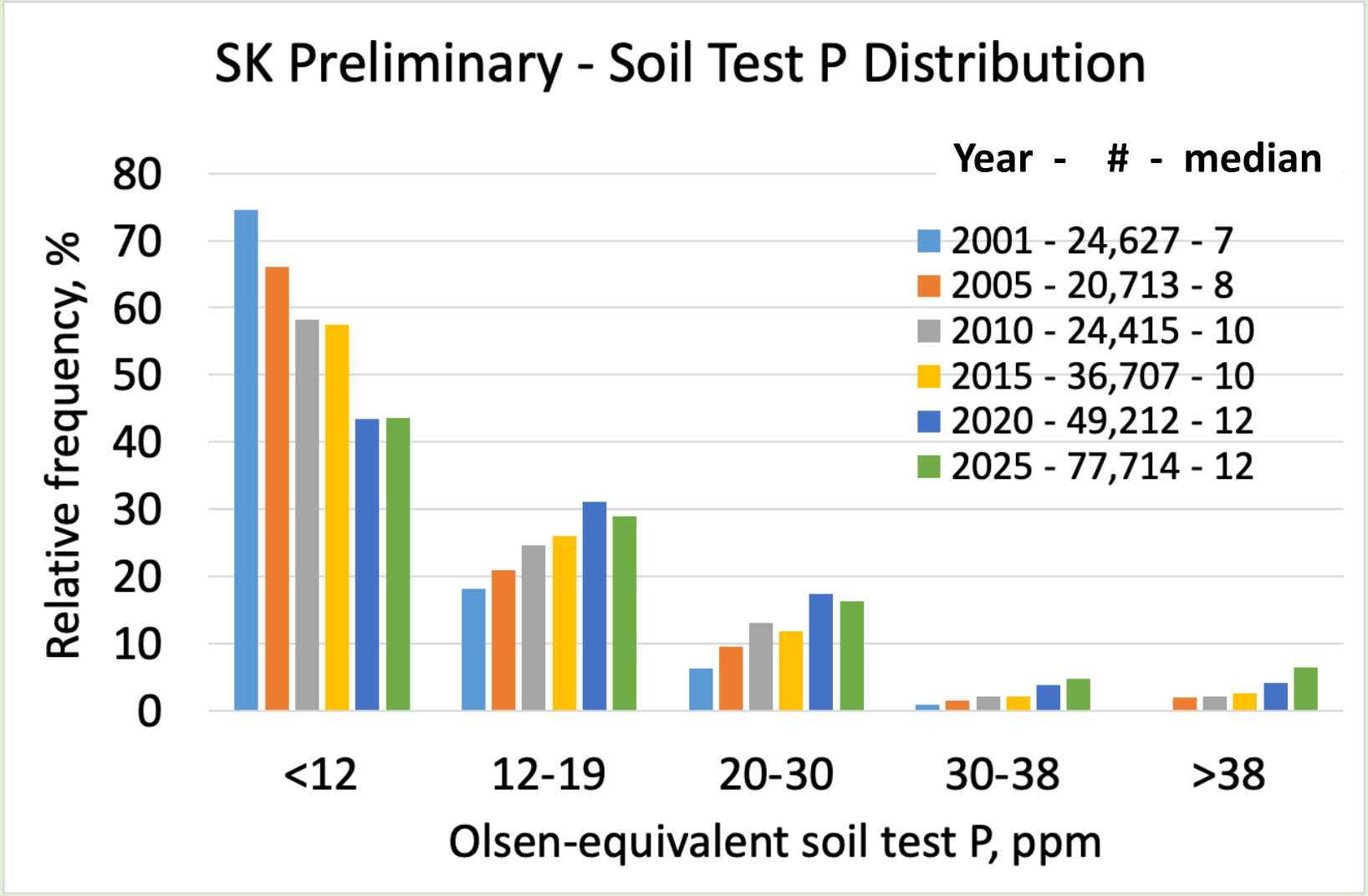


Crop removal includes all crops and harvested forage.

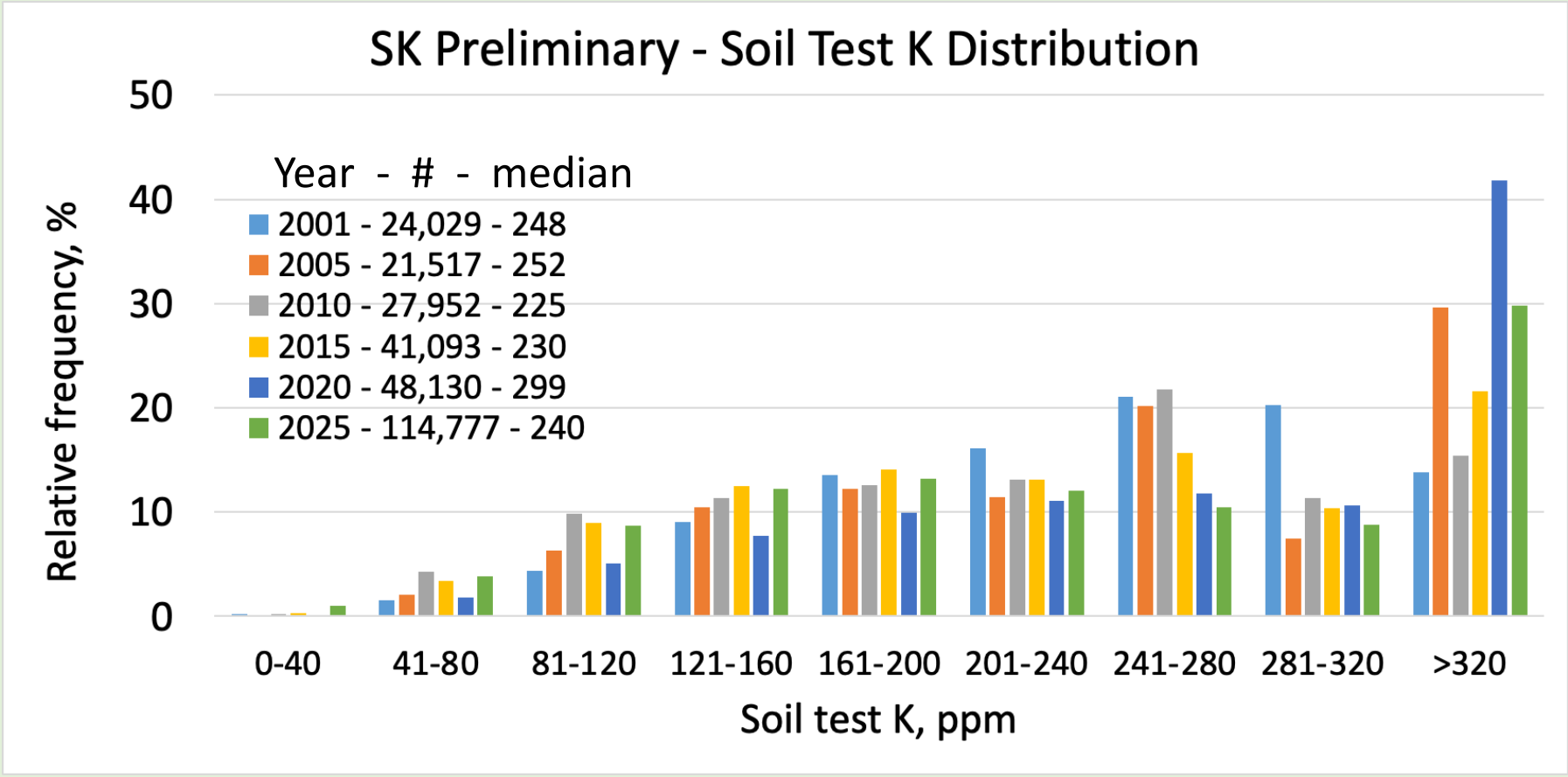
Data sources: Statistics Canada fertilizer shipments, livestock inventories, crop production.



Soil test P increased from 2001 to 2020, but plateaued since.

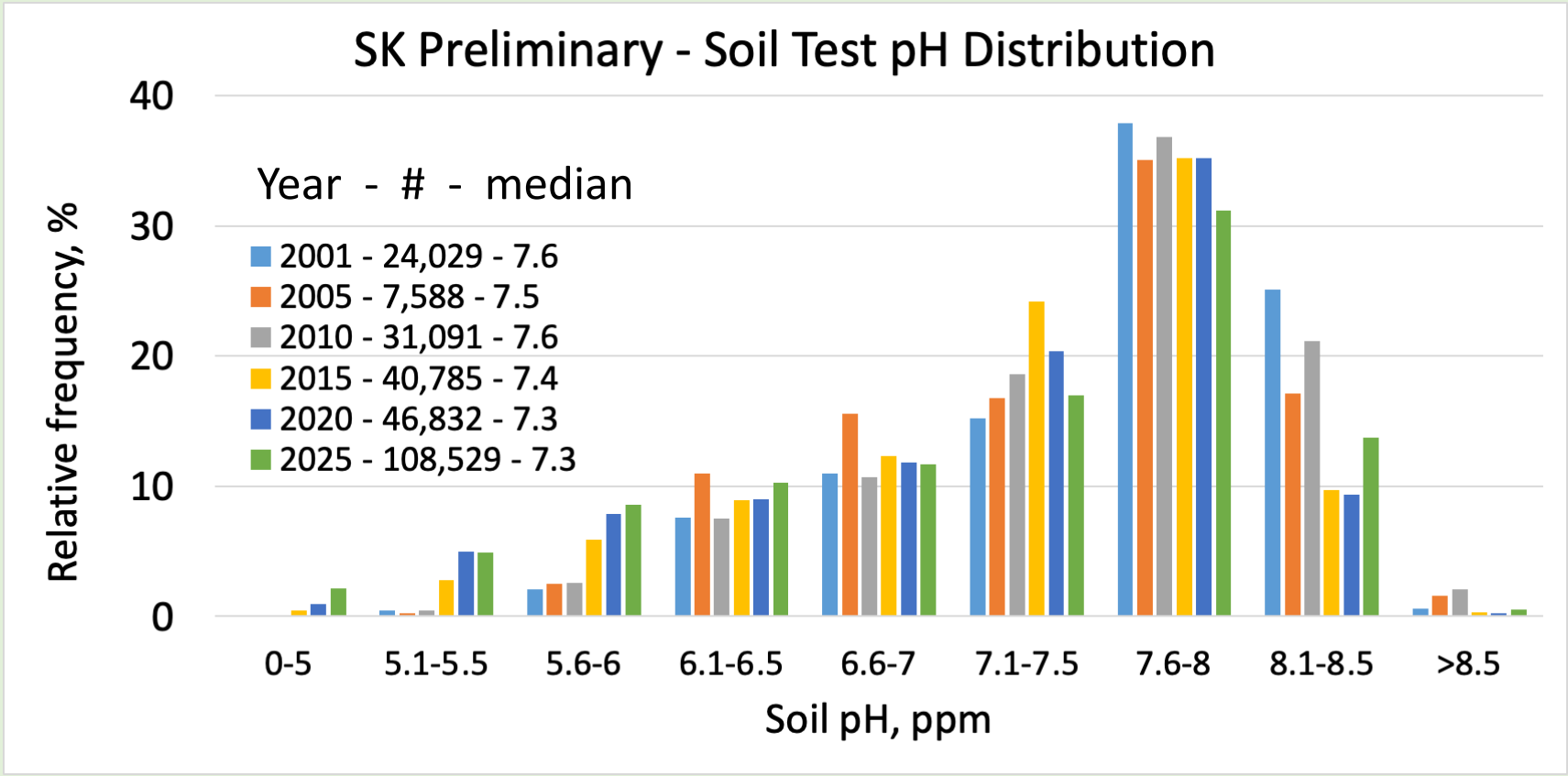
42% below 12 ppm, 71% below 19 ppm.

THE FERTILIZER INSTITUTE sts soil test summary



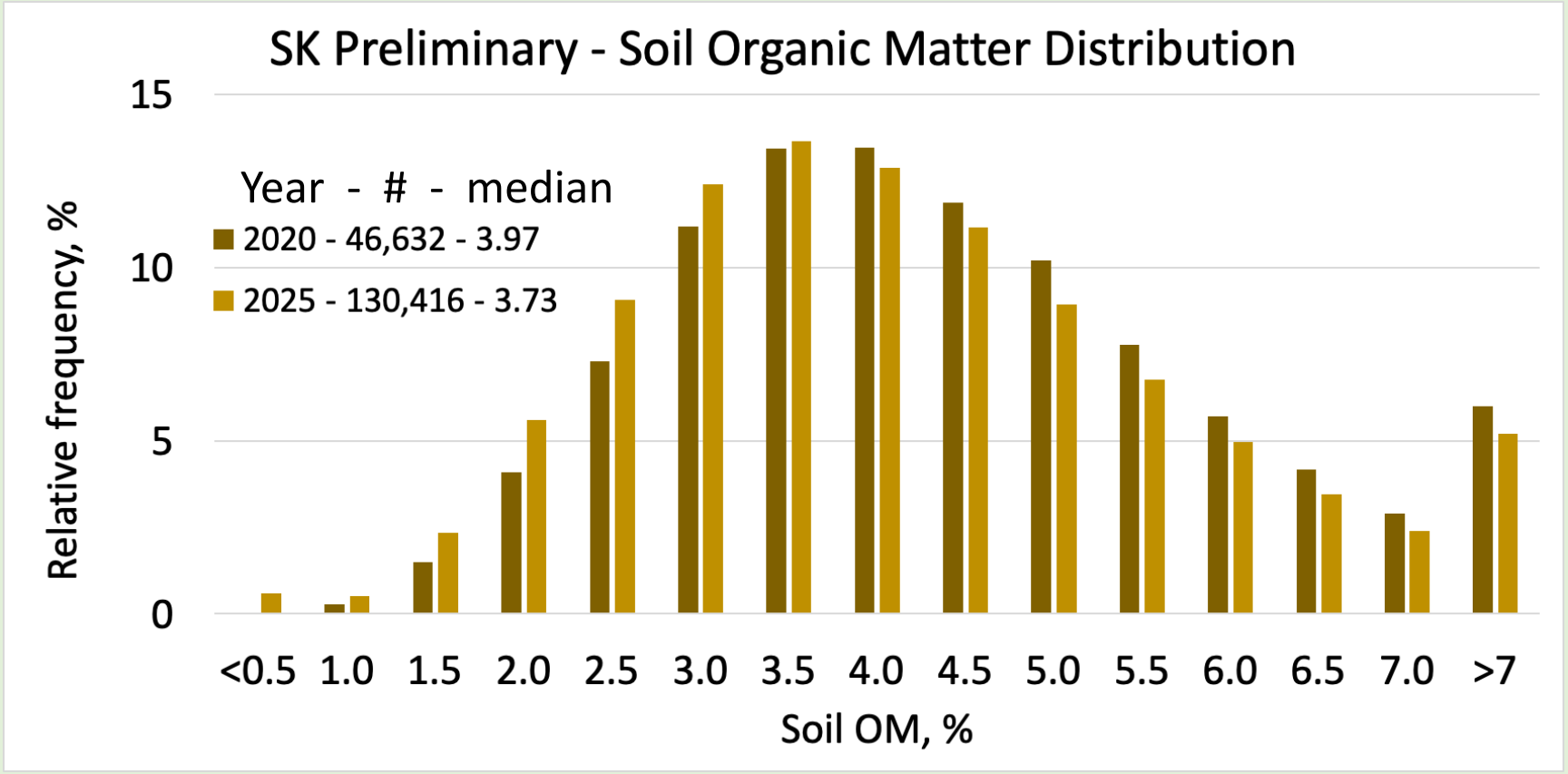
Soil test K varies over years, but remains high.
13% below 120 ppm, 39% below 200 ppm.

THE FERTILIZER INSTITUTE sts soil test summary



Slow decline in soil pH since 2001.

THE FERTILIZER INSTITUTE sts soil test summary



Slight decline in soil organic matter since 2020.

General Performance Outcomes

Nutrient Balances

N – surplus, P – balanced to surplus, K – deficit

Soil Test Summaries

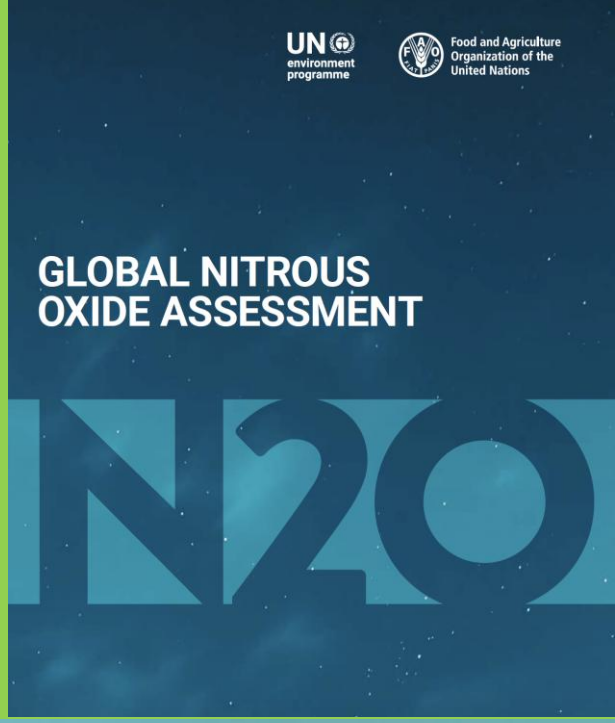
soil tests increasing

Olsen P – 50% low, K – decline?

pH – steady, SOM – small decline?

Strong international pressure to cut nutrient losses.

Not only for climate.



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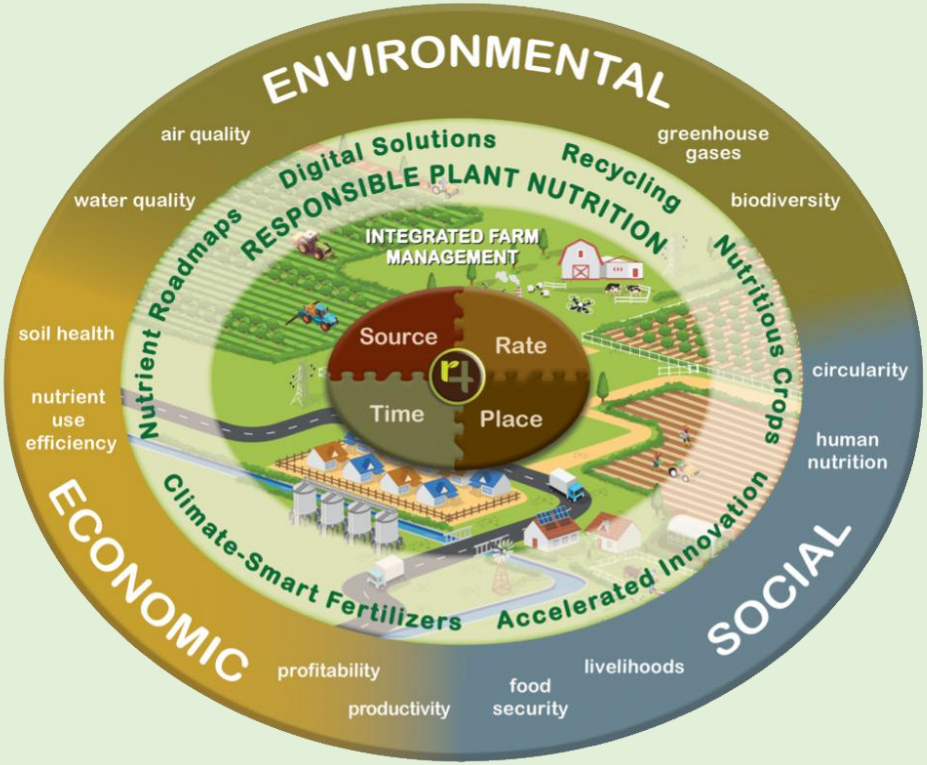
CANADIAN NITROUS OXIDE NETWORK



Collaborating with Canadian scientists to gain recognition for real 4R outcomes

nutrient stewardship

4R Practices – Real Outcomes

1. 4R Principles are globally recognized.
2. 4R Practices are site-specifically defined.
3. Gaining recognition for your 4R practices depends on tracking both **practices** and **outcomes**.
4. Outcomes like nutrient balances and soil test trends reflect 4R, crop & soil practices contributing to sustainable intensification.
5. Linking to sustainability outcomes and $ credits for ecosystem services requires collaboration with scientists to develop credible models.

nutrient stewardship