



Plant Nutrition
Canada



Tom Bruulsema,
Plant Nutrition Canada



2021
14 al 16 de JULIO
ONLINE



CONGRESO
INTERNACIONAL
de Nutrición y Fisiología
Vegetal Aplicadas™



Responsible phosphorus management seeks high yields and shows care for the environment

1



Plant
Nutrition
Canada

Research Resources Presentations About Contact



Supporting Science

Plant Nutrition Canada provides science support for the fertilizer industry's efforts to advance nutrient stewardship. We apply, interpret and extend science for sustainable plant nutrition.

<https://plantnutrition.ca>



FERTILIZER CANADA



THE
FERTILIZER
INSTITUTE



ifa
INTERNATIONAL
FERTILIZER ASSOCIATION

2

Outline – responsible phosphorus management

1. Responsible Plant Nutrition – a new paradigm
2. Multiple goals of responsible **phosphorus** management
 - Productivity, water quality, circular economy, biodiversity
3. 4R Nutrient Stewardship
 - Global industry support for science
4. Measuring & reporting performance
 - Soil test levels, nutrient balances and legacies, quantifying risks of yield loss & P loss



3



SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

A NEW PARADIGM FOR PLANT NUTRITION

Issue Brief, November 2020

What is the issue?
 What can be done?
 Who needs to do what?
 What will success look like?

<https://www.sprpn.org/>

4

Scientific Panel on Responsible Plant Nutrition

Vision: Responsible plant nutrition nourishes plants in a sustainable manner that enhances earth's capacity to support healthy life.

Objectives: Provide independent science-based knowledge to IFA and other stakeholders involved in food and agriculture on global issues of responsible plant nutrition.



Achim DOBERMANN
Scientific Panel on Responsible Plant Nutrition
Chief Scientist



Tom BRUULSEMA
Scientific Panel on Responsible Plant Nutrition
Chairman



Lini WOLLENBERG
ICRAR (ICRAF)
Fragging Leader in Low Emissions Development



Bernard VANLAUWE
ITA - International Institute of Tropical Agriculture
Director Central Africa Mills & Milk Program



Xin ZHANG
University of Maryland Center for Environmental Science (UMCES)
Assistant Professor



Bruno GERARD
CIAMIT - Centro Internacional de Mejoramiento de Maíz y Trigo
Director Sostenible Interacción Program



Pieter REIDGMA
Wageningen Agricultural University
Potato Professor



Fusuo ZHANG
China Agricultural University
Dean of the College



Klausrik MAJUMDAR
All-Care Plant Nutrition Institute (APNI)
Director, South



Mike MCLAUGHLIN
University of Adelaide



Ismail CAKMAK
Sakarya University
Professor of Plant Nutrition



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ON RESPONSIBLE PLANT NUTRITION

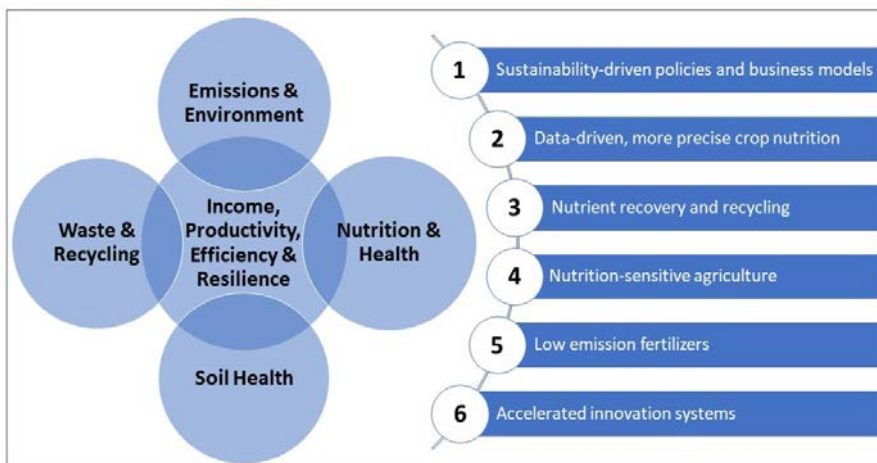


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<https://www.sprpn.org/>

5

A NEW PARADIGM FOR PLANT NUTRITION



Five interconnected aims, and six key actions

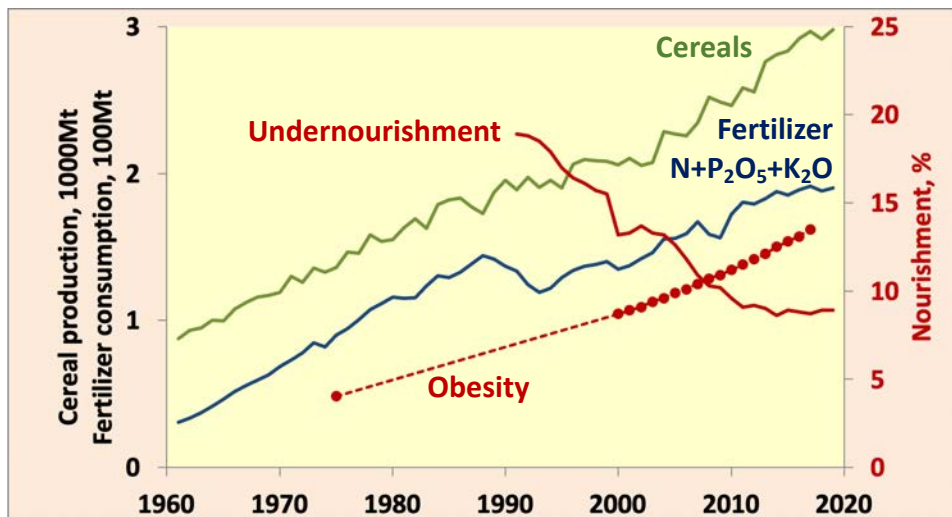


SCIENTIFIC PANEL
ON RESPONSIBLE PLANT NUTRITION

6

1 How can future growth in crop production be decoupled from growth in fertilizer consumption?

What is the issue?

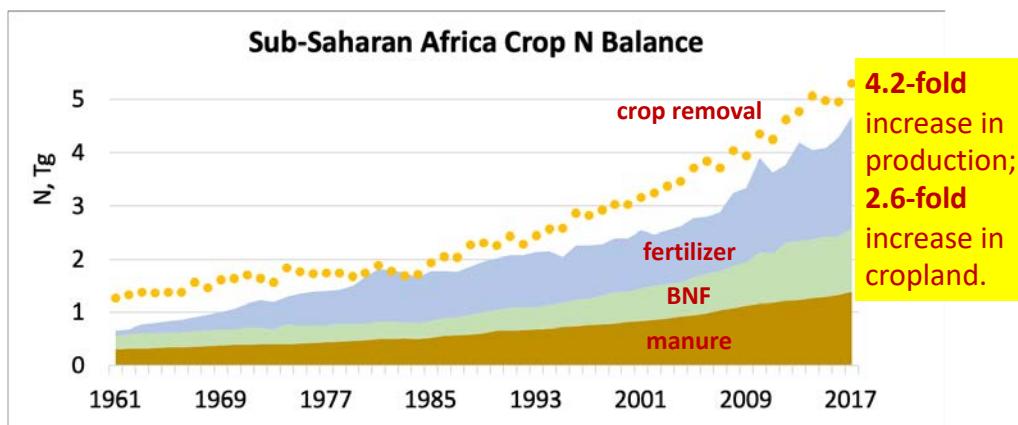


United Nations Food and Agriculture Organization (FAO), 2020

7

2 What are the key measures to double or triple crop yields in Africa with increasing and balanced nutrient inputs?

What is the issue?



Crop N removal by far exceeds N inputs from fertilizer, manure and biological fixation (BNF) in sub-Saharan Africa. Source: IFA Nutrient Use Efficiency database, 1961-2017.



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8

What is the issue?

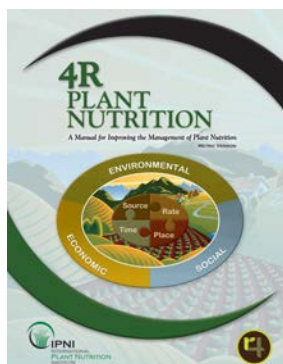
- 3 What data-driven technologies, business solutions and policies will accelerate the adoption of more precise nutrient management solutions by farmers?
- 4 Can nutrient losses and waste along the whole agri-food chain be halved within one generation?
- 5 How can nutrient cycles in crop and livestock farming be closed?
- 6 How can we improve soil health?
- 7 How should we manage nutrition of crops in changing climates?
- 8 What are options and targets for reducing fertilizer-related GHG emissions?
- 9 How can cropping systems deliver high quality, more nutritious food?
- 10 How can we better monitor nutrients and implement high levels of sustainability stewardship?



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9

What can be done?



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Action 1: Sustainability-driven policies and business models

Sustainability-driven nutrient policies and business models must be tailored to specific food systems in every country.

“Canada does not have complete data to present a supply chainwide view of emissions, ...overlooking 4R Nutrient Stewardship practices used to reduce direct emissions.”

10

What can be done?

Action 2: data-driven more precise crop nutrition

Knowledge-driven solutions and novel technologies will allow tailoring nutrient formulations and applications to local needs in an increasingly precise manner.

They need to be upscaled to millions of farmers through digitally supported advisory systems and integrated business solutions.



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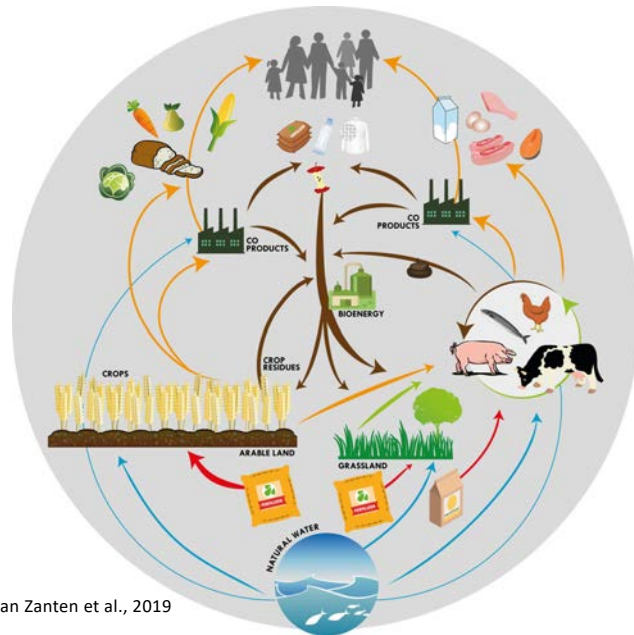
11

What can be done?

Action 3: Nutrient recovery/recycling

Crop-livestock integration, less food waste, by-products use and increased nutrient recycling are key measures to optimize nutrient use efficiency across the full food chain.

Political incentives, novel technologies and shifts in behavior will drive greater nutrient recovery from multiple waste streams, as part of circular, bio-based economies.



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Re-drawn and modified from van Zanten et al., 2019

12

What can be done?

Action 4: Nutrition-sensitive agriculture includes the targeted enrichment and application of fertilizers to deliver nutrients of importance to crop, animal and human health (e.g., N, Fe, Zn, Se, I).

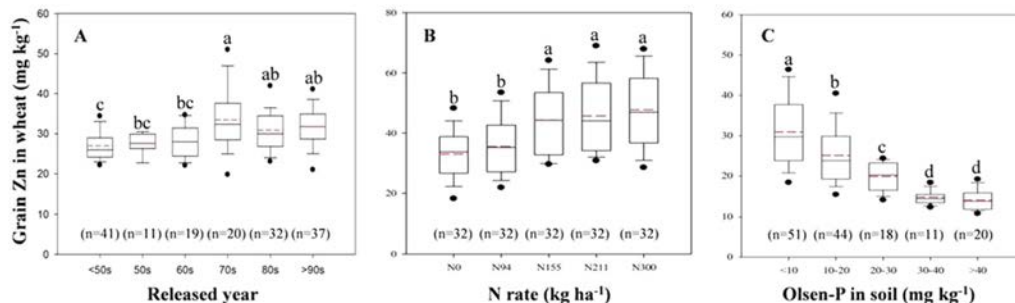


Figure 2. Measures of the “Green Revolution” including historical shift of varieties (A), N application rate (B) and elevated soil P concentration due to continuous application of P fertilizer (C) affect grain Zn in wheat grown in China. These historical varieties were grown in the same field at the North China Plain. And their grain Zn

Chen, X.-P., Y.-Q. Zhang, Y.-P. Tong, Y.-F. Xue, D.-Y. Liu, et al. 2017. Harvesting more grain zinc of wheat for human health. *Sci. Rep.* 7(1): 7016. doi: 10.1038/s41598-017-07484-2.



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What can be done?

Action 5: Low-emission fertilizers

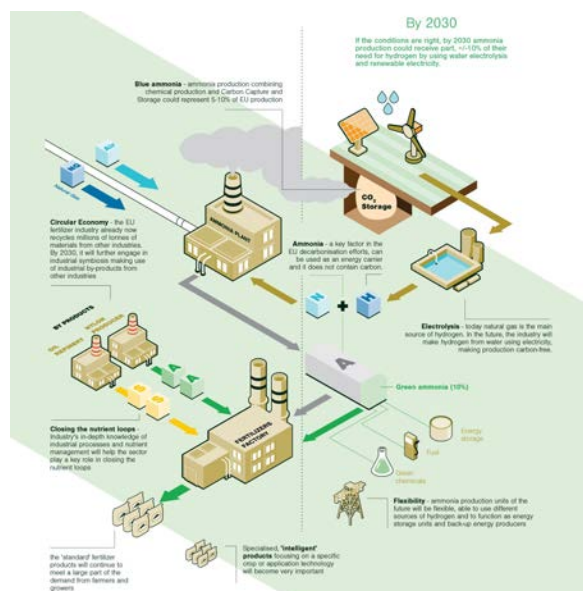
Fertilizers will increasingly be produced in an environmentally friendly manner and they will embody greater amounts of knowledge to **control the release** of nutrients to the plant.

The “**hydrogen economy**” may lead to abundant **green and blue ammonia**.



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Fertilizers Europe

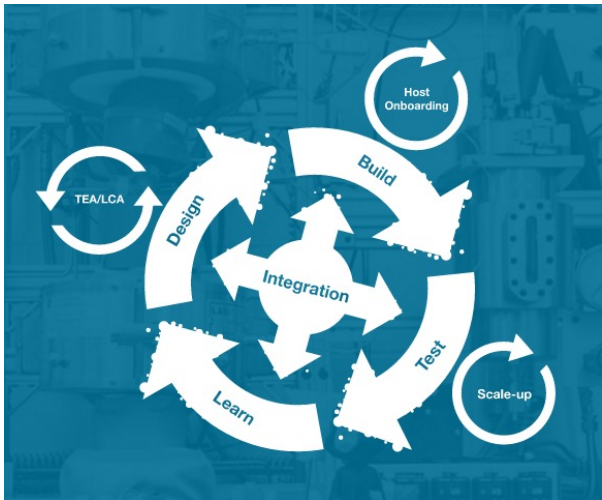


What can be done?


Action 6: Accelerated, more open innovation systems for faster translation of new ideas into practice

This requires more investment, collaboration, risk taking and entrepreneurship by industry, but also a massive culture change in science and science funding.

Science → Technology → Innovation



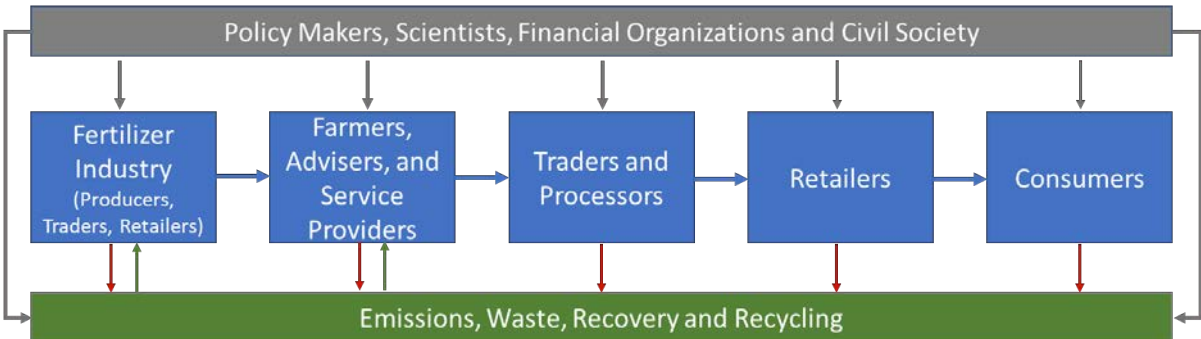
<https://agilebiofoundry.org/>




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15

Who needs to do what?



- Many participants in the agricultural value chain play important roles in responsible plant nutrition.
- The **fertilizer industry** has great influence on the **4Rs**:
 - making the **right source** available,
 - providing recommendations for applying
 - at the **right rate**,
 - at the **right time**, and
 - in the **right place**.



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16

What will success look like?

Responsible Plant Nutrition: Societal optimum

by 2040:

1. Accepted **standards and roadmaps** for nutrients along the whole chain.
2. Crop yield growth outpaces growth in fertilizer; **crop NUE ↑ to 70%**.
3. **Nutrient waste halved** to reduce harm; no more hotspots.
4. In sub-Saharan Africa, **fertilizer use has tripled**.
5. Extreme forms of **hunger and malnutrition gone**.
6. Fertilizer **GHG footprint reduced by 30%**.
7. Investments in research & innovation **triple**.
8. **Consumers appreciate** fertilizer's role and footprint.
9. All farmers access **tailored plant nutrition solutions**.



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ON RESPONSIBLE PLANT NUTRITION


17

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18



Millennium Ecosystem Assessment

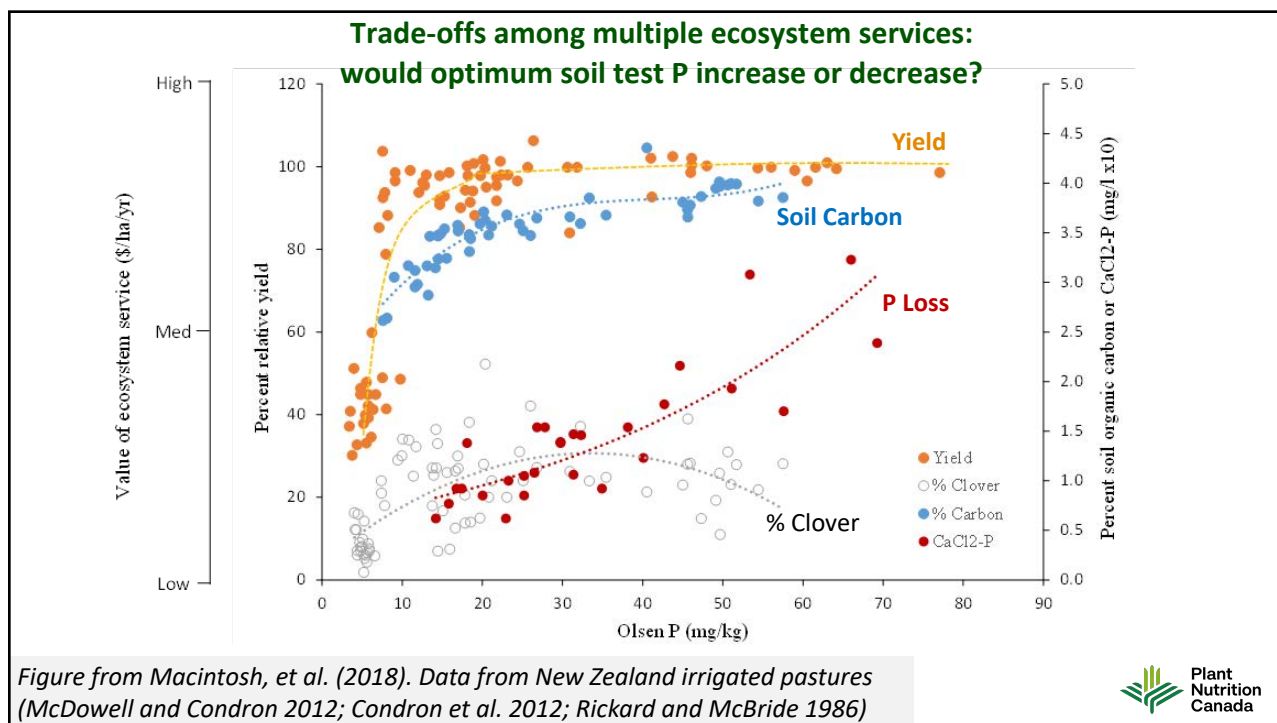
Ecosystem Services: The benefits people obtain from ecosystems

ECOSYSTEM SERVICES

Supporting NUTRIENT CYCLING SOIL FORMATION PRIMARY PRODUCTION ...	→	Provisioning FOOD FRESHWATER WOOD AND FIBER FUEL ...
...	→	Regulating CLIMATE REGULATION FLOOD REGULATION DISEASE REGULATION WATER PURIFICATION ...
...	→	Cultural AESTHETIC SPIRITUAL EDUCATIONAL RECREATIONAL ...

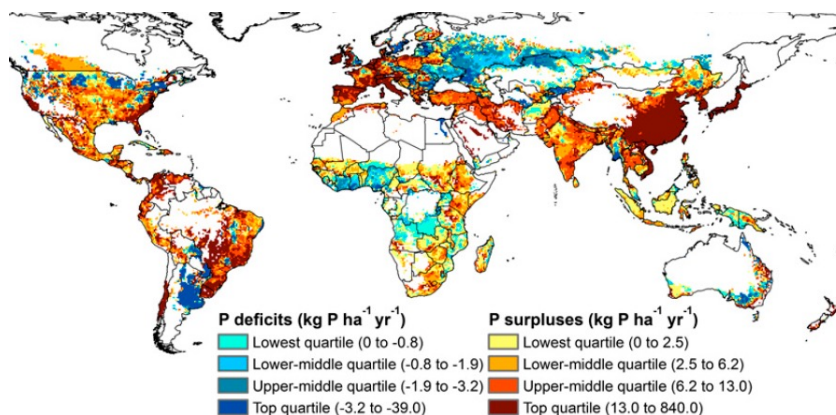
www.millenniumassessment.org | Strengthening Capacity to Manage Ecosystems Sustainably for Human Well-Being

19



20

What is the issue?



Global map of agronomic P imbalances for the year 2000 expressed per unit of cropland area.

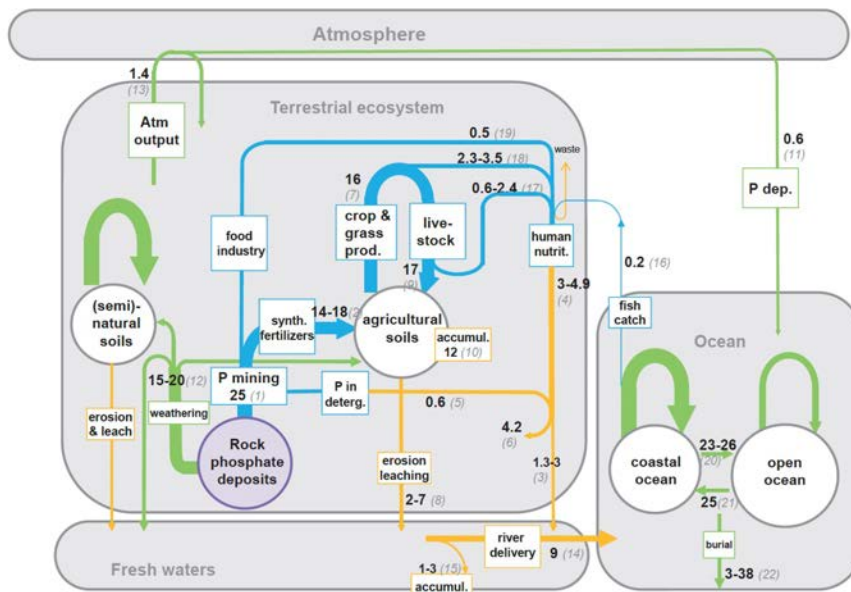


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MacDonald et al., 2011. PNAS 108(7)3086-3091. <https://doi.org/10.1073/pnas.1010808108>

21

Global P Cycle



Less than one-fifth of fertilizer P shows up in the food we eat

Global P cycle, around 2000-2010. Numbers indicate flows in million tonnes per year

22

Lake Erie & P

- Eutrophication
- Hypoxia
- Harmful Algal Blooms



NOTICE
 An algae bloom has made this area potentially unsafe for water contact. Avoid direct contact with visible surface scum.



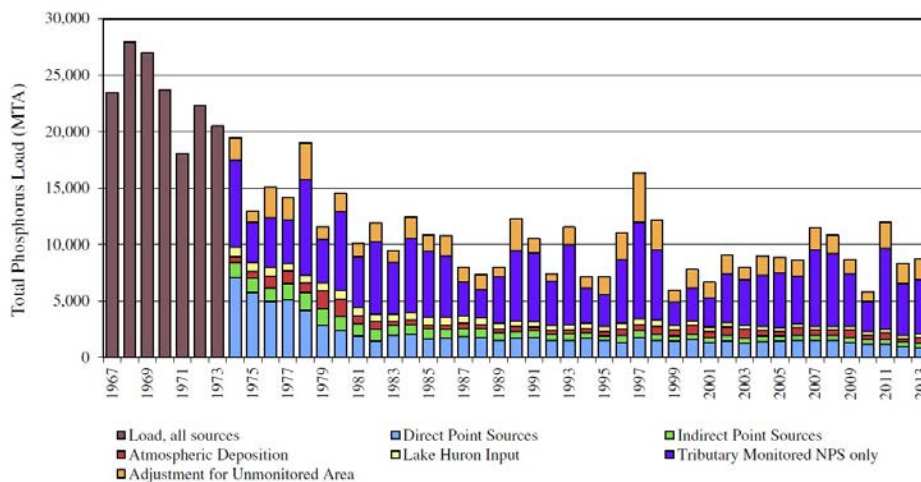
Sept 2011

Photo credit: Carrie Vollmer-Sanders, The Nature Conservancy



23

Lake Erie total P loads 1967-2013

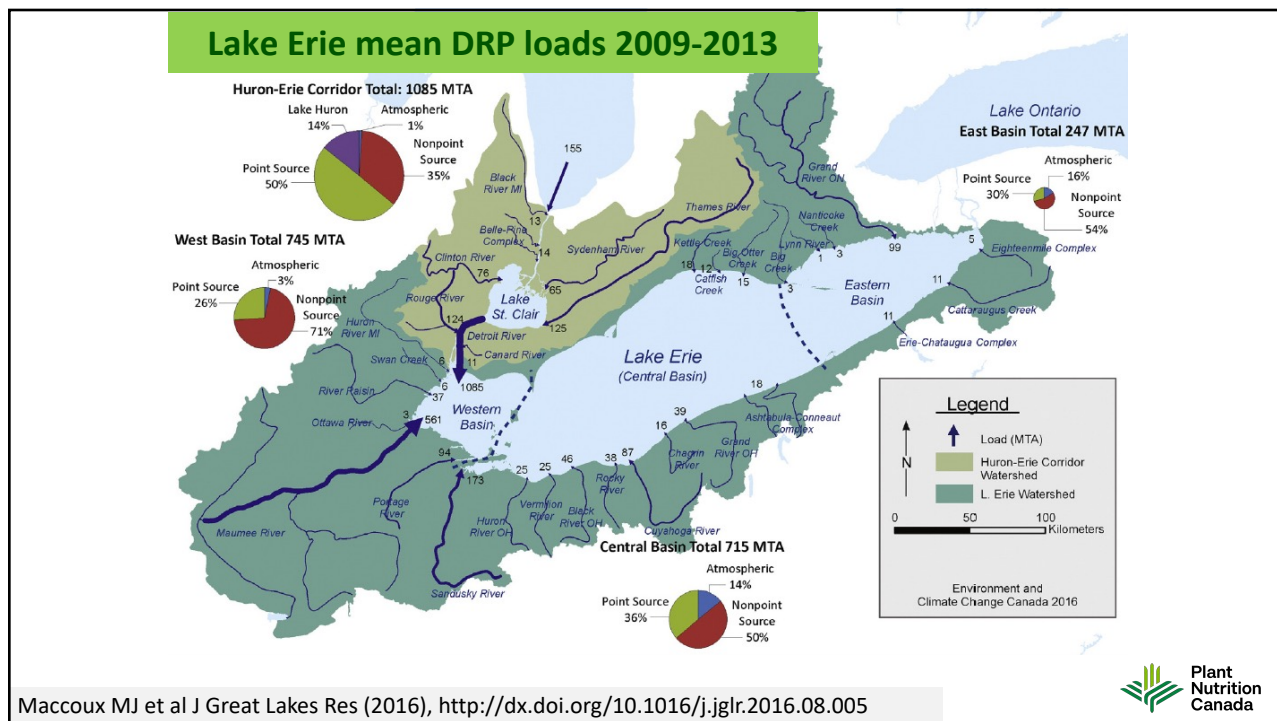


Total P load does not explain the increase in algal blooms since ~1995

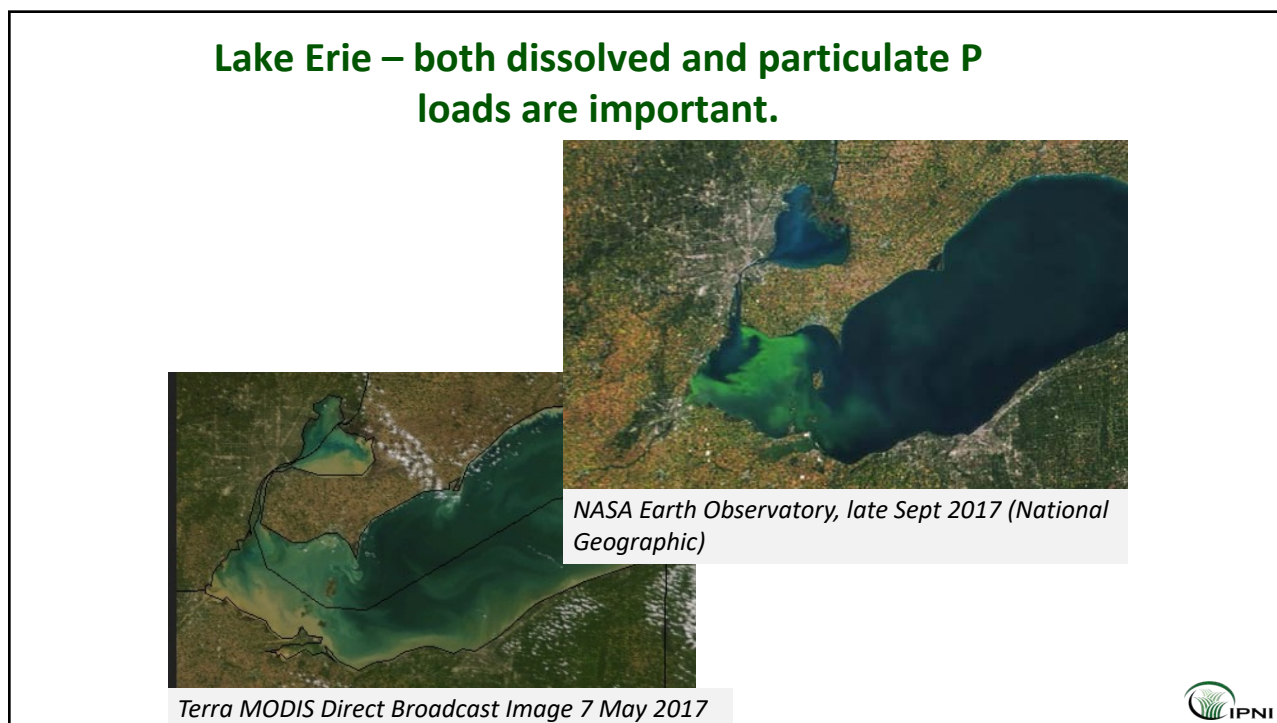
Maccoux MJ et al J Great Lakes Res (2016), <http://dx.doi.org/10.1016/j.jglr.2016.08.005>



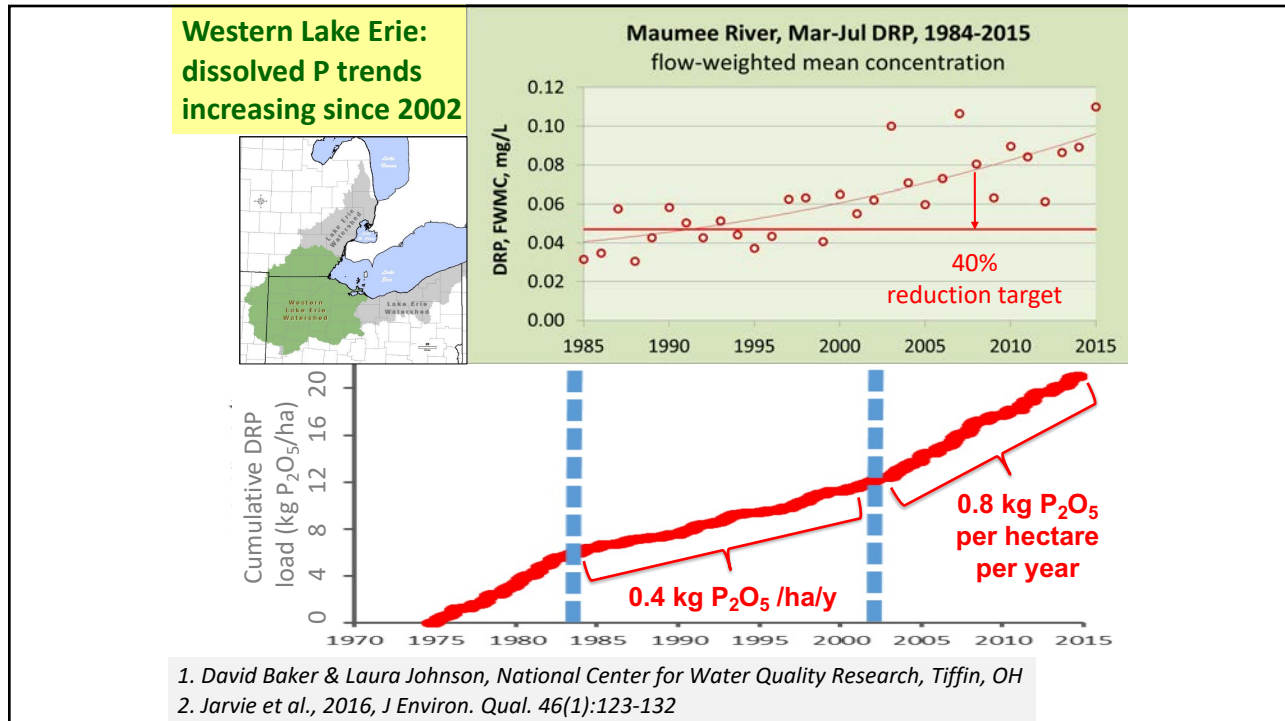
24



25



26



27

Western Lake Erie Watershed

Cropland PUE almost doubled.
Loss of dissolved P to the lake also doubled.

Year	P outputs, kt crop removal	P inputs, kt fertilizer manure		PUE
1987	30	37	5	72%
2014	49	31	5	135%

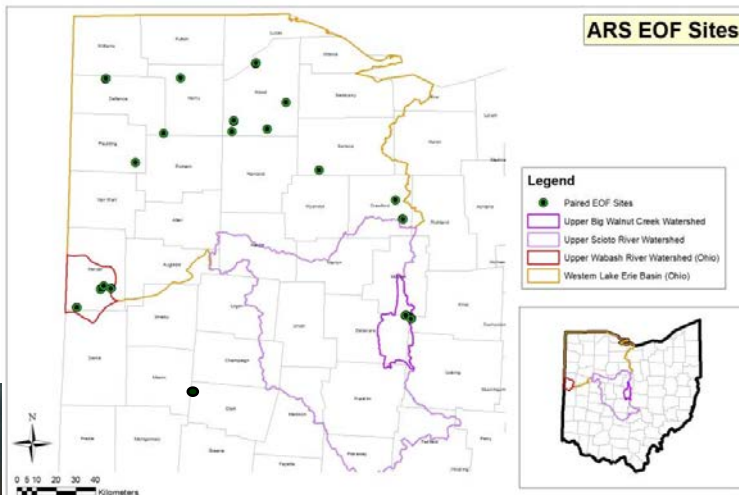
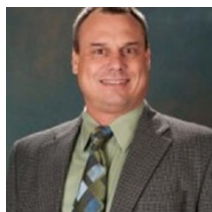
Increased DRP loss an “unintended consequence” of conservation tillage with **broadcast application** of P fertilizer. **“Right place” = subsurface.**

NuGIS
Nutrient Use Geographic Information System

Jarvie et al., 2017, J Environ. Qual. 46(1):123-132

28

Ohio P loss monitoring at edge of field



Funding Sources:

- 4R Research Fund
- USDA-ARS: USDA-Agriculture Research Service
- CEAP: Conservation Effects Assessment Project
- EPA: DW-12-92342501-0
- Ohio Agri-Businesses
- Ohio Corn and Wheat Growers
- CIG: 69-3A75-12-231 (OSU)
- CIG: 69-3A75-13-216 (Heidelberg University)
- MRBI: Mississippi River Basin Initiative
- The Nature Conservancy
- Becks Hybrids/Ohio State University
- Ohio Soybean Association



Kevin King, USDA-ARS, Columbus, Ohio



29

Our Vision

We envision a food system that manages phosphorus more sustainably to provide abundant, nutritious food while protecting the health of rivers, lakes, and oceans.



Sustainable Phosphorus Alliance

Allies Addressing a Complex Problem

The Sustainable Phosphorus Alliance is a membership organization addressing the complex problem of phosphorus sustainability. We are North America's central forum and advocate for the sustainable use, recovery, and recycling of phosphorus in the food system. We collaborate with our members and supporters to innovate and implement evidence-based solutions to the phosphorus sustainability challenge, to be shared and accessible to the community.

The Sustainable Phosphorus Alliance is a unit of the Julie Ann Wrigley Global Institute of Sustainability at Arizona State University. Our activities to advance phosphorus sustainability and benefit our members are funded by membership dues and contributions.



30

Platform ▾ Activities ▾ Members Links & Resources ▾ Success Stories SCOPE & News ▾ Events ▾ ESPCS 🔍

European Sustainable Phosphorus Platform

Sustainable management of phosphorus and other nutrients is crucial for agriculture, food, industry, water and the environment. The European Sustainable Phosphorus Platform (ESPP) brings together companies and stakeholders to address the Phosphorus Challenge and its opportunities.

Nutrient recycling R&D projects & technologies

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Read earlier **SCOPE** and **eNews** editions.

IN THE SPOTLIGHT

3rd European Nutrient Event at ECOMONDO 2018 green technology expo

Phosphorus and nutrient recycling and management in Italy, the Mediterranean region and in EU research, development and innovation.
8 - 9 November 2018, Rimini, Italy - Joint event ESPP and SMART-Plant
www.smart-plant.eu/ENE3

Day 1: phosphorus and nutrient recycling in Italy and the Mediterranean region, the new Italian Phosphorus Project.
Day 2: new nutrient recycling R&D projects, updates on current major projects, nutrient management in Horizon Europe, potential "Mission on Nutrients".
More information, programme and registration here

TWITTER

phosphorusfacts

The @iwama_project session during Eco-Tech conference is opened by Ludvig Herrmann @phosphorusfacts. He presents the...
twitter.com/i/web/status/1... Retweeted

Food Reform for #Sustainability and #Health - FReSH - #business partnership for a sustainable #food system...
twitter.com/i/web/status/1...

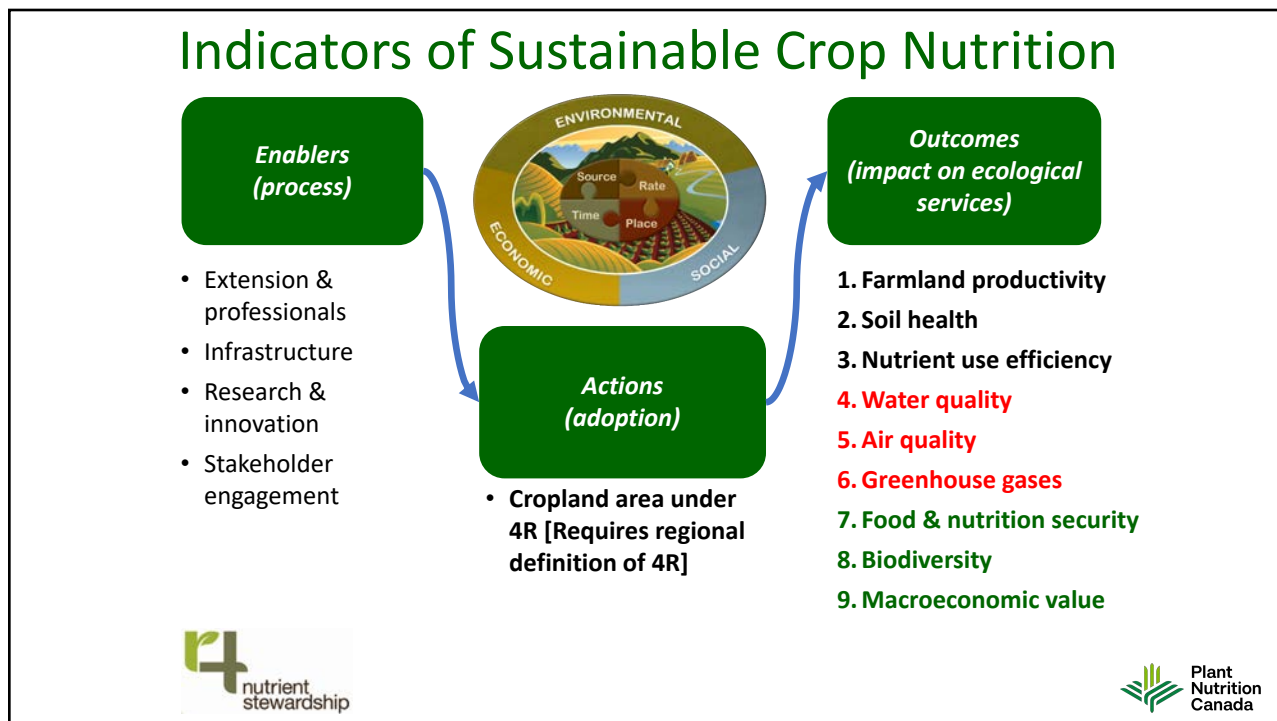
Seminar on the importance of healthy #soils and #soil #carbon sequestration in #agriculture 27 Nov. in @Europarl_EN...
twitter.com/i/web/status/1...

31

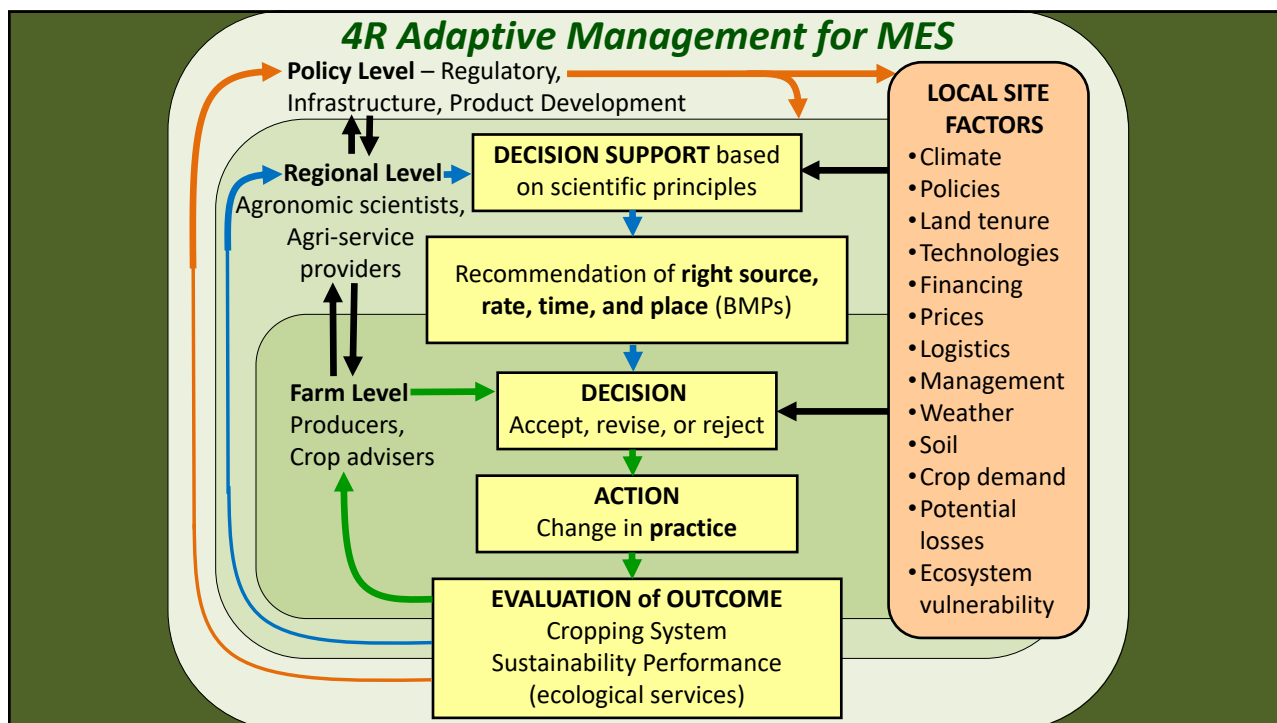
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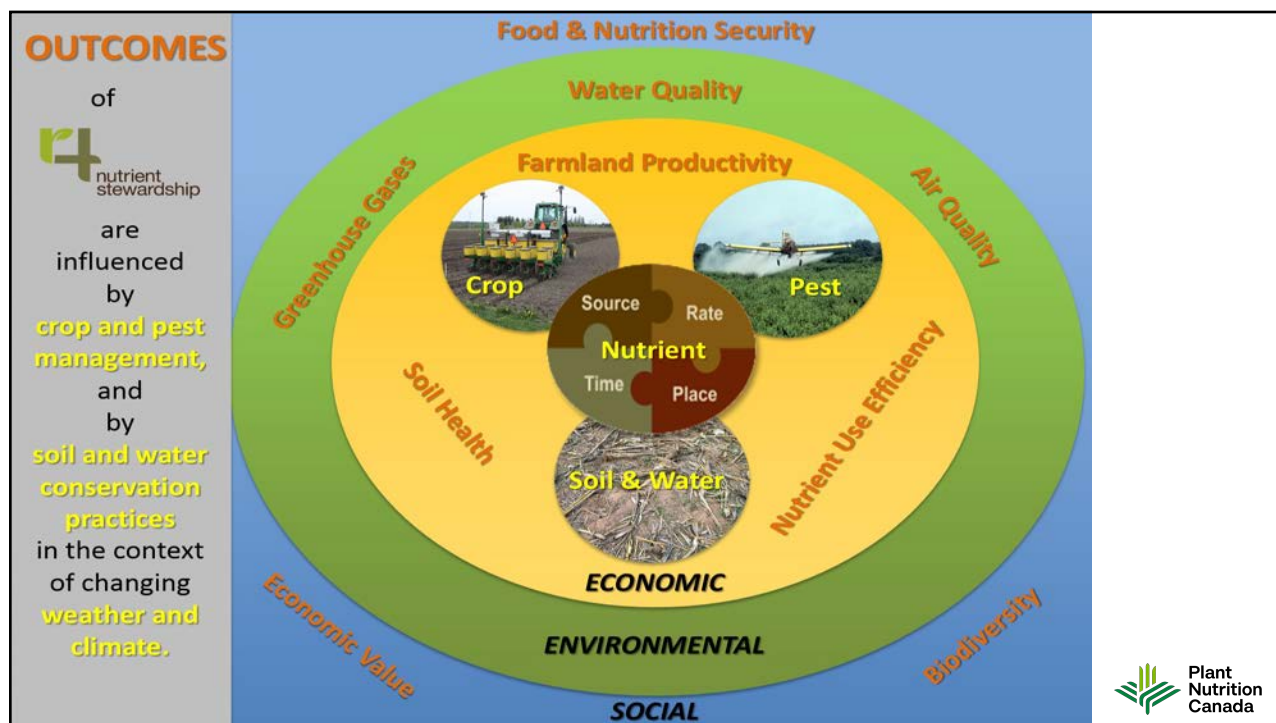
32



33



34



35

Approaches to recognition of crop nutrition impact on ecosystem services

- 4R certification
- Counting 4R acres
- Aggregate data on 4R practices
- Models of nutrient loss
 - Incentive programs
 - Water quality trading
 - Carbon trading



36

4R FARMERS & THE LAKE

Sustainable Crop Nutrition for the Western Lake Erie Basin
nutrientstewardship.org

Fertilizer Benefits

Fertilizers replenish soil nutrient supplies depleted by crop production

Within the watershed, crop harvest removes more phosphorus than is being applied as fertilizer and manure.

Fertilizers are key to food security

50% of food production is the result of fertilizer use.

4R PRINCIPLES OF NUTRIENT STEWARDSHIP

RIGHT SOURCE

Matches fertilizer type to crop needs

- Account for all sources of nutrients in recommendations

RIGHT RATE

Matches amount of fertilizer to crop needs

- Conduct soil tests regularly in uniform areas less than 25 acres
- Document crop yield goals based on crop history
- Base nutrient application on Tri-State recommendations or adaptive management using soil test and yield goals
- Calibrate nutrient application equipment annually

RIGHT PLACE

Keeps nutrients where crop can use them

- Utilize variable rate application
- Utilize phosphorus injection, subsurface banding or broadcasting with immediate incorporation
- Don't broadcast apply nutrients without incorporation unless the risk of phosphorus loss is demonstrated to be low
- Apply nutrients using minimum setbacks from sensitive areas

RIGHT TIME

Makes nutrients available when crops need them

- Don't apply phosphorus on frozen or snow covered ground
- Don't apply phosphorus or nitrogen if a large rainfall is in the weather forecast

37

4R NUTRIENT STEWARDSHIP CERTIFICATION PROGRAM

Voluntary program in Western Lake Erie Basin (WLEB) and entire state of Ohio for agricultural retailers & nutrient service providers implementing the 4Rs

61
CERTIFIED BRANCH FACILITIES

47
FACILITIES IN WLEB

4
NUTRIENT STEWARDSHIP CERTIFICATION

5,900
CLIENTS SERVICED

2.82M
TOTAL ACRES

1.54M
ACRES IN WLEB

4

2

55

GOALS

- Maximize crop nutrient uptake and minimize crop loss
- Positively impact local water bodies
- Provide up-to-date information on nutrient stewardship
- Help the agricultural sector adapt to new research and technology

REQUIREMENTS

- Initial training and on-going education
- Monitoring of 4R implementation
- Nutrient recommendation and application

THIRD-PARTY VERIFIED

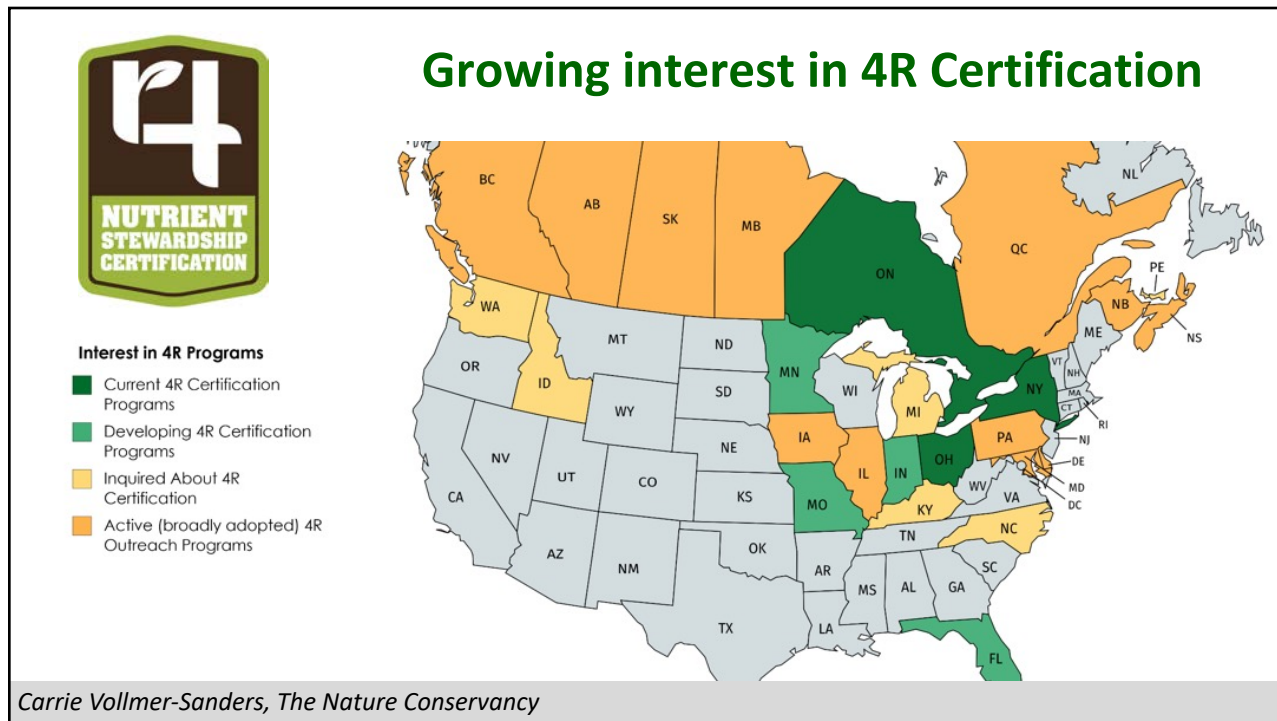
- Audits review training and education, recommendations to growers, and application records
- Third-party auditor verification occurs each year

For more information, visit 4rcertified.org

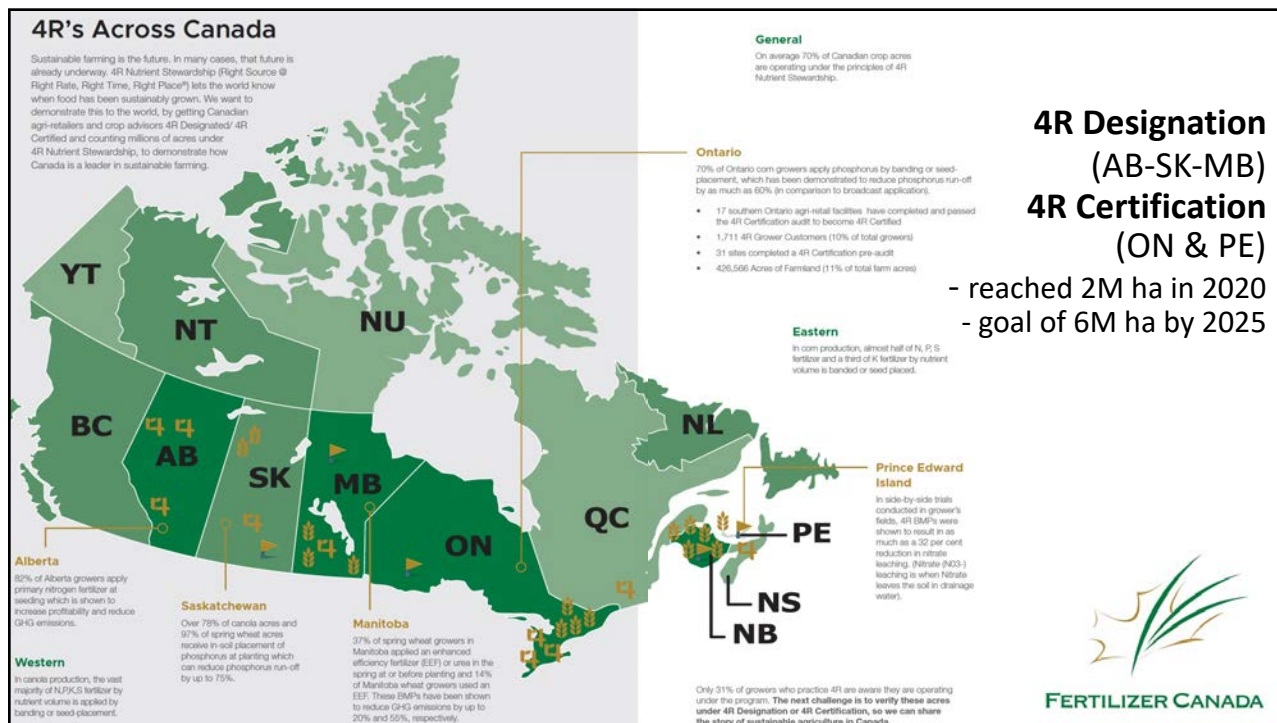
RIGHT SOURCE - RIGHT RATE - RIGHT TIME - RIGHT PLACE

 Plant Nutrition Canada

38



39



40

The international **Code of Conduct** for the **sustainable use** and **management** of **fertilizers**

Food and Agriculture Organization of the United Nations

Principles of 4R Nutrient Stewardship are embedded in the FAO Code of Conduct, and in other Codes of Practice.

RESPONSIBLE GRAIN
CANADIAN FARM STANDARDS

FARMERS · INDUSTRY STAKEHOLDERS · BUYERS · CONSUMERS · CODE CONTENTS · ABOUT US · CONTACT

Canadian Grain Farmers Code of Practice

Responsible Grain is a national, voluntary Code of Practice that will allow Canadian grain farmers to demonstrate their care and commitment to the environment.

itps
INTERNATIONAL TECHNICAL GROUP OF EXPERTS

PLANT NUTRITION CANADA

Plant Nutrition Canada

41

4
Solution

FERTILIZER CANADA

Co-operative Development Foundation of Canada

Global Affairs Canada / Affaires mondiales Canada

The Context and Relevance for 4Rs in Ghana and Ethiopia

Dr. Shamie Zingore | Director for Research
Dr. Samuel Njoroge | 4R Solution Project Scientist

AFRICAN PLANT NUTRITION INSTITUTE

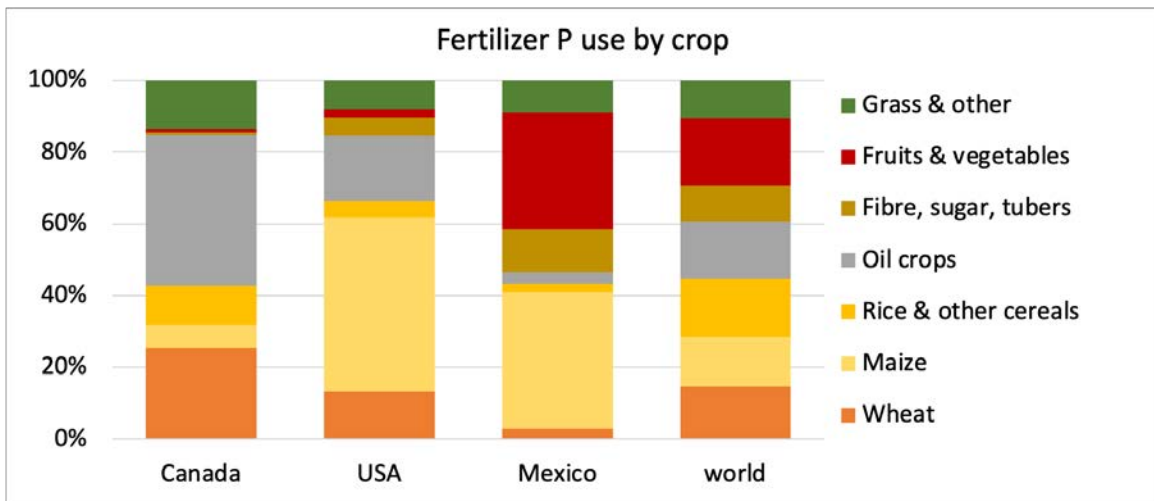
42

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43

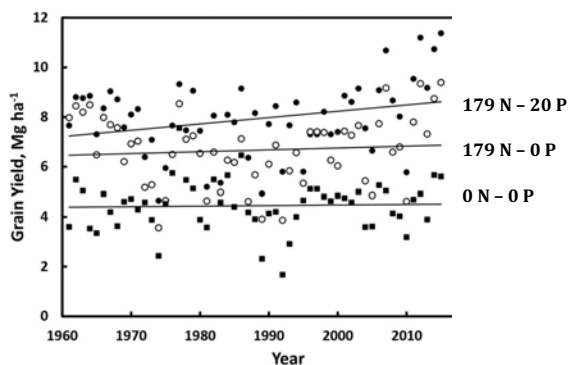


IFA. 2017. Assessment of Fertilizer Use by Crop at the Global Level 2014-2014/15. International Fertilizer Association, Paris, France.

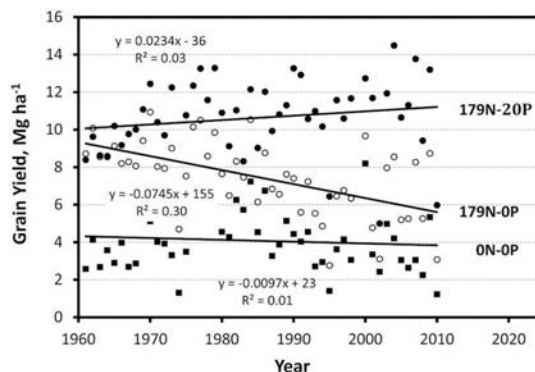


44

Long term benefit of P fertility



Annual rain yields from 1961 to 2015 for irrigated continuous sorghum grown near Tribune, KS
N and P rates in kg/ha



Annual grain yields from 1961 to 2010 for irrigated continuous corn grown near Tribune, KS.

Schlegel, A.J., and J.L. Havlin. 2020. Irrigated grain sorghum response to 55 years of nitrogen, phosphorus, and potassium fertilization. *Agron. J.* <https://doi.org/10.1002/agj2.20453>



45

sts

HOME ABOUT CHARTS MAPS TABLES MY ACCOUNT

LOCATIONS

OPTIONS

Year(s)	Element
<input checked="" type="checkbox"/> 2001	<input checked="" type="checkbox"/> Phosphorus
<input checked="" type="checkbox"/> 2005	<input type="checkbox"/> Potassium
<input checked="" type="checkbox"/> 2010	<input type="checkbox"/> Magnesium
<input checked="" type="checkbox"/> 2015	<input type="checkbox"/> Sulfur
<input checked="" type="checkbox"/> 2020	<input type="checkbox"/> Zinc
	<input type="checkbox"/> Chloride
	<input type="checkbox"/> Soil Organic Matter
	<input type="checkbox"/> pH

CANCEL OK

sts soil test summary

HOME

Soil Test Levels in North America

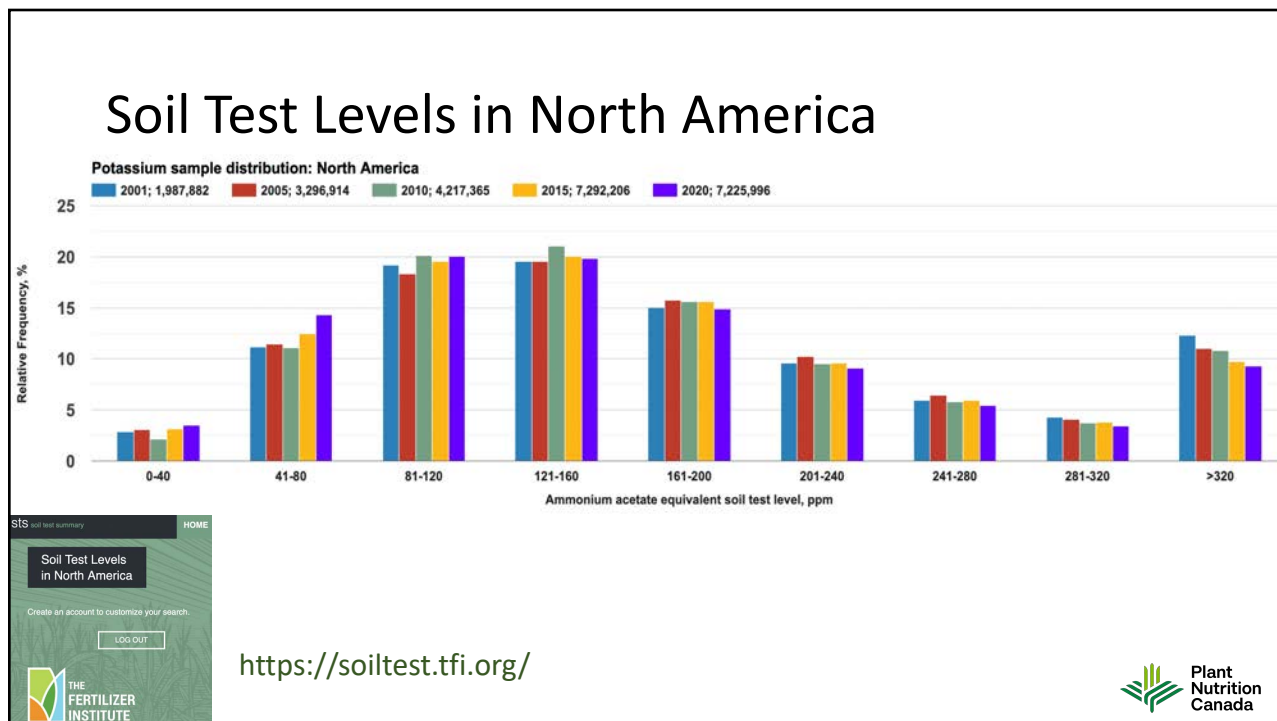
Create an account to customize your search.

LOG OUT

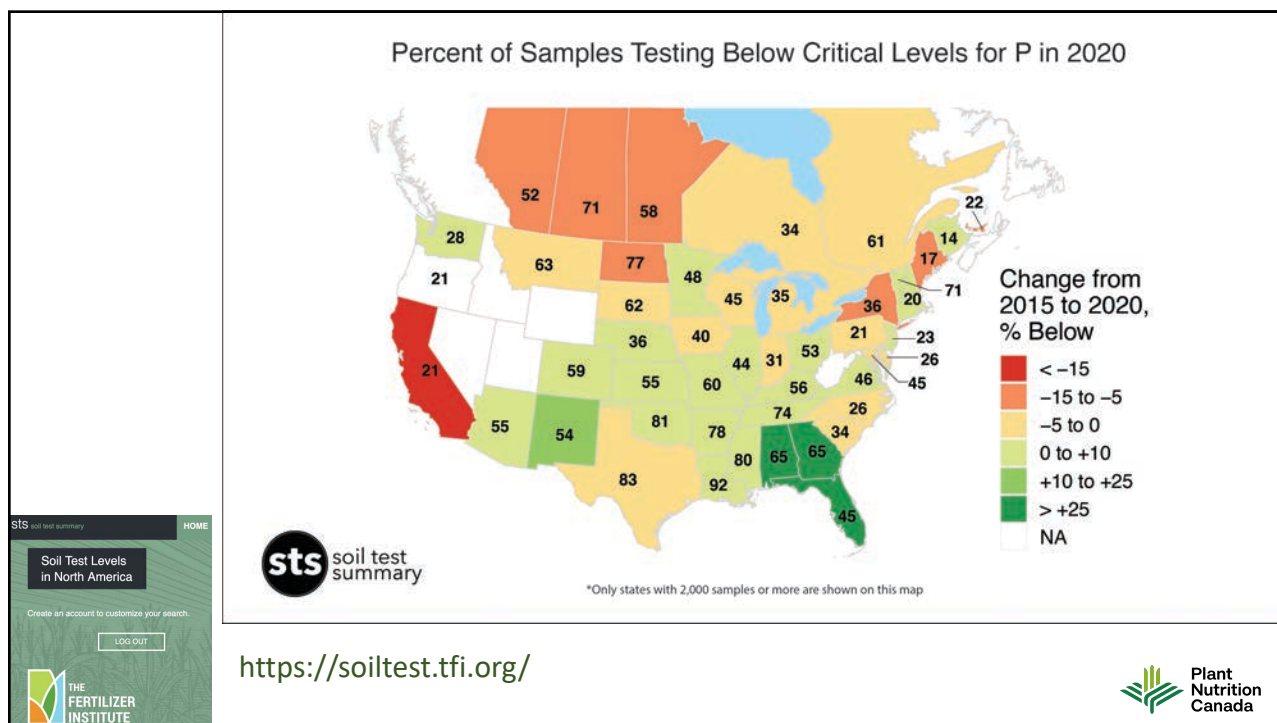
<http://soiltest.tfi.org>

Soil Test Summary by state & province

46

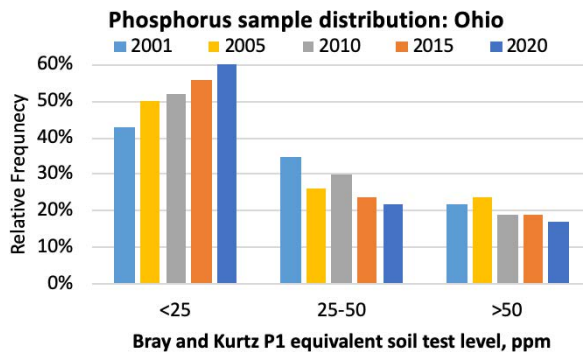
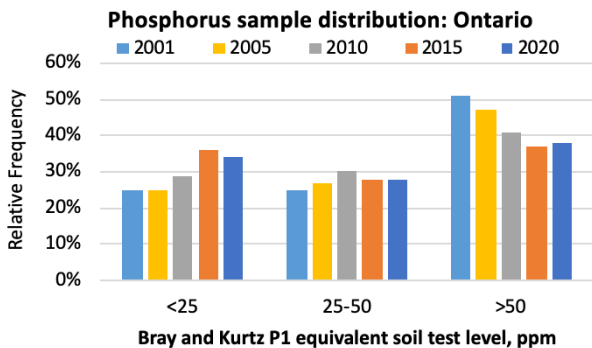


47



48

Ontario and Ohio – differ in soil P distribution



SIS soil test summary

HOME

Soil Test Levels in North America

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THE FERTILIZER INSTITUTE

To mitigate P loads to Lake Erie, soil P drawdown is more relevant in Ontario. Applying at “right time” and in “right place” is more relevant in Ohio.

<https://soiltest.tfi.org/>



49

NuGIS
Nutrient Use
Geographic Information System

HOME ABOUT MAP METHODS * TABULAR DATA CONTACT US

NuGIS Map

1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2016

County Data * Watershed (HUC8) Data * Watershed (HUC2) Data *

Overlays
Counties
Watershed (HUC8)
Watershed (HUC2)
Rivers

Ag Land Use Mask

Watershed (HUC8) Data
Balances
P₂O₅ Balance

Watershed (HUC8) P₂O₅ Balance

- less than -75 Noncropland ac
- 75 to -28
- 28 to -4
- 5 to 5
- 5 to 25
- 26 to 50
- 51 to 100
- 101 to 300
- greater than 300

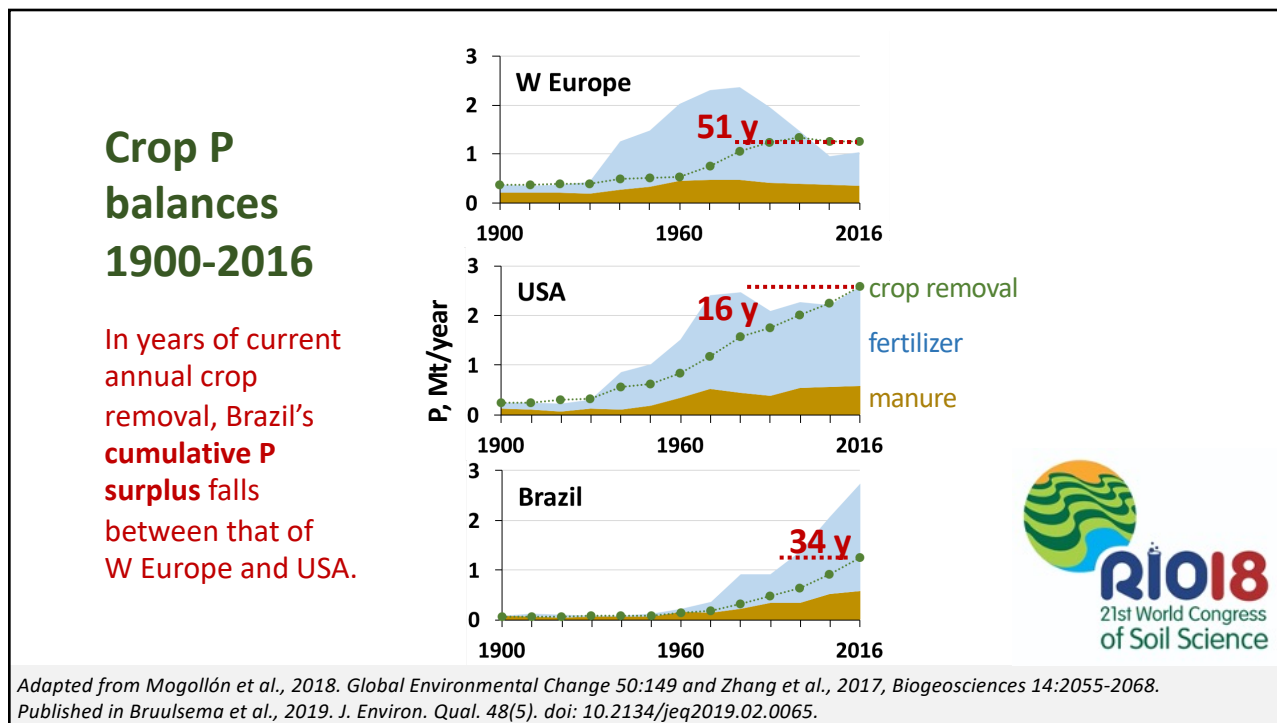
Deficits and surpluses in the US cropland P balance

Nutrient Input and Crop Removal - all P₂O₅

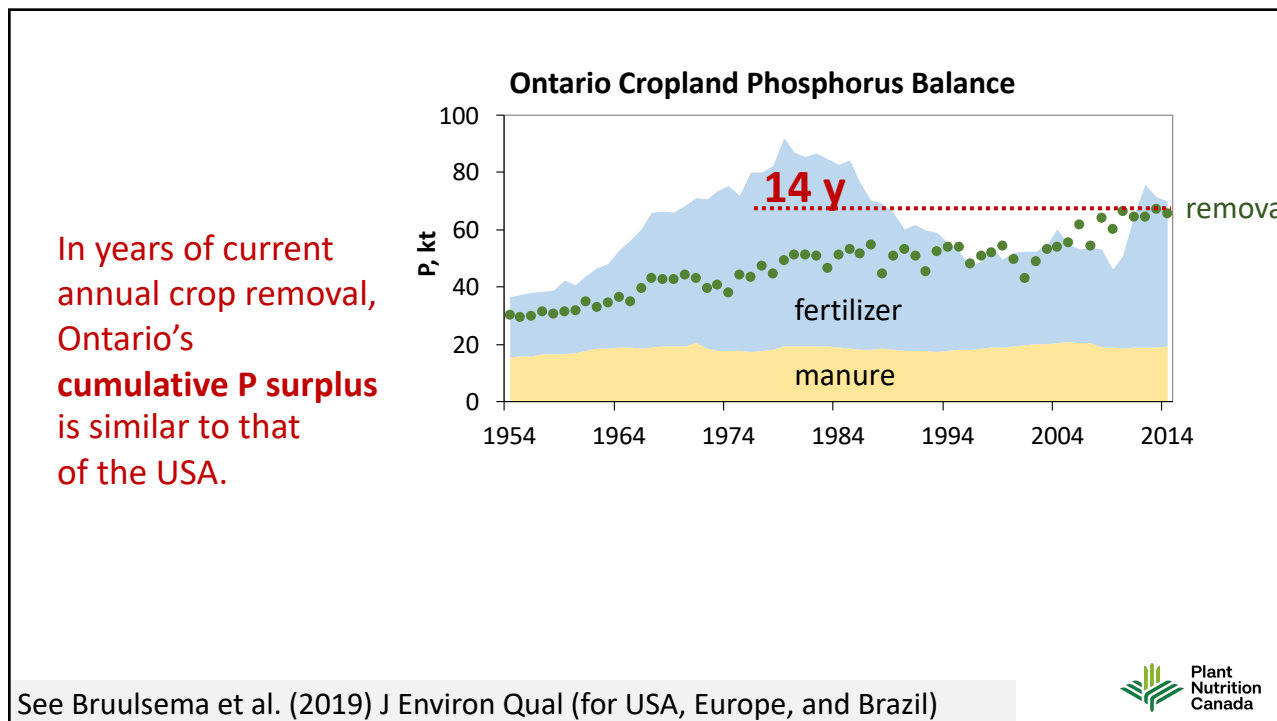
1000s of tons

Year

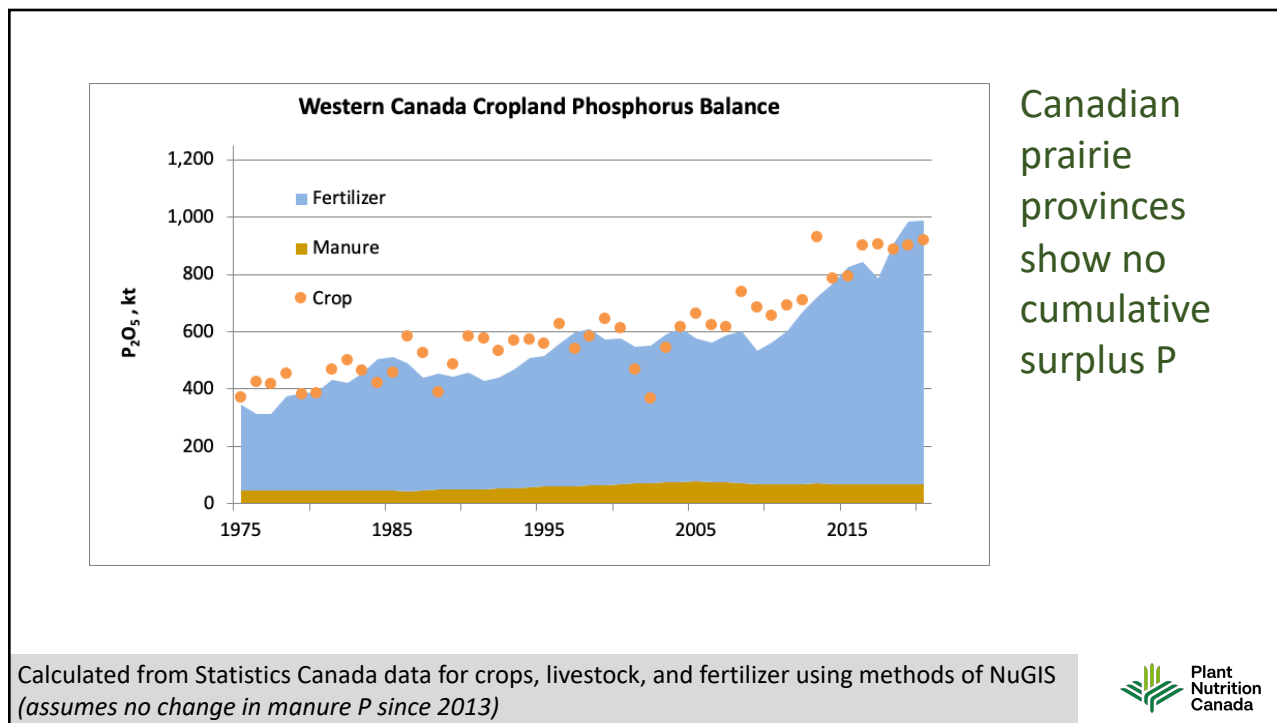
50



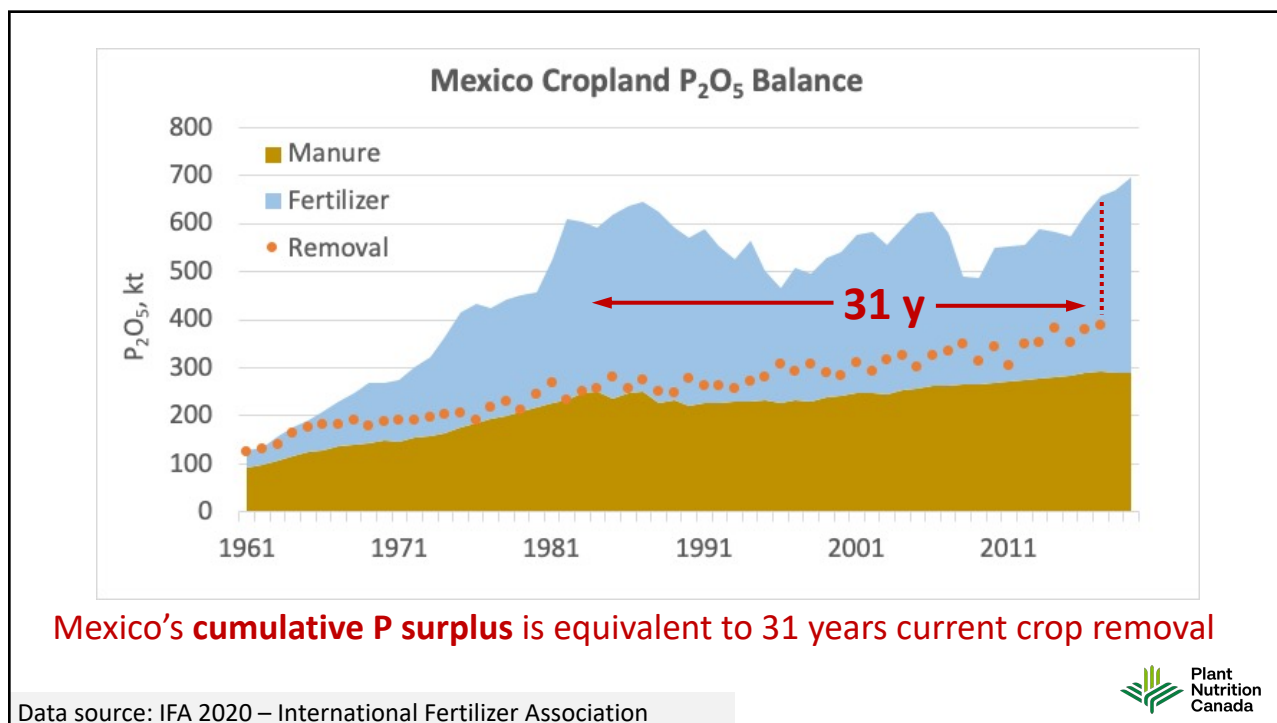
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52



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Legacies across Latitudes

Agricultural P legacies differ among countries and regions.

Europe's surplus larger owing to: assumptions about P fixation, soils longer depleted, socioeconomic policy, different crop mix

Moving to responsible phosphorus management depends on **continued research** to develop better assessment of soil P status, and to develop technologies that help crops exploit legacy P in soils.

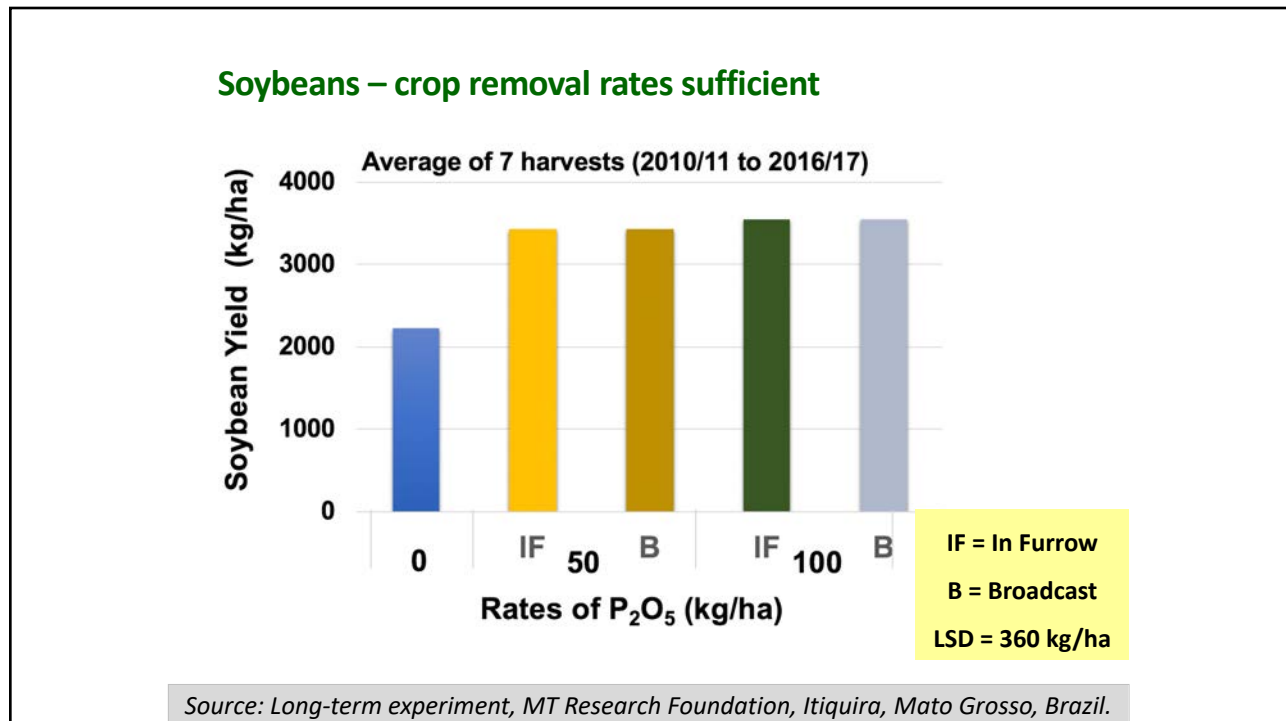
For Brazil: "Combined use of no-till, cover crops, and 4R enables a transition to align P inputs more closely to crop offtake."

(Withers et al., 2018)

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Summary

1. The new paradigm for plant nutrition recognizes its multiple responsibilities in sustainably enhancing earth's capacity to support life.
2. Responsible phosphorus management addresses multiple goals: Productivity, water quality, circular economy, biodiversity
3. Focusing on 4R Nutrient Stewardship is the fertilizer industry's most efficient contribution to responsible plant nutrition.
4. To further 4R, the industry needs to support science and report performance – soil tests, nutrient balances, & more

<https://plantnutrition.ca>

58