Aug 10 Great Lakes agriculture strategy session

Farm & Food Care Hosts:
Bruce Kelly
Who is Farm & Food Care Ontario?

• First coalition of its kind, whole sector approach – all types of farmers and associated businesses working together.

• Funded by members, sponsors, projects.

• Common goal – building public trust in food and farming.
Building Public Trust in Food & Farming in Canada

Coordination & Strategy

Advocacy
Intelligence
Issue
Management

“Play defense”

Practices
Programs
Research
Regulations

“Do the right thing”

Public Trust
& Outreach

“Let’s have a conversation”
RECOMMENDED BINATIONAL PHOSPHOROUS REDUCTION
TARGETS FOR LAKE ERIE

July 14th, 2015
Susan Humphrey – Environment Canada
Sandra George – Environment Canada
Current ecosystem conditions
Phosphorus Loadings over time

Canada contributes approximately 15% of phosphorus loads lakewide.
## Proposed Bi-National Phosphorus Load Reduction Targets

<table>
<thead>
<tr>
<th>Lake Ecosystem Objectives</th>
<th>Western Basin of Lake Erie</th>
<th>Central Basin of Lake Erie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Lakes Water Quality Agreement</td>
<td>40% reduction in total phosphorus entering the Western Basin and Central Basin of Lake Erie – from the United States and from Canada - to achieve 6000 MT Central Basin load</td>
<td></td>
</tr>
<tr>
<td>Annex 4, Section B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimize the extent of hypoxic zones in the Waters of the Great Lakes associated with excessive phosphorus loading, with particular emphasis on Lake Erie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain algal species consistent with healthy aquatic ecosystems in the nearshore Waters of the Great Lakes</td>
<td>40% reduction in spring total and soluble reactive phosphorus loads from the following watersheds where localized algae is a problem:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thames River - Canada</td>
<td>Sandusky River - US</td>
</tr>
<tr>
<td></td>
<td>Maumee River - US</td>
<td>Huron River, OH – US</td>
</tr>
<tr>
<td></td>
<td>River Raisin - US</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Portage River - US</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toussaint Creek - US</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leamington Tributaries – Canada</td>
<td></td>
</tr>
<tr>
<td>Maintain cyanobacteria biomass at levels that do not produce concentrations of toxins that pose a threat to human or ecosystem health in the Waters of the Great Lakes</td>
<td>40% reduction in spring total and soluble reactive phosphorus loads from the Maumee River (U.S.)</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Where are we at today?
06 Aug - The Microcystis cyanobacteria bloom has intensified in the western part of the western basin. Yesterday extensive severe scum was present west and south of West Sister Island to both the Ohio and Michigan shorelines. All areas in dark red in the satellite image had scum. The bloom also continues to extend eastward, although with only patchy scum areas, through the islands to the northeast offshore of Point Pelee. Microcystin is present in this bloom, with toxin levels especially high in scums.
Figure 2. Nowcast position of bloom for 06 August, 2015 using GLCFS modeled currents to move the bloom from the 05 August, 2015 image.
So Who Does this impact?
Data Source: 2011 Census of Agriculture, Statistics Canada
Land Information Ontario

Disclaimer: The Ontario Ministry of Agriculture, Food, and Rural Affairs, does not certify the correctness of any information on this map and is not liable for any actions taken or not taken by any person.

This map is illustrative only. Do not rely on it as an indicator of routes, features, nor as a guide to navigation.

Produced by the Environmental Management Branch
Ontario Ministry of Agriculture, Food and Rural Affairs

Number of Dairy Cows
- 0 - 1,000
- 1,000 - 7,500
- 5,000 - 7,500
- 7,500 - 15,000
- 15,000 - 35,000
- Suppressed Data/No Data

# Number of Dairy Farms

244
Phosphorus in Lake Erie

How Much Are We Losing?

What Can We Quantify?

Gabrielle Ferguson, OMAFRA

Farm and Food Care
GUELPH, ON
August 10, 2015
**DISTRIBUTION OF NPS LOAD BY WATERSHED**
(Avg 1967 – 2008)

An Estimate of Average Ontario Lake Erie Farmland contribution

- Total load 10,000 kg/yr
- From Ontario ~ 20 % to 25%
- Average TP Load from Cropland (kg/ha/year) ~0.63 – 0.78

(Source: Lake Erie Lakewide Management Plan, Nov 2008)
60 -80% of sediment and phosphorus loading occurs during the non-growing period (Nov 1 to April 1)
Timing and Frequency of P Application

Fraction of Annual Runoff

- Winter: JFM
- Spring: AMJ
- Summer: JAS
- Fall: OND

Manure P applied mid-Oct

Fertilizer P applied mid-Oct

M Macrae, U of Waterloo
# Phosphorus Rate and Timing

<table>
<thead>
<tr>
<th>NMAN 6 years</th>
<th>Agronomic P205</th>
<th>Crop Removal P205</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till soys P bcst</td>
<td>0-0-0-0-0-0</td>
<td>38-38-38-38-38-38</td>
</tr>
<tr>
<td>cC-cS-cW P band</td>
<td>18-0-0-18-0-0</td>
<td>83-0-83-83-0-83</td>
</tr>
<tr>
<td>No-till C-S P bcst</td>
<td>18-0-18-0-18-0</td>
<td>70-38-70-38-70-38</td>
</tr>
<tr>
<td>C-nS-nW Pbcst/incorp</td>
<td>18-0-0-18-0-0</td>
<td>166-0-0-166-0-0</td>
</tr>
</tbody>
</table>

**Soil Test level** 25 ppm

K. McKague, OMAFRA
PHOSPHORUS UPTAKE

P deficiency

P in soluble form and in close proximity to roots is taken up by plants
Placement of P Application

\[ y = 0.09e^{0.42x} \]

\[ r^2 = 0.77 \]

Source: Kleinman (Penn State, USDA-ARS)
# Phosphorus Rate and Timing

<table>
<thead>
<tr>
<th>NMAN 6 years</th>
<th>Ontario P-Index</th>
<th>USLE (ton/ac/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till soys</td>
<td>20</td>
<td>1.3</td>
</tr>
<tr>
<td>P bcst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cC-cS-cW</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>P band</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-till C-S</td>
<td>24.5</td>
<td>1.6</td>
</tr>
<tr>
<td>P bcst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-nS-nW</td>
<td>9.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Lower numbers are better

K. McKague, OMAFRA
Healthy Soils = Healthy Waters
And more profit for farmers

Unpredictable weather
erratic storms + yearly fluctuations

Can’t see the losses in any one year

2 feet of deposition – 25 yrs

FACT
800 tons = 50 truck loads of soil
Side-by-Side trial
same soil, slope, rainfall, current management

Poor soil health
65 bu/ac

Good soil health
201 bu/ac

Ross Wilson
rwilson@abcga.on.ca
Lack of Crop Diversity across Ontario

Field with only Corn or Soybeans

2011 – 2013

Add Wheat =
+10% Ridgetown
+14% Elora

Rotation effect
over 34 years =
+22% yield

+ 31 bu/ac adding wheat to Corn-Soy rotation (zero N)

Lambton and Middlesex
Fields with only Corn or Soybeans
2011 – 2013
Convention Tillage – is 30% residue enough?
No “typical” P losses

Research
Loam
0.3-0.5 kg/ha
Clay
0.7-1.0 kg/ha

“Tile” Flow

“Overland” Flow
**Cover Crops**

**Reduce Soil Loss = Less P Loss**

Chatham-Kent Soybeans

~40% less soil loss

<table>
<thead>
<tr>
<th></th>
<th>With Cover Crop</th>
<th>No Cover Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Erosion T/ha/yr</td>
<td>0.19</td>
<td>.33</td>
</tr>
<tr>
<td>Soil conditioning index</td>
<td>0.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

A higher SCI value = improving soil health

**RUSLE2 = Revised Universal Soil Loss Equation 2**

Download RUSLE2 computer tool from: [www.omafra.gov.on.ca/english/engineer/rusle2/index.htm](http://www.omafra.gov.on.ca/english/engineer/rusle2/index.htm)
**FILTERING PARTICULATE P**

Grassed Waterways effectiveness

<table>
<thead>
<tr>
<th></th>
<th>Sep 2011</th>
<th></th>
<th>Jan 2013</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[TSS] (mg/L)</td>
<td>[TP] (mg/L)</td>
<td>[TSS] (mg/L)</td>
<td>[TP] (mg/L)</td>
</tr>
<tr>
<td>Top</td>
<td>96</td>
<td>8.7</td>
<td>80-170</td>
<td>0.4</td>
</tr>
<tr>
<td>Bottom</td>
<td>26</td>
<td>0.5</td>
<td>80-170</td>
<td>0.4</td>
</tr>
</tbody>
</table>
TRAPPING FIELD RUNOFF

3 years
3 sites, CBW rotation

Avg Precip: 954 mm
Avg Runoff: 331 mm
Overland - 20%
Tile - 80%

Avg Annual P loss:
TP  0.3-0.5 kg/ha
DRP  0.03-0.1 kg/ha

Source: U of Waterloo, 2015

STORAGE SIZE NEEDED
4 m deep rectangular pond
(2:1 side slopes)
107 m X 107 m (1.1 ha surface area)
Suites of BMPS are more effective than a single BMP

Berm alone reduces
Sediment 10%, P 6%, N 6.5%

Systems approach
Sediment 24%, P 32%, N 16%

Structures + No-till + Rotation + Agronomic fertilizer
Craig Merkley, Upper Thames Conservation Authority
FILTERING PARTICULATE P

Runoff ponding time is key

• Smaller discharge tile/orifice
• Alternative inlet designs/socks?

• Adjust inlets to increase ponding times in non-growing season?
FILTERING DISSOLVED AND PARTICULATE P

Wisconsin Findings
Blind Inlet Nutrient Reductions vs Riser Inlet

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>2009 % Reduction</th>
<th>2010 % Reduction</th>
<th>Expected life: 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment</td>
<td>11*</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Ammonium-N</td>
<td>30</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Nitrate-N</td>
<td>34% increase</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Total Kjehldahl N</td>
<td>66</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Soluble P</td>
<td>64</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Total P</td>
<td>52</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

Indiana Findings: (7 years)
Total P – 66% lower
Dissolved P – 50% lower
TSS – 64% lower
“For every ten feet in height of a tree windbreak, you will see an increase in yield for approximately four to five times that (40’ to 50’) into the field.”
Earl Elgie, Kent County
Special thanks to:

Cindy Bradley MacMillan, Jacqui Empson Laporte, OMAFRA
Andrew Graham & Christine Schmalz, OSCIA
Dr. Merrin Macrae, University of Waterloo, Kevin McKague OMAFRA
Dr. Tom Bruulesma, IPNI
Adam Hayes, Anne Verhallen, Ted Taylor, Chris Brown OMAFRA
Craig Merkely, UTRCA and Anne Loeffler, GRCA
Staff of the Kettle Creek/ Upper Thames River and Ausable Bayfield Conservation Authorities
who shared their expertise and experience
The 4 Rs and the Agro-ecosystem

Dr. Ivan O’Halloran, University of Guelph, Ridgetown Campus
Right Product  

Right Placement  

COMMON SENSE  

Right Rate  

Right Time
Ontario’s Biophysical Condition – climate

Fall → Spring:
Runoff & tile flow

Source Weather Innovations Inc.
Ontario’s Biophysical condition – physiography and soils

- Clay Plains
- Sand Plains
- Till Plains
- Till Moraines
- Kame Moraines

30% poorly drained
30% imperfectly drained
Balancing Act

• Agriculture → Necessity

• Environmental Impact → Reality
In the soil
- P has low solubility
- P binds tightly to the soil

Therefore P only moves when soil erodes depends on perspective
Assume ~ 2 ppm change in Soil Test P to change fertilizer P recommendation and this represents an agronomic significant amount.

Assume ~ 40 cm runoff/drainage water at 0.03 mg/L (Water Quality guidelines).

Takes about 15-20 kg fertilizer P to increase soil test P by 1 ppm → similar to decrease?? → so loss of 30-40 kg P/ha to maybe be a significant agronomic loss.

0.4 m x 10,000 m²/ha x 1000 l/m³ x 0.03 mg/L = 0.12 kg/ha
What is the Estimated P Loading Contribution from Ontario Cropland?

Consider Ontario croplands draining to Lake Erie or Lake St. Clair only (see below).

Assume from Lake Erie studies that 10% of the total NPS P loading to Lake Erie originates from Ontario Cropland. NPS P is estimated to be 60% of the total P loading. Therefore NPS P loading from Ontario Cropland is \[0.1 \times 0.6 \times 10000 \text{ T/yr} = 600 \text{ T/yr} \ (600,000 \text{ kg/yr})\]

<table>
<thead>
<tr>
<th>Region/Watershed</th>
<th>Area (km²)</th>
<th>Cropland (%)</th>
<th>Cropland Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand River CA</td>
<td>6965</td>
<td>71</td>
<td>494515</td>
</tr>
<tr>
<td>Longpoint CA</td>
<td>2900</td>
<td>78</td>
<td>226200</td>
</tr>
<tr>
<td>Kettle CA</td>
<td>520</td>
<td>79</td>
<td>41080</td>
</tr>
<tr>
<td>Catfish CA</td>
<td>490</td>
<td>80</td>
<td>39200</td>
</tr>
<tr>
<td>Thames River WS</td>
<td>5820</td>
<td>82</td>
<td>477240</td>
</tr>
<tr>
<td>Lake Erie N. Shore</td>
<td>737</td>
<td>82</td>
<td>60434</td>
</tr>
<tr>
<td>St Clair CA/Sydenham</td>
<td>4100</td>
<td>86</td>
<td>352600</td>
</tr>
<tr>
<td>Essex CA</td>
<td>1631</td>
<td>79</td>
<td>128849</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>23163</strong></td>
<td></td>
<td><strong>1820118</strong></td>
</tr>
</tbody>
</table>

Estimated Net NPS P from Ontario (kg/year) \[600,000\]

Average TP Load from Cropland (kg/ha/year) \[0.33\]

Source: Env Canada, 2014
“The FLAW of Averages”
Olsen P ≤ 36.9 mg kg⁻¹: \( y = 0.00235x + 0.00744 \)

Olsen P > 36.9 mg kg⁻¹: \( y = 0.00727x - 0.174 \)

\( r² = 0.64 *** \)

Leaching DRP and STP

Runoff DRP and STP

\( y = 0.00275x + 0.0102 \)

\( r² = 0.72 *** \)
Nutrient losses in tile flow
soil types
annual losses and timing
nutrient sources
tillage systems
Tillage and P Loss

- P stratification in the soil → crop residues & surface applications of P

- **Note:** Soil test P differences would likely be greater if smaller depth increments used
Potential Consequence of Fall Surface Applied P (by the numbers)

20 kg/ha P fall applied (~45 kg/ha or 41 lb/ac of P$_2$O$_5$)

- Incorporated
  - ↓ P at surface less available for surface runoff
  - ↑ erosion potential
  - through soil loss ??? → likely depends upon degree of mixing and flow through soil
Consequence of Fall Surface Applied P (by the numbers)

20 kg/ha P fall applied (~45 kg/ha or 41 lb/ac of P$_2$O$_5$)

- Not Incorporated
  - Most of P stays at surface
  - Effective application rate is ???
    - If stays in top 2.5 cm $\rightarrow$ 6 x the rate

- Impact on soil test P
  - ↑ 6 – 60 ppm
Leaching DRP and STP

Runoff DRP and STP

Olsen P ≤ 36.9 mg kg⁻¹: \( y = 0.00235x + 0.00744 \)
Olsen P > 36.9 mg kg⁻¹: \( y = 0.00727x - 0.174 \)
\( r^2 = 0.64 *** \)

\[ y = 0.00275x + 0.0102 \]
\( r^2 = 0.72 *** \)
4R’s & Nutrient Management

Right Product
Right Placement
Agronomy & Environment
Right Rate
Right Timing
Phosphorus Primer – How P behaves in soil, and why it doesn’t always stay put!

D. Keith Reid
Forms of P in the soil

- Manure P
- Fertilizer P
- Labile P
- Soil Test P
- Solution
- Plant Available P
- ORGANIC
- INORGANIC
- Slow Transformation
- Stable
Runoff

Tile Drain

Infiltration

Dissolved P

Surface Water
Erosion

Infiltration

Particulate P

Rain

Tile Drain

Surface Water
Dissolved P Losses vs. Soil P

\[ y = 0.1608x - 1.9727 \]

\[ R^2 = 0.8231 ** \]

\[ y = 0.0233x + 0.0223 \]

Zhang et al, 2010
Dissolved P Losses vs. Soil P and Management

\[ y = 0.0233x + 0.0223 \]

\[ y = 0.1608x - 1.9727 \]

\[ R^2 = 0.8231 ** \]

Zhang et al, 2010

Direct DRP losses from “poor” application

Opportunity for short term improvement

Direct DRP losses from “good” application

Zhang et al, 2010
Dissolved P Losses vs. Soil P and Management

\[ y = 0.0233x + 0.0223 \]
\[ y = 0.1608x - 1.9727 \]
\[ R^2 = 0.8231 \]

Leachate DRP (mg L\(^{-1}\)) vs. WEP (mg kg\(^{-1}\))

Opportunity for slow, long-term improvement

Zhang et al, 2010
P Risk Assessment

High P source, but no transport  High transport, but no P source
= limited risk  = limited risk
Critical Source Areas

(Adapted from Kleinman, 2015)
Potential approaches to managing P loss

• Control Erosion
  – Highly effective where particulate P losses dominate, little effect on DRP losses

• Subsurface placement of P (banding or incorporation)
  – Immediate reduction in DRP losses in runoff and tile

• Application timing
  – Spring/summer generally lower risk than fall/winter

• Reduce P rates, P drawdown
  – Effective where history of excessive P applications

• Enhance infiltration
  – Reduces transport component
- The capacity of P to bind to soil means there is potential for it to accumulate over time with successive positive P-balances.

- Cumulative P (kg P/ha) calculated for each SLC via linear interpolation from P-balance data from 1981 to 2006.

- SLCs with higher cumulative P generally have more livestock.

- Significant portion of the basin has a negative P balance.
Phosphorus Balance Trend

- P-balance (kg P/ha/year) from each Census year data was also used to calculate trends over a 25-year period (1981-2006)

- No increasing trends in any SLCs

- Declining P-balance trends in some SLCs in the basin

Source: E. Van Bochove, K. Reid, AAFC
Distribution of Cropland in Lake Erie Basin

**Canadian portion**
- Soybeans: 34%
- Cereals, all: 20%
- Forages & Other: 13%
- Fruit and tree nut: 0%
- Nursery, sod, GH: 0%

Total Cropland = 14227 km²

**American portion**
- Soybeans: 40%
- Cereals, all: 10%
- Forages & Other: 14%
- Fruit and tree nut: 0%
- Nursery, sod, GH: 0%

Total Cropland = 29154 km²
Number of livestock in Canadian relative to the U.S. Lake Erie basin

- Cattle and calves
- Hogs and pigs
- Sheep, lambs & goats
- Horses and ponies
- Chickens, all
Consequences of differences in crops and livestock between Canada and U.S.:

- Greater proportion of nutrients from manure in Ontario
- Higher variability in distribution of nutrients
- More tillage for manure incorporation
- More complexity in crop rotations
Questions?
Distribution of Field Crops in Lake Erie basin

Source: Crop Inventory Map 2012 - AAFC, Science and Technology Branch, Earth Observation Service
CropScape: Cropland Data Layer 2012 - USDA, National Agricultural Statistics Service, Research and Development Division
Distribution of Corn in Lake Erie basin

Source: Crop Inventory Map 2012 - AAFC, Science and Technology Branch, Earth Observation Service
CropScape: Cropland Data Layer 2012 - USDA, National Agricultural Statistics Service, Research and Development Division
Distribution of Cereals in Lake Erie basin

Source: Crop Inventory Map 2012 - AAFC, Science and Technology Branch, Earth Observation Service
CropScape: Cropland Data Layer 2012 - USDA, National Agricultural Statistics Service, Research and Development Division
Other factors affecting P export

• Drainage patterns
  – Thames River drains into Lake St. Clair rather than directly into Lake Erie; P retention plus dilution from Lake Huron

• Soil pH
  – Much higher incidence of calcareous soils in Ontario than Ohio or Michigan; more P tied up with calcium or magnesium
Median Soil pH Levels in 2010

Map of North America showing median soil pH levels in 2010. The colors indicate the pH levels:
- Blue is within 0.2 of 2005
- Red is 0.3 < 2005
- Green is 0.3 > 2005

Source: International Plant Nutrition Institute
Other factors affecting P export

• Drainage patterns
  – Thames River drains into Lake St. Clair rather than directly into Lake Erie; P retention plus dilution from Lake Huron

• Soil pH
  – Much higher incidence of calcareous soils in Ontario than Ohio or Michigan; more P tied up with calcium or magnesium

• Tile Drainage
  – Extensive tile drainage throughout the basin; trend to intensifying drainage systems in Ontario (narrower spacing)

• Fertilizer recommendation systems
Contrasting Fertilizer Recommendation Systems

**Ontario**

- **Sufficiency Approach** – Expectation is that response to fertilizer will maximize return to fertilizer in the year applied.
- Application method affects response to fertilizer, greatest with banding at planting.
- Most farmers perceive value in additional time and labour for banding fertilizer.

**Tri-State (Michigan, Ohio, Indiana)**

- Build up and maintenance approach – build up soils so fertility does not limit yield, then replace nutrients removed.
- Application method has no effect on efficiency of maintenance applications.
- Most farmers perceive greater benefit to timely planting than response to fertilizer at planting.
Comparison of Ontario and Tri-State P Recs

<table>
<thead>
<tr>
<th>Ontario Soil Test values</th>
<th>Tri-State Soil Tests</th>
<th>Ontario Rec’s</th>
<th>Tri-State Recommendations at Realistic Yield Goals (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olsen (ppm)</td>
<td>Bray (ppm)</td>
<td>120</td>
<td>170</td>
</tr>
<tr>
<td>0-3</td>
<td>5</td>
<td>110</td>
<td>105</td>
</tr>
<tr>
<td>6-7</td>
<td>10</td>
<td>90</td>
<td>78</td>
</tr>
<tr>
<td>13-20</td>
<td>15-30</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>21-30</td>
<td>35</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>31+</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Ontario and Tri-State P Recommendations

- **Ontario**
- **Tri-120**
- **Tri-170**
- **Tri-250**

**Bar Chart**
- **VL soil test**
- **L soil test**
- **M soil test**
- **H soil test**
Consequences for Risk of P losses

• Tendency is for more banded P fertilizer in Ontario compared to Tri-State area

• This is changing over time, as larger farms in Ontario move to broadcast fertilizer because of time limitations and labour costs

• Some large farms have adopted air delivery systems to allow use of banded fertilizer on large planters (not cost effective for small to medium size planters)

• Highest risk scenario is broadcast application without incorporation in the fall or winter
Conclusions

• The Canadian and U.S. sides of the Lake Erie basin are more similar than different, BUT the differences will affect the amount and form of P entering the lake

• Canadian side has greater concentration of livestock (particularly swine and poultry), more cereals and more specialty crops (vegetables, greenhouses)

• Fertilizer recommendation systems adopted in each jurisdiction in the 1960s have consequences to the way phosphorus is managed, and therefore to the risk of P losses.
Phosphorus and Agricultural Best Management Practices: What Works?

Great Lakes Strategic Planning Session
August 10, 2015
Guelph.

Chitra Gowda, B. Eng., M.A.Sc.
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Conservation Ontario
Presentation Overview

• Roadmap of P Load Reduction
• Review of Agricultural BMPs
• Source Water Protection Links
• Achieving the Targets: Strategies for Discussion


2015-2025: Manage P Loadings: through effective education, outreach and BMPs.

2020: Meet Interim P Load Target of 20% reduction from 2008 level.

2025: Meet P Load Target.
Review of Agricultural Best Management Practices

- In 2013, Mari Veliz, Brynn Upsdell of the Ausable Bayfield Conservation Authority (CA) and Chitra Gowda (at the time, Essex Region CA) collaborated to conduct a comprehensive review of studies assessing agricultural BMPs.

- A total of 37 scientific/technical studies, 3 BMP review papers and 1 watershed management plan development paper were reviewed.
Agricultural BMPs which reduced Total Phosphorus (TP) and Dissolved Reactive Phosphorus (DRP) by at least 20% each

<table>
<thead>
<tr>
<th>Agricultural Best Management Practice</th>
<th>TP</th>
<th>DRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero/no tillage</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Crop rotation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fertilizer reduction</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cover crops</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Controlled tile drainage</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Constructed wetland intercepting tile drainage</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gully plugs: water and sediment control basins (WasCobs)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Livestock fencing</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Manure application rates based on soil needs</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced farmyard runoff by redirecting clean water</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>No winter manure application</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced fall and winter manure application</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Poultry litter incorporation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Spreader adjustment (for hog slurry): spreader was equipped with trailing pipes, followed by shallow cultivation</td>
<td>✓</td>
<td>No data.</td>
</tr>
</tbody>
</table>

Review of Agricultural Best Management Practices

Challenges and Considerations:

• It is difficult to assess the benefit of measures at a watershed scale; conversely the **assessment at a smaller scale** (generally, 1500 ha or less) is found to be practical and accurate.

• During wet weather events, the runoff can span over topographic watershed boundaries, thus bringing additional nutrient and soil loading into the study area. **BMPs must work during high flows also!**

• ‘**One size does not fit all**’. Watershed characteristics (soil type, topography, etc.), changing landscapes (land uses, altered hydrology, etc.), and climate conditions will influence the impact the BMP has, and its assessment. BMPs are also needed for **sub-surface drainage** as much of Ontario is tile drained.

Some Current BMPs…

No-till Vs Tillage:
- Breaks up pores
- Mixes in P to lessen surface concentrations
- This may lessen load to tile drains
- *But* more erosion in surface runoff

*Slide courtesy of: Dr. Merrin Macrae, Associate Professor, Geography and Environmental Management, University of Waterloo*
Some Current BMPs…

Cover Crops, Riparian Buffer Strips, Grassed Waterways, Water and Sediment Control Basins (WASCoBs)

• Build soil organic matter
• Slow surface erosion
• But may not work in winter, and may supply dissolved P

Slide courtesy of: Dr. Merrin Macrae, Associate Professor, Geography and Environmental Management, University of Waterloo
Strip tillage potential?

- May reduce P loss!

Why?
- Breaks up preferential pathways in subsurface
- P only applied in tilled areas (where crops planted)
- No-till strips provide benefit of improved soil organic matter, less erosion
- Possibly less P applied overall AND less P loss?

*Slide courtesy of: Dr. Merrin Macrae, Associate Professor, Geography and Environmental Management, University of Waterloo*
Source Water Protection Links

Great Lakes Targets and the Clean Water Act

• The Clean Water Act was passed in 2006 to protect sources of drinking water in source protection areas in Ontario.

• The Clean Water Act indicates that the Ministry of Environment and Climate Change (MOECC) can establish targets for Great Lakes water quality and quantity improvement.

• Once targets are established for specific lakes, policies must be written to address them. These will be mandatory policies in local Source Protection Plans.
Intake is 750 m from shore, and 4.5 m deep.

Map courtesy of: Essex Region Conservation Authority
Source Water Protection Links

BMP Resources:

- BMPs sorted by effectiveness and cost into a hierarchy table by City of Orillia; contact Chitra at Conservation Ontario:

<table>
<thead>
<tr>
<th>Measure Name</th>
<th>Measure Short Description</th>
<th>MOECC Rated Effectiveness</th>
<th>Implementation Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrient Management Training</td>
<td>Nutrient management training provides information on practices that could contribute to maximize the use of the prescribed materials, reduce nutrient loss and environmental damage and maximize crop uptake of nutrients.</td>
<td>3 - Low</td>
<td>Low</td>
</tr>
<tr>
<td>Locate Contamination Sources Downslope of Well(s)</td>
<td>Considering source water protection in the farm management process minimizes contamination threat to groundwater. For example, allocate the storage area in the down slope of the well, and prevent ponding of surface water in the vicinity of the well.</td>
<td>1 - High</td>
<td>Low</td>
</tr>
<tr>
<td>Grassen Waterways</td>
<td>Grasen waterways are a good solution to slow the water flow and protect channels from the eroding forces of runoff water when the watershed area generating the runoff water is relatively large.</td>
<td>2 - Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Usage of Farm Water and Sediment Control Basins</td>
<td>Erosion control structures installed to prevent bank and gully erosion on farmlands. The runoff water is temporarily stored behind the berm, eliminating its erosive capabilities further down slope.</td>
<td>1 - High</td>
<td>Low - Medium</td>
</tr>
</tbody>
</table>
Achieving the P Reduction Target: A Few Strategies for Discussion

Summary:
- Proposed target: 40% reduction from 2008 P Loading to Lake Erie.
- To be achieved by 2025 by various sectors: municipal, agricultural, residential, on both sides of the border.
- Comment period for proposed target ends August 31.

A Few Strategies for Discussion:
- Components of a Phased Approach for the Agricultural Sector:
  - Time: 2015 + 10 years
  - Type of practice: crop/livestock, scale of operation: prioritize?
  - Type of BMP: cultural, structural: rank (effectiveness, cost)?
  - Stewardship: funding agency programs to prioritize high impact BMPs for P load reduction to Lake Erie.
Thank you.

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Nutrient Management Strategies

Chris Attema (NMP)
Summary

- 10-years: A significant % of livestock agriculture with an approved Nutrient Management Strategy
- NMA compared to the Lake Erie Nutrient Target (LENT) recommendations (June 2015)
- NMA compared to 4R-Principles
  - Source – Rate – Place –Time
- Difference between a Nutrient Management Strategy & a Nutrient Management Plan
- NMP Phase-In Policy in Wisconsin
Number of Nutrient Management Strategies

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>1869</td>
</tr>
<tr>
<td>Beef</td>
<td>1107</td>
</tr>
<tr>
<td>Horses</td>
<td>1091</td>
</tr>
<tr>
<td>Swine</td>
<td>921</td>
</tr>
<tr>
<td>Chickens</td>
<td>838</td>
</tr>
<tr>
<td>Sheep</td>
<td>270</td>
</tr>
<tr>
<td>Goats</td>
<td>210</td>
</tr>
<tr>
<td>Turkey</td>
<td>116</td>
</tr>
<tr>
<td>Veal</td>
<td>75</td>
</tr>
<tr>
<td>Other</td>
<td>79</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6576</td>
</tr>
</tbody>
</table>

4708 active, approved Nutrient Management Strategies

Note: A significant number of the strategies that indicate horses are operations that commercially raise another type of livestock, but may have one or two horses for recreational purposes. Also, a number of these are Old Order Mennonite farms that have a few draft horses, but raise another type of livestock commercially.
Lake Erie Nutrient Targets Working Group


Manage nutrient applications on frozen or snow covered ground

_Description_
The action calls for the management of manure, fertilizer and biosolid applications under the following conditions: on frozen or snow-covered ground, on saturated soil, or when the weather forecast calls for a severe rain event.

- **Managing** or eliminating nutrient applications on frozen ground
Ontario: Winter spreading NOT RECOMMENDED
- Alternatives to winter spreading e.g. temporary manure storage
- CONTINGENCY - appropriate site selection

Current Winter spreading rules in the Nutrient Management Act, 2002, under Ontario Regulation 267/03 are consistent with the LENT recommendation to manage nutrient application on frozen / snow covered ground
- Liquid manure: injection or incorporation of within six hours of land application.
- Solid manure: incorporated into the soil within six hours of land application, or surface applied on fields with a living crop or crop residue.
While the winter spreading rules in the Nutrient Management Act, 2002, under Ontario Regulation 267/03 apply to phased-in farms, other environmental legislation regarding the release of contaminants applies to everyone.

- Environmental Protection Act
- Ontario Water Resources Act
- Fisheries Act

Adopt “4Rs Nutrient Stewardship Certification program” or other comprehensive nutrient management programs

Description
The 4Rs Nutrient Stewardship Certification program is a voluntary agricultural retailer certification program focused on nutrient stewardship. The program offers a special designation to retailers and crop advisors who assist producers with the implementation of best management practices (BMPs) that optimize the efficiency of fertilizer use, including:

- Voluntary

- Is the Ontario Nutrient Management Act and NMAN-software consistent with the 4-R principles?
4Rs OF NUTRIENT STEWARDSHIP
Economically, Environmentally & Socially Sustainable Crop Nutrition

The 4Rs promote best management practices (BMPs) to achieve cropping system goals while minimizing field nutrient loss and maximizing crop uptake.

4R Principles of Nutrient Stewardship

- **RIGHT SOURCE**: Matches fertilizer type to crop needs.
- **RIGHT RATE**: Matches amount of fertilizer to crop needs.
- **RIGHT TIME**: Makes nutrients available when crops need them.
- **RIGHT PLACE**: Keeps nutrients where crops can use them.
<table>
<thead>
<tr>
<th>Nutrient Management Strategy</th>
<th>Nutrient Management Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td># and type of livestock</td>
<td>Detailed individual field maps</td>
</tr>
<tr>
<td>Manure storage</td>
<td>Crop rotation - yields - tillage</td>
</tr>
<tr>
<td>Runoff management</td>
<td>Soil test - slope</td>
</tr>
<tr>
<td>Temporary in-field storage sites</td>
<td>Nutrient information</td>
</tr>
<tr>
<td>Limited destination information</td>
<td>Source - Rate - Time - Place</td>
</tr>
<tr>
<td>0.75 – 1.0 NU/acre</td>
<td>Incorporation - Nutrient balance</td>
</tr>
<tr>
<td>1 NU = 43 kg N or 55 kg P$_2$O$_5$</td>
<td>N-Index</td>
</tr>
<tr>
<td></td>
<td>P-Index</td>
</tr>
</tbody>
</table>
Nutrient Management Plan: Regulation Challenges

- Detailed individual field Nutrient Management Plan
- Practical implementation challenges for both the regulator & the regulated
- Plan – Approval – Record Keeping – Audit

- Is Regulation the right approach?
- A credible and thorough Regulatory Impact Analysis should consider if other approaches (education – awareness – voluntary) can meet the desired objective
- What would be the ‘phase-in’ trigger for non-livestock farms?
Wisconsin Nutrient Management

When can a NM Plan be Required?
Farms can be required to implement nutrient management with a $28/ac cost share offer or if:
1. Causing a significant discharge.
2. Regulated by local manure storage or livestock siting ordinances, or by a DNR WPDES permit,
3. Accepting NM planning or manure storage cost share funds, or
4. Participating in the Farmland Preservation Program.
2004-2014 Nutrient Management Plan Acres Reported by Program

in thousands of acres

Legend:
- Other = Voluntary
- CS = DNR NRCS Cost-Share
- DATCP = FP or Cost-Share
- CAFO = NR 243 WPDES Permit
- ORD = Manure Storage or Livestock Siting Ordinance

Year: 2004
- 0.7 M Acres
- 179
- 223

Year: 2005
- 0.8 M Acres
- 117
- 132
- 106
- 134
- 106

Year: 2006
- 0.9 M Acres
- 148
- 377
- 296
- 194

Year: 2007
- 1.0 M Acres
- 163
- 451
- 229
- 220
- 107

Year: 2008
- 1.3 M Acres
- 304
- 183
- 483

Year: 2009
- 1.4 M Acres
- 145
- 343
- 432
- 354

Year: 2010
- 1.5 M Acres
- 295
- 183
- 441

Year: 2011
- 1.8 M Acres
- 456
- 604
- 570

Year: 2012
- 1.9 M Acres
- 271
- 878
- 965

Year: 2013
- 2.3 M Acres
- 35
- 181

Year: 2014
- 2.58 M Acres
- 53
- 42

No Program
- 169
- 570
- 552
- 825
- 689
- 604
- 414
- 878
- 965

2,580,000-acres
X $28.00 /acre =

$72,240,000 US