

# Challenges of Phosphorus Loss Management from Agriculture

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# Phosphorus Cycling in Agricultural Fields

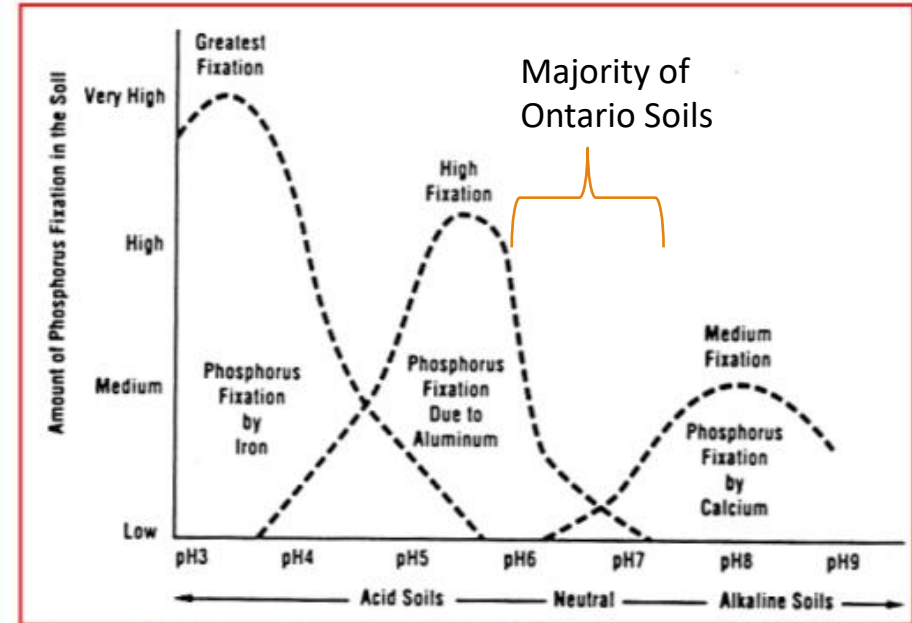
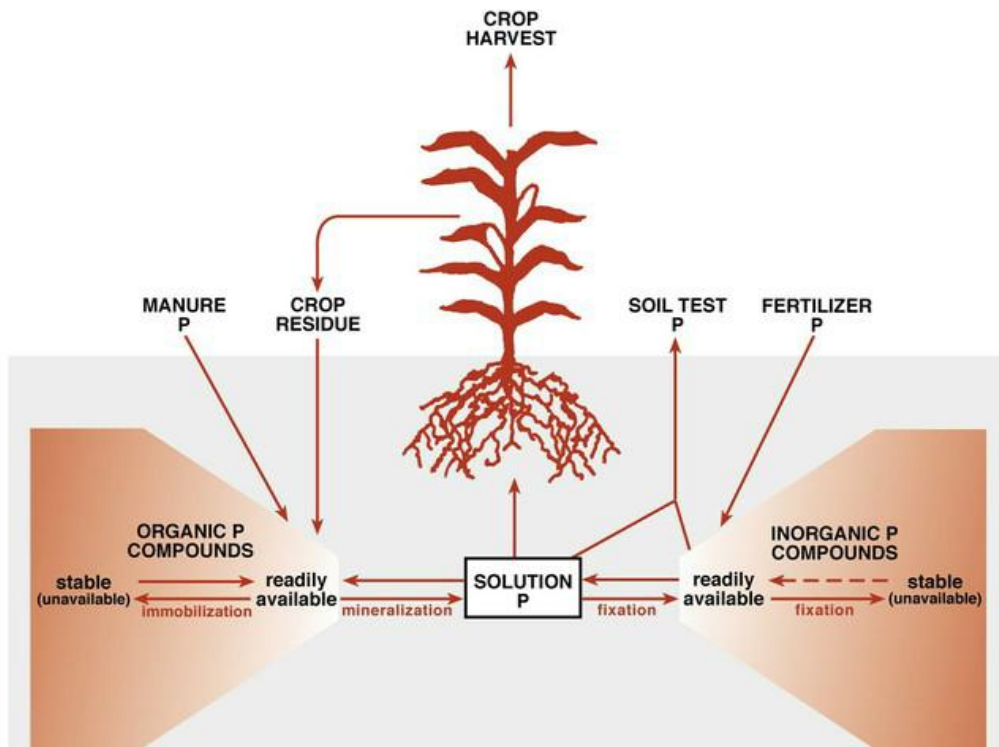


Figure 2. Phosphorus availability across pH ranges (California Fertilizer Association, 1995).

Source: USDA, NCRS

# Details of a Field P Cycle

## Inputs

Fertilizer.....Plant Residue....Manure....Municipal.... Waste Sludge

## Soil Physical Processes

Plant root development and decay.... Animal and insect soil stirring....  
surface runoff and erosion.... Infiltration and percolation of water....Atmospheric  
deposition and erosion

} P removal

## Soil Chemistry

Sorption/desorption of P on Clays, Fe, Al, Oxides,  
Secondary P Minerals Ca, Fe and Al Precipitation and dissolution  
Interaction with soil organic matter

} P Fixation

Plant uptake and export of P in harvested crop } P removal

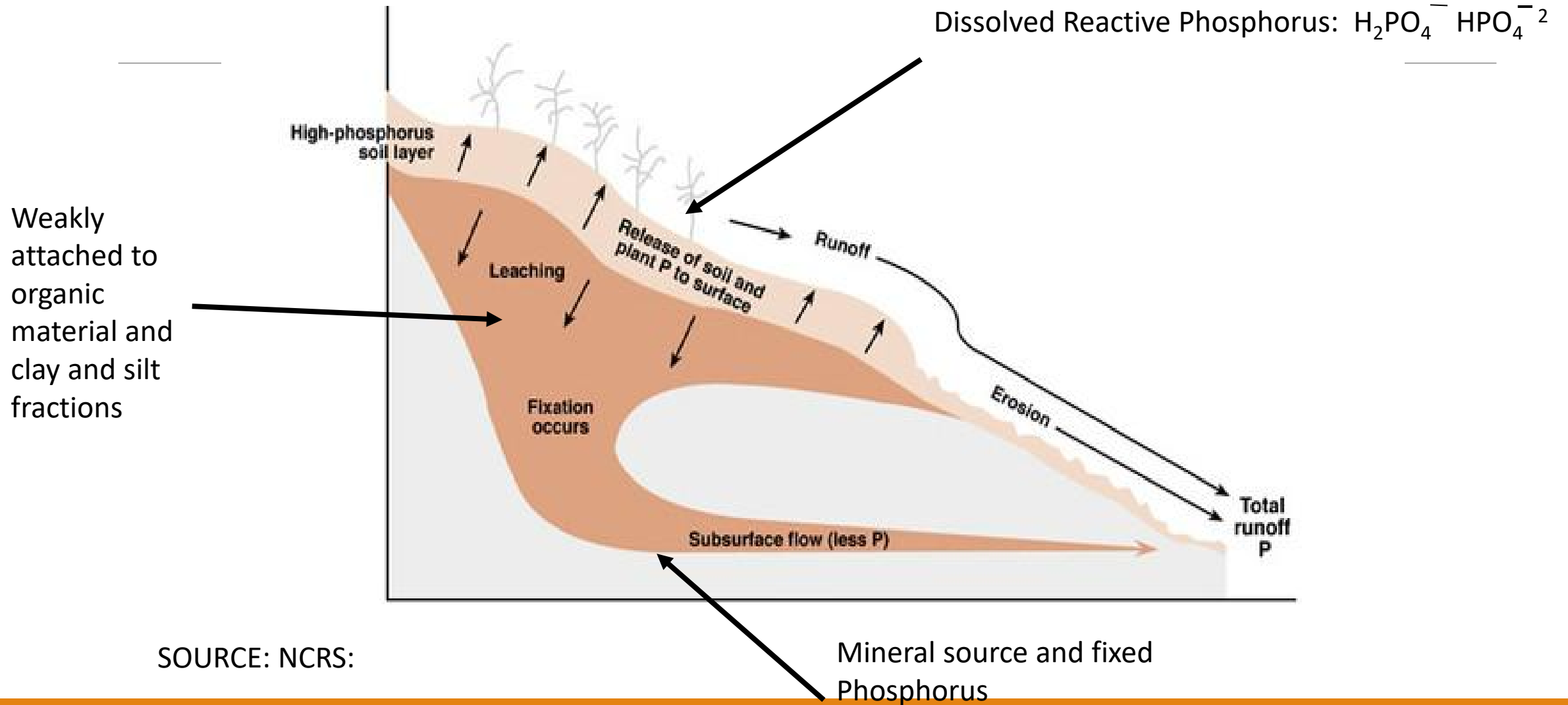
# Testing for Phosphorus

Key Factors: Soil PH, Crop Rotation, Historic use of Soil P amendments( Mineral fertilized and Manure for the most part, Level of soil P saturation, Soil Profile Characteristics

- 1) Use of hot HCL acid digestions to determine total P
- 2) Use Bray (strong Bray), Olsen 1 or Melich 3, for soils with pH from 6.5 to 7.5
- 3) Details of phosphorus testing and linkages to phosphorous input strategies can be found in paper by Keith Reid et al.

Source: Earth Sci., 05 September 2018 | <https://doi.org/10.3389/feart.2018.00135>

# Pathways of Phosphorus losses from Agricultural Fields



## Example Information Sheets for Assessment of P Management Tactics

# Cover Crops

## **Practice Description:**

Planting of a second plant cover either by under seeding or after harvest. The use of cover crops fulfills two functions: 1) protection of the soil surface to reduce or prevent soil erosion and 2) uptake of available phosphorous in the fall to reduce losses from soil via leaching, providing additional organic matter to the soil for soil structure and porosity.

A wide variety of plant materials may be used as cover crops. The characteristics most important to use of cover crops are: dense surface cover to protect the soil surface and maintenance of surface porosity, dense dendritic root form, and rooting depth at least to the B soil horizon.

## **Context for Implementation:**

Cover crops can be used on any soil from sands to clays. A wide range of species may be used as cover crops. They are used typically over-winter as they transpire in the spring and fall when other types of crops are not active (University of Minnesota | Extension, 2015).

## **Effectiveness of the Practice:**

The effectiveness of cover crops is dependent on the cover crop itself and the conditions of the soil. Cover crops can: increase infiltration and if there is enough crop growth allowed, cover crops can increase or maintain soils organic matter, reduce soil erosion, reduce pest populations, reduce compaction and improve overall soil structure, can reduce moisture loss or can be used as emergency forage (University of Minnesota | Extension, 2015 & OMAFRA, 2013). In fall and spring their root systems actually resist soil erosion (University of Minnesota | Extension, 2015).

The effectiveness may depend on management techniques, termination, nutrient management plans, species and following season crops (University of Minnesota | Extension, 2015). In addition, the types of cover crops planted as well as the management technique will ultimately have the largest effect on how well cover crops work and for what purpose they are used for.

## **Costs Associated with the Practice:**

The costs associated with cover crops will largely depend on the crop itself that is planted. OMAFRA had created a 2017 Field Crop Budget template found here (<http://www.omafra.gov.on.ca/english/busdev/facts/pub60.pdf>) which provides details on the cost of each cover crop based on \$/acre.

For example, a cost for corn conventional tillage includes: seed, treatment, fertility, pesticides, tillage, planting, spraying, fertilizing, harvesting and trucking, drying, production insurance, interest and marketing for a total cost of approximately \$558.20 per acre.

## **Acceptability to the Farmers:**

The acceptability of farmers now using cover crops has increased due to awareness that promotes the benefits of cover crops. However, the majority of land during the off-seasons are actually being used for cover crops (Ontario Cover Crops Strategy, 2017). The Ontario Cover Crops Strategy lists many reasons same to the ones listed in the template regarding the benefits. Its just up to advocating cover crops more intensively across Ontario and other provinces.

# Phosphorus Balance and Reserve

## **Practice Description:**

Phosphorus reserve in the soil typically has a composite soil sample taken for each field at the end of the crop year and at the beginning of the crop year. This provides a measure of the P loss over the winter period. The method of analysis for soil P is the Olsen method which is most applicable to the more alkaline soils of Southern Ontario PH 6.0 to 7.5. If the soils are neutral to acidic 7 or below (7.0 to 5.5) the Bray II (strong Bray method) should be used.

Records of application rates and estimates of crop removal (through crop yield P estimates) will provide a rough estimate of losses through the crop growing year.

Risk of P loss is estimated by the following equation:

$$P(\text{source factor}) = P(\text{soil test}) + P(\text{fertilizer input}) + P(\text{manure input})$$

## **Context of Implementation:**

In order to determine the risk of phosphorus losses soil tests and records of inputs and outputs are needed. The procedure has been used by the Cornell University as a component of the estimate the risk of phosphorous losses.

## **Effectiveness of the Practice:**

The method is only as good as the data. Soil test need to be done appropriately and sampling must be based on a field by field aggregate sample.

## **Costs Associated with the Practice:**

The major costs are the time and effort required to take the samples and have them delivered to the laboratory. Laboratory costs vary but range from \$15.00 to \$50 per field (\$150 to \$500 dollars assuming 10 fields).

## **Acceptability to the Farmers:**

There is a growing interest by farmers in soil testing to reduce input costs and to reduce impacts on environment. At this point we do not have sufficient evidence as to the acceptability by farmers.

# Constructed Wetlands

## **Practice Description:**

Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils and their microbial assemblages to improve water quality (US Environmental Protection Agency, 2015). Constructed wetlands are classified as surface flow or subsurface flow wetlands, which vary in removal efficiency. They incorporate wetland plants in a shallow pool. Pollutant removal is achieved by settling and biological uptake (Shueler, 1997).

## **Context for Implementation:**

Constructed wetlands are proposed as a best management practice to reduce the amount of phosphorus loads being discharged into Lake Erie. The wetlands can account for urban and agricultural sources of phosphorus pollution. Constructed wetlands can be used in a wide variety of areas where current land use is not benefiting anything.

## **Effectiveness of the Practice:**

Wetlands have been found to remove between 30% and 70% of total P loads (Zhang et al., 2009). They have also been found to reduce the median total, ortho-phosphate and dissolved concentrations in storm water. Total phosphorus experienced a statistically significant reduction due to wetland channels. Median removal efficiencies for wetlands were 51% for total P and 39% for soluble phosphorous (Schueler 1997).

## **Costs Associated with the Practice:**

Prices vary for constructed wetlands depending on the size of the pond that is built. Typical costs are in the area of \$100,000. Constructed wetlands appear to be more cost effective than other common best management practices such as dry extended detention basins, wet basins, sand filters etc., (Weiss et al. 2007).

## **Acceptability to the Farmers:**

May be expensive to create initially but is a fairly low maintenance project that could be created near a farm. This practice does require a large area so it is preferred to be in a location where land is less expensive. This could be an issue for farmers who do not have land to spare.

# Management of Agricultural Phosphorus Losses Nutrient Management

(Collaborative Regulatory Planning and Management)

## Strengths:

Requires a full assessment of the phosphorus balance for the “farm”

Requires that Owner Operator complete a nutrient management plan which can be audited periodically.

Renewed every five years

## Weaknesses:

Audits are based on a review of the Plan not conditions of the soil so Phosphorus losses are calculated using an index

The most frequent issues with Nutrient Management are excessive Phosphorus. In part due to the level of adsorption of P on clays and organic matter (Phosphorus reserve)

Nutrient management does not apply to small farms (Lt 300NU) and is focused on manure for the most part

# Instruments for Management of Phosphorus

Legislation and regulation (provincial)

Municipal By-laws for non agricultural sources

Incentives for Compliance with Regulatory Instruments

Phosphorus Trading Programs

Voluntary Stewardship Programs

Requirement for Liability insurance for pollution of adjacent properties and water

Best Management Practices

Phosphorus Recovery Programs

# Best Extension Delivery Methods for Farming Communities

- a) Peer to peer extension through local commodity and farm organizations is required.
- b) OFA county Federations need to be enlisted with the help of the Member Service Reps
- c) Local Champions need to be identified to assist in demonstrating and promoting “the Strategy”
- d) Development of model lease agreements for drainage and erosion management and promotion of inclusion of these clauses in lease agreements should be carried out. Farm and Food Cares GLASI project is looking into these issues.
- e) Municipalities will be asked to promote “the Strategy ”at scoping and onsite and public meetings meetings for new drainage projects.

## Extension materials for Farm Operators and Property Holders and Municipalities

- a) Agencies which have a record of extension work with farm operators and private land owners should deliver assistance with implementation of “the Strategy”. (CCAs, OSCIA County Organizations, Conservation Authority Staff, Drainage and Erosion Management Contractors)
- b) New funding should be provided on a sustained basis to ensure the extension delivery is sustained for the long term.
- c) CCAs would be paid on a meeting by meeting or farm visit basis. The Farmhouse Check-up Program delivered by OSCIA under the GLASI program could be a model.

### Materials for Municipalities

Development and promotion of a model by-Law based on current by-laws (Leamington, Huron-Kinloss) and other sources should be delivered to Municipalities (ROMA/AMO, Municipal Engineers, OGRA)

# Who Should do What in Promotion and Communicating the Strategy

- a) Communication and promotion of “the water management and drainage strategy” should be carried out by all of the stake holder agencies (Farm organizations, Conservation Authorities, Municipalities and Provincial government)
- b) Farm Organizations include: OFA, CFFO, FARM and FOOD CARE, Soil and Crop Improvement, OABA and the Cities and Municipalities
- c) The messaging should be evaluated by use of “Focus Groups” to determine the best approach to messaging, (Content and Media)
- d) Once established the core messaging should be shared with all of the stakeholders Commodity groups, Municipalities, Conservation Authorities and provincial agencies)
- e) Publication of the core messaging should be done through the farm press and media
- f) Presentation of the “Strategy should be made at farm meetings and conferences as well as farm events (e.g. Ploughing Match, Outdoor Farm Show, and Farm Smart)
- g) Municipalities should be encouraged to send out pamphlets with their regular mailings to households.

# Questions