P Risk Assessment and Current Management Tools

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Outline

- Why are soil P concentrations excessive?
- Why do we care about excessive soil P concentrations?
- How can we identify and manage excessive soil P?
- Guidance to growers

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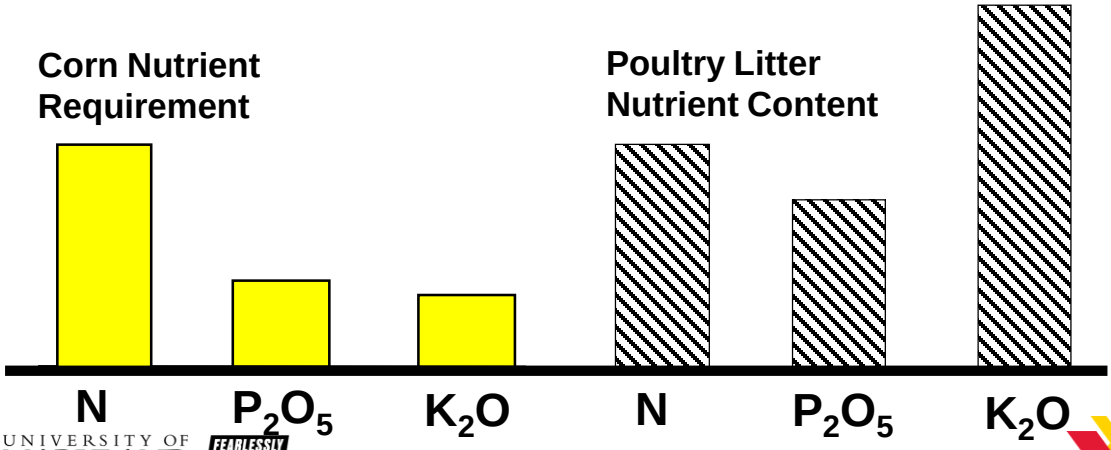
Why are soil P concentrations excessive?

- ….in a limited area – generally, with historic manure usage



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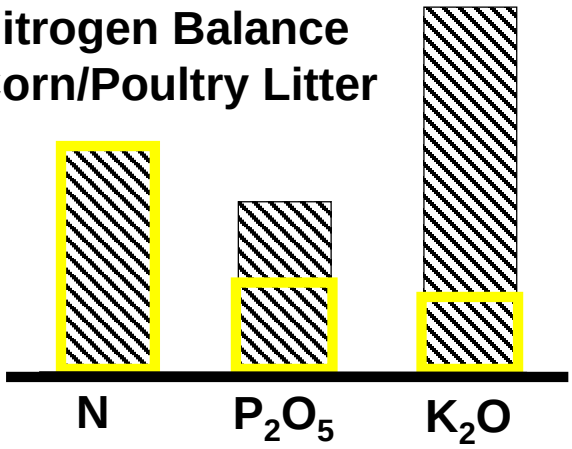
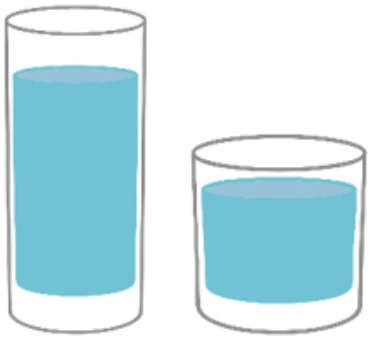
Nitrogen Balance Corn/Poultry Litter



Overapplication of P over time can saturate soil's capacity to "hold" P – regardless of soil type



Corn Nutrient Requirement Poultry Litter Nutrient Content

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Lessons Learned Over Time

- Manure recommendations at the time were based on the best available science – assumed an “unlimited capacity” for soils to hold P
- Environmental challenges have accelerated our knowledge of P behavior and management in soils

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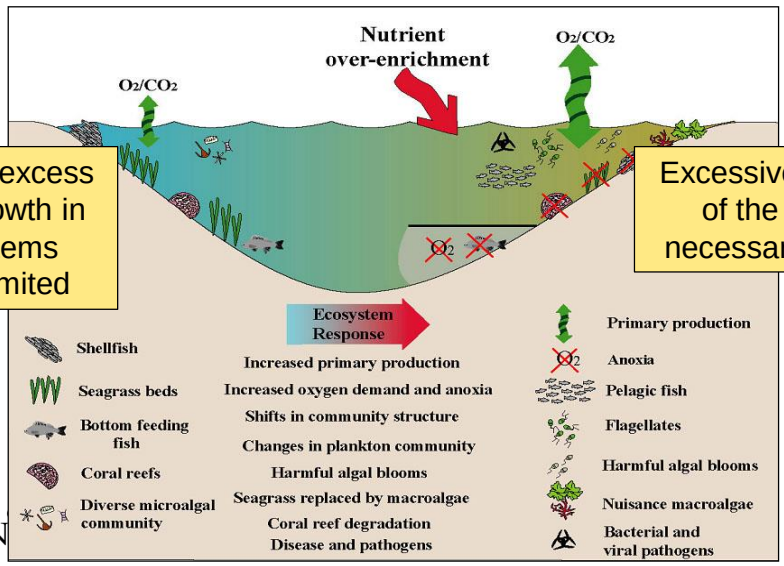
Why do we care about excessive soil P?

Goal: prevent excess vegetative growth in aquatic systems naturally P limited



Excessive soil P is ½ of the equation necessary for P loss

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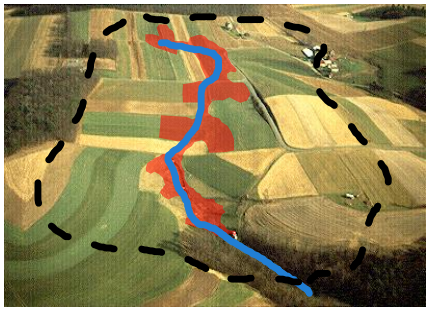
Soil Test as an Indicator of P Loss:
Poor correlation with P Loss

90% of the P from 10% of the land



P Loss Areas

Soil Test P

Low Med High

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USDA-ARS PSWMRU

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If soil P is only ½ of the equation, what is the whole equation then??

- Source of P alone does not indicate high risk for P loss
- The P has to be transported to water somehow….route of transport of P is the other half of the equation

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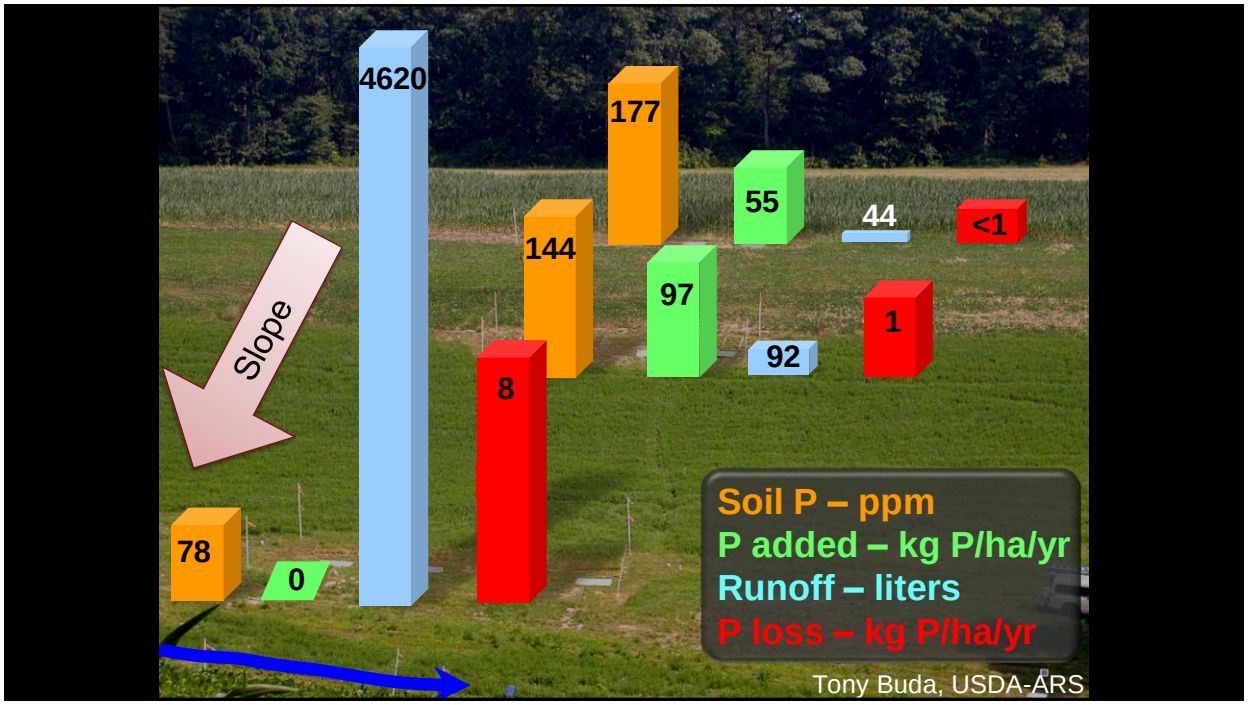

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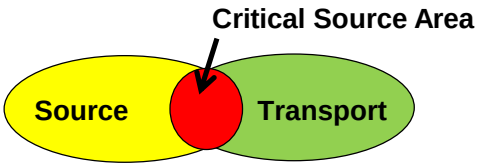
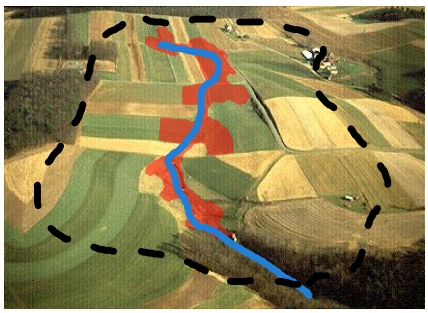
Identifying and Managing Excessive P & Loss Risk





- Where source and transport overlap = high risk of P loss
- P Index or PMT identifies these areas and targets management changes for loss prevention

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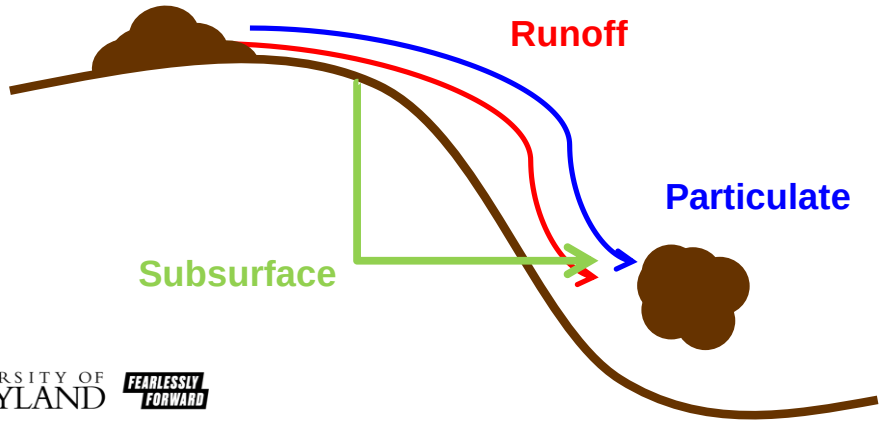
Phosphorus Transport Pathways



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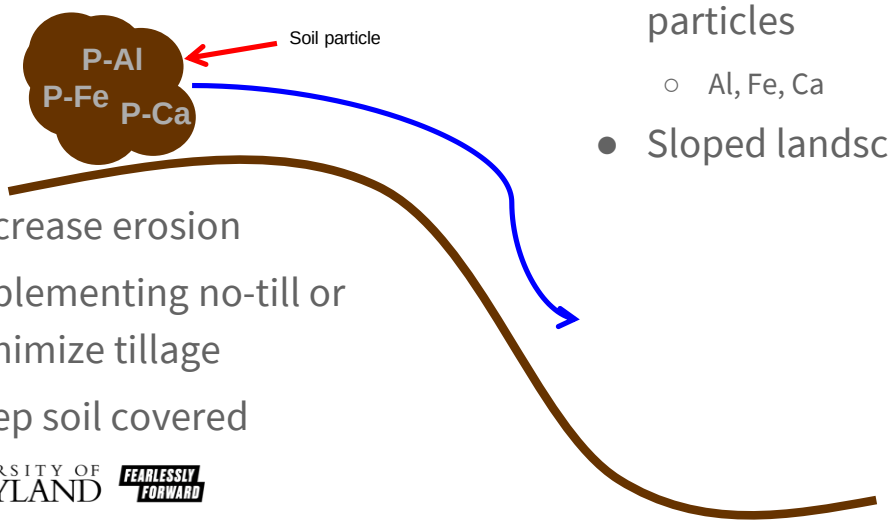
Particulate P Loss



- P adsorbed to soil particles
  - Al, Fe, Ca
- Sloped landscape

- Decrease erosion
- Implementing no-till or minimize tillage
- Keep soil covered

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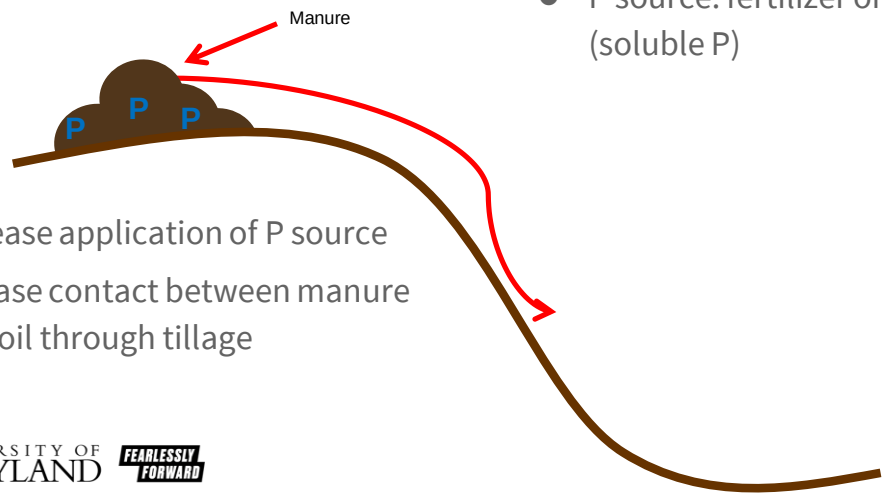
Runoff P Loss

- Sloped landscape
- P source: fertilizer or manure (soluble P)



- Decrease application of P source
- Increase contact between manure and soil through tillage

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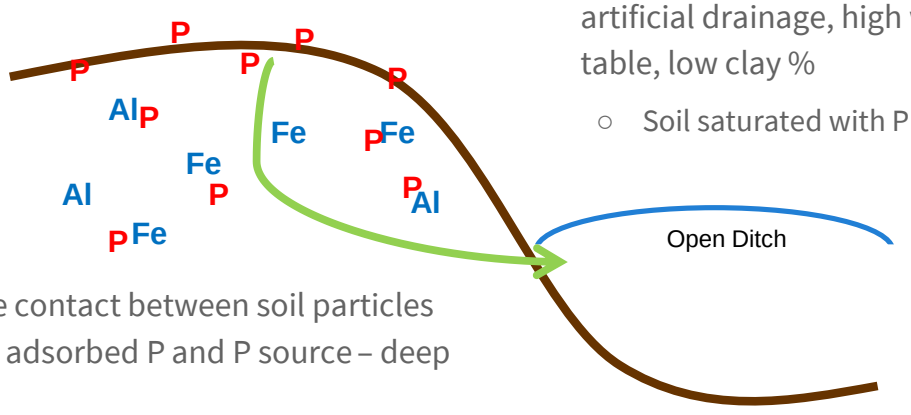
Subsurface P Loss

- Flat landscape
- Close proximity to water, artificial drainage, high water table, low clay %
  - Soil saturated with P



- Increase contact between soil particles without adsorbed P and P source – deep tillage

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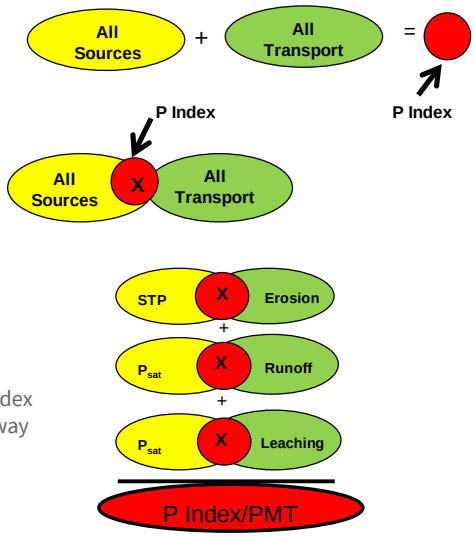
Evolution of the P Index Equations

- First Generation
  - Additive
- Second Generation
  - Multiplicative
- Third Generation
  - Component / Multiplicative
    - More mechanistic
    - Any one pathway can result in a high P Index
    - Better targets BMPs to specific loss pathway



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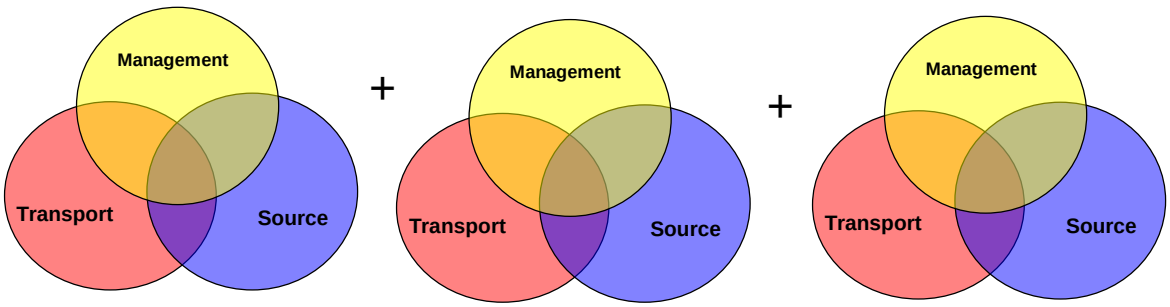
Phosphorus Management Tool (PMT) Equation



P loss risk via erosion

P loss risk via runoff

P loss risk via subsurface loss

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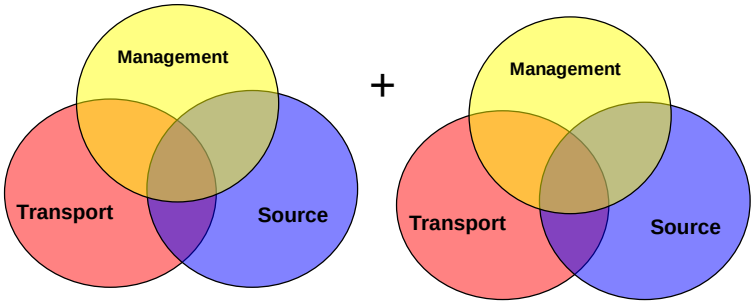
Phosphorus Management Tool (PMT) Equation



P loss risk via erosion

P loss risk via runoff

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Phosphorus Management Tool (PMT) Equation

Equation 1. General equation for the University of Maryland – Phosphorus Management Tool.

$$UMPMT = 0.1 * (SUBSURFACE + RUNOFF + PARTICULATE)$$

Where

$$SUBSURFACE = SD * DPR_{sub}$$

$$RUNOFF = DBF * SR * DPR_r$$

$$PARTICULATE = DBF * SED * FIV$$

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Solutions in your community

Extension Bulletin EB-405
2013

University of Maryland Phosphorus Management Tool: Technical Users Guide

The Phosphorus Index Concept

In 1990, a national cooperative workgroup of scientists from numerous universities and the United States Department of Agriculture (USDA) was organized to develop a procedure that could identify soils, farm management practices, and specific locations within a farm where phosphorus (P) losses in field drainage water may pose the potential for negative environmental impacts on nearby surface waters. The goals of this national work group were:

- To develop an easily used field rating system that rates farm fields according to the potential for P loss to surface water (the Phosphorus Index).
- To relate the P Index to the sensitivity of receiving surface waters to eutrophication and degradation resulting from nonpoint source P enrichment.
- To facilitate adaptation and modification of the P Index to regional and site-specific conditions.
- To develop agricultural management practices that will minimize the buildup of soil P to excessive levels and the transport of P from soils to sensitive water bodies.

The Objective of the University of Maryland Phosphorus Management Tool

Our objective was to develop a phosphorus site index (PSI) that uses readily available information to evaluate the relative risk of P transport from agricultural fields, including vegetable and row crop production and pasture based systems where P may be applied either as inorganic or organic fertilizer. Furthermore, the PSI should be applicable within all physiographic provinces present in Maryland. Phosphorus transport is controlled

Article can be downloaded: https://extension.umd.edu/resource/anmp-publications/

Provides the scientific background and step-by-step method for calculation

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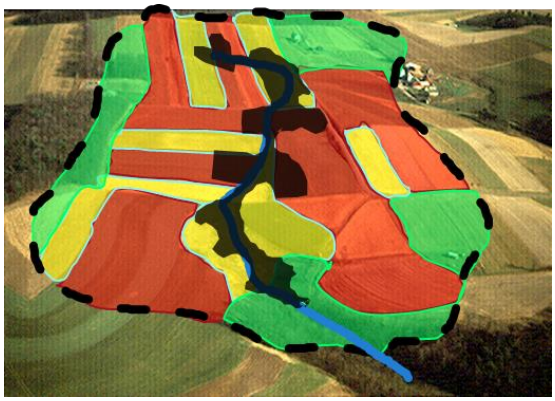
When to calculate the PMT

- On individual fields with FIV-P ≥ 150
- This is the “tipping point”
- Reminder: source is only half of the equation!



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Field Information Needed

- Estimated erosion
- Runoff
- Subsurface drainage
- Distance to surface water
- Buffers
- Field slope
- Soil test
- P applications (fertilizer and organic)
- Timing and method of applications
- Soil physical properties (soil type)

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Field Information Needed – Web Soil Survey

- Dominant map unit (soil type)
- Drainage class
- Permeability class
- Hydrologic soil group (HSG)
- Distance to surface water

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Field Information Needed - Grower

- Crop rotation
- Timing and type of tillage
- Nutrient sources, with timing and application method
- Presence and width of buffers
- Presence of surface water
- Soil test results

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Input Factors from operator or plan

- Soil P converted to FIV (soil test report)
- Degree of P saturation via Mehlich 3 (soil test report)
- Amount, analysis and type of P fertilizer applied
- Application method and timing of P fertilizer application
- Amount and type of manure, compost or biosolids applied
- Manure, compost, or biosolids analysis
- Application method and timing for manure, compost, or biosolids application
- Type and width of vegetated field buffers
- Crop rotation sequence
- Tillage rotation sequence
- Conservation practices such as strip or contour cropping, buffer strips, etc.
- Artificial drainage areas (drainage ditches, tile drains, or mole drains)

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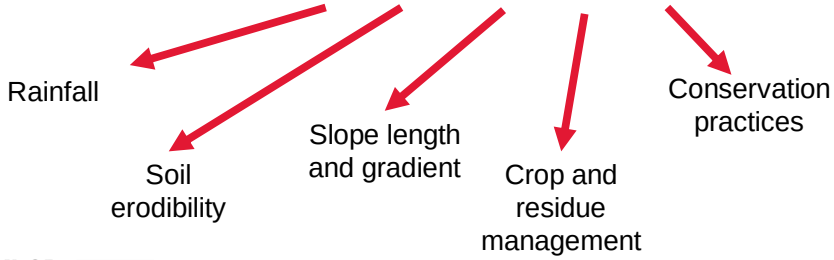
Erosion Estimation

- Using RUSLE 2 – Revised Universal Soil Loss Equation v.2
- Best method available for estimating annual soil loss

$$Soil\ Loss = R * K * LS * C * P$$



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Interpreting PMT Score

- Unitless value with three management categories

Score and Category	Interpretation
Low: 0-50	Low P loss potential; P applications should not exceed P removal over three-year period to prevent further P build-up
Medium: 51-100	Moderate P loss potential: P application to P removal for the year of application; prevent further P build-up and risk of incidental P loss from high application rate
High: >100	High P loss potential: no P application and active remediation techniques implemented (drawdown of soil P)

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Guidance for Growers

- If soil P concentrations are low, avoid continued application of P source that will ultimately increase soil P concentrations (above the 150 FIV threshold)
  - *Buildup of soil P concentrations is a LONG, SLOW process
  - *Monitor fields where soil P is increasing, use amendments sparingly (where possible)
  - Seek creative opportunities for manure disposal or transport – options available through the state to move manure to low P areas

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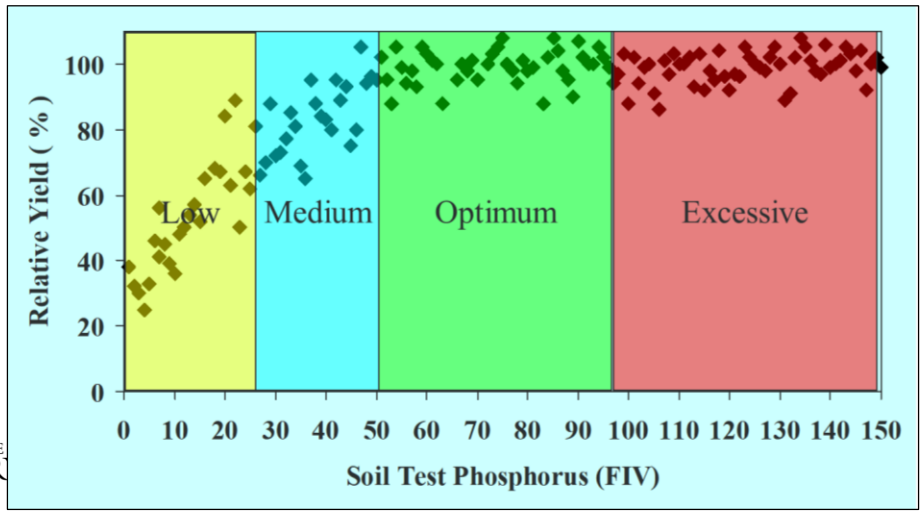
If my soil P is low, it's going to impact my yields; I need to get my soil P >150 FIV



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Guidance for Growers

- If soil P concentrations are low, avoid continued application of P to increase soil P concentrations
- If soil P concentrations are high, continue growth of high yielding crops with no P application to drawdown soil P concentrations over time
  - *Drawdown is as slow of a process as buildup of soil P
  - *This is our only real recommendation for soil P drawdown at this time

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Return to agronomic optimum soil P through phytoremediation (Fiorellino et al. 2017)

- 18 - 44 years predicted to drawdown soil P with continuous cropping and no additional P application

Rotation	Upper Marlboro	Salisbury	Wye
	Years of drawdown		
Forage	19	21	18
Grain	25	25	23

**Starting P concentration, mg kg^{-1}	Years of drawdown
50	-
109	2
181	22
271	36
362	44

at Salisbury location only

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