A Working Document for the Development of:

A BMP Toolbox for Reducing Dissolved Phosphorus Runoff from Cropland to Lake Erie

Prepared by:

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To Heidelberg University, National Center for Water Quality Research

Dr. David Baker, Project Director

Thank you for “Toolbox” input!

- Steve Davis. USDA-NRCS, Retired. Western Lake Erie Basin Advisor
- Cory Hohman. USDA-NRCS, Engineering Technician. Tiffin Field Office
- Mary Ann Hawk. USDA-NRCS, District Conservationist. Tiffin Field Office
- Frank Gibbs. USDA-NRCS, Resource Soil Scientist. Findlay Area Service Center
- Lynn Eberhard. Seneca SWCD, District Technician. Tiffin
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- Norman Fausey. USDA-ARS, Research Soil Scientist, Soil Drainage Research Unit. Columbus, OH
- Martin Shipitalo. USDA-ARS, Research Soil Scientist. Coshocton, OH

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- Tom Green, PhD, CCA, TSP. IPM Institute of North America Inc.
- Mark Scarpitti, State Agronomist, USDA-NRCS Ohio.

Why I’m concerned about water quality – the truth!!

Fishing on Lake Erie – August 16, 2011.

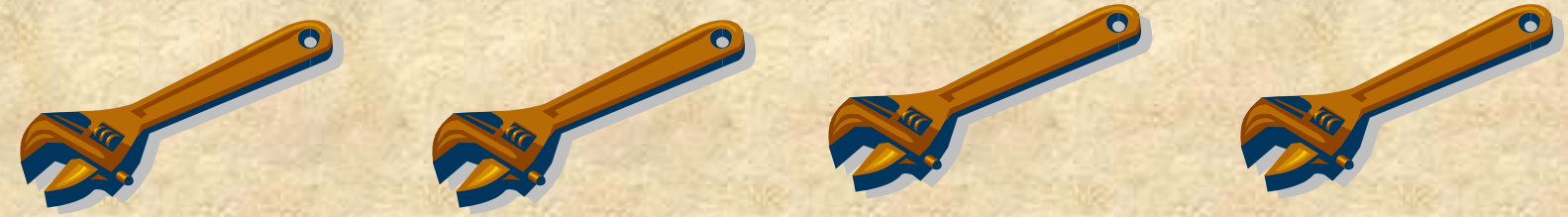
Purpose of "Toolbox"

- To compile a list of BMP's that conservation planners and farmers might use to reduce DP losses to streams and ditches draining NW Ohio.
- To provide information on the function of DP BMP's and which ones might be most effective and easily adopted.
- To serve as a framework for discussions on ways to reduce DP runoff from cropland into Lake Erie.



Other "Toolbox" objectives and sideboards

- Focus on BMP's that would reduce DP losses from commercial fertilizers and soils.
- Provide example conservation cropping and tillage system that would address the reduction of both DP and PP.
- Exclude BMP's that do little, or anything, to reduce DP in runoff.
- Determine areas where additional research might be needed.



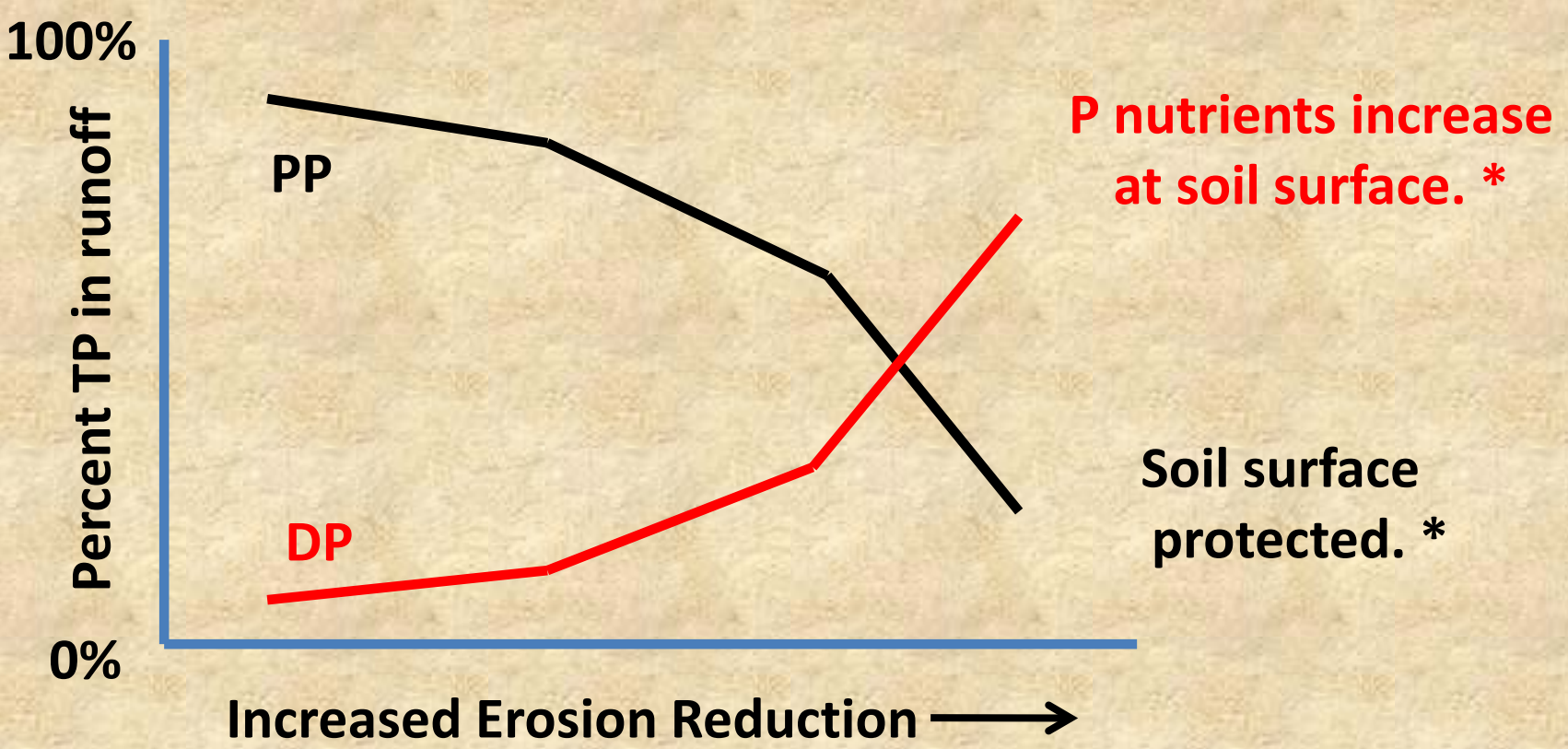
How were BMP's for DP reduction selected?

Two key concepts drove the selection process:

1. The equilibrium balance between BMP's for reduction of PP and BMP's for reduction of DP.

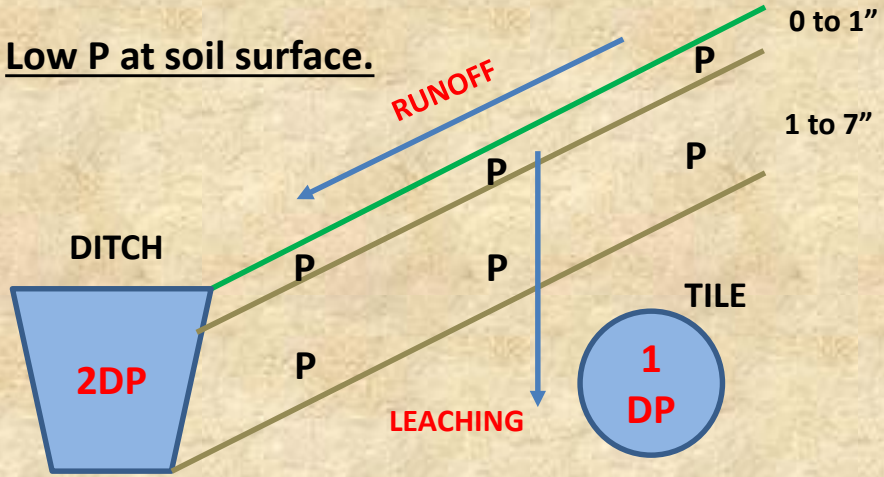
2. How P levels near the soil surface influence DP concentrations in both surface runoff and leaching.

Agricultural Phosphorus BMP's – the equilibrium balance.



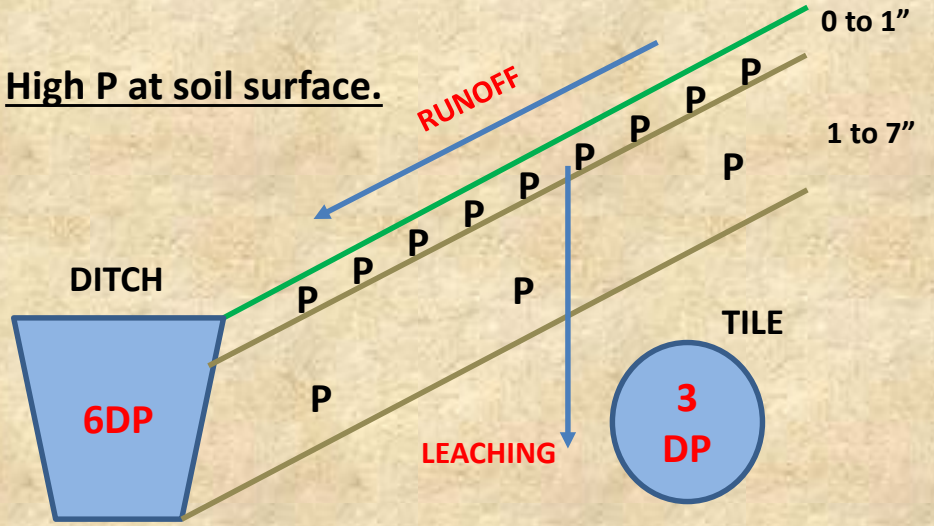
(* * Erosion control and nutrient management are BOTH needed)

Greater amounts of P at the soil surface mean higher DP concentrations in both runoff and leaching.



Causes of high surface P:

* P application on surface
* Shallow or reduced tillage
* Bioaccumulation



Amounts of P at the soil surface are reflected in stratified soil testing of the upper 1 to 2 inches.

Two criteria were then used to evaluate effectiveness of BMP's for DP reduction.

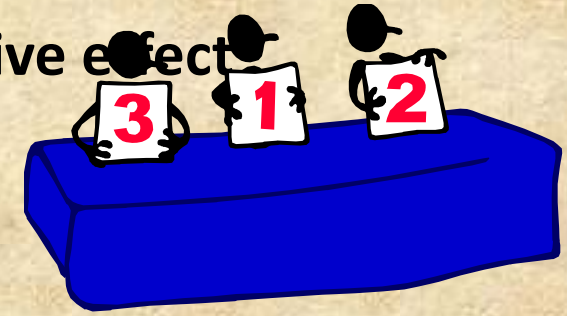
1. What is the potential of the BMP to reduce DP concentrations in field runoff or in some cases leaching?

2. What is the potential of the BMP to reduce field runoff amounts (storm/tile)?

(Concentration X Flow ~ Edge of Field Loading)

DP BMP's were then rated following the Conservation Practice Physical Effects (CPPE) approach of USDA-NRCS.

RATING	RATING DESCRIPTION
-3	Moderate negative effect – NEW!
-2	Somewhat moderate negative effect
-1	Minor negative effect
0	Little or no effect
+1	Minor positive effect
+2	Somewhat moderate positive effect
+3	Moderate positive effect
+4	Somewhat major positive effect
+5	Major positive effect



Practice Grouping for DP BMP's

- Nutrient Management (NM)
- Conservation Tillage (CT)
- Conservation Cropping (CC)
- Conservation Buffers (CB)
- Water Management (WM)

(Most practice definitions are found in Section IV of the USDA-NRCS FOTG for Ohio.)

Practice Rating Review: Concepts and Questions

Review and clarification of rankings based on more current research and the concept that DP concentrations in runoff are a function of:

1. **Amount of fertilizers**
2. **Depth of P fertilizer application**
3. **Depth of tillage**
4. **Permanent nature of the soil cover**

Important Questions in any exercise of this type:

1. **How do increases in soil OM levels alter the need for added commercial fertilizers? Need Tri State Fertility Guide update.**
2. **How do practice mixes impact P concentration in runoff amounts?**
3. **How do practice mixes impact runoff amounts of themselves?**

Nutrient Management

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Nutrient Management					
Soil Testing - agronomic	X		+1 → +3	0	Measures P requirements for optimal crop growth. Key to application rates.
					Importance to application rates.
Soil Testing - environmental	X		+2 → +5	0	Measures potential for DP losses in surface flow and leaching. Key to rates/method of application.
					Importance to application rates and methods plus evaluation of P stratification and nutrient management practices.
Vegetative Mining	X		+2	0	Uses cropping system to drawdown high soil test levels. May take 15 or more years.
P Application Rate	X		+5	0	Key component of all P Indexes. Major determinant of DP availability.
Variable Rate P Application	X		+3 → +5	0	Results in improved spatial placement of P fertilizers for crop utilization.
					A refinement of application rates reflected as well in application location.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

Nutrient Management - Continued

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Nutrient Management					
Time of P Application	X		+4	0	Considers: rain forecast; saturated, frozen or snow covered soils; growing crops.
P Application Method:					
Broadcast, Shallow incorporate.	X		+1	0	Incorporated 2 to 3 inches within 24 hours of application using full width tillage.
Broadcast, AerWay incorporate.	X		+1 → +2	+2	Can allow DP to infiltrate 6 to 8 inches while maintaining residue cover to slow runoff.
					Affords opportunity for P fertilizers to move at depth in loosened soil following initial rainfall.
Band with corn planter	X		+3	0	Placed at corn planting time in a band at least 2 to 3 inches deep.
Subsurface injection	X		+4	+1	Placed typically in a band more than 5 inches deep. Improved short term infiltration.
P Application Location	X		+3	0	Setbacks from watercourses, surface tile inlets, sinkholes and tile blow outs. Avoidance of floodplains, steep slopes or poorly drained soils.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

Conservation Tillage

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Conservation Tillage					
Mulch Tillage/Residue Mgt.	X		-1	+1	P can stratify. Slows runoff, increases infiltration and soil organic matter.
No-tillage/Residue Mgt.	X		-2 → -1	+2	P can stratify. Macropore formation. Improved infiltration. Improved soil organic matter levels.
					Some tillage often done within crop rotation.
Continuous No-till - NEW	X		-2	+3	Increased P stratification/macropore formation. Greater infiltration and soil organic matter.
Cont. No-till with Cov. Crops - NEW	X		-3	+4	Highest P stratification potential. Greatest infiltration. Highest soil organic matter levels.
Non Inversion Tillage	X		-2	+2	Reduces compaction and retains crop residues to promote infiltration. P can stratify.
Inversion Tillage - NEW	X		+4	-1	Incorporates P fertilizers at depth. Eliminates P stratification. Can increase surface runoff.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

Conservation Cropping

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Conservation Cropping					
Crop Rotation	X		+1	+1	Basis for P nutrient uptake, slowing runoff and increased soil organic matter content.
Cover Crops:					Growing cover/roots retain P. Improves infiltration and soil organic matter.
Cover Crops that winter kill - NEW	X		+1 → -3	+1	*Adds to P stratification and DP release before crop uptake. Improves infiltratioin.*
Cover Crops that do not winter kill - NEW			+1	+2	*Adds to P stratification; improved P retention for crop uptake. More infiltration, organic matter.*
Strip Cropping	X		+1	+2	Wheat or hay with row crops. Disperses P fertilizer application and crop/residue cover.
Hayland Planting	X		-2	+3	Permanent cover. Slows runoff and increases soil organic matter. P can stratify.
CRP Cover - Grass	X		+3 → -2	+4	Significant increases in percolation plus soil organic matter. Retards surface runoff. P can stratify.
					Removes P fertilizer application factor from practice.
CRP Cover - Trees	X		+4 → +1	+5	Permanent increases in percolation. Retards runoff. Greater P retention in woody vegetation.
					Removes P fertilizer application factor from practice.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

Conservation Buffers

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Nutrient Management					
Filter Strips - Grass		X	+1 → -2	+2 → +3	Needs proper design/installation. Improved infiltration. P stratifies with time.
					Removes P fertilizer application factor from practice. Better aligns runoff benefit with CRP Cover – Grass.
Filter/Recharge Areas		X	+1 → -2	+2 → +4	Grassed areas where water drains from field. Retards runoff. P stratifies with time.
					Removes P fertilizer application factor from practice. Aligns runoff benefit with CRP Cover - Grass.
Riparian Strips - Trees		X	+2→ +1	+4	P uptake is permanent. Greater percolation, retention of runoff. Surface runoff dispersal.
					Removes P fertilizer application factor from practice. Aligns DP benefit with other tree planting practices.
In Field Buffers - Grass	X		+1 → -2	+3	Greater infiltration. Retards runoff across landscape. P stratifies with time.
					Removes P fertilizer application factor from practice.
Field Windbreaks - Trees	X	X	+1	+3	P uptake is permanent. Improved infiltration. Retards runoff from fields.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

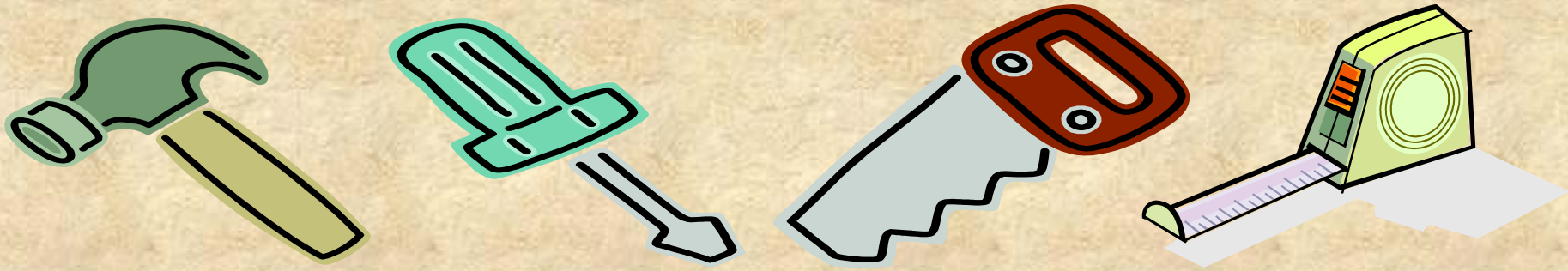
Water Management

BMP PRACTICE	PRACTICE LOCATION		FIELD REDUCTION RATING POTENTIAL		"TOOLBOX" of BMP's for DP
	IN FIELD	EDGE OF FIELD	DP CONCEN-TRATION	RUNOFF AMOUNT *	HOW THE PRACTICE WORKS / *RATIONALE FOR CHANGE*
Water Management					
Controlled Traffic	X		+1	+2	Reduces wheel traffic compaction. Improves infiltration. Improves crop uptake of P.
Tile Drain Outlet Control		X	+1	+1	Helps reduce runoff in fields having soils with preferential flow. Greater P uptake by crops.
Tile Drain Inlet Control	X		+1 → +3	+3	Blind inlets halt direct delivery of runoff DP to streams and permit greater infiltration.
					Blind inlets eliminate the direct entry of recently applied P fertilizers and soil Pto tile after storm events.
Tile Main Repair	X		+1 → +3	+3	Repairs eliminate direct entry of runoff DP to streams and permit greater infiltration.
					Repair eliminates the direct entry of recently applied P fertilizers and soil P to tile after storm events.
Wetland Construction		X	+1	+2	Slows/disperses runoff. Groundwater recharge. Reductions in DP are less with time.

* Runoff amount would include both surface and subsurface contributions following storm or snowmelt events.

Which DP "Tools" will work in NW Ohio?

- Soil testing – agronomic (includes grid sampling)
- P application rate
- P application method
- Time of P application
- Conservation cropping/tillage (residue management)
- Conservation buffers (grass establishment as setbacks)
- Water management (reduce compaction, fix tile "blow outs")



CN-SB-CN-SB-WH rotation using DP and PP BMP's

YR1: After WH harvest (YR5), dry BC or liquid band with incorporation; or band inject P needs for CN and SB (YR2). Apply added P if soil buildup is required for WH. A portion of total P needs could also be banded with corn planter.

YR2: Plant SB using either CT or NT. After SB harvest, band inject P needs for CN (YR3) and SB (YR4). If not done so in YR1, apply added P for WH if soil buildup is required. A portion of total P needs could also be banded with corn planter in YR3.

YR3: Plant CN using either CT or NT.

YR4: Plant SB using either CT or NT.

YR5: Plant WH using NT.

Other BMP's for DP

- Grassed filter strips with harvesting.
- Soil ammendments like gypsum.
- Bioreactors at edge of field.
- Others?

The future of fishing is high quality water!