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Phosphorus Index for Alabama

A Planning Tool to Assess & Manage P Movement

Non-point source phosphorus (P) pollution of surface waters is a complex set of processes that involves P application, its buildup in soils, and its transport to surface waters. High P application in the form of fertilizers or manures can increase the risk of P transport to surface waters, but unless there is loss in runoff, the risk is minimal. Extremely high soil test P also increases the risk of P enrichment, but there must be detachment and/or dissolution and transport of P before there is an environmental concern. Excessive P in surface waters is an environmental concern.

PHOSPHORUS CONCERNS IN THE ENVIRONMENT

Eutrophication can be caused by the nutrient enrichment of a water body. Nutrient movement in runoff and erosion from agricultural nonpoint sources is a resource management concern. The movement of phosphorus in runoff from agricultural land to surface water can accelerate eutrophication. The result of eutrophic conditions and excessive plant growth is the depletion of oxygen in the water. This is due to the heavy oxygen demand by microorganisms as they decompose the organic material. Phosphorus is generally the limiting nutrient in fresh water systems and any increase in P usually results in more aquatic vegetation. Society is concerned about maintaining clean drinking water. This concern has forced the inclusion of a cost for removing the color, turbidity, taste, and odor associated with the high trophic condition and vegetation growth in surface water brought about by excessive nutrients. Because of this concern, proper management of P in fertilizers, manures, and the soil is paramount in preventing nonpoint source pollution.

P INDEX CONCEPT

The P index is a tool to assess the site and management practices for potential risk of phosphorus movement to water bodies as the result of additional P applications. The P index helps to identify fields where the risk of phosphorus movement is relatively higher than that of other sites. When the parameters of the index are analyzed, it will become apparent that individual parameters could be influencing the index disproportionately. These identified parameters should be the basis for planning corrective soil and water conservation practices and management techniques.

The P Index uses specific field features and management practices to obtain an overall rating for each field. Not all field features and management practices have the same influence and input because research has shown that relative differences exist in the importance of each to P loss. The field features and management practices are weighted according to their importance in this tool (1, 2 or 3, with 3 having the greatest weight). Also, assigned to each of the field features and management practices are **value ratings** of VERY LOW / LOW (0 points), MEDIUM (1 points), HIGH (2 points), VERY HIGH (4 points), and EXTREMELY HIGH (8 points). Multiplying the **weighed**

factor by the **value rating** yields points for that specific field feature or management practice. Based on a summation of the points, the field will fall into an overall category rating of LOW, MODERATE, HIGH, or VERY HIGH.

Currently, these weighted factors are based on research as well as professional judgment. As more research becomes available, the P Index will be periodically reviewed and updated.

Field Features, Management Practices, & Weighted Factors Used in the P Index		
Field Feature and/or Mgt. Practice		**Weighted Factor**
1. Soil Test P		1
2. Phosphorus Application Rate	Traditional Application	3
	Precision Application	2
3 **Phosphorus** Application Method		3
4. Grazing Animals		1
5. Subsurface Drainage & Underground		3
6. Erosion Rate		3
7. Hydrologic Soil Group	Common Soil Health	3
	Improved Soil Health	2
8. Field Slope		1
9. Distance to Water		3
10. Filter Strip Width		2
11. Impaired or Outstanding		3

DESCRIPTION OF FIELD FEATURES AND MANAGEMENT PRACTICES

1. Soil Test P Value considers the extractable P concentration for surface soils (0 – 3 inches in sod crops and depth of plow layer in cultivated crops) based on the double acid (Mehlich 1) or Mississippi extract procedures, depending on the soil. Research indicates that high soil test P levels may only play a small role in determining the amount of P in runoff unless soil erosion and sediment movement into water is high.

2. Phosphorus Application Rate is the application rate of organic phosphorus and/or phosphate fertilizer in pounds per acre per year of P_2O_5 that is applied to the site. The phosphate application rate includes all sources of phosphorus whether from organic sources such as animal manure, compost, poultry litter or commercial fertilizer. Research indicates that the application rate plays a significant role in determining the phosphorus loss potential. When applications of phosphorus are made with equipment that is capable of precision application the "weighted factor" is reduced from 3 to 2. Precision application equipment must be used on all applications of phosphorus and must utilize GPS guidance, and a rate controller and/or automatic section control in order to take this reduction. Liquid applications made through irrigation systems that the rate and placement is controlled such as solid set systems should be consider as precision application. If any phosphorus applications are made to the field with traditional equipment the "weighted factor" of 3 should be used for determining the P index.

3. Phosphorus Application Method considers the manner that phosphate fertilizer or organic P is applied to the site and the amount of time that the P fertilizer or organic P is exposed on the soil surface. Injection implies that the fertilizer P is buried below the soil's surface at a minimum depth of two inches. Incorporation is the mixing of the P into the surface portion of soil. Surface applied manure or litter that has been treated with chemicals to reduce P solubility or the field has applications of gypsum at the same time as the manure/litter application should be considered as incorporated within 3 days of application. Both chemical treatments and gypsum application should be done in accordance with Alabama Cooperative Extension Systems recommendations for reducing P solubility.

4. Grazing Animals considers the effect of animals to cause excessive movement of P into streams and other surface waters. Surface waters include streams, springs, lakes, sinkholes, wetlands, or other related waterbodies. Farm ponds contained within the tract that do not have a continuous water flow are not considered unless the producer considers the farm pond to be sensitive and important. Large number of grazing animals with unlimited access to waterbodies or feeding animals in sensitive areas such as drainage ways, concentrated flow areas, or adjacent to a

stream can be a contributor to excessive P in waterbodies. Access may be considered restricted when pastures receive sufficient rest from grazing animals, e.g. rotational grazing systems. This usually results in generally stable stream banks, few livestock trails and signs of functioning stream bank vegetation. The P.I. values of 4 points and 8 points have a break of 100 animals to approximate streambank damage. There are other factors that can affect the condition of the streambank and riparian area, such as size of the paddock and length of time animals have access to the area. For this reason, general guidelines are listed below to help refine the value selected:

General conditions where a PI value of 4 points would be chosen:

- Isolated livestock concentration areas (< 5% of the area) with no more than one or two spots draining unbuffered,
- Streambanks or shorlines are mostly stable but possibly close grazed

General conditions where a PI value of 8 points would be chosen:

- Livestock concentration areas cover more than 5 per cent of the riparian area
- Hard to push a probe past compacted layers
- Banks on streams or shorelines are mostly bare or heavily grazed and sloughing is likely.
- Active gully erosion is present and fingerlike extensions are likely
- Evidence of contaminated runoff draining directly into the water in several locations

The Pasture Condition Scoresheet (PCS) can be used to refine the breaks between 2, 4 and 8; where a PI 2 point value relates to a PCS score of 4 or 5, a PI 4 point value relates to PCS score of 3 and PI 8 point value relates to PCS score of 1 or 2.

5. Terrace Tile Outlets and Subsurface Drains with Open Inlets may convey runoff water directly to a waterbody, ditch or drainage way without the treatment effect of vegetation and can be major way for dissolved P to enter a waterbody. Systems with open inlets should empty onto a grass filter or vegetative outlet.

6. Soil Erosion considers the risk of movement of sediment bound P in runoff. RUSLE II and the gully equation are used to estimate the total soil erosion. Field information needed to determine the erosion rate includes dominant soil type; type of crop cover; soil hydrologic group; soil erodibility; slope length; slope and information on contouring, ridge heights, and terracing; and gullies.

7. Runoff Class (Hydrologic Soil Group) considers the runoff potential of the site. The soils of Alabama are in four hydrologic soil groups. These groupings are based on runoff-producing characteristics of the soil. Research indicates that soil management can also have a significant effect on runoff potential. Generally, as soil health improves runoff and P loss will decrease on the same soil. If a producer has implemented BMP's and will continue to implement BMP's that will improve soil health the "weight factor" for the runoff class will be 2, To take this reduction, on crop land the following practices must have been adopted, residue management no-till/strip till (mulch till for strip till peanuts only), cover crops during all fallow segments of the rotation and crop rotation. On pasture land a managed rotational grazing system that is maintaining minimum forage height, has proper stocking rates, provide sufficient recovery time to promote the vigor of the plant community, and permit grazing only when soil moisture conditions support livestock traffic without excessive compaction must be implemented. In all other cases the "weight factor" for runoff class will be 3.

These groupings (Hydrologic Soil Groups) are:

A - Low runoff potential. These soils have a high infiltration rate even when thoroughly wetted. They mainly consist of deep, well drained to excessively drained sands or gravels and have a high rate of water transmission.

B - Moderate runoff potential. Soils of this group have a moderate infiltration rate when thoroughly wetted. They are moderately deep to deep, moderately well drained to well-drained soils that have moderately fine to moderately coarse textures. They have a moderate rate of water transmission.

C - Moderate high runoff potential. The soils of this group have a slow infiltration rate when thoroughly wetted. They usually have a layer that impedes downward movement of water or have moderately-fine to fine texture. They have a slow rate of water transmission.

D - High runoff potential. The soils of this group has a very slow infiltration and thus a high runoff potential. They chiefly consist of clay soils that have high swelling

potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface and shallow soil over nearly impervious material. They have a very slow rate of water transmission.

When more than one hydrologic soil group occurs in the field, use the predominate group. If a soil is assigned to two hydrologic groups, (B/C, for example), then the first letter is for drained fields, and the second letter is for the un-drained condition).

8. Field Slope, the inclination of the land surface from the horizontal, considers the average slope percent for the field based on the Soil Survey Report or actual field slopes if available. Field slope is given a weighted factor of 1 because slope is also considered in the soil erosion field feature.

9. P Application Distance to Water considers the distance in feet from the closest phosphorus application site within the field to surface water that receives runoff from the field. Surface waters include streams, springs, lakes, sinkholes, wetlands, or other related waterbodies. These waters will be identified on the U.S.G.S. topographic map as blue-line waterbodies or streams. Farm ponds contained within the tract that do not have a continuous water flow are not considered unless the producer considers the farm pond to be sensitive and important.

10. Vegetative Buffer considers the treatment effect of a vegetative buffer at all areas where water will flow from the field. This includes the down slope edges of fields as well as where water enters conveyance structures such as ditches or concentrated flow areas within the field. The treatment effect must be from sheet flow across the buffer. These vegetative buffers should meet the requirements of Alabama conservation practice standard filter strip (code 393) and/or riparian forest buffers (code 391) for the intended purpose. If a vegetative buffer is not required, then consider it as a low rating (0 points) on the P Index.

11. Impaired, Outstanding Waters, or Critical Habitat Waters considers the distance in feet from the closest phosphorus application site within the field to the listed segment of water that receives runoff from the field in the same 12-digit Hydrologic Unit Code area. Listed segments include those on the 303(d), or TMDL list impaired by nutrients from agriculture activities, Outstanding Alabama Water (OAW), Outstanding National Resource Water (ONRW), public water supplies, waters designated for shellfish and federally designated Critical Habitat waters for endangered and threatened species.

Site-Specific Application of the P Index

Within fields, components of the P Index such as slope, hydrologic soil group, and distance to watercourse may vary greatly.
Thus, there may be an advantage to site-specific application of the P Index, to a resolution as small as field equipment can manage. This can be useful in terms of avoiding manure or nutrient applications in sensitive areas of the field and applying variable rates based on soil and crop capacity to absorb and retain nutrients in other areas of the field. However, the P Index is only a crude estimator to evaluate sites on the relative risk of loss of P to surface water. Therefore, while the site-specific microscale approach can have advantages, it may not be seen to have value by all users. For some, a field level application of the P Index may be more appropriate.

USE OF THE P INDEX

The P Index is an approximation of risk. It was developed to evaluate relative risks, and its level should not be interpreted as an assurance of low P loss. It is a planning tool that can be used in resource management planning and should direct conservation efforts. The P Index can also provide a suite of management and conservation options available to a farmer to reduce the risk of P loss. This should result in more rational, lower cost efforts to minimize the impact of intensive agriculture on water quality. It may also be useful in identifying sites, which do not have elevated soil test P, but which may also be prone to loss of surface P applications.

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Alabama Phosphorus Index

Field Features & Management Practices		Weight	Value Ratings: Low → Very High (0 point)	(1 point)	(2 points)	(4 points)	(8 points)
Source Characteristics							
1. Soil Test P Value		1	Very Low / Low	Medium	High	Very High	Extremely High
2. P Application Rate (lbs. P_2O_5/ac/year)	Traditional Application	3	---	< 60 lbs.	60-120 lbs.	121-180 lbs.	>180 lbs.
	Precision Application	2	---	< 60 lbs.	60-120 lbs.	121-180 lbs.	>180 lbs.
3. **Phosphorus** Application Method		3	---	Injected deeper than 2"	Incorporated within 3 days, sprinkler applied or surface applied treated	Surface applied & incorporated within 4 to 30 days	Surface applied, not Incorporated
4. Grazing Animals		1	None	No access to water and not fed in sensitive area	Restricted access to water & not fed in sensitive area	Unlimited access to water &/or fed in sensitive area <100 animals	Unlimited access to water &/or fed in sensitive area >100 animals
Transport Characteristics							
5. Underground Outlet Systems		3	None	Runoff passes through a of grass filter strip before leaving the system	Outlets empty into grass waterways	< 30% of field has outlets emptying into drainageways or waterbodies	> 30% of field has outlets emptying into drainageways or waterbodies
6. Erosion Rate (tons/ac/yr)		3	< 3 tons	3-5 tons	5-10 tons	10-15 tons	> 15 tons
7. Hydrologic Soil Group	Common Soil Health	3	--	A	B	C	D
	Improved Soil Health	2	--	A	B	C	D
8. Field Slope (%)		1	< 1%	1-3%	3-5%	5-8%	> 8%
9. P Application Distance to Water (ft)		3	> 400 ft.	201-400 ft.	101-200 ft.	50-100 ft.	< 50 ft.
10. Vegetative buffer Width (ft)		2	≥ 50 ft. or not required	30-49 ft.	20-29 ft.	10-19 ft.	<10 ft.
Receiving Water Categories							
11. Impaired, Outstanding, or Critical Habitat Waters		3	Field not in watershed	> 400 ft.	201-400 ft.	101-200 ft	<100 ft

Risk Categories for Phosphorus Loss

Total Points from P Index	Phosphorus Application Rate	Generalized Interpretation of P Index
≤ 65	Nitrogen Rate	**LOW** potential for P movement from the field. There is a low probability of an adverse impact to waterbodies
66 to 75	3 x P removal by crops	**Moderate** potential for P movement from the field. The chance of organic material or nutrients getting into waterbodies exists. Buffers, setbacks, lower manure rates, cover crops, and crop residue practices alone or in combination may reduce impact.
76 to 85	2 x P removal by crops	**Moderately High** potential for P movement from the field. The chance of organic material or nutrients getting to waterbodies is possible. Buffers, setbacks lower manure rates, cover crops, crop residues, etc., in combination may reduce impact.
86 to 95	P removal by crops	**HIGH** potential for P movement from the field and an impact on waterbodies.
≥ 96	No P Application	**Very HIGH** potential for P movement from the field and an adverse impact on waterbodies.