



PPM Plus: A Tool to Aid in Nutrient Management Plan Development

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Phosphorus in the Environment

The over application of fertilizer containing phosphorus (P) to agricultural fields often has a negative impact on water quality. Excess nutrients from field runoff may trigger algal blooms, which may reduce dissolved oxygen in streams, rivers and reservoirs. These algal blooms may cause fish kills and produce undesirable water conditions for recreation and consumption. P is often the nutrient in shortest supply, which limits productivity in aquatic systems based on P availability. Reducing P loss from agricultural fields is often an effective strategy to control aquatic plant and algal growth.

PPM Plus: a Phosphorus Management Tool

PPM Plus is a software tool which can predict the average amount of P and sediment lost from an agricultural field in Oklahoma. PPM Plus considers detailed land characteristics and how the land is managed. PPM Plus is based on the Soil

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and Water Assessment Tool (SWAT); a product of more than 30 years of model development by the Agricultural Research Service (ARS), a branch of the U.S. Department of Agriculture (USDA). Models like SWAT are primarily used by highly trained specialists and are too complex for use by most conservation and nutrient management planners. PPM Plus simplifies the operation of SWAT to put the predictive power of one of our best water quality models into the hands of people who make daily decisions that affect water quality.

PPM Plus Uses

PPM Plus predicts the amount of P and sediment delivered to the nearest stream from a single agricultural field. It can make predictions under a myriad of management options. PPM Plus can be used to develop conservation and nutrient management plans that specifically address off-site surface water quality concerns (Figure 1). Many management scenarios can be easily evaluated to identify the proper management, i.e. Best Management Practices (BMPs), for a particular field. There are many BMPs included in PPM Plus that may reduce sediment and P losses. The effectiveness of a BMP varies depending upon local conditions like soil type, slope, field management, and proximity to streams. A BMP that is very effective at one site may not be effective at another. PPM Plus can be used to identify appropriate BMPs for a particular field, and determine the total P lost both before and after BMP implementation.

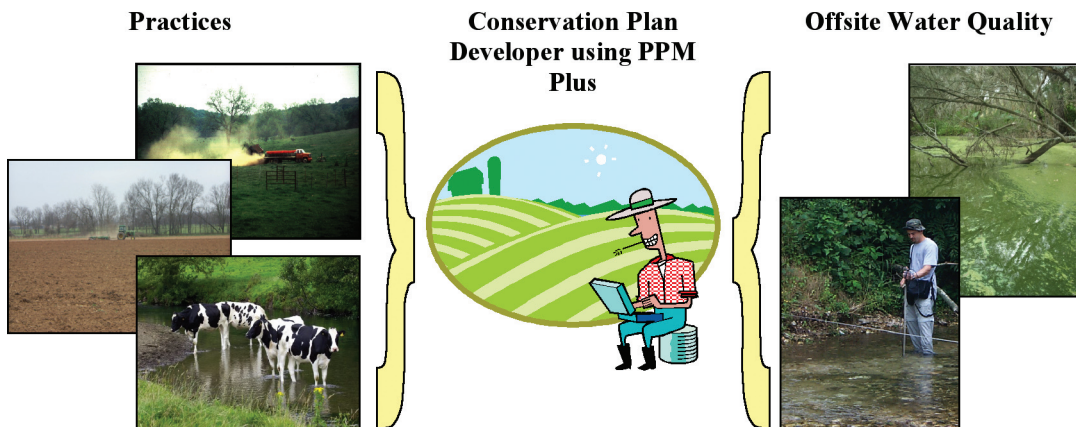


Figure 1 PPM Plus, a part of an effective overall field-level water quality management strategy.

PPM Validation and Testing

It is critical that tools used to make important management decisions be as reliable as possible. PPM Plus was extensively tested and validated using 283 field-years of data collected on small fields across Oklahoma and other areas of the southern United States. Nine field-years of data were collected in eastern Oklahoma specifically for the validation of PPM Plus. The remainder was derived from published studies that included a variety of soils, rainfall, crops, and fertilization schemes. PPM Plus performed very well in this test of accuracy, and was deemed suitable for application across the Oklahoma to address existing and emerging water quality concerns (White 2007).

PPM Plus Interface

PPM Plus was designed to be very easy to use. The PPM Plus user interface is the only portion of the tool that the user sees; the SWAT model is hidden. The majority of inputs are displayed on a single form, with the main form shown in Figure 2. Most user inputs include tool tips, which give a description of each input. In addition, PPM Plus includes critical reference tables and on-screen calculators to aid in estimating input values. The PPM Plus user needs field-level information: a soil test, management information, a soil survey manual, and a topographic map. There are four sections on the main form: Field Information, Best Management Practices, Management, and Simulation. Each section is described below:

Field Information

The Field Information box contains entries for field record keeping, topographical characteristics, soil types, and climate selection. All inputs are archived if the user saves

the project. Saved PPM Plus files can be useful for record keeping or project management. Record keeping inputs like field owner and plan developer names are required, but are not directly used by PPM Plus. Topographical characteristics include slope, Universal Soil Loss Equation (USLE) slope length, field area, and distance to stream. Up to three soil series are possible and a soil test P (STP) is required. A STP tool can be used to convert Arkansas STP Indices to its equivalent as used by the Oklahoma State University Soil, Water and Forage Analytical Laboratory. Nine climate zones are available for Oklahoma; the user can select one from a display map. The user must also specify either a cultivated field or pasture from the menu.

Crop and Pasture Management

The Crop and Pasture Management dialog boxes are the most complex portion of the PPM Plus interface. Each pasture and cultivated agricultural field must be treated separately; management dialogs change depending upon whether pasture or cropland is selected in the Field Information section. With each change in land use, only relevant management operation buttons are shown. These management buttons spawn other dialogs that allow the user to describe management operations. Once the user completes describing each management operation, the operation is shown in the management table with a simple description.

Crop and Harvest

The user must select a crop, planting and harvest dates, irrigation, and harvest method. Options are available for crops which are not harvested. If irrigation is selected, scheduling is based on crop need and will vary with rainfall and temperature.

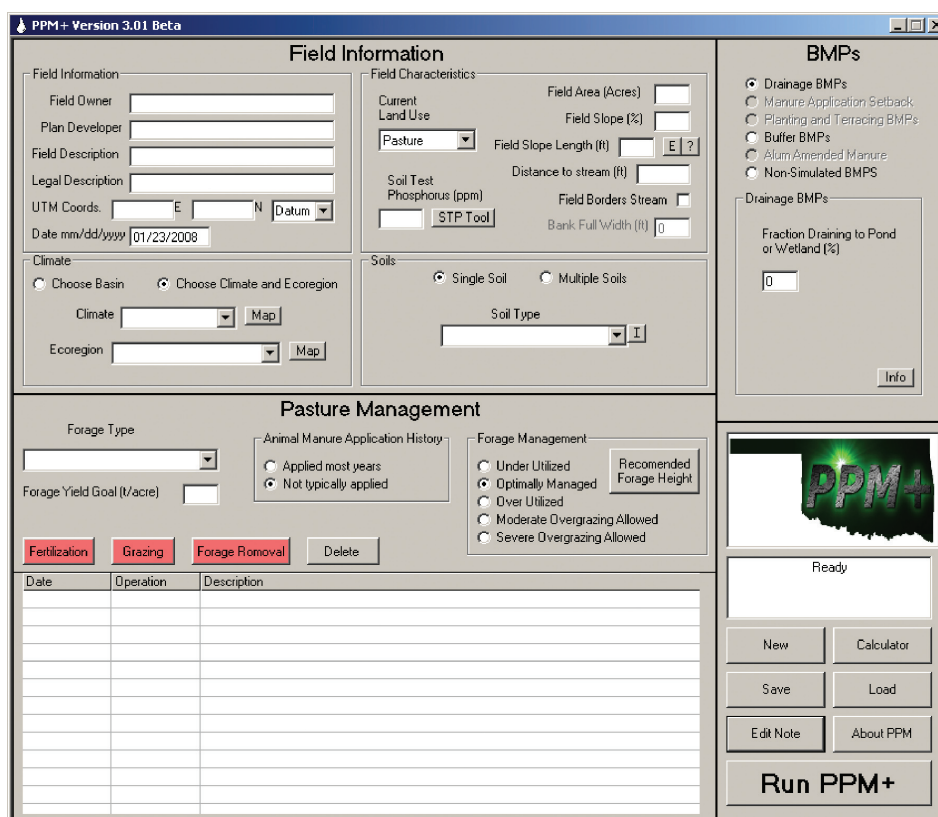


Figure 2 PPM Plus user interface.

Fertilization

The user can select fertilization materials, dates, and fertilizer nutrient content. There are three available options:

- Select a common fertilizer and amount of bulk material applied.
- Input actual nutrient application rates.
- Specify fertilizer analysis and bulk application rate.

Tillage

The user must select tillage types and dates for cultivated crops. Tillage operations are divided into primary and secondary tillage. One primary tillage type must be selected; the choices are conventional tillage, conservation tillage, and no-till. Secondary tillage operations are optional.

Grazing

To simulate grazing, the user specifies the start date, the end date, and the number of animal units per acre grazed. Two types of grazing are supported:

- Cattle will be moved on and off the field throughout the specified period as forage availability changes. The program includes rotational and flash grazing systems. These grazing systems are used in highly managed fields to maximize forage production.
- Cattle will remain on the field throughout the specified period; supplemental feed (hay or feed) will be given as available forage declines. This method is more common with less intensively managed fields and cow-calf operations.

Additional on-screen tables are available to aid in estimating animal units from stocking numbers and animal weight. Grazing is halted or supplemental feed is provided if the available forage declines below a level specified in the Forage Management section of the Pasture Management dialog. Five options are available:

- *Under-utilized* - Under-stocked, excellent forage stand during the growing season. Minimum dry forage is 1800 lb/acre during the growing season.
- *Optimally Managed* - Optimally managed for forage production; no significant overgrazing during the growing season. Minimum dry forage is 1300 lb/acre during the growing season.
- *Over-utilized* - Over-utilized due to excessive stocking. Short periods of overgrazing allowed during the growing season. No visible signs of erosion. Minimum dry forage is 1100 lb/acre during the growing season.
- *Moderate Overgrazing Allowed* - Moderate overgrazing allowed during the growing season. Visible signs of erosion. Minimum dry forage is 700 lb/acre during the growing season.
- *Severe Overgrazing Allowed* - Severe overgrazing allowed for a significant portion of the year. Severe erosion visible with possible active gullies and rills. Minimum dry forage is 450 lb/acre during the growing season.

Forage Removal

Forage Removal allows the user to specify the date when hay is cut.

Forage Type

The user can select from four different forage types:

- Cool Season (Fescue, Rye Grass)
- Bermudagrass
- Native Grass
- Mixed Warm and Cool Grasses

Animal Manure Application History

The application of P-rich animal manures alters the P-distribution within the soil profile. Pastures that have a recent history of manure application have a P-enriched zone at the soil surface. Checking this box accounts for prior animal manure application.

Best Management Practices

PPM Plus predicts the effects of a number BMPs. These BMPs are categorized and described in the following six groups.

Drainage BMPs

The Drainage BMP options allow the user to specify a portion of the field that drains to a pond or wetland. This allows P to be trapped before reaching the stream.

Manure Application Setback

Manure application guidelines use setbacks to prevent manure application in sensitive areas near streams, water wells, and property boundaries.

Planting and Terracing

Planting and terracing BMPs are among the most popular methods to reduce sediment and nutrient losses from cultivated fields.

- Straight Rows – Default condition; crop is planted in straight rows regardless of slope (not a BMP).
- Contour Planted - Crop is planted along the contour.
- Terrace and Contour - Field is terraced and crop is planted along the contour.

Riparian and Grass Buffers

Grass and Riparian Buffers trap sediment and nutrients passing through them before they reach the stream. Buffers may be among the most effective BMPs when properly established and maintained.

Riparian Cattle Exclusion

Cattle exclusion is offered as a BMP. Cattle are assumed to have unrestricted access to the stream if the field is adjacent to the stream, unless the Riparian Buffer Cattle Exclusion is checked.

Alum Amended Animal Manures

The application of alum to animal wastes prior to application can significantly reduce soluble P losses in surface runoff. The application of these manures still increases soil P, but P is applied in more stable forms not readily available for loss in surface runoff.

Record Keeping Best Management Practices

PPM Plus includes recordkeeping options for a number of important BMPs commonly used in Oklahoma. These in-

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output.txt - Notepad
File Edit Format View Help
Created 10/30/2007 10:27:38 AM by PPM+ Alpha version 0.5 - For demonstration purposes only-

Field Owner: Dale Dribble
Plan Developer: Rusty Shackelford
Field Description: South 40
Climate Region: 6                      Ecoregion:Cross Timbers
Simulation Duration 288 Months
UTM Coordinates: 15648E 145247N Datum
Legal Description south Half T21 R15
Plan Date: 02/14/2007                  Field Area (acres): 4096
Field Slope (%): 3                     Slope Length (ft): 150
Fraction to Pond (%): 0                Soil Test P (ppm): 120
Manure App. Setback (acres): 0         No Alum Used
Non-simulated BMPs:
Grass Buffers Width(ft): 0             Grass Buffer Area(acres) : 0
Riparian Buffers width(ft): 0          Riparian Buffer Area(acres) : 0
Soil #1 (100.0%): Abilene_clay loam Hy. Group C CN2: 81
Soil #2 ( 0.0%): Hy. Group C          CN2: 81
Soil #3 ( 0.0%): Hy. Group C          CN2: 81
Planted on a Countour
Interface Type: Advanced
Description:

-----Cropland Management-----
Date operation Description
-----
06/13 Harvest Harvest Small Grains
07/01 Tillage Performing Conventional tillage (Primary)
09/30 Plant Planting Small Grains
10/01 Fertilization Commercial Fertilization (Phosphorus only) 0.0 lb/acre of P2
10/01 Fertilization Commercial Fertilization (Nitrogen only) 80.0 lb/acre of N

----- Monthly Predictions -----
Month Fertilizer Precip Runoff water Sediment Phosphorus
      N P      (in) (in) Yield Total Soluble
      (lb/acre) (lb/acre) (in) (t/acre)-(lb/acre)--(%)
Jan 0 0 1.9 0.2 0.6 0.006 0.04 51
Feb 0 0 2.4 0.3 0.6 0.013 0.07 35
Mar 0 0 3.4 0.1 0.5 0.002 0.01 41
Apr 0 0 3.9 0.1 0.4 0.002 0.01 62
May 0 0 6.2 0.1 0.4 0.005 0.03 43
Jun 0 0 4.6 0.1 0.5 0.005 0.03 41
Jul 0 0 2.9 0.1 0.4 0.168 0.44 4
Aug 0 0 2.6 0.1 0.4 0.156 0.38 3
Sep 20 0 5.0 0.6 1.0 0.873 2.06 3
Oct 60 0 4.4 0.6 1.1 0.961 1.01 6
Nov 0 0 3.4 0.1 0.7 0.006 0.04 50
Dec 0 0 2.8 0.1 0.6 0.001 0.02 82
Ann. 80 0 43.3 2.6 7.3 1.598 4.15 7

Total P loss averages 4.15 (lb/acre/year) but will range from 1.38 to 19.84
most years, but may differ significantly during years with unusually high or low rainfall.

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Figure 3 PPM Plus Output.

puts do not influence model predictions. These BMPs include composting facilities, heavy use area protection, conservation crop rotation, alternative water sources, wind barriers, stream bank protection, drop structures, and grassed waterways.

Running PPM Plus

The simulation portion of the main form allows the user to save and load previous scenarios and to execute the tool. All user inputs are checked to make sure they are reasonable before the tool is executed. Once executed, the tool performs a 25-year simulation using local historical rainfall data.

After execution, a single page of output is displayed in Microsoft Notepad (Figure 3). All the information entered by the user is listed in the output, along with average monthly and annual precipitation, runoff, sediment, total P, and estimated STP change. A range of total annual P losses is also given based on the inherent variability in weather over a 25-year period.

Summary

PPM Plus is designed to allow conservation plan developers, nutrient management planners, and farm managers to take

advantage of the predictive power of a complex hydrologic water quality model. PPM Plus can be used to develop better conservation and nutrient management plans by evaluating the offsite water quality impact arising from proposed management activities. PPM Plus can also be used to evaluate the effect of a BMPs before implementation to facilitate the selection of the proper BMP for a particular site or to gage the effectiveness of state and federally sponsored BMP programs.

Availability

PPM Plus is available for download at <http://storm.okstate.edu/>.

References

White, Michael J., Development and Validation of a Quantitative Phosphorus Loss Assessment Tool, Ph.D. Dissertation, Biosystems Engineering, Oklahoma State University, Stillwater, Oklahoma, December 2007.

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