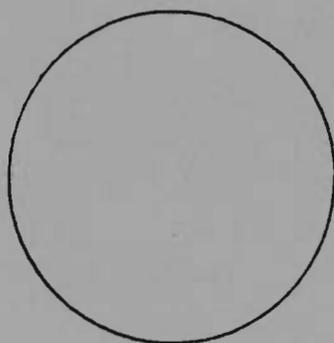


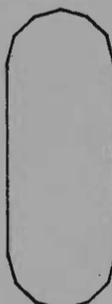
# PHOSECON

(LOTUS Template Version)

P



$P_2O_5$



## Economics of Phosphorus Fertilizer Management



**NDSU EXTENSION SERVICE**

North Dakota State University, Fargo, ND 58105

**PROSECON USER'S GUIDE: LOTUS VERSION 1.01**

by

**Dr. Ardell D. Halvorson  
Soil Scientist  
USDA-ARS  
Akron, Colorado**

**Dr. Ed H. Vaney  
Extension Soil Specialist  
North Dakota State University  
Fargo, North Dakota**

**Dr. David L. Watt  
Agricultural Economist  
North Dakota State University  
Fargo, North Dakota**

**Contribution from USDA-ARS and Cooperative Extension Service and  
Agricultural Experiment Station at North Dakota State University.**

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## INTRODUCTION

Many soils in the northern Great Plains are deficient in plant-available phosphorus. Therefore, wheat and other grain crops often respond to the application of  $P_2O_5$  fertilizer to a phosphorus deficient soil. Today's farm economic situation dictates that crop production inputs be carefully evaluated to assure maximum economic returns are achieved for the dollars invested. The software program PHOSECAN was developed to help farmers, lenders, fertilizer dealers, Cooperative Extension Service personnel, and other agribusiness people evaluate the economic consequences of applying different amounts of fertilizer  $P_2O_5$ , either as a single broadcast application or as a combination of broadcast plus annual (band) applications, with or without the addition of nitrogen (N) fertilizer each crop year. This software program can be used to help make management decisions as to what method of application and rate of  $P_2O_5$  should be used to achieve the greatest profit potential. This can be accomplished by the program user inputting different cost and price factors and  $P_2O_5$  management strategies and then comparing the resulting output for each run of the program to observe changes in estimated profits.

PHOSECAN was developed using crop yield and soil test data from a long-term soil fertility study conducted on a Williams loam soil, a dominant soil in western North Dakota, eastern Montana, and the northern Great Plains. The study was conducted from 1967 to 1983 near Culbertson in northeast Montana (Black, 1982; Halvorson and Black, 1985a, 1985b, 1985c). Halvorson et al. (1986) conducted an economic analysis of the data from this study which served as the basis for developing PHOSECAN. PHOSECAN, however, allows the user to change input costs, crop

prices, money discount rates, and tax rates. PHOSECAN also uses information from other sources, including the knowledge and experience of soil scientists, to simulate the effects on spring wheat yields of: (a) banding  $P_2O_5$  fertilizer annually at a user specified rate following an initial broadcast  $P_2O_5$  fertilizer application; (b) banding  $P_2O_5$  fertilizer annually at a user specified rate without an initial broadcast application; and (c) annually banding a computer recommended rate of  $P_2O_5$  fertilizer to achieve near maximum yield potential. Yield data from the long-term Culbertson study are used to calculate projected yields for each of the eleven crop years for the banding simulation. The efficiency of banding versus broadcasting  $P_2O_5$  is taken into account and adjusted as a function of soil test P level similar to that reported by Peterson et al. (1981).

PHOSECAN is presented in two parts which are indicated as "One-Time-Broadcast" and "Broadcast-&-Annual" on the main option menu when the program is running. The "One-Time-Broadcast" option evaluates the long-term economic consequences of applying a single, one-time application of  $P_2O_5$  as influenced by the costs and prices input by the user while assuming crop yields and cropping sequences of the original data base. The "One-Time-Broadcast" option presents the following economic analysis of the data base by presenting data tables and graphs showing:

- 1) Table of cumulative increase in grain yield above check plot (no N or  $P_2O_5$  added) from crop year 1 through 11.
- 2) Table of cumulative increase in value of protein premium above check plot with each additional wheat crop year.

- 3) Table of cumulative gross income plus protein premium above check plot minus fertilizer costs discounted and taxed at user input rates.
- 4) Graphs of cumulative gross income plus protein premium above check plot minus fertilizer costs discounted and taxed at user input rates are presented for each of the one-time  $P_2O_5$  application rates of 0, 46, 92, 183, and 366 lb  $P_2O_5$ /acre.
- 5) Graphs of cumulative gross income plus protein premium above check plot minus fertilizer costs, discounted and taxed at user input rates are presented for each of N fertilizer rate of 0, 40, and 80 lb N/acre.

The "Broadcast-&-Annual" option of PHOSECAN simulates the effects of using both broadcast and/or annual band applications of  $P_2O_5$  with or without the addition of 40 lb N/acre each crop year. This option allows the user to select and input different  $P_2O_5$  rates but not N rates, however, the N fertilizer costs can be changed. The "Broadcast-&-Annual" option allows the user to also extrapolate the data base to other soils that may have similar yield potentials but a different soil test P level from the data base soil. Responses to  $P_2O_5$  fertilization are limited to the yield difference between the check plot and that  $P_2O_5$  treatment with the maximum yield each crop year, using the yield data from the long-term study. Cumulative yields and dollar returns above check plot (no N or  $P_2O_5$  added) are presented for each of 11 crop years using the same cropping sequences simulated in "One-Time-Broadcast" option. Phosphorus and N fertilizer can be applied by: a) either broadcasting or banding the  $P_2O_5$  and N the first crop year with only a banding option available for applying N and  $P_2O_5$

fertilizer for crop years 2 through 11 at  $P_2O_5$  rates specified by the user; and b) banding  $P_2O_5$  for optimum crop yield as determined by PHOSECAN starting with either crop year 1 or 2.

The second option, "Broadcast-&-Annual", presents six tables and a graph to display results of user inputs. Two tables present the effect of  $P_2O_5$  fertilization on economic returns when no N fertilizer is added. Two other tables present the effect of  $P_2O_5$  fertilization on economic returns with the addition of 40 lb N/acre each crop year. For each pair of tables, with or without fertilizer N, the user has the option of indicating the amount of  $P_2O_5$  to band each crop year for one of the tables (Specified or Spec), while the computer calculates an optimal amount of  $P_2O_5$  fertilizer needed to maximize yields for the other table (Optimum or Opt). Cumulative yields and dollar returns above check plot (no N or  $P_2O_5$  added) are presented for each of 11 crop years. In addition, two other tables show the change in soil test P levels with the user specified  $P_2O_5$  fertilization program (Fert\_spec) and with the computer recommended optimum rates (Fert\_opt).

For both the "One-Time-Broadcast" and the "Broadcast-&-Annual" options, the first 6 crops (crops 1-6) simulate spring wheat grown in a wheat-fallow sequence and the last 5 crops (crops 7-11) simulate spring wheat grown annually without a fallow period between crops.

#### INSTRUCTIONS FOR USING PHOSECAN

PHOSECAN was developed to run on an IBM PC2 or compatible computer using PC.DOS or MS.DOS operating systems and having at least one 5 1/4" disk drive and 512K RAM. This user's manual is intended to be used while running PHOSECAN. Turn your computer ON

and boot the system using your LOTUS<sup>2</sup> systems diskette in drive "A". Remove the LOTUS systems diskette from drive "A". Insert the "PHOSECON" diskette in drive "A", depress the / key to activate the LOTUS menu, and select Files and Retrieve from the Lotus menu. When the file name is requested, press the RETURN or ENTER key. If LOTUS is being operated from a hard drive, the user will need to tell the LOTUS program that the PHOSECON worksheet is located in the "A" disk drive. It will take several seconds for the PHOSECON worksheet to load. Watch for the READY sign to appear in the upper right-hand corner of the screen. At this point, the program is ready to run with the display of the first selection menu and a brief introductory screen.

**NOTE:** To obtain a hard copy of a given screen, depress the Shift and Prt Sc keys simultaneously. This option will give you a copy of only those screens you wish to have copied to the printer, excluding graphic screens.

**Screen 1:** Presents a brief description of the worksheet and a listing of PHOSECON authors and programmer. This screen presents the main selection menu or branch options of the PHOSECON worksheet.

#### DESCRIPTION OF SCREENS FOR THE "ONE-TIME-BROADCAST" MENU OPTION

**Screen 1:** Displays program default values for fertilizer N and P<sub>2</sub>O<sub>5</sub> costs; fertilizer application<sup>2</sup> costs; grain price for wheat;

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<sup>2</sup>Mention of trade names or manufacturer within the context of this article are used solely to provide specific information and does not constitute a guarantee or endorsement by the U.S. Dept. of Agriculture or North Dakota State University.

protein premium; discount rate (your cost of money above inflation rate); and tax rate. The "Highlighted" values can be changed by selecting the Change menu option. Any or all values can be changed by using arrow keys to select the value to be changed and then inputting the new value. When you have finished changing values, press the ENTER key "twice" to return to the main menu.

**Graphic Screens:** Selecting the Graphs menu option will result in a new menu being displayed. From this menu, you can select any of eight graphs to be displayed: (1) P<sub>2</sub>O<sub>5</sub>=0; (2) P<sub>2</sub>O<sub>5</sub>=46; (3) P<sub>2</sub>O<sub>5</sub>=92; (4) P<sub>2</sub>O<sub>5</sub>=183; (5) P<sub>2</sub>O<sub>5</sub>=366; (6) N=0; (7) N=40; and (8) N=80. Note, numbers to the left of the equal sign represent the P<sub>2</sub>O<sub>5</sub> or N rate in lb/acre. The second line of the menu provides a brief explanation of the option being selected. Use arrow keys to move the cursor to the desired graph option and press ENTER key. The graph selected should be displayed. Pressing the ENTER key again will bring up a brief explanation of the graph. Selecting Graph from the menu will return you to the last graph that was displayed. Selecting the Continue-Graphs option will bring up the graphics menu from which other graphs can be selected. Selecting the Return option brings up the main menu of the "One-Time-Broadcast" option.

**Table Screens:** Selecting the Tables option from the menu will cause a menu of tables to be displayed. Selecting the Yield Table option will bring up a table showing cumulative grain yield above check plot for each of the N and P<sub>2</sub>O<sub>5</sub> treatments progressing from Crop year 1 to 11. Selecting the Protein Table option will bring up a table showing cumulative value of grain protein premium (wheat crops only) for each of the N and P<sub>2</sub>O<sub>5</sub> treatments

progressing from crop year 1 to 11. Selecting the Tax Table option will bring up a table of cumulative gross income plus protein premium minus fertilizer costs discounted and taxed at user inputted rates for each N and  $P_2O_5$  treatment progressing from crop year 1 to 11. Selecting the Quit option will return program control back to the Main menu.

**DESCRIPTION OF SCREENS FOR  
"BROADCAST-&-ANNUAL"  
MENU OPTION**

Selecting the "Broadcast-&-Annual" option of the main menu will bring up a screen displaying default prices for grain, N and  $P_2O_5$  costs, fertilizer application costs, and protein premium; discount rate on money and income tax rates for crop year 1 and crop years 2-11; and sodium bicarbonate extractable P level of the native soil that has never received any  $P_2O_5$  fertilizer and current soil test P level in the 0 to 6 inch soil depth in ppm (note: ppm P = [lb P/acre]/2). Any of the default values can be changed by selecting the Change option from the menu. Use arrow keys to move the cursor to the value to be changed, input the new value, then move to the next value to be changed with the arrow key. When all the desired changes have been made, depress the ENTER key once to return to the menu.

The program assumes a sodium bicarbonate extractable P level (Olsen Test) of 18 ppm (36 lb/acre) in the 0 to 6 inch soil depth is needed to achieve optimum yield potential (Halvorson, 1986). The computer program estimates the amount of broadcast and incorporated  $P_2O_5$  required to raise the soil test level to 18 ppm the first crop year and the amount that needs to be banded each crop year to maintain the soil test level at 18 ppm, similar to the method used by Halvorson and Kresge (1982). The user

inputs the amount of  $P_2O_5$  to be broadcast the first year and the amount to be banded in subsequent years. If the user specifies no (zero)  $P_2O_5$  is to be broadcast the first year, the program then assumes that  $P_2O_5$  will be banded the first year at the rate input for the band application. Results are displayed in six tables and one graph and can be viewed by selecting the Tables or Graph options from the menu.

Table Screens: Selecting the Tables option from the menu will bring up a new menu with six table options: (1) Opt-P-0N; (2) Opt-P-40N; (3) Spec-P-0N; (4) Spec-P-40N; (5) Fert\_opt; and (6) Fert\_spec. The Table options with "Opt-P" in the title refer to  $P_2O_5$  rates recommended by the computer program as being optimum for maximum wheat yield potential. The Table options with "Spec-P" in the title refer to  $P_2O_5$  rates specified by the user of this program. The "0N" and "40N" part of the titles simply refer to the lb/acre of fertilizer N applied each crop year. Each table displays cumulative effects, above check plot, of  $P_2O_5$  fertilization with either no N or 40 lb N/acre applied each crop year on grain yield, fertilizer cost, gross income, protein premium, gross income minus fertilizer cost, gross income plus protein premium minus fertilizer cost, gross income plus protein premium minus fertilizer cost with money discounted at input discount rate, and gross income plus protein premium minus fertilizer cost with money discounted at the inputted discount rate and with tax credits and debits figured at user inputted tax rate. The Fert\_opt and Fert\_spec tables display changes in estimated soil test P levels each year as a result of  $P_2O_5$  applied for the computer optimum and the user specified rates, respectively.

Selecting the Return option from the menu will return you to

the main menu of the "Broadcast-&-Annual" option. One can now select any of the listed options to continue or Quit to end the program.

**Graph Screen:** Selecting the Graph menu option will bring up a graph showing gross income plus protein premium minus fertilizer cost with money discounted at user inputted discount rate and with tax credits and debits figured at inputted tax rates from each of the first four option Tables (last column of each table). This graph displays the results of the selected management decisions for easy comparison. Depressing the ENTER key will return you to the main menu of the "Broadcast-&-Annual" option.

Selecting the Change menu option will allow you to input new prices and fertilizer P rates. Selecting the Main-Menu option will send the program back to the original starting menu of the worksheet.

#### REFERENCES

1. Black, A. L. 1982. Long-term N-P fertilizer and climate influences on morphology and yield components of spring wheat. *Agron. J.* 74:651-657.

2. Halvorson, A. D. 1986. Soil test and P rate relationships to maximum yield: West. 8 p. In *Proc. Maximum Wheat yield Systems Workshop*, March 6-7, 1986, Denver, CO. Potash and Phosphate Institute, Atlanta, GA.

3. Halvorson, A. D., and A. L. Black. 1985a. Long-term dryland crop responses to residual phosphorus fertilizer. *Soil Sci. Soc. Am. J.* 49:928-933.

4. Halvorson, A. D., and A. L. Black. 1985b. Fertilizer phosphorus recovery after seventeen years of dryland cropping. *Soil Sci. Soc. Am. J.* 49:933-937.

5. Halvorson, A. D., and A. L. Black. 1985c. Safflower helps recover residual nitrogen fertilizer. *Mont. AgResearch* 2:19-22.

6. Halvorson, A. D., A. L. Black, D. L. Watt, and A. G. Leholm. 1986. Economics of a one-time phosphorus application in the northern Great Plains. *Applied Agricultural Research* 1(3):137-144.

7. Halvorson, A.D., and P. O. Kresge. 1982. FLEXCROP: A dryland cropping systems model. U.S. Dept. of Agric. Production Research Report No. 180.

8. Peterson, G.A., D.H. Sander, P.H. Grabouski, and M.L. Hooker. 1981. A new look at row and broadcast phosphate recommendations for winter wheat. *Agron. J.* 73:13-17.

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