United States Department of Agriculture
Natural Resources Conservation Service
South Dakota

SD FS 47

Building Soil Test Phosphorus

Explanation of the Calculations in the South Dakota Initial Nutrient Management Plan (form SD-CPA-7)

Background

In 2003 substantial changes were made to the South Dakota General Livestock Permit and the NRCS nutrient management standard to address the environmental issues associated with phosphorus (P). Throughout this process of change, various groups/agencies in South Dakota recognized that as structural livestock facilities are properly designed in the state, those designs also needed to be completed with the correct land base for application of the waste produced by these facilities. The Initial Nutrient Management Plan (form SD-CPA-7) is a Microsoft Excel spreadsheet constructed to help the user arrive with the required land base calculation needed for waste application.

A number of questions have been asked concerning the P calculations in the Initial Nutrient Management Plan. This fact sheet was developed to address these questions.

Initial Nutrient Management Plan (form SD-CPA-7) Calculations

The SD-CPA-7 actually utilizes two separate calculations in the spreadsheet to approximate building phosphorus (P) soil test levels. The first P calculation is in column 34 of the SD-CPA-7. It is designed to address the issue of building soil test P levels on an individual field using the premise that manure applications would occur on that field every year at the maximum rate based on the average nitrogen (N) needed in the rotation as entered by the user. The program uses the current P soil test of the field, subtracts this value from 50 ppm, and then calculates the rate of soil test P increase based on the P:N ratio of the manure and the average rate of crop removal.

The second P calculation at the bottom of the SD-CPA-7 is designed to address a whole farm estimate of how quickly soil test P level will increase on all the fields entered by the user with the current livestock numbers. The program individually subtracts the current soil test P levels from 50 for each field and then multiplies this value by 20 (20 pounds of P_2O_5 applied above crop removal will raise soil test levels by 1 ppm) to arrive at a total amount of phosphorus that would raise all fields up to 50 ppm. This value is then divided by the total amount of phosphorus produced annually in excess of crop removal.

Example

A producer has 500 steers in an open lot weighing an average of 800 pounds for 365 days. The nutrients produced in this facility are 11,485 pounds of N and 36,500 pounds of P_2O_5. The field the manure will be applied on is right beside the feedlot and is 172.3 acres with a P soil test of 8 ppm and has 100 bushel corn/30 bushel soybeans in rotation. The average additional N used in this rotation is 67 pounds per acre and the average P removed in the rotation is 27 pounds P_2O_5. This 172.3 acre field would require 11,487 pounds of N, and 4,664 pounds of P_2O_5 to meet the average crop need.

Please note that 11,485 pounds of N were produced by the facility, and 11,487 is required by the field. So, if the manure is applied based on crop N need, all the manure will be applied on this field. However, the crop only needs 4,664 pounds of P_2O_5. With all the manure applied to this field, the producer has put on 36,500 pounds of P_2O_5.

The calculation for this single field in column 34 would be:

$$\text{The number of years to build the field to 50 ppm} = \frac{50 - \text{current P soil test}}{(\text{average of additional N required for rotation X P:N ratio of manure produced}) - \text{average P removed for rotation} \div 20}$$

Or, using the example figures for the single field, the equation would be:

$$\text{The number of years to build the field to 50 ppm} = \frac{50 - 8}{(67 \text{ X } 3.18) - 27 \div 20} = 4.52 \text{ years}$$

(The computer would round this value up to 5 years.)

Note: the P:N ratio in this example is 36,500 pounds of $P_2O_5 \div 11{,}485$ pounds of N.

The calculation at the bottom of the SD-CPA-7 for the whole farm (or in this example only field 1):

$$\text{The number of years to build all the fields in the plan to 50 ppm} = \frac{\begin{array}{c}(50 - \text{current P soil test X } 20 \text{ X field 1 acres}) \\ + (50 - \text{current P soil test X } 20 \text{ X field 2 acres}) \\ + (50 - \text{current P soil test X } 20 \text{ X field 3* acres})\end{array}}{P_2O_5 \text{ produced in excess of crop removal}}$$

**Add additional fields as appropriate.*

Or, using the example figures, the equation would be:

$$\text{The number of years to build all the fields in the plan to 50 ppm} = \frac{(50 - 8) \text{ X } 20 \text{ X } 172.3}{(36{,}500 - 4{,}664)} = 4.55 \text{ years}$$

(The computer would round this value up to 5 years.)

So, the result of this simple example is that because 31,836 pounds of P_2O_5 in excess of crop removal are being applied, in 5 years P soil test levels will be above 50 ppm.

Extended Example

What would happen if a second field were added to the example? An extended example would be that field 2 is exactly the same as field 1. If field 1 and field 2 were exactly the same, the resulting calculation (in column 34 of the SD-CPA-7) the computer would run through would be exactly the same calculation for field 1 and field 2. The result would be the same for both fields. The computer calculation would be 4.52 years (rounded to 5) for both fields. Please keep in mind this calculation is designed to estimate how rapidly P soil test values could be built on an individual field.

Now remember that in this example, the producer ran out of manure on the first field. So, the P calculation at the bottom of the SD-CPA-7 (which is designed to address a whole farm estimate of how quickly soil test P level) will change substantially.

This calculation for all fields in this second example is as follows:

$$\text{The number of years to build all the fields in the plan to 50 ppm} = \frac{\begin{array}{c}(50 - \text{current P soil test X } 20 \text{ X field 1 acres}) \\ + (50 - \text{current P soil test X } 20 \text{ X field 2 acres}) \\ + (50 - \text{current P soil test X } 20 \text{ X field 3* acres})\end{array}}{P_2O_5 \text{ produced in excess of crop removal}}$$

**Add additional fields as appropriate.*

Or, using the extended example figures, the equation would be:

$$\text{The number of years to build all the fields in the plan to 50 ppm} = \frac{\begin{array}{c}(50 - 8) \text{ X } 20 \text{ X } 172.3 \\ + (50 - 8) \text{ X } 20 \text{ X } 172.3\end{array}}{(36{,}500 - 9{,}328)} = 10.65 \text{ years}$$

(The computer would round this value up to 11 years.)

Please remember the difference between these two calculations is that the first calculation is based on the rotational average N needed on each field and the second is based on the total amount of P produced on the feedlot and the total amount possible for the soil in all fields to retain up to 50 ppm.
