Land Application Examples

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The purpose of this section is to provide several examples related to nutrient application calculations. These examples will demonstrate the application of several of the concepts presented in chapters 3, 4, and the previous portions of 5. The examples will be related to calculation of application rates and estimation of the total amount of land needed to utilize plant nutrients in an environmentally responsible manner.

CALCULATION OF APPLICATION RATE

Example 1

A swine producer had the surface water of his lagoon tested for plant nutrients by a laboratory. The laboratory report provided the following results on an as-sampled or wet basis.

Nutrient	lbs / 1,000 gal
Ammonium-N	3.4
Organic-N	1.4
Incorporated Available Nitrogen Estimate	3.6
Surface Available Nitrogen Estimate	2.5
P_2O_5	2.8
K_2O	6.1
Moisture Content = 99.63%	

The lagoon water will be applied to cropland using a traveling gun irrigation system.

1. What value should be used as the estimate of the plant available nitrogen?

The incorporated available nitrogen estimate is to be used for irrigation. Therefore the PAN estimate is 3.6 lbs/1,000 gal.

2. Assume that the nutrient data shown above is the current rolling average for lagoon surface water on this farm. Calculate the application rate for corn if the nitrogen requirement is 120 lb N/acre in gallons per acre and in inches.

Application rate = 120 lb N/acre ÷ 3.6 lb PAN x 1,000 gal = 33,333 gal / acre
One acre-inch of water contains 27,154 gallons (see section on conversion factors in chapter 7). The application rate in inches is:
33,333 gal / acre ÷ 27,154 gal / ac-in = 1.23 inches of lagoon water.

3. How much phosphorous, expressed as P_2O_5, is applied to the corn fields in this example?

The application rate was previously determined to be 33,333 gal / ac. The P_2O_5 content of the manure is 2.8 lb/1,000 gal. The amount of P_2O_5 from manure that is applied to the corn field is:
33,333 gal/ac x 2.8 lb P_2O_5 ÷ 1,000 gal = 93 lb P_2O_5 / ac.

4. Is this application of P_2O_5 greater than crop removal? If so, how much greater?

The P_2O_5 removal for 100 bu / ac. corn in South Carolina is about 44 lb / ac. (see Table 3, chapter 5a). Therefore, 2.1 times more phosphorous is added than removed.

5. Calculate the application rate for corn based on phosphorous removal.

Crop removal = 44 lb P_2O_5 / acre ÷ 2.8 lb P_2O_5 x 1,000 gal = 15,714 gal / acre
One acre-inch of water contains 27,154. The application rate in inches is:
15,714 gal / acre ÷ 27,154 gal / ac-in = 0.58 inches of lagoon water.

6. Determine how much nitrogen must be applied from a commercial, or purchased, source if lagoon water is applied at the rate based on crop phosphorous removal.

Step 1. Calculate the amount of PAN applied if lagoon water is spread based on P_2O_5.
15,714 gal/ac x3.6 lb PAN ÷ 1,000 gal = 57 lb PAN / ac.
Step 2. Calculate the amount of nitrogen needed by the corn that is not supplied by the manure.
120 lb N/ac - 57 lb PAN/ac = 63 lb N/ac
Therefore, commercial fertilizer must be spread to provide 63 lb N/ac.

Example 2

Nutrient data for manure from an agitated lagoon indicates that the incorporated estimate of PAN is 5.6 lb / 1,000 gal. The P_2O_5 content of the mixture of sludge and lagoon water is 11.3 lb / 1,000 gal. What is the application rate for dry land corn based on nitrogen requirement and crop phosphorous removal?

Based on the previous example the N requirement for corn is 120 lb/ac and crop removal of P_2O_5 is 44 lb/ac. The application rate based on N is:
N-Application rate = 120 lb N/acre ÷ 5.6 lb PAN x 1,000 gal = 21,429 gal / ac.

The application rate based on P is:
P_2O_5-Application rate = 44 lb N/acre ÷ 11.3 lb PAN x 1,000 gal = 3,894 gal / ac.

ESTIMATION OF THE AMOUNT OF LAND NEEDED FOR LAND APPLICATION

The amount of land needed to properly use the plant nutrients in swine manure will vary with the type of crops grown, the average crop yields, the number of acres that are double cropped, and the number of times manure is applied each year. These types of calculations must be performed on a field-by-field basis to develop and implement a land application plan for a particular farm.

Example 3

A swine producer has three buildings that each house 880 finishing hogs. The manure is stored and treated in an anaerobic lagoon. The current rolling average for PAN is 3.6 lb/1,000 gal for the lagoon surface water. Irrigation records indicate that 1,824,240 gal of lagoon water must be pumped each year. The lagoon water will be used to fertilize corn. The nitrogen requirement of the crop is 120 lb N/ac.

1. Calculate the total amount of PAN that must be used by corn each year.

3.6 lb PAN x 1,824,240 gal/year ÷ 1,000 gal = 6,567 lb PAN/year.

2. How many acres of corn are needed to balance this nitrogen production?

6,567 lb PAN / year ÷ 120 lb N / ac = 55 acres of corn.

3. The total amount of P_2O_5 produced per year in this case is 5,016 lb. How many acres of corn are needed if lagoon water is spread based on crop removal of P?

The P_2O_5 removal of the crop is about 44 lb/ac (from example 1).
5,016 lb P_2O_5 / year ÷ 44 lb P_2O_5 / ac = 114 acres of corn.

Example 4

The same swine producer as in the previous examples plans on agitating and removing sludge from the lagoon in five years. No increase in hog numbers is anticipated. Therefore, the average number of finishing swine on the farm is 2640 (3 x 880/house). The lagoon will be agitated and the mixture of sludge and supernatant will be spread in the spring using a tank spreader. The sludge will be incorporated the same day it is applied as part of pre-plant tillage operations.

1. Use Table 4.8 (page 4-29) to estimate the amount of extra PAN that will be land applied.

From Table 4.8, the amount of PAN from sludge is 8.4 lb / hog. The total amount of PAN that must be accounted for in the nutrient management plan is:
2,640 hogs x 8.4 lb PAN/hog = 22,176 lb PAN.

2. How many additional acres of corn, requiring 120 lb N/ac, will be needed if the sludge is applied based on nitrogen?

22,176 lb PAN / 120 lb N/ac = 185 acres

3. What is the total amount of corn land needed for land application every 5 years?

55 acres for lagoon water (example 3) + 185 acres for sludge = 240 acres.

4. How many acres of commercial pine plantation are needed if the extra nitrogen from sludge is used to fertilize pine trees at the rate of 100 lb PAN/acre using a side-discharge spreader?

Surface application of lagoon sludge will result in an increase in the loss of ammonium-N. The PAN estimate for surface spreading of sludge, given in Table 4.8, is 7.3 lb PAN/hog.
The total amount of PAN = 2,640 hogs x 7.3 lb PAN/hog = 19,272 lb PAN
The amount of pine plantation needed is:
19,272 lb PAN ÷ 100 lb N/ac = 193 acres.