Published at the Chat 'n Chew Cafe, 26 March 2002
URL: http://www.kingcorn.org/news/articles.02/Fert_Math-0326.html

Fertilizer Reckoning for the Mathematically Challenged

R.L. (Bob) Nielsen
Agronomy Dept., Purdue Univ.
West Lafayette, IN 47907-1150
Email address: rnielsen@purdue.edu

- Relative nutrient costs play an important role in the fertilizer selection process.
- Examples are provided to help understand the fertilizer mathematics involved in calculating nutrient costs for single or multiple nutrient fertilizers.

What do you think of when you see the numbers: 82-0-0, 46-0-0, 0-0-60, 9-18-9, and 3-18-18? No, they are not a list of winning Indiana Lottery numbers. Rather, they are examples of guaranteed analysis values for the percentages of nitrogen (N), available phosphorus (P_2O_5) and water-soluble potassium (K_2O) in common fertilizer sources. These values represent plant-available nutrients and are required by law to be publicly available when you purchase fertilizers in Indiana.

With these and so many other possible sources of fertilizer for use in Indiana row crop production, determining the least costly form of fertilizer can be challenging and unwieldy. When comparing potential sources of fertilizer, you ought to be calculating and comparing the relative costs per pound of nutrient, not the costs per ton of fertilizer product.

Unfortunately, fertilizer mathematics is not a strong suit for many agriculturalists. Sharpen your pencils and follow along with these examples of nutrient cost calculations. Remember, where appropriate, to substitute your own local fertilizer prices for those used in these examples.

Example 1: Single Nutrient Products

For single nutrient fertilizer products such as anhydrous ammonia (82-0-0) or 28% UAN (28-0-0), calculating the costs per pound of nutrient is simple. Fertilizer sources and retail prices used for this example are anhydrous ammonia ($285/ton) and 28% UAN ($225/ton).

Example 1: Single Nutrient Products

First, calculate the lbs of nutrient per ton of product:

- Pounds of N per ton of anhydrous ammonia = 2000 × 82% = 1640 lbs of N
- Pounds of N per ton of 28% UAN = 2000 × 28% = 560 lbs of N

Second, calculate the cost per lb of nitrogen:

- Cost per lb of N in 1 ton of anhydrous ammonia = $285 ÷ 1640 lbs N = 17 cents per lb N
- Cost per lb of N in 1 ton of 28% UAN = $225 ÷ 560 lbs N = 40 cents per lb N

This simple mathematical example also illustrates why anhydrous ammonia has historically been a popular source of fertilizer nitrogen for corn production in Indiana: It is typically a very inexpensive source of N.

Example 2: Multiple Nutrient Products (N & P)

Calculating the price per pound of nutrient for multiple analysis fertilizer products can be more challenging. Typically, the cost of one nutrient in the mix is of primary interest to you. Consequently, the costs for one or more of the other nutrient components of the mixture are set to standard values based on the cost of single nutrient sources.

For example, let's say that you wanted to compare the relative nitrogen costs of 28% UAN (28-0-0) and 10-34-0 for making an economic decision on starter fertilizer products. Assuming that the phosphorus component of the 10-34-0 is also of value to the crop, calculating the nitrogen cost share of the mix must therefore account for the cost share of the mix that can be attributed to the phosphorus.

Because the relative nitrogen costs are the ones of interest in this example, the phosphorus cost per lb P_2O_5 can simply be set to a standard value. What value should this be? The simplest value would be that equal to the price per lb of P_2O_5 in a common single nutrient source such as 0-46-0 (triple super phosphate).

Fertilizer sources and retail prices used for this example are 28% UAN ($225/ton), 10-34-0 ($260/ton), and 0-46-0 ($260/ton).

Example 2a: Multiple Nutrient Products (N & P)

First, calculate the lbs of nutrient per ton of product:

- Pounds of N per ton of 28% UAN = 2000 × 28% = 560 lbs of N
- Pounds of N per ton of 10-34-0 = 2000 × 10% = 200 lbs of N
- Pounds of P_2O_5 per ton of 10-34-0 = 2000 × 34% = 680 lbs of P_2O_5

Second, calculate the standard cost per lb of P_2O_5 in 0-46-0:

- Pounds of P_2O_5 per ton of 0-46-0 = 2000 × 46% = 920 lbs of P_2O_5
  Cost per lb P_2O_5 = $260 ÷ 920 lbs P_2O_5 = 28 cents per lb P_2O_5
  (This will become the standard value used in the next calculation.)

Third, calculate the phosphorus share of the total cost in one ton of 10-34-0:

- Cost of P_2O_5 per ton of 10-34-0 = 680 lbs P_2O_5 × 28 cents per lb = $190
  (This value will be used in the next calculation.)

Fourth, calculate the nitrogen share of the total cost of 10-34-0 per ton of product:

- Nitrogen share = Total cost of 10-34-0 per ton minus phosphorus share
  Nitrogen share = $260 minus $190 = $70 per ton
  (This value will be used in the next calculation.)

Finally, calculate the relative costs per lb of nitrogen for the two nitrogen sources:

- Nitrogen cost in 1 ton of 28% UAN = $225 ÷ 560 lbs N = 40 cents per lb N
- Nitrogen cost in 1 ton of 10-34-0 = $70 ÷ 200 lbs N = 35 cents per lb N

This mathematical example indicates that the 10-34-0 fertilizer product would be a less expensive source of nitrogen for use in starter fertilizer programs. The caveat to this, however, is the recognition that with 10-34-0 you would be purchasing phosphorus in addition to nitrogen.

So, remember to finish this mathematical exercise by calculating the per acre cost for the two products. In order to do so, it is important that you calculate the per acre costs considering identical rates of starter nitrogen (apples to apples). Let's assume a starter fertilizer nitrogen rate of 20 lbs N for both products:

Example 2b: Multiple Nutrient Products (N & P)

First, calculate the per acre cost of the single nutrient 28% UAN product:

- 20 lbs N per acre as 28% UAN × 40 cents per lb N = $8 per acre cost

Second, calculate the per acre cost of the multiple nutrient 10-34-0 product:

- 20 lbs N per acre rate would require 200 lbs of product.
- 200 lbs of product = (200 lbs ÷ 2000 lbs per ton) × $260 per ton = $26 per acre

So, while 10-34-0 is technically the cheaper source of nitrogen (per lb N) in this example, the total cost per acre would be greater than that for using 28% UAN as a starter fertilizer source because of the additional costs due to the phosphorus component of 10-34-0. But hold on, the story does not end here.

IF the phosphorus component would be beneficial to the corn crop because of less than adequate phosphorus soil test levels, the additional cost per acre ($19) may be rewarded by increased corn yields. However, IF the phosphorus soil test levels were above the critical value for corn (greater than 30 lbs P per acre, Bray P_1), then the inclusion of the phosphorus in the starter mix may be of little value to the corn crop and, thus, the less expensive starter N source of 28% UAN would be the economic choice.

Example 3: Multiple Nutrient Solution Products (N, P, & K)

Calculating per pound costs for nutrients in products that contain nitrogen, phosphorus, AND potassium is slightly more challenging but similar to that described above for products containing two nutrients. Depending on which of the three nutrients is the one of interest, you simply set the price of the other two equal to that calculated from single nutrient sources. For example, if you wanted to calculate the nitrogen cost of a multiple analysis product such as 9-18-9, you would first subtract the relative costs of the phosphorus and potassium portions from the total cost.

Assume you wanted to calculate the nitrogen share of the cost of a 9-18-9 liquid fertilizer. The phosphorus and potassium share of the fertilizer product cost will be calculated using standard costs per lb for P_2O_5 and K_2O, calculated from the single nutrient sources 0-46-0 and 0-0-60.

This example also illustrates how to calculate nutrient price per pound when the product is priced on a per gallon basis, not on a per ton basis. Fertilizer sources and retail prices used for this example are the common single nutrient sources 0-46-0 ($260/ton), 0-0-60

($175/ton), and 9-18-9 ($3/gallon).

Example 3: Multiple Nutrient Solution Products (N, P, & K)

First, calculate the standard cost per lb of P_2O_5 and K_2O:

- Pounds of P_2O_5 per ton of 0-46-0 = 2000 × 46% = 920 lbs of P_2O_5
  Cost per lb P_2O_5 = $260 ÷ 920 lbs P_2O_5 = 28 cents per lb P_2O_5
  (This value used in the third step below.)
- Pounds of K_2O per ton of 0-0-60 = 2000 × 60% = 1200 lbs of K_2O
  Cost per lb K_2O = $175 ÷ 1200 lbs K_2O = 15 cents per lb K_2O
  (This value used in the third step below.)

Second, calculate the lbs per gallon of 9-18-9 for the nitrogen, phosphorus, and potassium nutrient components of this fertilizer product. This product, like many fertilizer solutions, weighs about 11 lbs per gallon.

- Pounds of N per gal of 9-18-9 = 11 × 9% = 1 lb of N
  (rounded to nearest whole number)
- Pounds of P_2O_5 per gal of 9-18-9 = 11 × 18% = 2 lbs of P_2O_5
- Pounds of K_2O per gal of 9-18-9 = 11 × 9% = 1 lb of K_2O

Third, calculate the relative cost shares of P_2O_5 and K_2O in one gallon of 9-18-9:

- Cost of P_2O_5 per gal of 9-18-9 = 2 lbs P_2O_5 × 28 cents per lb = 56 cents
  (Using the standard P_2O_5 cost calculated in the first step.)
- Cost of K_2O per gal of 9-18-9 = 1 lb K_2O × 15 cents per lb = 15 cents
  (Using the standard K_2O cost calculated in the first step.)

Finally, calculate the cost per lb of nitrogen in 9-18-9:

- Nitrogen cost share per gal = Total cost minus P_2O_5 share minus K_2O share
  Nitrogen cost share per gal = $3 minus $0.56 minus $0.15 = $2.29 per gal
- Cost per lb of N of 9-18-9 = $2.29 per gal ÷ 1 lb N per gal = $2.29 per lb N

Surprised? Many liquid fertilizer products sold on a per gallon basis can be quite expensive on a per pound of nutrient basis, yet are no more effective or efficient in supplying nutrients to crop plants. This fact alone makes it worth your while to become skilled at fertilizer mathematics.

Summary

These examples provide you with some guidelines to follow in order to calculate nutrient costs on a per pound basis. Working with single nutrient sources is simple and straightforward. Working with multiple nutrient sources is somewhat more complicated, yet also fairly straightforward if you follow the steps.

Remember that most fertilizer products are equally effective in their use as crop plant nutrient sources. Part of your decision process for fertilizer inputs involves calculating and comparing the relative costs among alternative products. Taking the time to do the type of fertilizer reckoning described in this article will better enable you to compare the relative costs of different fertilizer products.

End of document