PART 1

Phosphorus and Potassium Economics in Crop Production: Costs

By T.S. Murrell and R. D. Munson

Economic evaluations of P and K fertilization are usually performed through partial budgeting. Partial budgeting considers only the cost and revenue items associated with a particular management practice.

Low crop prices have led many farmers to re-examine their soil fertility programs. Many are trying to cut costs and still maintain their production levels. Phosphorus (P) and potassium (K) are integral and well-proven parts of a profitable nutrient management program. Management decisions about P and K must be based on sound agronomic principles to assure profitability. Amounts of P and K producing maximum economic yields also minimize losses in tough times. This is the first of a three-part series that will provide a review of the economics of P and K fertilization to assist farmers, dealers, consultants, and other agribusiness professionals in their management of these nutrients.

Soil sampling costs include laboratory analyses and labor for sample collection. **Fertilizer product expenses** are the costs per pound of nutrients and the amount needed. **Fertilizer application costs** are those associated with product application, such as custom spreading. With yield increases from fertilization, added costs are incurred for **handling (auger, tractor or truck, and labor) and hauling** to the farmstead and/or market. In addition, increased yields may translate to increased **drying costs and increased storage expenses**. Storage expenses will be determined from the farmer's decision whether or not to store grain and if so, for how long. The cost for each of these items will vary by location and depend on whether farmers do the work themselves or use commercial services. It is important for farmers who do the work themselves to include their own expenses, such as equipment, labor, fuel, and other costs.

Calculating Expenses Associated with P and K Fertilization

Calculating expenses requires the identification of inputs that have value beyond the current year. Such practices should have their costs spread over time (amortization). For instance, soil sampling for immobile nutrients such as P and K is usually conducted once every 2 to 4 years. Information gathered from sampling often affects fertilizer management decisions for two or more years. In corn and soybean rotations, the recommended rates of P and K for corn and soybeans are often applied only one year in the rotation. However, the fertilizer application has value for at least two years, depending on the rate used. A simple approach to amortizing such investments is to divide the total costs by the number of years between reinvestments as shown in the examples in **Table 1**.

Amortizing expenses accounts for the value that P and K fertilization may have beyond the year of application if rates are great enough. In some cases, farmers can spread payments for some of these investments over time. Farmers must have sufficient capital to pay expenses up front that cannot be paid on an annual schedule. This is the usual case for fertilizer product costs. Concerns over

TABLE 1. Example calculations of annual expenses associated with fertilization.

Example cost items	Example cost	Amortized?	Years amortized	Annual expense
Soil sampling				
Grid soil sampling (analysis and labor)	\$8.00/A	yes	4	\$2.00
Soil sample analysis only (P, K, and pH)	\$7.50/sample	yes	2	\$3.75/sample
Fertilizer product	\$0.25/lb P_2O_5	yes	2	\$0.125/lb P_2O_5
	\$0.12/lb K_2O	yes	2	\$0.06/lb K_2O
Fertilizer application				
Bulk fertilizer application (labor, power, and applicator provided)	\$4.50/A	yes	2	\$2.25/A
Variable rate fertilizer application (labor, power, and applicator provided)	\$10.00/A	yes	4	\$2.50/A
*Harvest expenses of additional yield**				
Grain hauling from field to farmstead storage	\$0.05/bu	no	—	\$0.05/bu
Grain hauling from storage to market, one way by truck, minimum charge	\$0.06/bu	no	—	\$0.06/bu
Grain handling (auger, tractor, and labor)	\$0.04/bu	no	—	\$0.04/bu
*Drying expenses of additional grain** (continuous flow dryer with fuel)	\$0.022/pt/bu	no	—	\$0.022/pt/bu
Storage expenses of additional grain (optional)*				
Monthly rental	\$0.02/bu	no	—	\$0.02/bu
Annual rental	\$0.11/bu	no	—	\$0.11/bu

*Data: Lazarus, W. 1997. Minnesota farm custom rate survey. University of Minnesota Extension Service Publication FS-3700-GO. University of Minnesota, St. Paul, MN.

cash flow may cause many to attempt to recover their P and K fertilization investments the first year, even though P and K have value beyond the year of application.

Long-term Benefits of P and K

Both P and K can increase yields for several years if rates are adequate. These nutrients undergo many complex reactions in soils and become part of a nutrient pool that is available over time. They are released from this pool as crops take them up from the soil solution. To show just how long P and K may be available, one needs to examine the long-term effects of a single fertilizer application. **Table 2** shows that a one-time application of 298 lb P_2O_5/A produced a 14-year total return of \$661.44. The application also raised soil test levels to 43 parts per million (ppm). Using \$0.23/lb P_2O_5, which was the April, 1975 price of 0-46-0 (National Agriculture Statistics Service), the fertilizer product cost was \$68.54/A. Adding to this a one-time \$4.50/A bulk fertilizer application fee and \$7.50/A for soil testing, plus a total of \$43.08/A of additional harvest expenses for the 14-year period, the total return was \$537.82/A, providing an average annual net return to the P application of \$38.42/yr. Averaged over the 14-year period, the annual application rate was 21 lb P_2O_5/A. When the same initial rate of P_2O_5 was applied, followed by annual applications of 23 lb P_2O_5/A for the 14-year period, the total and average annual net returns were \$562.16/A and \$40.15/A/yr. respectively. Annual applications of 23 lb P_2O_5/A without the large initial application produced total and average net returns of \$467.24/A and \$33.38/A/yr. Historic March or April P_2O_5 prices were used to calculate phosphate fertilizer expenses each year. Application costs of \$4.50 were assumed for each year for the 23 lb P_2O_5/A rate. Corn price during this 14-year period ranged from \$1.41 to \$3.12 per bushel, demonstrating that low crop prices have occurred before. The current price situation is not unique and will probably occur again. In this example, a single, large P_2O_5 application

TABLE 2. Residual effects on corn grain yield and returns from a one-time P application of 298 lb P_2O_5/A, applied in the spring of 1975.

Year	Corn grain yield[1] 0 lb P_2O_5/A	Corn grain yield[1] 298 lb P_2O_5/A	Corn grain yield increase from P	Average annual corn price[2], $/bu	Annual return from yield, $/A	Bray P-1 soil test 0 lb P_2O_5/A (17 ppm in fall, 1975)	Bray P-1 soil test 298 lb P_2O_5/A (43 ppm in fall, 1975)
	bu/A					ppm	
1976	138.0	138.9	0.9	2.05	1.85	14	33
1977	134.1	135.3	1.2	1.99	2.39	13	36
1978	150.9	157.2	6.3	2.17	13.67	11	29
1979	160.9	176.7	15.8	2.42	38.24	9	23
1980	157.9	169.9	12.0	3.00	36.00	9	25
1981	163.2	185.0	21.8	2.34	51.01	9	23
1982	145.7	179.0	33.3	2.69	89.58	8	18
1983	120.3	147.3	27.0	3.12	84.24	6	14
1984	111.2	151.8	40.6	2.51	101.91	7	13
1985	144.6	175.0	30.4	2.02	61.41	7	13
1986	116.5	157.5	41.0	1.41	57.81	7	15
1987	129.6	152.8	23.2	1.89	43.85	6	11
1988	60.2	74.6	14.4	2.45	35.28	7	9
1989	123.4	142.7	19.3	2.29	44.20	4	8
Mean	132.6	153.1	20.5	2.31	47.25		
Total			287.2		661.44		

[1]J.R. Webb, A.P. Mallarino, and A.M. Blackmer. 1992. Effects of residual and annually applied phosphorus on soil test values and yields of corn and soybean. J. Prod. Agric. 5(1):148-152.
[2]Iowa Agricultural Statistics Service data for average annual price received by Iowa farmers. Data available online at http://www.nass.usda.gov/ia/prices/crn60_up.txt

that raised the soil test to very high levels, followed by annual applications, resulted in greater long-term profitability than either a similar amount of P_2O_5 distributed annually over the 14-year period or the single large application by itself. This example demonstrates that P has long-term effects on yield, so limiting the amortization schedule of P and K to short times between applications may produce very conservative estimates of actual benefits produced, depending on the rate applied. Both P and K are capable of providing benefits well beyond such periods.

The long-term benefits of P and K are complex, and general principles for determining long-term value are being investigated. Much of the complexity is due in part to the site-specific reactions of P and K. The amortization process outlined above is an attempt to recognize the value of P and K beyond the year of application. These estimates may be used as a first approximation until better amortization schedules are developed.

Knowing the appropriate costs involved with P and K fertilization is critical to making well-informed decisions about nutrient management in times of low crop prices. BC

Dr. Murrell is PPI North Central Director, located at Andover, Minnesota. E-mail: smurrell@ppi-far.org. Dr. Munson is a consultant, located at St. Paul, Minnesota.