RETURNS FROM P AND K INPUTS

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When times are tough, farmers try to lower their fixed and variable costs. Fixed costs are relatively inflexible and often hard to reduce. They can be controlled somewhat by improving efficiency and by making decisions such as maintaining a functional piece of equipment rather than purchasing a new one. Many farmers may target variable costs, such as fertilizer, for cost reductions. However, before cutting down on phosphate (P) and potash (K) use, farmers should carefully evaluate their soils and fertility program. Nitrogen, P and K account for a high percentage of current crop yields and are critical to successful farming operations. Those who fine-tune their system for maximum economic yields maximize their profits in good times and minimize their losses in bad times.

Response to P and K Lowers Unit Costs of Production

Fertilizer used appropriately can result in yield increases that help spread fixed and variable costs over more bushels, lowering the total cost of production per bushel. Lowered expenses per bushel means that the farm is operating more efficiently, a characteristic seen in more profitable farms. Calculating costs per bushel requires not only fertilizer costs, but also the entire set of overhead and direct costs associated with a farm and a particular crop. Average base costs of production can be obtained from the farmer. In the event that the farmer has not accounted for all of his or her expenses, local farm management associations may have summary data of farmers belonging to a local association.

To calculate production costs per bushel, one simply divides the total costs of production by the bushels produced. As an example, consider corn response to potash fertilization in **Table 1**. In this example, the costs considered were soil sample analyses, fertilizer, application, and harvest costs. Soil samples, taken every 2 years, representing 5 acres, and analyzed for P, K, and pH, were assumed to cost $0.75/A/yr. for chemical analysis. Potassium fertilizer price was set at $0.14/lb K_2O and application costs were $2.25/A, associated with a $4.50 dry bulk application amortized over 2 years. Harvest costs included $0.15/bu for handling and hauling, and $0.17/bu drying costs, assuming corn was harvested at 23.0% moisture and dried to 15.5% at $0.022/pt/bu [(23pt – 15.5pt)($0.022/pt/bu) = $0.17/bu].

These data demonstrate that crop responses to appropriate application rates of potash can lower unit costs of production and increase net profit per acre. In this example, the total cost per bushel dropped from $2.05 to $1.84. In this case, higher investments led to greater returns and improved efficiency. The same concepts also apply to appropriate

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phosphate fertilization. Local crop response data, where it exists, provides estimates for the profitability of P or K additions. Where local data do not exist, generalized responses, like those discussed in Part 2 of this series, may provide first approximations needed to calculate expected returns. It should also be noted that the returns and lower unit costs were based upon response data from a single crop in a rotation. Residual effects of P or K applications on future crops were not considered. These data, then, may underestimate the true value of P and K fertilization, depending upon the rates used.

Table 1. Potassium fertilization increases corn yields and return per acre by lowering the unit cost of production (Ohio).

K_2O rate	Corn grain yield	Yield in-crease	Gross revenue from yield	Added gross revenue	Additional costs from yield response to K	Additional input costs from K fertilization	Net return	Added net return	Total cost per bushel
(lb/A)	(bu/A)	(bu/A)	($/A)	($/A)	($/A)	($/A)	($/A)	($/A)	($/bu)
0	146	--	292.00	--	--	--	-8.00	--	2.05
50	167	21	334.00	42.00	6.72	10.00	17.28	25.28	1.90
100	174	28	348.00	14.00	8.96	17.00	22.04	4.76	1.87
200	187	41	374.00	26.00	13.12	31.00	29.88	7.84	1.84

Base cost without K: $300/A; soil test K: 126 to 209 lb/A, corn price: $2.00/bu.

Crop prices and recommended rates

The optimum fertilizer rate is determined by the farmer's preference of marginal net return. Marginal net return is the added dollar value returned per last dollar invested. **Figure 1** shows marginal returns for long term P response data. The optimum rate was determined from single year crop response as the P rate yielding $1.00 returned per $1.00 invested. Applying more phosphate than optimum would result in less than $1.00 return per $1.00 invested, cutting into profits. Such curves do not normally consider multiple-year effects of a single application.

An analysis of economic optimum, or maximum profit, rates is based upon current market prices. Changing market conditions will lead to changes in optimum fertilizer rates. Two important economic factors that vary from year to year are crop price and fertilizer material cost. Curves similar to that in Figure 1 were constructed for corn prices ranging from $2.00 - $4.00/bu and for phosphate prices ranging from $0.15 - $0.35/lb P_2O_5. **Table 2** shows the influence of these two variables on the optimum P rate calculated from the previous examples. This table demonstrates that optimum P rates for the example in Figure 1 can vary from 28-51 lb P_2O_5/A, considering phosphate prices from $0.15 - $0.35/lb P_2O_5 and corn prices from $2.00 - $4.00. Fluctuations in P fertilizer price affect optimum rates less at higher corn prices. Fluctuations in crop price affect optimum rates less at lower P fertilizer prices. If modest swings in P fertilizer cost or corn price are expected in a given year, the optimum P rate chosen for a particular crop year does not change greatly. For instance, if the corn price increases from $2.00 - $2.50 and P costs are $0.20/lb P_2O_5, the optimum rate changes by only 4 lb P_2O_5/A, which is beyond the precision of most application equipment.

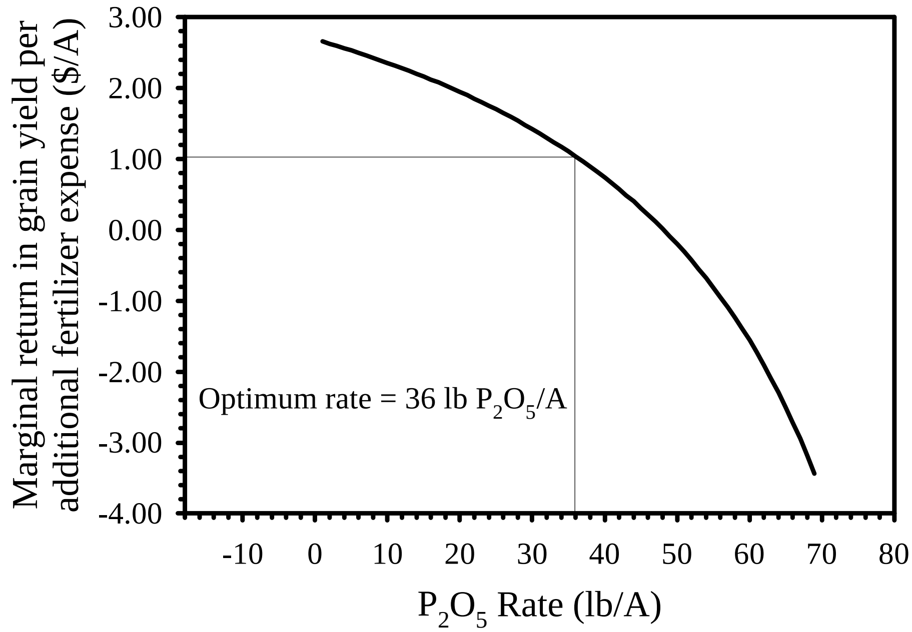

Figure 1. Marginal returns to phosphate fertilizer expenses for $2.00/bu corn, $0.25/lb P_2O_5, and added handling, harvest, and drying costs. Data source: Webb, J.R., A.P. Mallarino, and A.M. Blackmer. 1992. Effects of residual and annually applied phosphorus on soil test values and yields of corn and soybean. J. Prod. Agric. 5(1):148-152.

Table 2. The effects of crop prices and fertilizer expenses upon recommended P rates for corn, based on an Iowa State University 14-year P rate study.

$/lb P_2O_5	Corn price ($/bu) 2.00	2.50	3.00	3.50	4.00	Difference from $2.00/bu corn prices (lb P_2O_5/A)
0.15	44	47	49	50	51	7
0.20	40	44	47	48	49	9
0.25	36	41	44	46	48	12
0.30	32	38	42	44	46	14
0.35	28	35	40	42	44	16
Difference from $0.20/lb fertilizer costs (lb P_2O_5/A):	16	12	9	8	7	

Data: Webb, J.R., 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.

Managing risk

There three basic types of risk that producers face in their fertilization program: 1) risk that a fertilizer application will not be profitable, 2) risk that soil test levels within a field are yield-limiting, and 3) risk that soil test levels are not high enough to cushion errors or financially-trying times (reduced flexibility). Figure 3 shows how these risks are related to soil test levels. At lower soil test levels, there is a higher probability that a fertilizer application will be profitable in the year of application, but increased risk that soil test levels are yield-limiting or do not allow much room for error. Soil fertility held very near medium, based on general small plot soil test calibration research, requires that soil testing and sampling be performed well and that the sampled field have fairly uniform soil test levels. In addition, soil test levels close to the medium range require annual fertilizer additions, or at least additions large enough to cover the nutrient needs of the crops produced between applications. Building soil test levels to the high side of medium or to high allows more room for error and reduces the risk that soil tests might be yield limiting. In addition, producers who have built their soil test levels to high or very high levels may be able to skip an annual P or K application to cut costs. However, building soil tests to levels higher than medium increases the risk that annual yield returns will not cover fertilizer expenses. Each producer must realize the risks associated with the various soil test levels and make decisions based upon the risks he or she is willing to accept.

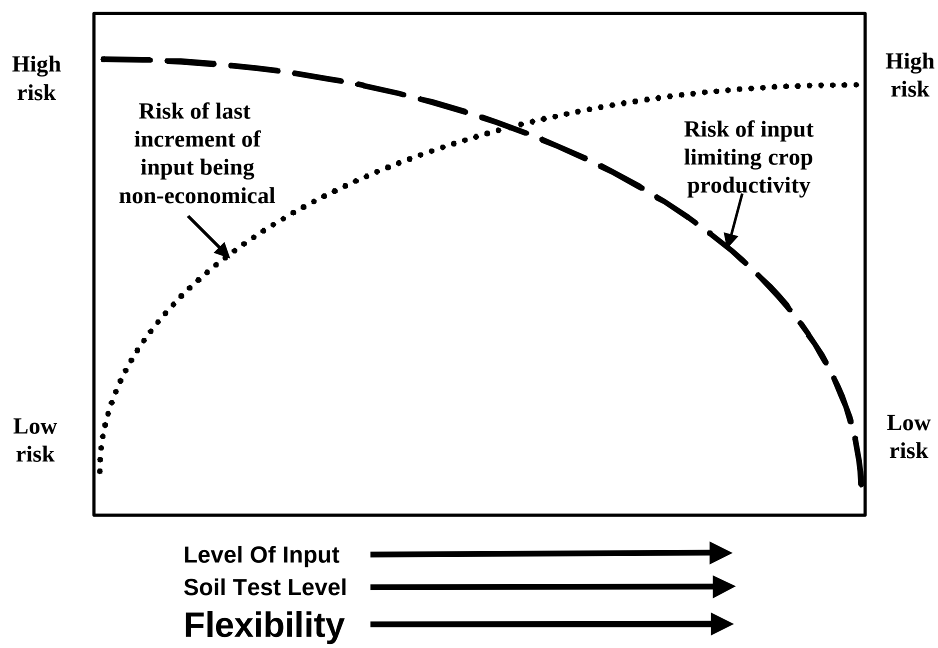

Figure 3. Risk incurred at various soil test levels (D. Leikam, personal communication).

Managing soil test levels

Without soil testing, no reasonable estimate of yield responses to fertilizer can be made. The previous discussion has demonstrated that soil testing is important for managing risk. Soil testing is a very inexpensive management practice upon which important decisions are made. Time spent on management decisions, such as analysis and problem assessment, is a characteristic of more profitable producers.

It is important to remember that nutrients are removed from a field when harvested portions of the crop are removed. Some average removal rates for corn, soybeans, and wheat are listed in **Table 3**. Crop removals will reduce the quantity of P and K in the soil. This will be reflected in reduced soil test P and K values. The effects of crop removal are shown in Part 1, Table 3 of this series. Since no annual P was applied after the first year, soil test levels decreased with time. It is also interesting to note that soil tests declined more rapidly for the soil with a higher initial soil test level. This is a relationship that is commonly observed in long-term studies. For this reason, farmers with soil test levels high enough to skip an application of P or K should closely monitor changes in soil test levels to ensure they have not dropped to yield-limiting levels.

Table 3. Average P and K crop removal numbers for corn, soybeans and wheat (Potash & Phosphate Institute).

Crop	P removal (lb P_2O_5/bu)	K removal (lb K_2O/bu)
Corn	0.38	0.28
Soybeans	0.80	1.4
Wheat	0.5	0.26

Nutrient interactions

Information presented so far has concentrated upon the effects of a single nutrient. However, nutrients often interact to provide benefits beyond those possible by themselves. An example of this is shown in **Figure 4**. These data demonstrate that both N and K are needed for optimum corn yields. Higher levels of K led to lower N requirements to produce higher yields and larger profits. Knowledge of interactions is important when trying to assess the effects of one nutrient application. Yield-limiting levels of one nutrient reduce the yield and quality effects of another nutrient. For this reason, balanced nutrition is necessary to ensure optimum crop growth and yield. Potash and phosphate are important parts of a profitable farming operation. They provide many benefits in addition to yield. In times of low crop prices, P and K can increase efficiency and improve profits. Knowledgeable decisions related to the management of these nutrients can be of great assistance to farmers as they find ways to improve their farming operations.

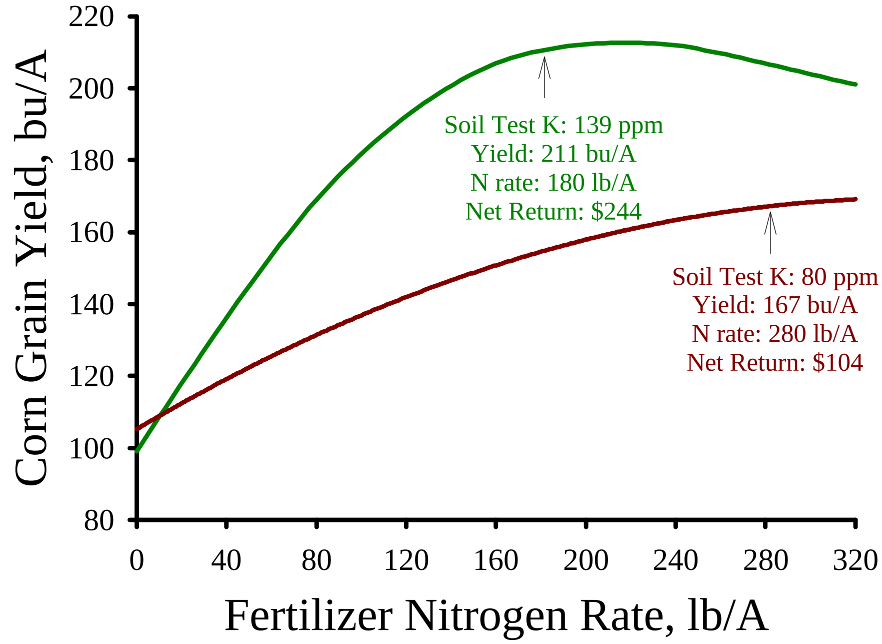

Figure 4. Higher soil test K levels increase nitrogen use efficiency and net returns to N fertilization (Data: Ohio; prices set at $2.50/bu corn, $0.20/ lb N).