FERTILIZER USE VS. CROP PROFITS

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Growing crops in farming is a complex business that requires large investments in land and equipment, as well as considerable borrowing of money for operating capital. With these costs and low commodity prices most farmers are keenly aware of continuing difficulty in maintaining profitability in their cropping operations.

Usually farmers do not have much control over their fixed costs in crop production. Variable costs, however, can sometimes be adjusted. Unfortunately some of these adjustments can reduce profits if the farmer has not based his cost reductions on wise judgement, backed with technical expertise. If one or more variable cost items can be reduced without causing yield reductions, then the practice can be profitable. However, cost cutting which leads to lower yields, even slight reductions, will nearly always lead to lower profits. The goal must be to either maintain yields with lower input costs, or increase both costs and yields in a relationship that improves profits.

A major variable cost in crop production is fertilizer. One of the key factors in profitable crop production is proper fertilizer usage based upon a well-designed soil testing program with a reputable soil testing laboratory which follows fertilizer recommendation guidelines prescribed by the Land Grant Universitiy. The fertilizer recommendations made by the university Soils, Crop Science, and Agronomy departments are based on many years of agronomic research. These recommendations based on soil tests are designed to help farmers raise optimum crop yields while maximizing profits.

There are undoubtedly some growers using too much fertilizer, who could improve their profits with soundly-based cutbacks. There are others who may jeopardize their net profits by reducing fertilizer rates indiscriminately in an effort to lower their crop production costs when facing low commodity prices. This approach should be used only when based upon soil testing and sound fertilizer recommendations.

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The purpose of this paper is to describe an approach for relating fertilizer usage to expected yield increases due to the use of that fertilizer, so that an economic evaluation of fertilizer expenditures can be made. It is based on the proper use of research response data, soil tests, soil test calibration work and interpretation of those studies into fertilizer recommendations. The data I will use to illustrate are from the University of Illinois for nitrogen and phosphorus.

YIELD INCREASES DUE TO FERTILIZER

In Table 1. long term nitrogen response data for corn are shown. You can see that as nitrogen rate increases, the long term average yield went from 79 to a maximum of 155 bushels per acre. The yield increases due to nitrogen range from 21 to 76 bushels per acre. These data will be used later to help illustrate fertilizer economics. In Table 2. are shown the expected average corn yield increases due to phosphorus fertilizer as related to soil test, % sufficiency data, and yield goal. The yield increases in Table 2 are calculated by multiplying the reciprocal of % sufficiency (which is % deficiency) times yield goal. The equation is shown in the footnotes of Table 2.

The yield increase is the estimated proportion of total yield that can be attributed to the use of recommended phosphorus fertilizer. As you can see, as soil P test increases, % sufficiency increases. This is the percent of maximum yield under given conditions, that would be achieved at a given soil test level if no P fertilizer was applied. You can thus see that as soil P test (and % sufficiency) increases, the expected yield attributable to fertilizer decreases. Responses can be quite large at low soil tests, declining to slight to none at high or very high tests. (Note: blanks in Table 2 imply the higher yields may be unattainable at the lower soil tests.)

In other words, the use of the soil test is a very important key to determine the likelihood of, and the size of, yield response due to the use of added fertilizer. The figures will vary by crop and soil test levels, but in general, P fertilization (likewise for K) consistently provides a profitable return at low to medium soil tests. When soil tests are high, a farmer has some potential flexibility. He can reduce (or even eliminate if very high) P fertilizer use for a short time without risking serious yield reductions. However, such a decision is not without cost and perhaps limited risk, since soil test levels will decline if nutrients removed by the crop are not replaced. We can't guarantee there won't be some yield loss, but the odds certainly seem to be in favor of cutback in a short term situation. Soil testing should be done every year in such a program.

COST OF FERTILIZER RELATIVE TO EXPECTED YIELD

Let's take a closer look at the economics of phosphorus. Table 3 shows the approximate P fertilizer recommendations (U. of Illinois basis) for corn according to soil tests and yield goals. (Note: both Tables 3 and 4 closely relate to Table 2.) These recommendations consist of combined "build-up + maintenance" fertilizer at P tests below 45 lb/A, and "maintenance" only for P tests of 45 to 64 lb/A.

Table 4 shows the cost of the recommendations in Table 3, based on a P fertilizer cost of 18c/lb of P2O5. One can see that, if corn sold for $2.50 per bushel (assumed goverment program participation, but here you'll actually have to put in your own price since it varies widely) and the soil P test is 30, at 150 bu/A yield, the fertilizer cost of $17.64 would require 7 bushels to pay for it (Tables 3 and 4.). In Table 2 it is seen that the expected average yield increase due to this fertilizer treatment at this soil test would be 14 bu/A. Therefore this would be a very profitable investment.

On the other hand, let's look at a soil P test of 55 lb/A, 150 bu/A yield, where the fertilizer recommendation is 64 lb/A P2O5 (Table 3) at a cost of $11.52 (Table 4). From Table 2, the expected yield increase is 3 bu/A., for a value of $7.50. Obviously, the expected yield return does not pay for the fertilizer application.

MAINTENANCE FERTILIZATION

The above example challenges the economics of maintenance fertilization. Maintenance is defined here as the amount of nutrient removed in the harvested portion of the crop. Some will argue that maintenance is justifiable at higher soil tests while others contend it is not. The answer may lie in an assessment of individual situations. Such a program may be an investment in the ongoing and future productivity of the soil, which may be adequate reason for landowners. It may be quite different for renters.

If the maintenance approach is not followed for a number of years, soil test levels will decline (at differing and arguable rates), and the flexibility to skip or reduce nutrient use in a tight money year will be lost, and nutrients will need to be added in later years at potentially higher cost. It is also impossible to predict at precisely what point in a cropping sequence without fertilizer that you will begin to lose yield, and thus have to resume fertilization, without suffering some financial loss.

It is recognized that some soil nutrients are inherently quite high in certain regions, and that maintenance fertilization is regarded as inappropriate. An example is the high K soils in the Plains states.

FERTILIZER PROFITABILITY

It's tempting to show profitability comparing a "no fertilizer" crop yield to one with optimum fertilization. The figures are always very impressive. Instead, let's look at a case that may be closer to reality.

What if the farmer decided just to cut back his N rate to reduce expenses? If he reduced his N rate from 150 to 120 lb/A, he would reduce the fertilizer bill by $3.00 per acre. Would that be a wise choice? To answer that, look at Table 1, and find that the long-term average data shows that reducing N rate from 150 to 120 lb/A would reduce corn yield by 8 bushels per acre (from 150 to 142). Now let's see what happens to total crop production costs and cost per bushel with this reduction in both N rate and yield.

The total crop production cost picture is illustrated in Table 5. The right-hand column shows crop costs, assuming a full fertilizer rate of 150-64-42 and achievement of the 150 bu/A yield goal. The column on the left assumes a reduced fertilizer rate of 120-64-42 and a yield of 142 bu/A. The variable costs are adjusted accordingly for less nitrogen and slightly reduced cost of harvesting, etc. The end result of cutting back on Nitrogen from an appropriate rate is to increase the production cost on a per bushel basis, and to decrease the profit per acre. The saving on nitrogen would not be a wise choice for the grower to make.

SUMMARY

Significant crop responses from fertilizer use are well documented by research and responses can be assessed in terms of profit to farmers. The author recognizes there are limitations to the use of research data in this matter. However, since fertilizer recommendations are made on the basis of these data, it doesn't seem entirely inappropriate to use soil tests and % sufficiencies to estimate expected average crop responses to use of proper rates of fertilizer. We do make fertilizer recommendations based on the research data and soil tests, and it seems only fair to try to give a farmer some estimate of what he should expect to get from his fertilizer investment.

Table 1. Expected Corn Yield Increase Due to Use of Recommended Nitrogen Fertilizer as Related to Yield Response Data. (Based on University of Illinois Research)

Nitrogen Rate Lb/A	Long-Term Avg. Yield, Bu/A	Expected Yield Increase, Bu/A
0	79	--
30	100	21
60	117	38
90	131	52
120	142	63
150	150	71
180	154	75
210	155	76
240	155	76

Table 2. Expected Corn Yield Increases Due to Use of Recommended Phosphorus Fertilizer as Related to Soil Test and Yield Response Data. (Based on Univ. of Illinois Research)

Soil P Test lb/A	%Suf-fiency	Expected Average Corn Yield Increase (Bu/A) Due to Recommended P Fertilizer * — Yield Goal (Bu/A) 125	150	175	200
15	69	--	--	--	--
20	79	26	--	--	--
25	87	16	20	--	--
30	91	11	14	16	--
35	94	8	9	10	12
40	95	6	8	9	10
45	96	5	6	7	8
55	98	2	3	4	4
65	99+				

* Expected Yield Increase Due to Fertilizer =
[1 - (% Sufficiency / 100)] X [Yield Goal]

Table 3. Phosphorus Fertilizer Recommended for Corn Relative to Soil P Test and Yield Goal. (Univ. of Illinois Guidelines)

Soil P Test Lb/A	Phosphorus Fertilizer Recommended for Corn Lb/A P2O5			
	Yield Goal, Bu/A			
	125	150	175	200
15	122	132	143	154
20	110	120	131	142
25	99	109	120	131
30	88	98	109	120
35	76	86	97	108
40	65	75	86	97
45	54	64	75	86
55	54	64	75	86
65	0	0	0	0

Table 4. Cost of Phosphorus Fertilizer Recommended for Corn as Related To Soil Test P and Yield Goal.

Soil Test P Lb/A	Cost of Recommended P2O5 Fertilizer for Corn ($/A) *			
	Yield Goal, Bu/A			
	125	150	175	200
15	21.96	23.76	25.74	27.72
20	19.80	21.60	23.58	25.56
25	17.82	19.62	21.60	23.58
30	15.84	17.64	19.62	21.60
35	13.68	15.48	17.46	19.44
40	11.70	13.50	15.48	17.46
45	9.72	11.52	13.50	15.48
55	9.72	11.52	13.50	15.48
65	--	--	--	--

* P2O5 at 18c per lb.

Table 5. Analysis of Profitability of Fertilizer for Corn With A Yield Goal of 150 Bu/A.

	Typical Costs	
Production Costs Per Acre	Without Proper Fertilization	With Proper Fertilization
Land Preparation	$ 22.00	$ 22.00
Seed and Planting	20.00	20.00
Chemicals and Application	20.00	20.00
Cultivation	7.50	7.50
Irrigation	--	--
Harvesting, hauling	34.08	36.00
Drying, Storage	17.04	18.00
Land, taxes, interest	120.00	120.00
Insurance	5.00	5.00
Other, Lime, etc	5.00	5.00
Fertilizer	27.30	30.30
Total Costs:	$277.92	$283.80
Expected Yield	142	150
Cost Per Bushel	$ 1.96	$ 1.89
Expected Selling Price	2.50	2.50
PROFIT Per Bushel	0.54	0.61
PROFIT Per Acre	$ 76.68	$ 91.50

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