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Economics of Fertilization

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Crop prices have dropped drastically in recent years while most production costs have continued to increase. During the last three years of the 1950's as compared with the first three years of the 1950's the average Indiana farm price for various crops had declined as follows: corn, 29%; soybeans, 23%; oats, 22%; wheat, 15%; and hay, 12%. In 1961 the prices of these crops will no doubt be lower than during the late 1950's. This does not necessarily mean that we should use less fertilizer. Whether one should use less or more largely depends upon fertilizer application rates in the past.

Yields Must Be High for Profitable Production

Higher yields offer the greatest opportunity for reducing per bushel or per ton cost of production on most Indiana farms. This is because fixed costs -- land charge, machinery investment and various overhead costs make up such a large proportion of the total cost. Also, some of the variable costs such as labor and tractor fuel are often nearly as great for a low yield as for a higher yield.

According to a recent Cornell study the per bushel cost of producing corn yielding 50 bushels per acre was more than 60 percent higher than corn producing 90 bushels per acre.

If Indiana farmers are to make a substantial profit in crop production yields must be above the state average. During periods of narrow profit margins it's "paying attention to details" and "getting the job done right" that hold out hope for a profit. With low yields the task is hopeless regardless of volume. Getting the job done right means, among other things, applying fertilizer where needed, when needed and in quantities needed for more economical returns. It also means strict attention to variety selection, population, weed control, insect and disease control and the many other practices that make the fertilizer a profitable investment.

Labor and land have been moving out of agriculture in recent years, but increased use of capital inputs, (fertilizer, power and equipment, etc.) have more than offset reduction in land and labor. Capital inputs have increased even while crop prices were declining because farmers generally felt that this was the best way to reduce per unit cost of production.

Table 3. Cost Per Pound of Plant Food When Purchased in Various Analyses[1/]

Analysis	Cost per ton	Cost per pound of plant food (cents) N	P_2O_5	K_2O
33½-0-0	$79.00	11.8	-	-
0-45-0	77.35	-	8.6	-
0-0-60	49.00	-	-	4.1
3-12-12	53.50	14.8	11.6	7.1
6-24-24	91.30	13.3	10.1	5.6
12-12-12	74.05	13.9	10.7	6.2
8-32-0	84.45	13.1	9.9	-

1/ Local Lafayette elevator price in November 1960

How Much Fertilizer Is Profitable?

In deciding how much fertilizer is profitable one should consider the following factors:

1. Probable yield response from various levels of application. As more and more fertilizer is applied the yield response to the last pound of fertilizer used declines (diminishing returns). In estimating yield response one should: (a) test his soils, (b) study fertility trials on similar soils, (c) consider weather conditions, (d) run some yield checks on his own farm and (e) consider your level of management.

2. Probable price levels for various crops. If fertilization rates were pushed to the most profitable levels when corn was $1.50, less fertilizer should be used with $1.00 corn, assuming other technologies constant. However, improved technologies (other than fertilizer) have tended to increase responses from fertilizer. Also, many farmers could profitably have used more fertilizer when crop prices were higher. Nevertheless, one should again carefully appraise levels of fertilizer application in view of lower grain prices.

3. Cost of fertilizer must be considered. If one can purchase a pound of plant food at a lower cost (and assuming that the lower cost goods will give the same response) then he can profitably use more fertilizer.

4. Costs other than fertilizer must be considered. For crops such as corn, soybeans, and wheat additional yields don't substantially increase per acre production costs. For crops such as hay and silage, however, higher yields do substantially increase per acre harvesting costs.

5. Capital available is an important consideration. It isn't good enough to get $1.10 or even $1.50 return per dollar spent for fertilizer if capital is quite limited and if some of these limited dollars will give a higher return in money or satisfaction if invested in gasoline for the tractor, feed for the hogs or an operation for the wife. With ample capital one should apply fertilizer until the last dollar spent just returns $1 net. With limited capital one may stop with a modest fertilizer application so as to have enough money left to cover other necessary expenditures.

How Much Plant Food Do Crops Remove?

Table 4. Average Nutrient Content of Indiana Field Crops

Crop	Yield per acre	Part of crop	Pounds per acre N	P_2O_5	K_2O
Corn[1]	80 bus.	Grain	60	25	18
	4000 lbs.	Fodder	35	8	52
	1200 lbs.	Stubble & roots	9	2	10
		Total	104	35	80
Soybeans[1]	30 bus.	Grain	115	26	30
	3000 lbs.	Straw	36	9	15
	900 lbs.	Stubble & roots	10	3	4
		Total	161	38	49
Wheat[1]	35 bus.	Grain	32	20	11
	3000 lbs.	Straw	18	7	31
	1100 lbs.	Stubble & roots	6	2	5
		Total	56	29	47
Oats[1]	50 bus.	Grain	37	14	10
	2500 lbs.	Straw	16	4	35
	900 lbs.	Stubble & roots	4	1	7
		Total	57	19	52
Rye[2]	25 bus.	Grain	29	10	7
	3000 lbs.	Straw	14	5	27
		Total	43	15	34
Barley[2]	30 bus.	Grain	27	12	12
	1600 lbs.	Straw	9	3	19
		Total	36	15	31
Alfalfa[1] (2 yrs. old)	6000 lbs.	Hay	180	20	120
	4000 lbs.	Stubble & roots	100	15	40
		Total	280	35	160
Sweet clover[1] (biennial) (1st yr. growth)	3000	Tops	100	10	45
	2000	Roots	60	8	20
		Total	160	18	65
Red clover[1]	4000	Hay	100	14	60
	1500	Stubble & roots	40	4	14
		Total	140	18	74
Lespedeza[1]	4000	Hay	80	10	40
	1200	Stubble & roots	15	1	10
		Total	95	11	50
Ladino Clover[1]	4000	Hay	110	15	55
	1500	Stubble & roots	35	6	18
		Total	145	21	73

1/ From Purdue Station Bulletin 635, March 1956, by A. J. Ohlrogge.
2/ From Purdue Mimeo AY 25a -- (revised April 1954).

Table 6. Returns Per Dollar Spent for Nitrogen above Extra Costs when Varying Amounts are Use Under Different Price Relationships on Non-Erosive, Non-Droughty Silt Loam Soils in Indiana when Varying Amounts of Corn are Grown (Clermont, Crosby, Fincastle, Loess, Miami and Vigo Soils)1/

Harvest price of corn per bushel	Applications of nitrogen pounds per acre	Returns above extra costs per dollar spent for nitrogen with the following costs of elemental nitrogen applied2/					
		1st year corn after good legume sod			2nd year corn after sod		
		Cents per pound for N			Cents per pound for N		
		8	10	13	8	10	13
$ .75	1st 40#	$1.02	$ .94	$ .63	$2.03	$1.63	$1.25
	2nd 40#	.81	.65	.50	1.22	.98	.75
	3rd 40#	.41	.33	.25	.81	.65	.50
$ .90	1st 40#	1.25	1.00	.77	2.50	2.00	1.54
	2nd 40#	1.00	.80	.62	1.50	1.20	.92
	3rd 40#	.50	.40	.31	1.00	.80	.62
$ 1.25	1st 40#	1.80	1.44	1.11	3.59	2.88	2.21
	2nd 40#	1.44	1.15	.88	2.16	1.73	1.33
	3rd 40#	.72	.58	.44	1.44	1.15	.88
		3rd year corn after sod			Continuous Corn		
		Cents per pound for N			Cents per pound for N		
		8	10	13	8	10	13
$ .75	1st 40#	3.05	2.44	1.88	3.65	2.92	2.25
	2nd 40#	1.63	1.30	1.00	2.44	1.95	1.50
	3rd 40#	1.02	.81	.63	1.63	1.30	1.00
	4th 40#	.61	.49	.38	.81	.65	.50
.90	1st 40#	3.75	3.00	2.31	4.50	3.60	2.77
	2nd 40#	2.00	1.60	1.23	3.00	2.40	1.85
	3rd 40#	1.25	1.00	.77	2.00	1.60	1.23
	4th 40#	.75	.60	.46	1.00	.80	.62
$ 1.25	1st 40#	5.39	4.31	3.31	6.46	5.17	3.98
	2nd 40#	2.88	2.30	1.77	4.31	3.45	2.65
	3rd 40#	1.80	1.44	1.11	2.88	2.30	1.77
	4th 40#	1.08	.86	.66	1.44	1.15	.88

1/ Yield response in bushels:

Pounds of nitrogen	1st corn	2nd corn	3rd corn	Continuous corn
1st 40	5	10	15	18
2nd 40	4	6	8	12
3rd 40	2	4	5	8
4th 40	0	1	3	4

Yield responses are estimates by Purdue Agronomy Department and are based upon rotation and fertility experiments on silt loam soils.

2/ Extra costs considered are for additional picking and handling costs for higher yields and for extra phosphate and potash that would be removed from the soil. These extra costs are computed at 10 cents per additional bushel of corn.

How Much Row Phosphate Is Profitable?

At test levels of 80# of available phosphate per acre; corn, soybeans, wheat and hay all have given profitable yield responses to modest row phosphate applications on the Purdue Agronomy Farm. Wheat, especially, gave a large yield response. At test levels of 140# there was little or no response except from wheat. At test levels of 250# there was little or no response (Table 8).

Table 8. Yield Response to Row P_2O_5 on Raub Silt Loam on Purdue Agronomy Farm (1952-1959 Average Yields)[1/]

Test level	Additional pounds row P_2O_5[2/]	Yield response from additional row applications			
		Corn (bu.)	Beans (bu.)	Wheat (bu.)	Hay (tons)
80	+ 10	2.9	1.8	15.9	.24
80	+ 15	2.2	2.2	1.7	.42
80	+ 25	1.7	-1.1	-.9	.13
140	+ 10	-1.2	.4	4.1	.14
140	+ 15	-.7	-1.0	1.2	.06
250	+ 10	-.5	-.1	.7	.04
250	+ 15	-.3	1.1	-.5	.16

1/ Fertility trials under supervision of S. A. Barber, Purdue Agronomy Dept.
2/ P_2O_5 was applied one-fourth on corn and 3/4 on wheat in a four rotation or corn-soybeans-wheat-hay.

Table 9. Most Profitable Rate of Row Phosphate Application for Various Rotations on Raub Silt Loam at Lafayette, Indiana at Different Soil Test Levels, High and Low Crop Prices and with P_2O_5 at 10½ Cents Per Pound Applied[1/]

Rotation	Most profitable row P_2O_5 application - (lbs. per acre)			
	80# soil level		140# soil level	
	High prices[2/]	Low prices[2/]	High prices[2/]	Low prices[2/]
C-SB-W-H	36	26	11	7
C-B-W-H-H	38	27	11	7
C-SB-W-(M)	34	25	10	8
C-C-C-SB-W-H	36	25	7	5
Continuous corn	36	23	0	0

1/ Based on yield responses shown in Table 8.
2/ High price level assumes: corn, $1.50; soybeans, $3.04; wheat, $2.58; hay, $17.65. Low price level assumes: corn, $.85; soybeans, $1.72; wheat, $1.46; hay, $10.00. These are harvest time prices for additional yields unharvested.

Based on Tables 8 and 9 only modest row applications of phosphate appear profitable at 80# test levels and only small row applications are profitable at 140# or higher test levels. As soil test levels increase row applications of phosphate give a smaller

Table 11. Returns from P_2O_5 When Used to Raise Phosphate Soil Test Levels with Various Rotations on Raub Silt Loam Soils at Lafayette

Item	140# test level vs 80# test level	180# test level vs 140# test level
Annual value of increased yields:[1]		
(1) Continuous corn rotation	$ 4.85	$ .77
(2) C-B-W-H rotation	1.88	.14
(3) C-C-C-B-W-H-H	2.77	.60
Cost of raising test from previous level	22.80[2]	7.60[3]
Annual cost:		
Depreciation over 12 years[4]	1.90	.63
Interest on investment @ 6%	.68	.23
Total annual cost	2.58	.86
Net return per acre above added P_2O_5 investment for:		
(1) Continuous corn rotation	2.27	-.09
(2) C-B-W-H rotation	-.70	-.72
(3) C-C-C-B-W-H-H	.19	-.26

1/ See Table 10 for yield responses from various crops.

2/ This would require approximately 240# of P_2O_5 @ 9.5 cents per lb. to raise soil test from 80 to 140# test.

3/ This would require approximately 80# of P_2O_5 to raise test level from 140# to 180#

4/ Phosphate investment was depreciated out over a 12 year period. If the land should be sold, it is questionable if the investment in phosphate for raising soil test levels would be fully reflected in land values.

How Much Row or Broadcast K_2O Is Profitable on Corn?

There appears to be little difference in yield response to potash on corn whether the potash is applied in the row or braodcast. Also, on most soils, there appears to be good response to potash for several years after applied if liberal amounts are used (Table 12). On Brookston soils, however, there appears to be sufficient "tieup" of potash so that applications should be made for only one or two year periods.

Table shows the "break even" point for row or broadcast applications of potash on corn when row potash is priced at 6 cents and broadcast potash at 4.7 cents per pound. Corn is priced at from $.85 to $1.50 per bushel.

Table 13. Most Profitable Level in Pounds Per Acre of K_2O Application for Corn on Raub Silt Loam at Lafayette, Indiana (Soil Test Level 110# per acre)[1/]

Harvest price of corn	1957 application		1957 & '58 application	
	Row[2/]	Broadcast[2/]	Row[2/]	Broadcast[2/]
$ .85	64	80	96	113
1.25	84	100	118	134
1.50	93	110	128	144
	1957-'58-'59 application[3/]		1957-'58-'59-'60 application	
	Row[2/]	Broadcast[2/]	Row[2/]	Broadcast[2/]
$ .85	111	115	199	236
1.25	132	133	241	277
1.50	142	142	260	297

1/ See Table 12 for yield responses.
2/ Potash priced at 6.0 cents per pound if row application and 4.7 cents per pound if applied broadcast.
3/ The third year of the experiment (1959) was a dry year with little responses from potash.