FARM Assistance Focus

TEXAS A&M AGRILIFE EXTENSION

Deep Soil Testing Offers the Potential to Reduce Fertilizer Costs

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FARM Assistance Focus
2022-1
February 2022

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Soil testing offers the opportunity to control high and variable fertilizer costs by determining the most appropriate type and rate of fertilizer needed for each commodity, which helps agricultural producers achieve optimum annual economic yields.

Fertilizer application is almost always necessary to achieve optimum crop yields in the Texas High Plains region. Fertilizer supplements available plant nutrients already present in the soil and helps meet crop fertility needs. While plant growth is dependent on many nutrients, proper nitrogen (N) application is critical. According to Outlaw (2022), of the three primary types of commercial fertilizer – nitrogen, phosphorus, and potassium – nitrogen accounts for more than 50% of total use by weight. Prices for N fertilizer products have increased dramatically in recent months due to rising natural gas prices and supply chain disruptions from the COVID-19 pandemic. In fact, the cost of N in 2022 is 55% higher than in 2021 and more than 200% higher than in 2020! Similar or greater price increases have occurred for other nutrients and chemicals, causing significant financial concerns among producers.

Crop N requirements depend on both yield potential and residual N already present in the soil. In Texas, field studies show that around 50 pounds of available N per acre (from all sources) is needed for each bale of cotton produced. For corn and wheat, the N requirements are approximately 1.1 pounds per bushel (Benavidez, 2021). Many plant nutrients have limited solubility and tend to concentrate in the upper 6 inches of soil especially in reduced till and no till fields. Thus, traditional soil tests typically sample to a depth of 6 inches. However, N in the nitrate-N form is very soluble and can move deeper into the soil with irrigation or rainfall. Fromme (2009) reported that deep soil sampling can measure in excess of 100 pounds of plant available N to a depth of 48 inches in some locations. This amount is sufficient to meet the N requirements for 2 bale per acre cotton (Hons, 2004) or 65 bushel per acre wheat. Much of this N is located in the 6 to 24-inch zone of soil, which suggests that a soil test at a depth of 24 inches should be sufficient enough to show the amount of residual N available for crop growth.

Most agronomists recommend soil testing each year, as near to planting time as possible, to assess the availabilityof N and other essential nutrients. Soil testing can help producers reduce fertilizer costs by determining the most appropriate type and rate of fertilization needed for each commodity, which enables them to achieve optimum annual economic yields. More importantly, deep soil sampling (6-24 inches or deeper, if feasible) should be done whenever possible to allow utilization of N below the upper 6-inches of soil. In addition to reducing fertilizer input costs, proper management of N in crop production systems can impact the need for and rates of other production inputs such as herbicides, insecticides, growth regulators, and harvest aids. This study evaluates the financial and management benefits of adjusting N application rates based on deep soil testing.

Assumptions

The Financial And Risk Management (FARM) Assistance program is used to determine common crop mixes for the Texas High Plains (THP) region. FARM Assistance is a pro forma financial analysis program aimed at helping farmers and ranchers with strategic planning and risk management. According to FARM Assistance database averages, a typical THP operation consists of 1,000 irrigated acres, with a cropping mix of 400 acres of corn, 400 acres of cotton, and 200 acres of wheat. Once a representative farm is established, Extension budgets are used to illustrate the potential financial benefits of deep soil testing by adjusting N application rates for each commodity. Budgeted per acre costs are shown in Tables 1, 2, and 3. Corn N expenses run $116 per acre with an application rate of 225 pounds (140 lbs ANH3 and 85 lbs of UAN). Cotton costs run $74.25 per acre at a rate of 135 pounds (all urea). Finally, wheat budgets show a N expense of $32 per acre at a rate of 65 pounds (45 lbs of ANH3 and 20 lbs of UAN). Local agronomists estimate crop yields at 225 bu/acre for corn, 1,500 lbs/acre for cotton, and 50 bu/acre for wheat. Crop price projections come from commodity futures markets and are adjusted for local basis. In this study, the cost of a hand probe needed to obtain soil samples runs around $125, which equals $0.13 per acre on a 1,000 acre irrigated crop farm. Deep soil testing costs between $0.25 to $0.50 per acre plus another $0.25 for labor. In total, the estimated cost of deep soil testing is approximately $1.00 per acre although the price varies by service providers (Bell personal communication, 2022).

Table 1. Estimated Costs per Acre for Corn, Sprinker Irrigated 225 bu. Yield Northern High Plains					
Specified Expenses	% N Applied				
	100%	75%	50%	25%	0%
Seed	$95.17	$95.17	$95.17	$95.17	$95.17
Fertilizer					
Nitrogen	$116.05	$87.04	$58.03	$29.01	$0.00
Phosphorus	$64.80	$64.80	$64.80	$64.80	$64.80
Field Operations					
Herbicide & application	$73.38	$73.38	$73.38	$73.38	$73.38
Fertilizer application	$17.59	$17.59	$17.59	$17.59	$17.59
Insecticide & application	$45.75	$45.75	$45.75	$45.75	$45.75
Custom harvest & haul	$112.50	$112.50	$112.50	$112.50	$112.50
Crop consultant	$8.25	$8.25	$8.25	$8.25	$8.25
Crop Insurance	$45.00	$45.00	$45.00	$45.00	$45.00
Labor					
Operator Labor & Hand Labor	$11.28	$11.28	$11.28	$11.28	$11.28
Irrigation Labor	$22.01	$22.01	$22.01	$22.01	$22.01
Fuel					
Equipment	$13.10	$13.10	$13.10	$13.10	$13.10
Irrigation	$86.02	$86.02	$86.02	$86.02	$86.02
Repair & Maintenance					
Implements	$5.29	$5.29	$5.29	$5.29	$5.29
Tractors & Pickup	$7.84	$7.84	$7.84	$7.84	$7.84
Irrigation-Above Ground	$82.50	$82.50	$82.50	$82.50	$82.50
Interest-operating capital	$15.36	$15.36	$15.36	$15.36	$15.36
Total Variable Costs	$821.90	$792.89	$763.87	$734.86	$705.85
Fixed Costs	$208.64	$208.64	$208.64	$208.64	$208.64
Total Specified Expenses	$1,030.54	$1,001.53	$972.51	$943.50	$914.49
Cost Savings per Acre		$29.01	$58.03	$87.04	$116.05

This study evaluates five possible Nitrogen application scenarios based on soil testing results: **1)** Apply 100% of recommended N (0% residual), **2)** Apply 75% of recommended N (25% residual), **3)** Apply 50% of recommended N (50% residual), **4**) Apply 25% of recommended N (75% residual), and **5)** Apply 0% of recommended N (100% residual). Residual plant nutrient levels in the soil can vary greatly from year-to-year based on many factors, including fertilizer application rates and plant uptake in the prior year. As a result, only a one-year analysis comparing the five scenarios for each crop is completed. When taken as a whole, this study provides insight into the potential cost savings that can be achieved through deep soil testing.

Table 2. Estimated Costs per Acre for Wheat, Sprinkler Irrigated 50 bu. Yield Northern High Plains					
Specified Expenses	% N Applied				
	100%	75%	50%	25%	0%
Seed	$13.87	$13.87	$13.87	$13.87	$13.87
Fertilizer					
Nitrogen	$32.25	$24.19	$16.13	$8.06	$0.00
Phosphorus	$18.00	$18.00	$18.00	$18.00	$18.00
Field Operations					
Herbicide & application	$0.00	$0.00	$0.00	$0.00	$0.00
Fertilizer application	$17.59	$17.59	$17.59	$17.59	$17.59
Insecticide & application	$11.27	$11.27	$11.27	$11.27	$11.27
Custom harvest & haul	$37.00	$37.00	$37.00	$37.00	$37.00
Crop Insurance	$36.30	$36.30	$36.30	$36.30	$36.30
Labor					
Operator Labor & Hand Labor	$8.70	$8.70	$8.70	$8.70	$8.70
Irrigation Labor	$15.72	$15.72	$15.72	$15.72	$15.72
Fuel					
Equipment	$9.21	$9.21	$9.21	$9.21	$9.21
Irrigation Fuel	$39.10	$39.10	$39.10	$39.10	$39.10
Repair & Maintenance					
Implements	$5.57	$5.57	$5.57	$5.57	$5.57
Tractors & Pickup	$5.54	$5.54	$5.54	$5.54	$5.54
Irrigation-Above Ground	$37.50	$37.50	$37.50	$37.50	$37.50
Interest-operating capital	$10.45	$10.45	$10.45	$10.45	$10.45
Total Variable Costs	$298.08	$290.02	$281.95	$273.89	$265.83
Fixed Costs	$159.30	$159.30	$159.30	$159.30	$159.30
Total Specified Expenses	$457.38	$449.32	$441.25	$433.19	$425.13
Cost Savings Per Acre		$8.06	$16.13	$24.19	$32.25

Table 3. Estimated Costs per Acre for Cotton, Sprinkler Irrigated 1,500 lb. Yield Northern High Plains					
Specified Expenses	% N Applied				
	100%	75%	50%	25%	0%
Seed	$90.16	$90.16	$90.16	$90.16	$90.16
Boll Weevil Assess.-Irr	$0.75	$0.75	$0.75	$0.75	$0.75
Fertilizer					
Nitrogen	$74.25	$55.69	$37.13	$18.56	$0.00
Phosphorus	$42.90	$42.90	$42.90	$42.90	$42.90
Field Operations					
Herbicide	$85.69	$85.69	$85.69	$85.69	$85.69
Fertilizer application	$5.86	$5.86	$5.86	$5.86	$5.86
Insecticide & application	$12.14	$12.14	$12.14	$12.14	$12.14
Harvest					
Harvest aids	$31.77	$31.77	$31.77	$31.77	$31.77
Strip & module	$220.35	$220.35	$220.35	$220.35	$220.35
Ginning	$189.03	$189.03	$189.03	$189.03	$189.03
Crop Insurance	$53.00	$53.00	$53.00	$53.00	$53.00
Labor					
Operator Labor & Hand Labor	$12.41	$12.41	$12.41	$12.41	$12.41
Irrigation Labor	$12.58	$12.58	$12.58	$12.58	$12.58
Fuel					
Equipment	$13.97	$13.97	$13.97	$13.97	$13.97
Irrigation	$46.92	$46.92	$46.92	$46.92	$46.92
Repair & Maintenance					
Implements	$3.72	$3.72	$3.72	$3.72	$3.72
Tractors & Pickup	$7.90	$7.90	$7.90	$7.90	$7.90
Irrigation-Above Ground	$45.00	$45.00	$45.00	$45.00	$45.00
Interest-operating capital	$18.79	$18.79	$18.79	$18.79	$18.79
Total Variable Expenses	$967.19	$948.63	$930.07	$911.50	$892.94
Fixed Costs	$159.44	$159.44	$159.44	$159.44	$159.44
Total Specified Expenses	$1,126.63	$1,108.07	$1,089.51	$1,070.94	$1,052.38
Cost Savings per Acre		$18.56	$37.13	$55.69	$74.25

Results

While commodity prices have increased greatly over the past year, unfortunately so have production expenses. This study shows that even small investments or minor operational changes can lead to large financial savings. Tables 1, 2, and 3 demonstrate how deep soil testing allows producers to take advantage of N already present in the soil and apply less fertilizer. Corn (Table 1) shows the greatest benefit from reduced fertilization expenses because it has the highest N application rates, ranging from $29 per acre with a 25% residual to $116 per acre for a 100% residual. Cotton (Table 3) indicates the second highest advantage with cost savings ranging between $18 and $74 per acre. Finally, wheat (Table 2) shows the least benefit due to low N application rates compared to the other crops, falling between $8 and $32 per acre. While Tables 1,2, and 3 show farm financial benefits on a per acre basis, Table 4 exhibits the total impact of reducing fertilization rates on a 1,000 acre irrigated crop farm. Results show that taking advantage of even relatively low levels of residual N can make a big difference to the bottom line. For example, if a producer applies only 75% of their budgeted Nitrogen because testing shows 25% is already in the soil, they can save almost $20,000! Greater levels of residual lead to even bigger savings, reaching a high of $81,570 at the 0% of budgeted N level (100% residual). In conclusion, due to significant increases in 2022 production costs, it is well worth spending around $1 per acre for deep soil testing. With a return on investment that ranges between 1964% and 8157% (Table 4), it is a very smart decision.

Implementing the most cost-effective fertilization strategies offers crop producers the potential to improve profitability, liquidity, and ultimately, overall financial condition.

Table 4. Estimated Cost Savings for 1,000 Irrigated Acres, Northern High Plains

Crop	Irrigated Acres	% N Applied				
		100%	75%	50%	25%	0%
Wheat	200	$0	$1,613	$3,225	$4,838	$6,450
Cotton	400	$0	$7,425	$14,850	$22,275	$29,700
Corn	400	$0	$11,605	$23,210	$34,815	$46,420
Gross Savings		$0	$20,643	$41,285	$61,928	$82,570
Minus Testing ($1.00 per acre)			$1,000	$1,000	$1,000	$1,000
Net Savings			$19,643	$40,285	$60,928	$81,570
Return on Investment			1964%	4029%	6093%	8157%

Summary and Conclusions

Agricultural operations are continuously faced with unpredictable and often rising production costs each growing season. Annual deep soil testing is a management tool that offers the potential for significant cost savings. Knowing the amount of residual N in a soil profile allows farmers to customize fertilizer application rates based on crop needs and production goals. Furthermore, implementing a more cost- effective fertilization strategy should improve profitability, liquidity, and ultimately, overall financial condition.

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