Optimizing Cotton Profitability with Efficient Nutrient Use

By Steve Phillips, Mike Stewart, and C.S. Snyder

High fuel prices, increased worldwide demand, and short supplies have driven fertilizer prices to record highs. Nonetheless, targeting high nutrient use efficiency by applying the right nutrient source in the right place at the right rate and right time allows growers to continue to strive for high cotton yields even in economically challenging times.

In 2007, much of the dryland cotton in the southern USA was affected by extreme drought. Growers throughout the region, particularly in several Southeast and Midsouth states, experienced the worst growing season in decades resulting in severely reduced yields and profitability. In 2008, inclement weather forced replanting in several areas, which has been costly to growers. In addition to increased establishment costs, fertilizer prices have increased approximately 50% since last year (**Figure 1**). Considering that many growers are still feeling the financial sting from last year and have concerns about the potential for this year's crop, it's no wonder that options for lowering costs are in the front of everyone's mind. One of the first places growers are looking to cut costs is fertilizer. The question is: Is it really economical to reduce fertilizer rates?

To answer this question, one must first consider the effect of reducing fertilizer rates on lint yield. Both dryland and irrigated cotton take up approximately 16 lb N/A to produce 100 lb lint/A (IPNI, 2008). Some of this N requirement will be provided through the soil; however, most of the N will need to be applied as fertilizer. **Tables 1 and 2** display the economic optimum N rates (EONR) for cotton production in Alabama and Arkansas across a range of N fertilizer and cotton prices. Obviously, EONR decreases as fertilizer price increases at a set cotton price. However, the decrease in EONR associated with a 50% increase in fertilizer price is only 5 to 10 lb N/A (**Tables 1 and 2**). Data from the southern high plains in Texas followed a similar pattern, demonstrating that EONR is sensitive to wide fluctuations in N fertilizer price, but net returns are affected more than the most profitable N fertilization rate (Bronson and Boman, 2008).

Other factors to take into account when considering reducing fertilizer applications below recommended rates are the

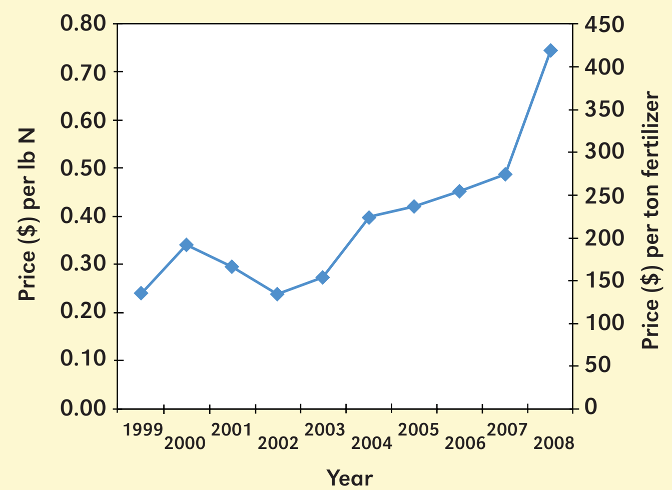

Figure 1. Urea ammonium nitrate fertilizer (28% N) price from 1999 through 2008 (Bronson and Boman, 2008).

long-term sustainability and balance of soil nutrients. Keeping essential plant nutrients in balanced supply results in more efficient utilization and prevents depletion of soil reserves. Research in Mississippi showed that optimum K fertility increased the efficiency of fertilizer N use by 19% and lint yield production per pound of N applied by 13% (Varco, 2000), which makes costly N applications more economical. It is true that when soil test levels are high for a particular nutrient, like P or K, a yield response to further additions is not expected even though a low application rate might be recommended as part of a maintenance program. However, a cotton crop will remove approximately 14 lb P_2O_5 and 20 lb K_2O/bale (IPNI, 2008); thus, maintenance applications can only be skipped so many times before yields begin to decline. So, allowing that reducing fertilizer inputs below recommended rates will immediately or eventually reduce yield, how can growers be

Table 1. Economic optimum N rates for cotton on a Decatur silty clay loam in Alabama (adapted from Snyder and Stewart, 2005).

N price, $/lb	Cotton Price			
	$0.52/lb	$0.62/lb	$0.72/lb	$0.82/lb
	--------- Economic optimum N rate, lb/A --------			
0.50	81	84	86	88
0.55	79	82	85	87
0.60	78	81	83	86
0.65	76	79	82	85
0.70	74	77	81	84
0.75	72	76	80	83

Table 2. Economic optimum N rates for irrigated cotton on an alluvial Sharkey Silty Clay in Arkansas (adapted from Snyder and Stewart, 2005).

N price, $/lb	Cotton Price			
	$ 0.52/lb	$ 0.62/lb	$ 0.72/lb	$ 0.82/lb
	-------- Economic optimum N rate, lb/A --------			
0.50	151	154	157	158
0.55	150	153	155	156
0.60	148	151	154	155
0.65	146	150	153	154
0.70	144	149	152	153
0.75	143	147	150	151

Abbreviations and notes for this article: N= nitrogen; P = phosphorus; K = potassium.

Precision agriculture technologies such as variable-rate fertilizer applicators can increase cotton profitability by improving nutrient use efficiency.

more profitable while still targeting high yields? The answer is: By increasing nutrient use efficiency (NUE).

Nutrient use efficiency can be increased by improving the uptake and utilization of applied nutrients, which increases the percentage of applied fertilizer that results in increased crop yield. There are numerous ways to calculate NUE (Snyder and Bruulsema, 2007), but the basic premise to increasing NUE is by selecting the right nutrient source and applying it in the right place at the right rate and right time. All agroecosystems have inherent loss mechanisms that affect nutrient efficiency such as surface volatilization, denitrification, runoff, and leaching. By managing nutrients in a way that minimizes these loss mechanisms, NUE can be increased. Some key steps that can be taken to improve NUE and optimize cotton profitability include the following (Snyder, 2006):

- Use N forms appropriate for soil, crop, and environmental system.
- Place N beneath surface residues and place at least some of the less mobile nutrients like P and K in the root zone.
- Develop field-specific yield goals based on measured yield history
- Soil test annually for N where justified by university research (this is especially relevant in the drier, high plains region) and at least every three years for P and K.
- Consider plant nutrient uptake patterns when making decisions regarding time of application. Split applications of N according to crop development in high rainfall areas or areas prone to leaching.

Another consideration for increasing NUE is site-specific nutrient management using precision agriculture technologies. Precision agriculture technologies have not always been economical for small to medium-sized farming operations. However, with precision agriculture equipment becoming less expensive, tools such as guidance systems, yield monitors, and variable-rate fertilizer applicators may now contribute to savings for all growers. The rising costs of inputs considerably increase the risk of making the wrong management decision.

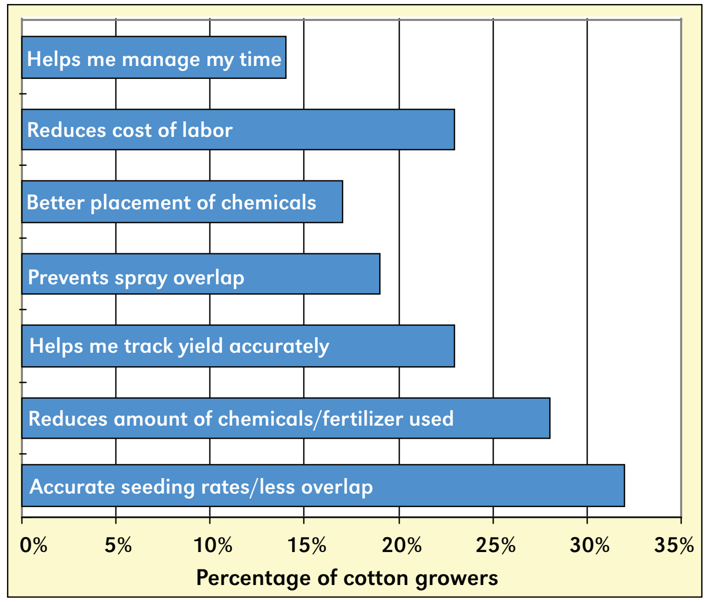

Figure 2. Primary cost reductions and production benefits to cotton growers adopting precision agriculture technologies (based on a survey of 65 cotton growers; Nowels, 2008).

Thus, even small farms can profit from using technologies that improve production efficiency. A recent survey of 271 growers across the USA found that 80% said they were more profitable since adopting a precision agriculture technology (Nowels, 2008). Reasons for the increased profitability included reduced fertilizer rates, reduced spray overlap, and several others (**Figure 2**). BC

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