STRATEGIES FOR DEALING WITH THE HIGH COST OF FERTILIZERS FOR COTTON

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Abstract

The relative high cost of all fertilizers, especially N materials, have cotton farmers concerned about the cost of production relative to returns. Options are few but there are some proven strategies that producers can use to reduce the cost of fertilizers. Producers can pay closer attention to (1) soil test results and apply only those nutrients with a high probability of producing a net profit. In the southeastern U.S., (2) the use of winter legumes as cover crop can replace most if not all of the N needs for high-yielding cotton. States such as Arkansas, Georgia, Alabama and Mississippi can take advantage of (3) poultry broiler litter which has a proven record as a reliable source of N, P, and K for cotton. Finally, producers need to (4) check around for the lowest cost fertilizer N material. Urea and urea-ammonium nitrate (UAN) solutions are definitely less expensive compared to some other materials, and the fact that urea is subject to some volatilization losses has been greatly over-emphasized. There are ways of controlling potential volatilization losses.

Introduction

Like fuel, the skyrocketing price of fertilizers has all farmers concerned (Fig. 1). All N fertilizer requires fossil fuel for manufacture. Phosphate and potash fertilizers require fuel for mining, refining and transportation. In addition, we are importing more and more of our N and K fertilizers and competing on the world market for all fertilizers, especially P and K. The lower value of the dollar makes these more expensive to purchase. If commodity prices kept up with fertilizer prices, all would be well but we know this isn't the case. The relative price of cotton has not increased as grain prices have soared.

So, what's a cotton, grain or livestock farmer to do if they have depended on cheap fertilizers to maintain a slim margin of profit? Realistically, there are not a lot of options.

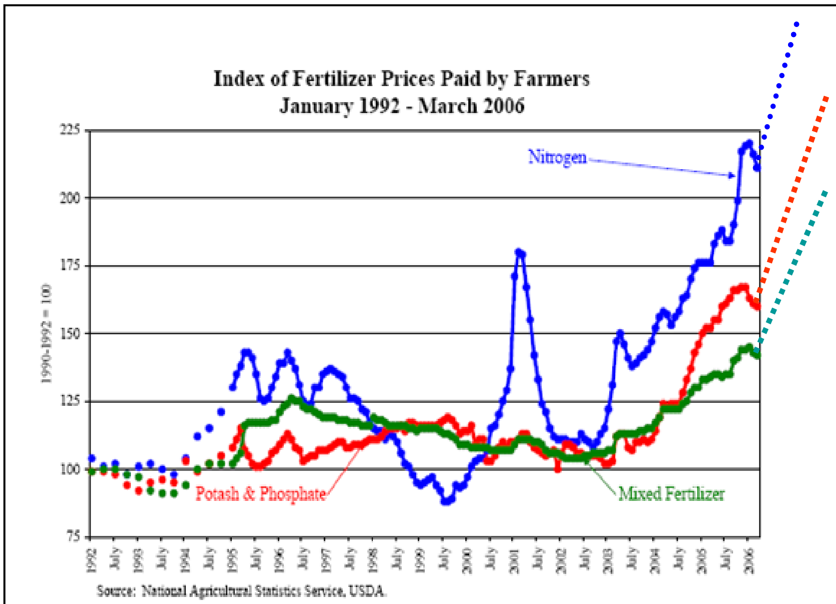

Fig. 1. Since 2006, fertilizer prices have soared to more than 5 time 1992 prices. Image adapted from The Fertilizer Institute, Washington, DC.

Nitrogen, the most expensive nutrient, is a different story. The only way N can build up in the soil is by building up soil organic matter. Unfortunately, most southeastern U.S. cotton producers have depended on cheap N to substitute for organic matter. Now we find ourselves with expensive N fertilizers and very little soil organic matter. A survey of cotton fields in 2000 in Central Alabama found topsoils averaging 0.6% organic matter (Kuykendall et al., 2002). Another study showed that maximum cotton yields were produced when soil organic matter was AT LEAST 2% (Mitchell and Entry, 1998). The extra, slow-release, organic N may contribute to a higher yield potential. In addition, organic matter increases soil moisture reserves, improves infiltration of rainfall, and increases beneficial soil microorganisms (Reeves, 1997). Building soil organic matter is a slow process but high-residue, conservation tillage can speed up the process in most of our well drained, cropland fields.

Following are some thoughts on strategies cotton producers in the Southeast can use to deal with the high cost of nutrients. None are novel. None are new. They all can help improve production and lower the relative cost of producing cotton. Some have been proven to help make long-term cotton production in the southeastern U.S. more sustainable.

Soil Test

First, we can draw on soil reserves of P, K and micronutrients. We can take advantage of high soil test levels. Research has shown rather conclusively that cotton and grain crops DO NOT remove much P and K from a soil that tests "High" or "Very High" in these nutrients (Mitchell and Mullins, 1999; Mitchell, 2000). Experiments on 7 Alabama Agricultural Experiment Station outlying units looked at P and K drawdown over 15 years and found only a small decline in soil test levels of these nutrients when cotton, corn for grain and soybeans for grain were produced and the residue returned to the soil. As long as the soil test is in the "high" range, yields will not be compromised by not applying additional P and K. In the southeastern U.S., the public soil testing laboratories that use the Mehlich-1 extraction procedure (Alabama, Georgia, Florida, Tennessee, and Virginia), have a fairly narrow range between what they would consider to the a "Medium" soil test P where additional P would be recommended and a "High" soil test P where very little or no additional P would be recommended. Experiments with cotton on 4 Alabama Coastal Plain soils verify the critical values used by these public laboratories (Fig. 2). If private laboratories or consultants are used for soil testing and recommendations, make certain that they use these research-based interpretations and are not over-recommending expensive nutrients.

Both agricultural consultants and extension agents have espoused the merits of soil testing for decades. Knowing a soil's ability to supply nutrients to a crop is fundamental for good nutrient management of any crop or forage. While we often look at soil testing to help us predict how much to apply to a crop for optimum production, soil testing is best used to predict when we DO NOT need to apply a nutrient. For 100+ years, farmers have applied "fertilizers" with little regard to their nutrient content. "Just throw out some 8-8-8 or 13-13-13 if you can afford it," has been a familiar practice when fertilizers were less expensive. Now is the time to take advantage of the soil's ability to hold and release certain nutrients such as phosphorus (P), potassium (K), and magnesium (Mg). Decades of research, illustrated in Fig. 2 for P, have given us a good idea of critical soil test levels above which a crop is not likely to respond to additional applications of that nutrient. Diammonium phosphate fertilizer, the most common source of fertilizer P was $1200 a ton at the end of July, 2008. That translates into $1.30 per pound of P_2O_5 fertilizer. For a cotton soil testing "low" in P in Alabama, a standard recommendation is for 90 pounds P_2O_5 per acre (Adams et al., 1994). That would be an output of $117 per acre before any cotton is harvested. This expenditure is impossible for all but the wealthiest producers. On the other hand, the most recent soil test summary for Alabama indicates that 56 percent of the cotton fields test "High", "Very High", or "Extremely High" in P and do not need additional P fertilization for optimum yield. Forty-eight percent of the fields DO NOT need additional K, and 88 percent DO NOT need additional Mg. Therefore, don't waste your precious fertilizer dollars on an expensive nutrient that may not needed. Only soil testing can identify this potential savings.

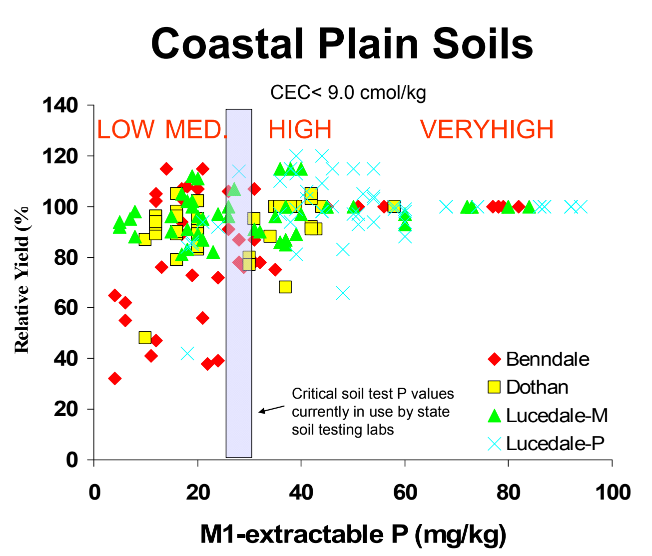

Fig. 2. Soil test calibration for P on Coastal Plain soils of the Southeastern U.S. using Mehlich-1 (M1) extractable soil P. Cotton in the High and Very High range are not likely to respond to addition P fertilization.

If soil testing identifies a field that is "low" in P or K based upon local research, then some source of P is absolutely needed whether it comes from fertilizers or from manures such as poultry litter.

Use Legumes

Traditionally, N has been the most expensive plant nutrient we purchase. As energy, oil, and gas prices go up, so does the cost of producing ammonia (NH_3), the basic material used in all nitrogen fertilizer manufacture. Since N is an essential component of all proteins, we must have N for both dry matter production and protein production. Cheap fertilizers after World War II led many producers to abandoned traditional legumes as a source of N for all crops. Now, legumes are beginning to be attractive again.

Alabama's Old Rotation experiment (circa 1896) on the campus of Auburn University is the oldest, continuous cotton experiment in the world, but it illustrates just how much N can be produced from a winter annual legume (Table 1). The 10-yr, non-irrigated, cotton yields suggest that N from crimson clover will produce almost the same yield as 120 pounds fertilizer N per acre (Mitchell et al., 2008). Adding this much fertilizer N plus the crimson clover will increase yields a little but not much.

Table 1. Cotton lint yields as affected by crimson clover winter cover crop and fertilizer N on Alabama's Old Rotation experiment (circa 1896).

Treatment	Cotton lint yield, 1995-2004 (lb/acre)*
No N and no legume	390 c
Crimson clover only	1010 b
120 lb. fertilizer N per acre	1060 b
Crimson clover + 120 lb. fertilizer N per acre	1160 a

* Values followed by the same letter are not significantly different at $P<0.05$.

Other, unpublished research in Alabama and Georgia suggests that a winter annual legume (hairy vetch, common vetch, crimson clover, lupines, etc.) will produce between 75 and 150 lb. N per acre for the following crop. How much N the legume fixes depends on the growth of the legume e.g., variety selection, when it was planted, stand establishment, growing season, etc. This, of course, varies from year to year.

Use Poultry Litter

Poultry production accounts for over 60% of Alabama's gross agricultural production. Most of the birds that are raised in Alabama and the rest of the southeastern U.S. are raised on imported grains. Very few nutrients are harvested in the birds. The N, P, and K remains behind in the 1.8 million tons of poultry broiler litter produced annually in Alabama. The fertilizer nutrients in poultry litter can vary tremendously so anyone buying or selling poultry litter for fertilizer should have it tested. However, for the sake of discussion, let's assume that poultry boiler litter is about a 3.0-3.9-2.8 grade fertilizer. These are the values used by USDA-NRCS in their nutrient management code 590 for Alabama (USDA-NRCS, 2002). This means that each ton of litter would contain 60-78-56 pounds N-P_2O_5-K_2O. At fertilizer prices listed for Alabama on December 22, 2008 (Table 2), this poultry litter would be worth \$155 per ton! This is \$40 per ton for the N, \$72 per ton for the P_2O_5, and \$43 per tons for the K_2O. This makes poultry litter worth over 4 times what it was worth 3 years ago.

Table 2. Retail fertilizer material prices for Alabama in 2008.				
	July, 2008		December, 2008	
Material	Price per ton	Price per lb. of nutrient	Price per ton	Price per lb. of nutrient
Ammonium nitrate (34-0-0)	$555	$0.82 (N)	$620	$0.91 (N)
UAN solution (28-0-0)	$430	$0.77 (N)	$375	$0.67 (N)
Anhydrous ammonia (82-0-0)*	$865	$0.53 (N)	$650	$0.40 (N)
Ammonium sulfate (21-0-0)	$380	$0.90 (N)	na	na
Urea (46-0-0)	$800	$0.87 (N)	$415	$0.45 (N)
DAP (18-46-0)	$1200	$1.30 ($P_2O_5$)	$850	$0.92 ($P_2O_5$)
Liquid 10-34-0	$1140	$1.68 ($P_2O_5$)	$1100	$1.62 ($P_2O_5$)
Muriate of potash (0-0-60)	$750	$0.63 ($K_2O$)	$9.15	$ 0.76 (K_2O)
* Midwest prices; not readily available in Alabama				

Therefore, if you just need a good source of N and can get poultry litter spread for less than $40 per ton, it is a good deal. Of course, not all the total N is poultry litter is available immediately after application like N in ammonium nitrate or urea. A conservative rule-of-thumb is to assume that 2/3 of the total N will be available to this year's crop. Therefore, if 90 pounds total N per acre is recommended for a cotton crop, then about 2.25 tons litter per acre will supply adequate N for the crop, assuming 60 lb. total N per ton (Fig. 3). Research for 11 years with poultry litter as a source of N for cotton and corn in the Tennessee Valley and in Central Alabama has confirmed this recommendation. Annual poultry litter N was actually closer to 90% available over the 11-yr period. (Mitchell and Tu, 2005).

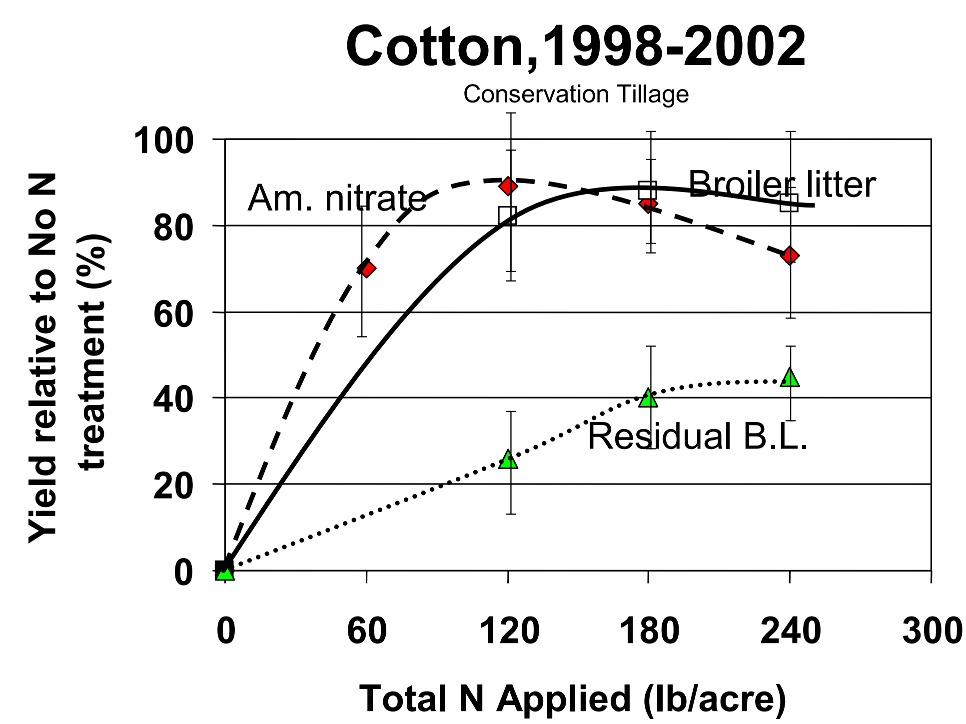

Fig. 3. Relative mean cotton lint yields using ammonium nitrate and poultry broiler litter applied based on total N in 1998 through 2002 in a Central Alabama Coastal Plain soil (from Mitchell and Tu, 2005).

If you need to build soil P and K for later planting of legumes, poultry litter is the best way to do this. Another advantage of poultry litter is that it is not nearly as acid-forming as commercial fertilizers. Little or no ground limestone is needed if poultry litter is the only source of N used. Commercial N fertilizers require about 3 to 5 pounds of ground limestone to neutralize the acidity in one pound of N as commercial fertilizer (urea, ammonium nitrate, ammonium sulfate, etc.).

Many producers, who want litter, cannot get it because the demand has increased along with the price of commercial fertilizers. In addition, poultry producers are not cleaning out their houses as frequently because the price of bedding (shavings) has also gone up. Add to this the increased cost of transportation and spreading and it is easy to see why the days of $20 per ton litter are history just as $180 per ton ammonium nitrate is also history.

Compare Prices

Historically, N has been the most expensive of the primary plant nutrients, followed closely by P then K. Today, because of world competition and the value of the dollar, P has surpassed N as the most expensive nutrient. Because P builds up in the soil, we may not need to apply it if soil tests are already high in P. If we can get poultry litter spread for less than $72 per ton, then we still have an alternative to high P prices. There are few alternatives to fertilizer N other than manures and some other by-products such as municipal biosolids.

Ammonium nitrate used to be the N source of choice for most Alabama crops and forages. It is easy to handle dry, easy to spread, available, and very stable. Even though it has always been more expensive to manufacture than urea, the fact that ammonium nitrate would lie on the soil surface for weeks and still be available when it rained was a distinct advantage in our hot and sometimes dry summers. Department of Transportation and Department of Homeland Security have put so many restrictions on the storage, handling, and transportation of ammonium nitrate that many small fertilizer dealers have chosen not to handle it anymore. Liquid UAN solutions have replaced ammonium nitrate over the past decade or so and its costs is usually somewhere between the cost of ammonium nitrate and dry urea. Urea has always been a much cheaper alternative to ammonium nitrate. Last summer, demand for urea in fertilizer blends and as a substitute for ammonium nitrate actually drove urea prices higher than ammonium nitrate prices for the first time in history (Table 2). However, most producers cannot get ammonium nitrate at any price so they are forced to use dry urea or liquid urea-ammonium nitrate e.g. 28-0-0 or 30-0-0. As of December, 2008, granular urea prices have assumed their traditional role as the least expensive, dry N material.

Volatilization Losses from Urea-based Fertilizers	
MAXIMUM LOSS	**MINIMUM LOSS**
• Midsummer application	• Early spring application
• Hot and dry but humid enough for heavy dews	• ½-inch rain within 3 days
• High residue conservation tillage, pastures, hayfields	• Urea broadcast on tilled, acid (pH<7) soil
• Soil pH > 7	• Urea injected or incorporated
• Urea or UAN solution broadcast	• Urea applied through fertigation
• No rain for 2 weeks	• UAN solutions dribbled or squirted on soil surface or banded

Urea, whether as a liquid or solid, is subject to volatilization losses as ammonia gas. This process is aggravated by surface application; high temperatures, dry but humid conditions, old vegetation or organic matter on the soil surface, and near neutral or alkaline soil pH (7.0+). This is exactly what we find in high residue, conservation or no-till fields. Liquid UAN solutions can be applied in a concentrated stream, applied behind a coulter or injected into the soil to eliminate volatilization losses. Spraying over the surface is the worse way to apply it because the urea is exposed to the maximum vegetation in this way. The plant enzyme, urease, is what breaks down urea to ammonia gas. Irrigation or rainfall within 3 days, cool weather, or application to bare soil will minimize volatilization losses when urea and UAN solutions are applied. Therefore, we are not likely to have much of a problem when using urea-based fertilizers to topdress cool season crops in late winter or early spring or when applying to a prepared seedbed. However, sidedressing or broadcast topdressing in the heat of the summer could present a problem.
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During the hot, dry summer of 2007, we measured volatilization losses from urea and UAN solutions when applied to a bare soil and to a soil with a thick residue of dead rye. Over an 8-day period with no rainfall and daytime temperatures near 100F, we lost about half of the N from urea (1/4 from the UAN solution). Using a urease inhibitor (Agrotain®) reduced this loss by half but it also added additional cost to the fertilizer.

This experiment was repeated in 2008 as a sidedress for corn and cotton planted into a heavy rye residue cover (Fig. 4-5). Interestingly, dry granular urea as a broadcast, topdressing in July produced the highest cotton yields with low ammonia volatilization while UAN solution without a urease inhibitor (Agrotain®) had lower yields and higher volatilization. We attribute this to the fact that dry urea fell below the dry, rye residue and was in contact with the soil while the UAN solution was trapped by the dry ground cover. Both the corn and the cotton experiments were topdressed during hot, dry periods and did not receive a rain for several days after application.

In spite of the potential for ammonia losses from dry urea, producers need to look at the cost of N materials and realize that the risk may not be as high as often thought. Urease inhibitors work but producers must consider the additional cost of these additives.

Summary

With retail fertilizer prices at an all-time high and still increasing along with fuel prices, Alabama cattlemen who depend on forages for a successful cow-calf or stocker operation have few choices when it comes to holding fertilizer costs down. Strategies that can help reduce or eliminate the need for some fertilizer materials include:

1. **Soil testing** to take advantage of high levels of P and K.
2. **Recycle nutrients** in a pasture by practicing good grazing management.
3. Using more annual and perennial **legumes** in pastures and hayfields to reduce the need for fertilizer N.
4. Use **poultry litter** if available to build soil P and as an alternative source of N.
5. **Compare prices**, especially for N fertilizer materials, and use the least expensive source if conditions permit. Urea-based materials need special considerations to reduce potential volatilization losses on summer pastures and hayfields.

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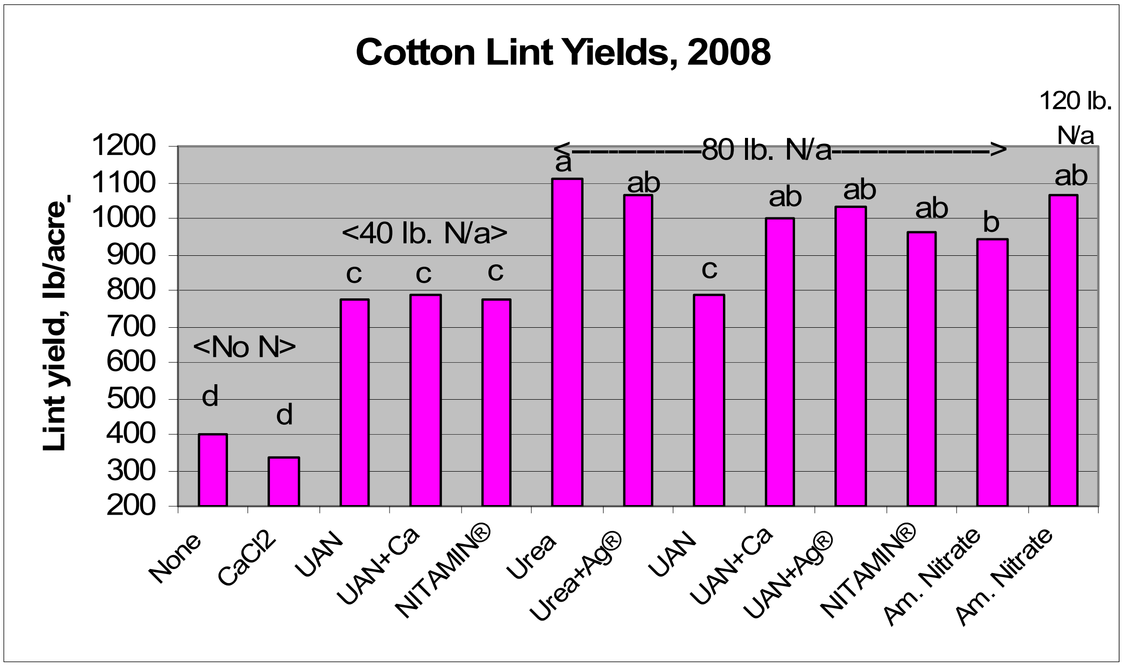

Fig. 4. Cotton yield response to sources and rates of side dress N with and without Agrotain® and a calcium chloride solution (Ca) in Central Alabama.

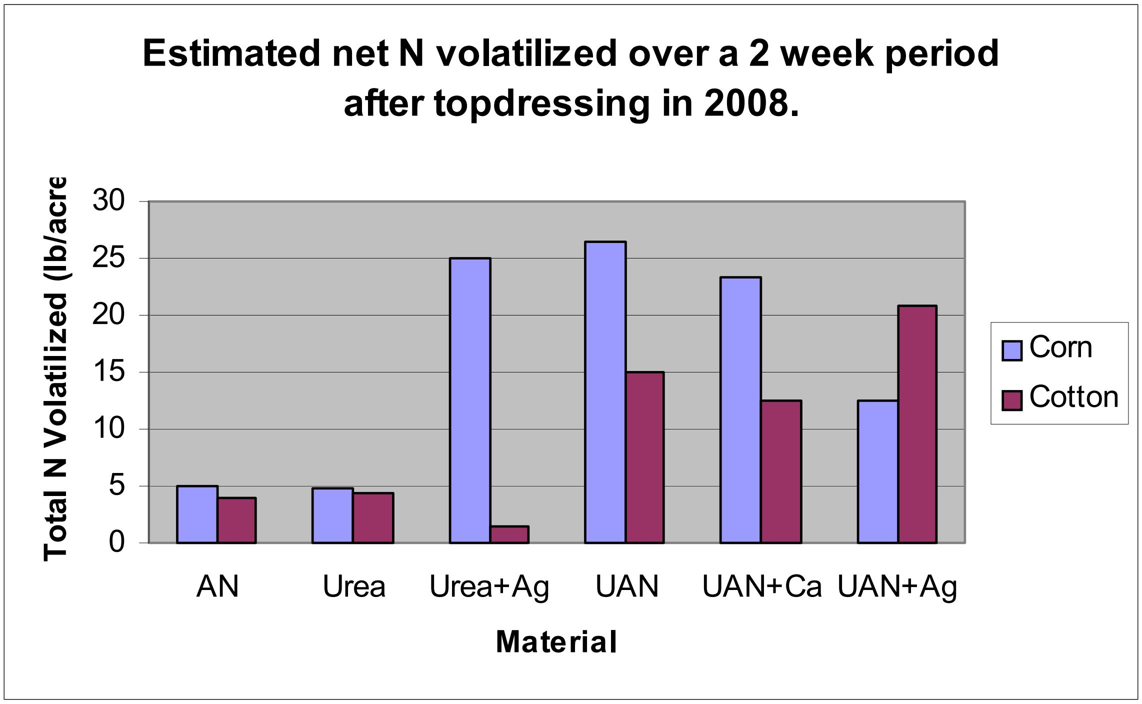

Fig. 5. Measured N volatilization over a 14-day period following topdressing with 120 pounds N per acre on no-till corn on May 28 and 80 pounds N per acre on no-till cotton on July 8.