

Soil Facts

How Rising Fertilizer Prices Affect Optimum Nitrogen Rates

Recent increases in nitrogen (N) fertilizer prices and current expectations about crop prices mean growers should consider reductions in fertilization rates in order to achieve maximum profits.

Nitrogen recommendations for maximum crop yield are generally based on yield potential or realistic yield expectation (RYE), which varies by soil type or productivity, climate, and various other soil and crop management factors. However, the N rate for maximum economic yield depends on the fertilizer N cost and the market price received for the crop. Historically for corn, the Crop price:N cost ratio typically has varied from 10:1 to 15:1 (i.e., a 10:1 ratio results from \$2.50/bushel : \$0.25/pound N). Under this range in price ratios, the N rate for maximum economic corn yield varies only slightly. However, when the N fertilizer price increases significantly and the crop price holds steady, the economic optimum N rate will decrease more. Fertilizer N rates for maximum profit are always lower than the N rates required for maximum yield.

Energy Prices and the Fertilizer N Price

The majority of commercial fertilizer N products is manufactured from anhydrous ammonia, NH_3 , which is produced from reacting N_2 (nitrogen from the air) and H_2 (hydrogen from natural gas) under high pressure and temperature. Since 1999, the cost of natural gas and other energy sources has increased substantially (Figure 1).

There are two primary reasons for the recent increases in energy prices, one short term and the other longer term. Short-term increases are normally the result of significant disruption in production due to political conflicts and weather disasters. In 2005, weather in the Gulf of Mexico was the primary factor. Longer-term factors include a steady and substantial increase in foreign and domestic energy demand and a reduction in domestic oil production and

refinery capacity (U.S. Department of Energy, Energy Information Administration, Annual Energy Review). In addition, the U.S. capacity to produce anhydrous ammonia has decreased approximately 50 percent since 1998. As a result, the price for N and other fertilizers has been increasing, albeit somewhat erratically (Figure 2).

Current prices for N fertilizers range from \$0.30 to \$0.50/pound of N, depending on the source. The main sources are anhydrous ammonia, urea, ammonium nitrate, and urea-ammonium nitrate solutions such as UAN-30; the price per pound of N varies substantially among these sources. Because each source has a different concentration of N, it pays to compare them on the basis of the per-pound cost of N. Anhydrous ammonia contains 82 pounds of N per 100 pounds of product; ammonium nitrate, 34 pounds; ammonium sulfate, 21 pounds; urea, 46 pounds. Liquid N

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solutions vary but typically contain 28 to 32 pounds of N per 100 pounds of product.

Determining N Rate for Maximum Profit

To determine the most profitable N application rate, it is important to

understand the relationship between crop yield and N fertilizer rates. This relationship is called the N response function. Figure 3 shows two examples for corn that represent high and low yielding sites. As you can see, there is some production without any added N. Also, the first amount of N that is added has a

bigger effect on yield than the later additions. Each subsequent addition of N produces a smaller yield increase up to a maximum. The N rate required for maximum yield represents the point on each curve where no additional corn production is obtained even though more N is applied. For the low yielding site, 166 pounds of N/acre produce the maximum yield of 117 bushels of corn. For the high yielding site, 213 pounds of N/acre produce the maximum yield of 160 bushels.

It is important to recognize that, when commercial fertilizer is used, the N fertilizer rate for maximum profit or return on the investment in fertilizer N is always less than the N rate for maximum yield because there comes a point where the value of the additional crop yield will not cover the cost of the additional fertilizer N. This point will vary with N fertilizer prices and the crop price received (Table 1). Historically, Corn:N price ratios generally range between 10:1 and 15:1. The shaded boxes in the table represent the typical historical range in the Corn:N price ratio of 10:1 to 15:1.

Within this historic range of Corn:N price ratios, the N rates needed for maximum economic yield vary by only about 10 pounds N/acre for the high corn yield site, compared to 7 pounds N/acre for the low yield site. Under these Corn:N price ratios, growers often do not adjust N rates for market price conditions. However, as the N price increases relative to a given corn price, the N rate for maximum economic yield decreases further (Table 1). Under current expectations about corn and N prices for the 2006 crop, the Corn:N price ratio is between 5:1

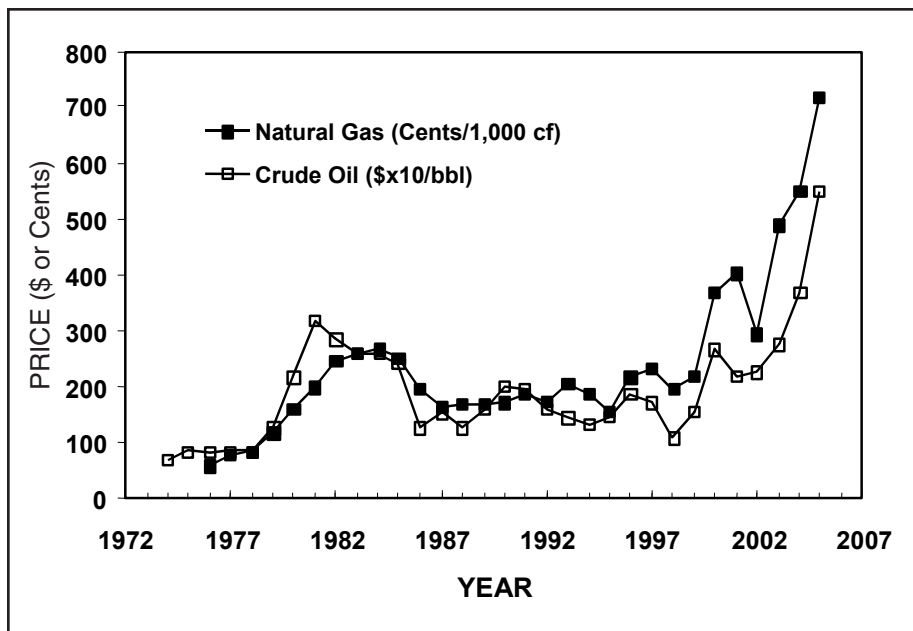


Figure 1. World market prices for natural gas and crude oil, 1972-2005.
Key: Natural gas price is shown in cents/1,000 cubic feet, and crude oil price is in \$x10/barrel.

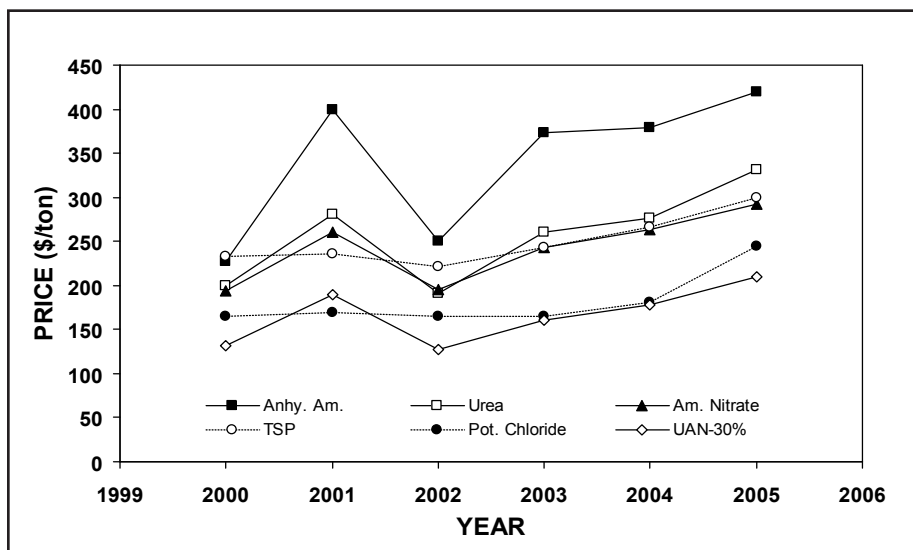


Figure 2. Market prices for some common agricultural fertilizers.
Key: Anhy. Am = anhydrous ammonia
Am. Nitrate = ammonium nitrate
TSP = triple super phosphate
Pot. Chloride = potassium chloride
(Source: "Agricultural Prices," U.S. Department of Agriculture, National Agricultural Statistics Service)

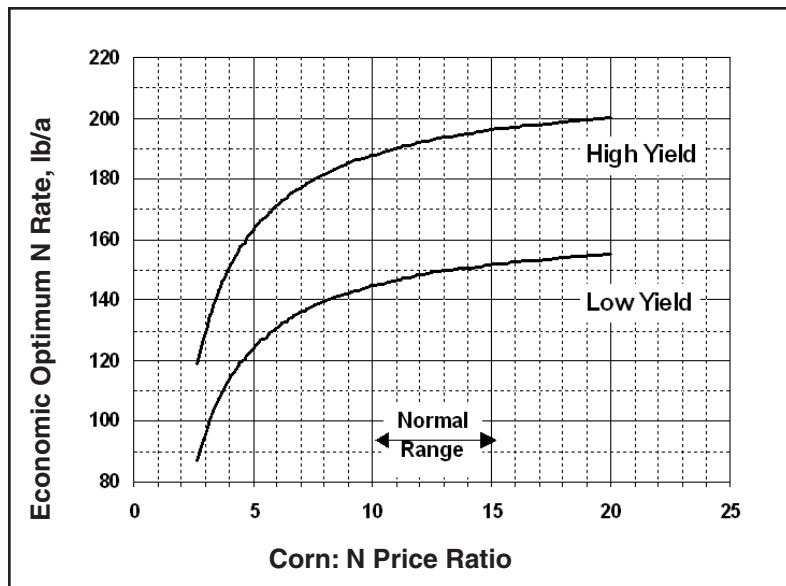


Figure 4. The effect of Corn:N price ratio on economic optimum N rates for corn at two yield levels.

Under no-till and conservation tillage systems, surface or subsurface N applications may also increase crop recovery of applied N by reducing N immobilization by the surface crop residue. Subsurface N placement may also increase N use efficiency by about 10 percent, but this must be balanced against whether any additional application costs might be incurred.

This discussion has focused on the optimum use of N in crop production. However, higher energy prices have also affected diesel fuel prices and many other farm input costs. Rising input costs and flat commodity prices may create a situation where the expected revenue from the sale of the crop will not cover out-of-pocket costs, making a particular field or crop unprofitable. These cost increases may also change the relative profitability among cropping alternatives, creating incentives

to change the crop selection or to adjust the crop mix. The overall impact of these changes on the profitability of individual crops should be assessed by developing enterprise budgets. NCSU publishes budgets for selected crops, and these can be used as templates for developing budgets for specific farm situations.

In summary, economic optimum N rates will be reduced during periods when N prices are unusually high relative to crop prices. However, these reductions should be relatively small compared to the optimum fertilization rates under more typical fertilizer N and crop prices. A small reduction in yield can be expected, but this can be minimized by employing sound agronomic practices. Growers should also evaluate the cost effectiveness of changes in N management practices that will increase the efficiency of fertilizer N use by the crop.

Additional resources

Best Management Practices for Agricultural Nutrients. 1997. J. P. Lilly. North Carolina Cooperative Extension Service. AG-439-20.

The Economics of Fertilizer Management. 2002. D. H. Hardy, D. L. Osmond, and Ada Wossink. North Carolina Cooperative Extension Service. AG-439-45.

An Overview of Nutrient Management with Economic Considerations. 2002. D. H. Hardy, D. L. Osmond, and Ada Wossink. North Carolina Cooperative Extension Service. AGW-439-55

Soil Tests for Corn Nitrogen Recommendations and Their Relationships with Soil and Landscape Properties. 2005. J. D. Williams. Dissertation. North Carolina State University.

Additional soil fertility and nutrient management information at <http://www.soil.ncsu.edu/> North Carolina enterprise budgets are available at http://www.ag-econ.ncsu.edu/extension/Ag_budgets.html

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