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Comparing the Cost of Broadcasting Versus Injecting Nitrogen in No-Tillage Corn

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Introduction

No-tillage has become a popular production option with many Tennessee farmers in the past 20 years. In 1993, no-tillage production systems were used on 290,000 acres of corn in Tennessee, or 44 percent of the total corn acreage planted in the state (TDA). Many farmers see no-tillage as a way to reduce the cost of growing corn. Others have chosen no-tillage as a way to comply with governmental regulations covering the farming of highly-erodible soils.

Input levels and prices are important to consider in any production system. A major expense in corn production is nitrogen (N) fertilizer. No-tillage budgets published by The University of Tennessee Agricultural Extension Service include N (ammonium nitrate) application rates as high as 125 pounds per acre, at a cost of \$31.25 per acre (Gerloff). In this publication, the costs of five fertilization methods are compared and break-even prices to land, management and risk are calculated. The methods studied are: 1) broadcasting urea; 2) broadcasting ammonium nitrate (AN); 3) broadcasting urea-ammonium nitrate (UAN-B, 32 percent solution); 4) injecting urea-ammonium nitrate (UAN-I, 32 percent solution); and 5) injecting anhydrous ammonia (AA).

Methods

Data on corn yields as a function of nitrogen sources and application methods were collected in the mid 1980s at the Milan Experiment Station (Howard and Tyler). Corn yields in Tennessee between 1984-1994 averaged 94 bushels per acre (TDA). A simple regression analysis with yields as the dependent variable and time as the only independent variable was run for 1984-1994. No sta-

tistical evidence of a positive yield trend for corn was found for Tennessee. Since the same application methods and nitrogen sources are being used currently, these data are applicable in defining cost-efficient fertilizer applications.

In the Milan experiment, N application rates were varied from 0 to 200 pounds per acre, in 50-pound increments (Howard and Tyler). Sources

of N studied were ammonium nitrate (AN), urea, urea-ammonium nitrate (UAN), urea-urea phosphate (UUP) and anhydrous ammonia (AA). AN, urea, UAN and UUP were broadcast and urea, UAN and AA were injected. The production system was no-tillage, in a killed wheat cover. Some studies suggest that surface-applied AN is immobilized by the microbial decomposition of the wheat residue (Howard and Tyler). Therefore, caution should be used when applying this study's comparisons among broadcast AN and injected N sources to other production systems, such as corn after soybeans.

Yields were significantly higher for injected N compared to broadcasting. Broadcasting AN resulted in higher yields than broadcasting UUP, UAN or urea. Yields were not significantly different among broadcast UUP, UAN or urea, and there were no significant differences in yields among the three injected sources of N (Howard and Tyler).

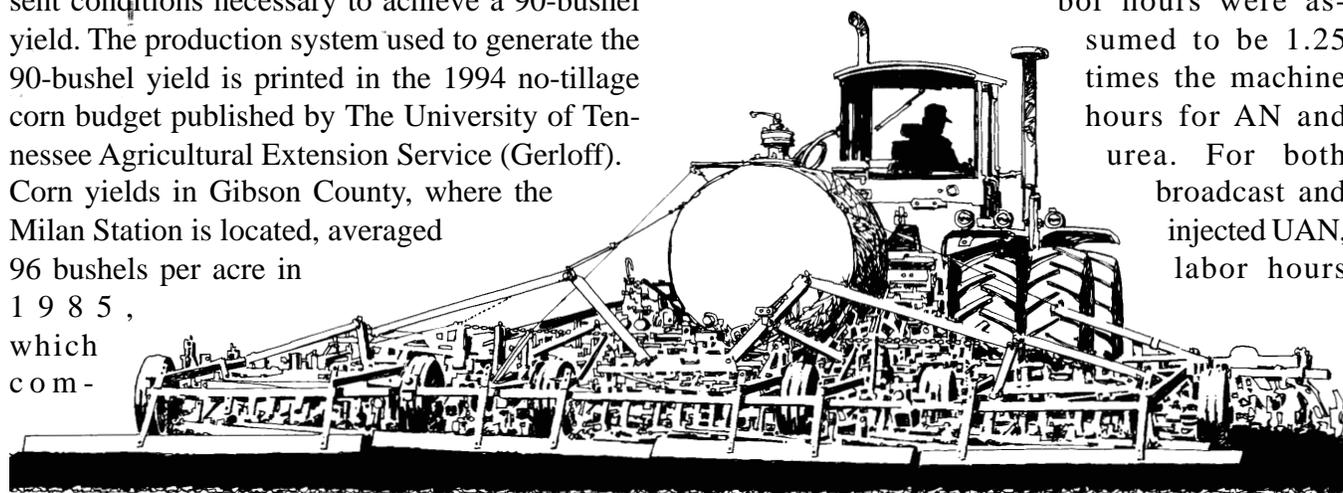
Roberts, et al. estimated yield response equations for each method based on the Milan Experiment Station data for 1983, 1984 and 1985 (Howard and Tyler). On the experiment station, 1985 was considered an "average" production year, 1984 a "better-than-average" production year and 1983 a "worse-than-average" production year. Without knowing what kind of production year is in store, a corn grower would want to fertilize at a rate that would be most efficient. The 1985 production year is viewed as the one most likely to occur. Assuming a corn-grower would fertilize for the "average" or most likely production year, the 1985 yield response equation was chosen to represent conditions necessary to achieve a 90-bushel yield. The production system used to generate the 90-bushel yield is printed in the 1994 no-tillage corn budget published by The University of Tennessee Agricultural Extension Service (Gerloff). Corn yields in Gibson County, where the Milan Station is located, averaged 96 bushels per acre in 1985, which com-

pares favorably with the 90-bushel budget. Also, according to the Tennessee Agricultural Statistics Service, the average state corn yield from 1984-1993 was 92 bushels per acre (TDA).

The yield response functions for 1985 were used to estimate the N rates from applying urea, AN, UAN-B, UAN-I and AA (postplant) required to achieve the 90-bushel yield in that year. Resulting nitrogen rates were put into the yield response equations for 1983 and 1984. From those equations, yields were estimated for 1983 and 1984. Thus, N rates were held constant over the three years and each year's weather, which is described by the equations, determined yield in a given year.

A partial budgeting approach was used to compare the costs of the N application methods. A budget was prepared for each N method, which included variable and fixed costs of fertilization. All costs not associated with N application were held constant across these budgets. Application costs included fuel, repairs, machinery depreciation and interest and labor. An eight-row machinery complement was assumed for estimating machinery costs.

Since machinery and labor costs were calculated on the basis of hours of machine use, time required for each application method was an important variable. Tractor time required to pull the fertilizer spreader was assumed to be 0.07 hours per acre for the urea, AN and UAN-B methods. For the injected UAN and AA methods, tractor hours per acre to pull the injector tanks were assumed to be 0.16 and .21 hours, respectively (Wills). Fertilizer application labor hours were assumed to be 1.25 times the machine hours for AN and urea. For both broadcast and injected UAN, labor hours



for application were set at 1.35 times the machine hours. For AA fertilizer application, labor hours were set at 1.5 times the machine hours. This extra labor was assumed to cover the time associated with preparation and clean-up. Extra labor time is needed in preparing to apply UAN and AA because of the time needed to hook up the tank to the delivery hoses, and, in the case of AA, take additional safety precautions. Charges for spreader or tank rental are assumed to be included in the price of the fertilizer. Harvest costs are not assumed to differ based on yield differences. Net returns to land, management and risk were then calculated using the costs and returns in the budget adjusted by the method of N application.

Results

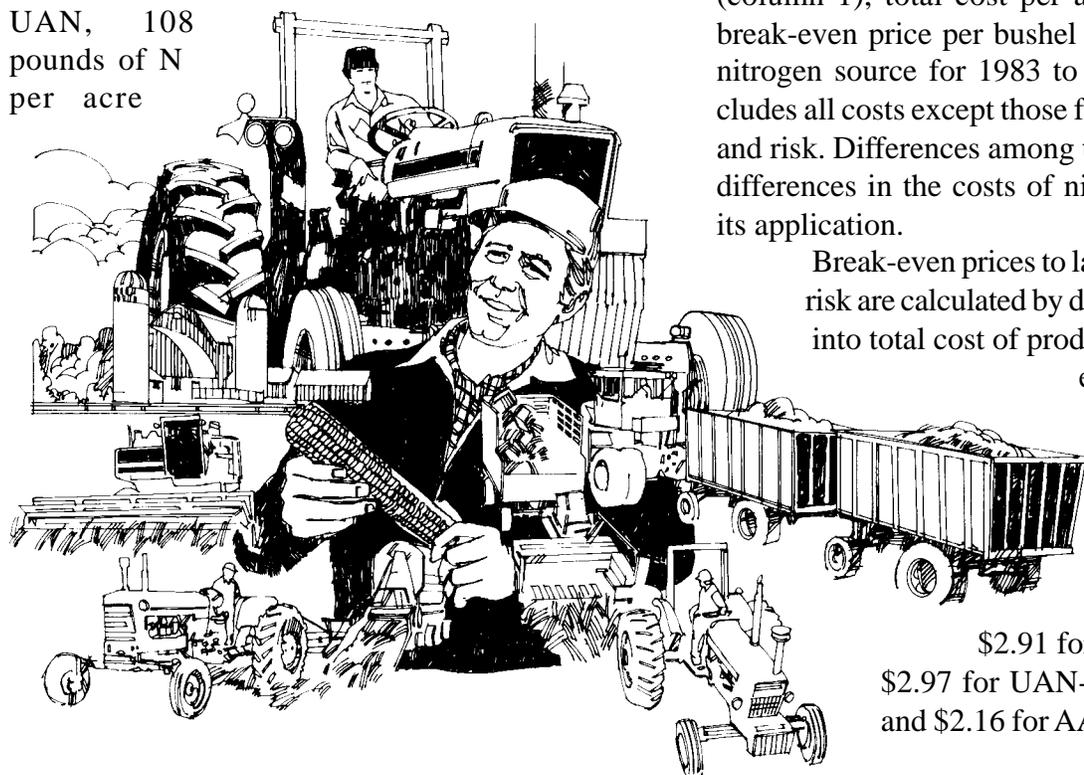
Table 1 lists the pounds of each nitrogen source needed to produce yields of 90 bushels in 1985 (column 2), the price of N (Hopper) (column 3), the variable cost of the N applied (column 4), the cost of applying each N source (column 5) and the total cost of N (column 6).

To achieve a 90-bushel yield using the 1985 equation would require 133 pounds of N per acre from broadcast urea or UAN, 108 pounds of N per acre

from broadcast AN and 72 pounds of N per acre from injected AA or UAN. Differences in Table 1 among the N sources show in the variable N cost per acre and the cost of application. Urea, AN and UAN-B have higher variable N costs, because of the greater amount of N needed to achieve the specified corn yield. UAN-I and AA have a lower application rate, at 71.5 pounds of N per acre, and AA has a significantly lower price of N compared to the other methods. The cost of applying N is higher for the injected methods (UAN-I and AA) because of the greater time required to apply N. Both labor and machinery costs increase as field time increases, making UAN-I and AA more expensive. However, combining the variable and application costs of N results in UAN-I and AA still having a total cost advantage. UAN-I has a \$12.40 per acre total cost advantage over UAN-B (\$31.84 minus \$19.44), and AA has a \$18.26 per acre total cost advantage over UAN-B (\$31.84 minus \$13.58). Also, UAN-I has a \$9.23 per acre total cost advantage over AN (\$28.67 minus \$19.44) and AA has a \$15.11 per acre total cost advantage over AN (\$28.67 minus \$13.58). Cost advantages of UAN-I and AA over urea are similar to the cost advantages of UAN-I and AA over AN.

Table 2 lists the estimated yield per acre (column 1), total cost per acre (column 2) and break-even price per bushel (column 3) for each nitrogen source for 1983 to 1985. Total cost includes all costs except those for land, management and risk. Differences among the methods relate to differences in the costs of nitrogen fertilizer and its application.

Break-even prices to land, management and risk are calculated by dividing the yield level into total cost of production (Table 2). For example, in 1983, a major drought year, the break-even price to cover all costs of production except land, management and risk is \$2.91 for urea, \$2.71 for AN, \$2.97 for UAN-B, \$2.25 for UAN-I and \$2.16 for AA. With higher yields



in 1984 and 1985, the break-even prices decline notably, but there are still differences among the methods.

Assuming a Tennessee corn grower fertilizes for an average weather year to achieve a yield of 90 bushels per acre, the results show (from the 1985 year of Table 2) a savings of \$0.17 per bushel, comparing AA to AN. Marketing year average prices in Tennessee over the 1984-1993 time period have averaged \$2.36 per bushel for corn. For a year like 1985, given an average of \$2.36 per bushel, use of AA returns an average net return of \$0.92 per bushel ($\$2.36 - \1.44), while AN returns \$0.75 per bushel to land, management and risk. On a per-acre basis, with a 90-bushel yield, AA returns \$82.50 (90 bu. times \$2.36/bu., less \$129.90 total costs) to land, management and labor, while urea and AN return \$67.02 and \$67.10, respectively.

Those levels of return, \$82.50, \$67.02 and \$67.10, may be adequate to pay for land expenses, with some residual for the owner's management and risk. However, in a year like 1983, when yields are lower, return to AA based on the \$2.36 price is \$12.17 per acre (60.2 bu./acre times \$2.36/bu., less \$129.90 total costs). Returns for UAN-I are also positive, at \$6.42 per acre (60.2 bu./acre times \$2.36/bu., less \$135.65 total costs). Urea and AN returns, however, drop to a -\$27.38 per acre and -\$18.80 per acre, respectively.

Therefore, in addition to the cost savings associated with the use of AA and UAN-I, in years when yields are below average, use of AA or UAN-I reduces the risk of negative returns to land. In highly-leveraged farm operations, the use of AA or UAN-I appears to be a risk-reducing factor as well as a profit-enhancing one.

Summary and Conclusions

Nitrogen application costs vary among methods used, including broadcasting urea, ammonium nitrate (AN) and urea-ammonium nitrate (UAN-B); injecting anhydrous ammonia (AA); and injecting urea ammonium nitrate (UAN-I). Estimated yields for 1983-1985 weather conditions, given constant levels of nitrogen applications using the five methods, gave the lowest break-even prices for corn using the AA technique. The next lowest break-even price was for UAN-I. These results suggest that the lower N requirement for injection outweighs the higher cost of application compared with broadcasting N.

For no-tillage corn growers in Tennessee, injecting AA or UAN should be considered when applying nitrogen to both reduce the risk of negative returns in years with low yields, and enhance profits in years with average-to-high yields. It is important to consider all costs, including relative prices and efficiencies of nitrogen placement methods and sources, before deciding on the method of nitrogen application.

Caution should be used in applying the results of this study to non-wheat residue production systems. Nitrogen immobilization from broadcast AN may not occur to the same extent in other residue, such as corn following soybeans, for example.

Last, the cost of safety concerns in using injected AA was not addressed other than the time considerations in the machinery costs. Safety precautions are an extremely important consideration in determining the feasibility of the nitrogen source to use in a farming operation.

Table 1. Pounds of N Applied, Price, Variable Cost of N, Application Cost and Total Cost of N for Broadcast Urea, Broadcast Ammonium Nitrate (AN), Broadcast Urea-Ammonium Nitrate (UAN-B), Injected Urea-Ammonium Nitrate (UAN-I) and Injected Anhydrous Ammonia (AA), 1985.

N source	Pounds of N applied per acre	Price of N (\$/lb.)	Variable cost of N (\$/acre)	Cost of applying N ^a (\$/acre)	Total cost of N ^b (\$/acre)
Urea	133.2	0.206	27.44	1.31	28.75
AN	107.7	0.254	27.36	1.31	28.67
UAN-B	133.2	0.229	30.50	1.34	31.84
UAN-I	71.5	0.229	16.37	3.07	19.44
AA	71.5	0.126	9.01	4.57	13.58

^a Budget used was no-tillage, using 8-row equipment (Gerloff). Costs include fuel, repairs, depreciation and interest for a 100-horsepower tractor plus tractor-operating labor. A 125-horsepower tractor was assumed for the AA operation only. Costs do not include interest on operating capital.

^b Variable cost of N plus cost of applying N.



Table 2. Estimated Yield, Total Cost and Per Bushel Break-even Price for No-Tillage Corn, Applying Broadcast Urea, Broadcast Ammonium Nitrate (AN), Surface-Applied Urea-Ammonium Nitrate(UAN-B), Injected Urea-Ammonium Nitrate (UAN-I) and Injected Anhydrous Ammonia (AA), Applied at Rates to Achieve 90-Bushel Average Corn Yields at Milan, Tennessee, 1983-85.

	Estimated yield (bu/Acre)	Total cost ^a of production (\$/Acre)	Break-even price ^b (\$/Bu)	Difference in break-even prices (AA as base)
1983:				
Urea	50.0	145.38	2.91	+0.75
AN	53.6	145.30	2.71	+0.55
UAN-B ^c	50.0	148.60	2.97	+0.81
UAN-I ^d	60.2	135.65	2.25	+0.09
AA	60.2	129.90	2.16	
1984:				
Urea	112.8	145.38	1.29	+0.10
AN	110.6	145.30	1.31	+0.12
UAN-B ^c	112.8	148.60	1.32	+0.13
UAN-I ^d	108.9	135.65	1.25	+0.06
AA	108.9	129.90	1.19	
1985:				
Urea	90.0	145.38	1.62	+0.18
AN	90.0	145.30	1.61	+0.17
UAN-B ^c	90.0	148.60	1.65	+0.21
UAN-I ^d	90.0	135.65	1.51	+0.07
AA	90.0	129.90	1.44	

^a Excludes costs of land, management and risk.

^b Based on returns to land, management and risk.

^c UAN-B is surface-applied urea-ammonium nitrate (32 percent solution).

^d UAN-I is injected urea-ammonium nitrate (32 percent solution).

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a U.T. Ag. Extension Reminder...

The University of Tennessee Agricultural Extension Service has an ongoing educational program to assist farm families in financial planning and management. Known statewide as “MANAGE”, this educational program has assisted hundreds of farm families.

Area specialists-farm management, trained in financial planning, administer this program. These area specialists travel to the farm to meet with the family. Information on the farm’s production expenses, yields, output prices, and proposed changes are needed to complete the financial planning program.

Often, computers are used to help create financial reports needed for planning. The computer software allows the farm families to consider several “what-if” strategies, concerning the financial future of their farm.

Changes in the farm’s profitability can be predicted, based on each strategy. The farm family can then decide on putting the proposed changes into effect.

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