FLUID DIGEST®

Research Update from the Fluid Fertilizer Foundation

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Up to 41 bu/A

Banding UAN boosts corn yields

Researchers at the University of Missouri have demonstrated how knifing optimizes UAN efficiency and contributes to environmental protection. In experiments at Bradford Farm in 1989, they compared yields produced in no-till plots where UAN was broadcast, dribbled and knifed in (Figure 1). Note that knifed-in corn yields were 35 bu/A more than broadcast for the 120 lbs/A rate and 41 bu/A more when the rate was increased to 180 lbs/A.

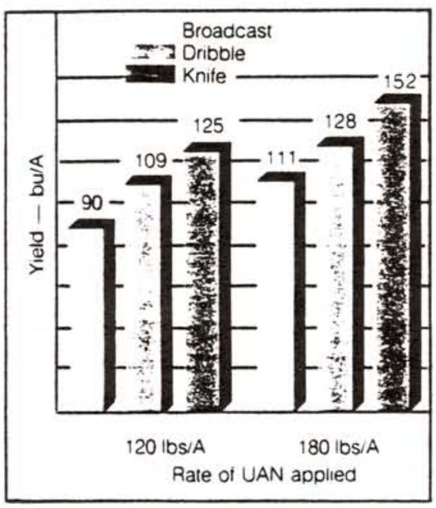

Figure 1. Effect of method of preplant UAN applications on no-till corn yields (Buchholz, Wollenhaupt, McVay, Flanary and Smoot, 1989, University of Missouri, Bradford Farm).

These yield increases translate into substantial economic gains for a typical well-managed farm operation. Assuming $2.50 corn, gross income would have increased $87.50 at the 120-lb/A N rate or $102.50/A at the 180-lb/A N rate when knifing UAN instead of broadcasting. (Also, note the advantage of knifed-in over dribble.)

Although knifing can optimize N efficiency and improve corn yields over broadcast or dribble, a recent two-year study in DeKalb and Elwood, Illinois, indicates knifing N between every or every other row produced nearly the same corn yields (Figure 2). When application rates were varied for the spacing, results were still similar.

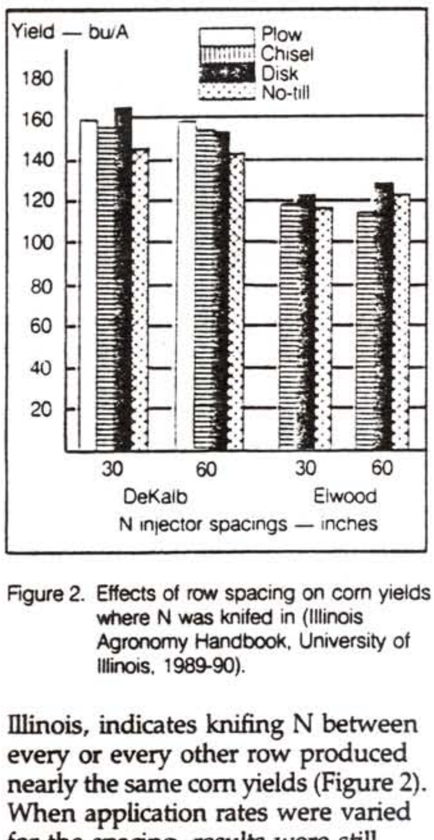

Figure 2. Effects of row spacing on corn yields where N was knifed in (Illinois Agronomy Handbook, University of Illinois, 1989-90).

New FFF reports being readied

Dr. Robert D. Munson, research consultant for the FFF, reports that more research results will be available for presentation at the upcoming 1991 FFF Symposium. Watch for the reporting of these results in future issues of *Fluid Digest!*

Up 16 bu/A

Liming beneficial to wheat yields

N use over a period of years can decrease soil pH, often more than we think. Westerman of Oklahoma State University has shown that by increasing soil pH from 4.3 to 6.1 by applying 4.8 tons of ag lime per acre (Effective Calcium Carbonate Equivalent, ECCE), wheat yields increased from 31 bu/A to 47 bu/A — or 16 bu/A. That's a hefty $59.50/A increase in gross income, assuming $3.50/bu wheat. Liming should last a number of years, depending on N rate and the buffer capacity of the soil. Because of its fineness, fluid lime applied at adequate rates can be very effective in improving soil pH. Higher soil pH will also help soybeans, where double-cropped.

The key to determining whether or not liming is needed: a good soil test!

New publications

Two new publications from the Agricultural Competitiveness and Environmental Quality Project are available from the Center for International Food and Agricultural Policy, University of Minnesota, St. Paul, MN 55108. Write, or call 612/625-8713 to order. The first publication analyzes fertilizer and chemical use on corn, soybeans and wheat from five top-producing states in the U.S. (1950 through 1988). The production of each crop is also given. The second publication describes ways to improve fertilizer and chemical efficiency through precision farming.

INSIDE:

Up to 11%

NPK fluids boost cotton yields

Research on cotton response to N, P and K fluids from two different geographic regions of the U.S. shows the importance of rate of application, placement and timing in improving both yields and crop quality.

Tennessee

In a 1989 study, Howard of the University of Tennessee showed the benefits of banding a proportion of total nutrients applied on cotton. Yields increased by more than 11% (Figure 3). Howard compensated for restrictions in soil nutrient availability in his work on no-till land by putting some of the application down as an NP band to give cotton plants an extra boost. He recommends that no-till cotton growers apply all of N and P as a band placement.

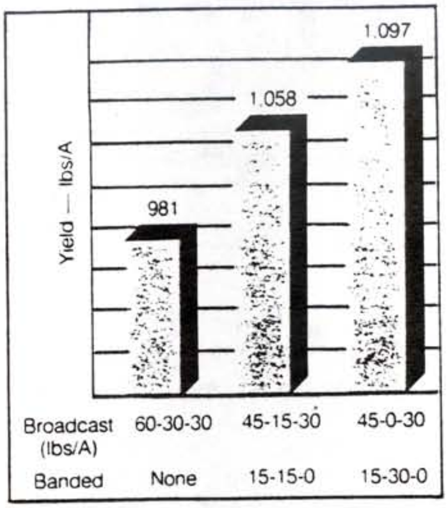

Figure 3. Effect of NPK placement and timing on yield of no-till cotton (Howard, University of Tennessee, 1989).

California

Cassman of the University of California, Davis, reports in his 1989 studies that cotton yield and quality are economically improved through the use of exceptionally high rates of fluid potash. Soils of the San Joaquin Valley have a tremendous K-fixing capacity, such that the crop may exhibit deficiency even where potash is applied.

Potassium elevates the K status of the plant and lint K concentration appears to be directly related to fiber quality (Table 1).

Such is the high rate of K required. Cassman continues to examine cost-effective and efficient ways to place fluid fertilizers. Varietal differences have been found and data suggest that the cotton root system is "plastic" and will therefore adapt and respond to localized nutrient placements.

Table 1

Effect of K application on cotton quality (Cassman, UC, Davis, 1989).

K rate (lbs/A)	Lint K concentration (parts per thousand)	Quality factors: fiber length (mm)	Quality factors: micronaire index
0	5.4	28.0	3.54
430	6.2	28.6	4.00

Increase of $38/A

Fluids on irrigated alfalfa profitable

FFF-sponsored research by Stevens and colleagues of Washington State University indicates that a spring fluid broadcast treatment of 45 lbs N, 60 lbs P_2O_5 and 40 lbs of S increased alfalfa yield of 12% moisture hay (four cuts) by 0.86 tons/A. That doesn't seem like much, but subtracting the cost of the fertilizer ($6.20/A) for $75/ton hay, the net profit would have increased $38.30/A.

Some other subtle things also occurred. Phosphorus content of the alfalfa was improved, making it more in line for the nutritional needs of breeding cattle, increasing on an average from 0.268% to 0.317% P for the four cuts.

Phosphate removals by the four unfertilized cuttings increased from just over 89 to 118 lbs of P_2O_5/A.

Phosphate removals per ton of alfalfa hay ranged from 10.9 to over 13 lbs of P_2O_5/ton of 12% moisture hay.

Washington State recommends an Olsen soil test P level of 10 ppm or more for alfalfa.

Over check in 19-year corn studies

Fertilizers boost yields up to 100 bu/A

Studies over a 19-year period by Kapusta of Southern Illinois University (Belleville Research Center) have shown the benefits of fertilizing continuous corn in varying tillage systems (Table 2). Note that the control plots (0+0+0) and nitrogen alone treatment showed yield differences of 15 and 18 bu/A among the tillage treatments. Adding phosphate and potash with the N increased yields another 17 to 30 bu/A, depending upon tillage system.

Where P and K were adequate, differences in yields among the tillage systems decreased. Also note that when fertility was adequate, adding row fertilizer did not increase the yield over all broadcast.

Estimates of nutrient removal for the highest long-term average yield (143 bu/A) were 74 lbs of N, 55 lbs of P_2O_5 and 40 lbs of K_2O per acre per year. Based on the rates of P and K used, soil tests should be building in this study and should now be very high.

The economics? Impressive. At $2.50/bu corn, long-term annual yield increases (from 92 to 100 bu/A) would have boosted annual gross income from $230 to $250/A. The average annual return from fertilizer investment, N at 20 cents/lb, P_2O_5 at 22 cents/lb and K_2O at 15 cents/lb, would have ranged from $150 to $170/A.

Table 2

Effects of NPK on yields of continuous corn in varying tillage systems over a 19-year period (Kapusta, 1989, Progress Report, Belleville Research Center, Southern Illinois University).

N	P_2O_5 lbs/A	K_2O		19-year avg. corn yield — bu/A, Tillage system: Conventional	Chisel	No-till	Diff.
0	0	0		43	50	35	15
175	0	0	BC[1]	125	120	107	18
175	80	180	BC[2]	142	140	137	5
160	50	150	BC[3]	143	142	135	[illegible]
15	30	30	row				
Largest increase				100	92	102	

BC[1] = Broadcast. Only 125 lbs N/A applied first 3 years.
BC[2] = Broadcast. 125 + 50 + 125 applied first 3 years.
BC[3] = Broadcast. 115 + 30 + 100 applied first 3 years.
Row = 10 + 20 + 25 applied first 3 years.

Does rotation improve yields?

We hear a lot about crop rotations, but what is the bottom line on some recent results?

Wisconsin

In a recent 10-year study in southwestern Wisconsin, conducted by Peterson et al. of the University of Wisconsin, six cropping sequences were evaluated using actual prices and no government supports. Economic analysis was based on a 400-acre farm. It is important to remember that crops like alfalfa and soybeans fix nitrogen and break disease and insect cycles that can be beneficial, if needed, and used to good advantage. Rotations were continuous corn, corn-soybeans-corn-oats-alfalfa, corn-corn-oats-alfalfa-alfalfa, corn-corn-corn-alfalfa-alfalfa, corn-corn-alfalfa-alfalfa or continuous alfalfa. Rates of 0, 50, 100 and 200 lbs of N were applied to corn to help estimate the amounts of N the legumes were contributing to the corn and/or benefits other than N.

It turned out that continuous corn without N lost $21,888 per year, but with 200 lbs N per acre (the most profitable application rate) returned $32,096 per year — giving the greatest return of any treatment/rotation combination. The next most profitable rotation ($19,864 per year) was continuous alfalfa with no nitrogen. Peterson and colleagues indicate that if grain or hay had been fed to livestock on the farm, potential income increase would have been between $15,000 and $20,000 per year. From an environmental standpoint, you need to consider the possible soil losses and possible impacts of pesticide use under continuous cropping — costs that may be external to the profit picture.

Researchers' conclusions?

- Rotations continue to have a place in livestock agriculture.
- Nitrogen can be supplied by legumes if other soil nutrients are adequate.
- Good corn yields can be grown by applying adequate levels of N and other required nutrients. Neither rotation nor manure is essential for good corn yields.
- N carryover from that applied to corn can increase oat yields.

Missouri

Research conducted on no-till continuous corn and a corn-soybean rotation at the University of Missouri has something interesting to say as dramatized in Figure 4.

As plainly seen, rotation advantage ranged from 30 to 75 bu/A, depending upon N source. Why better yields and responses under rotation?

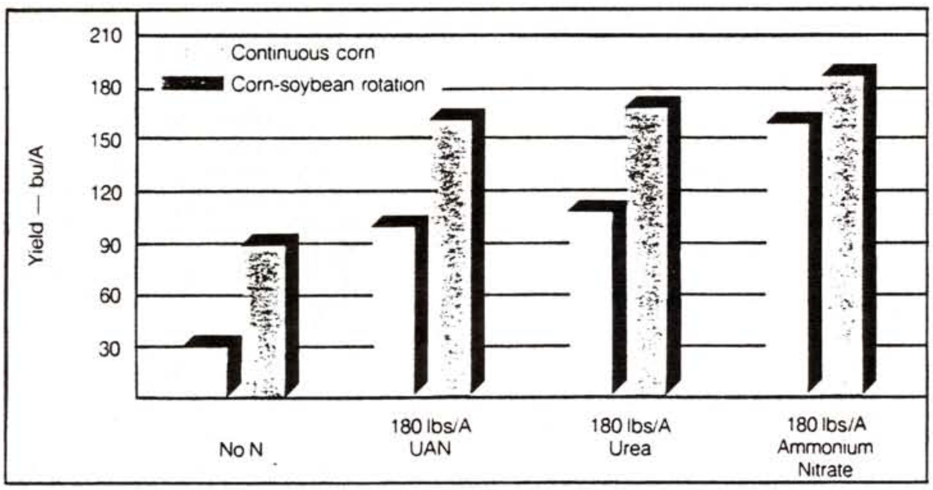

Figure 4. Comparison of yield results in continuous corn versus corn-soybean rotation using three N sources (Stecker, et al., 1990, University of Missouri, Bradford Farm).

It could be better soil-fertilizer contact because of less residue following soybeans and less urease activity (the enzyme that splits the urea molecule) to release ammonia. It is also interesting to note that soybeans benefited corn in terms of nitrogen control, N-equivalence being worth approximately 98 lbs/A of N when compared against the most responsive N source.

As can be seen, at $2.50 corn, the economic gain of rotation over continuous corn in this study would be substantial even for the check (no N): $2.50 x rotation advantage of 61 bu/A = $152.50/A.

Another interesting observation is that the differential in economic return between sources was much greater in continuous corn than corn-soybeans ($147.50 for continuous corn compared to only $52.50 in corn-soybeans, assuming $2.50 corn). Why? It appears that on no-till soils at the Bradford Farm near Columbia, Missouri, surface-applied UAN and urea both lost considerable ammonium-N, perhaps due to the effects of surface residues. Had rain occurred soon after application, it is likely the results for each source would have been the same *or* if the N had been knifed in or worked in at preplant the results might have been the same.

Iowa

A six-year rotation study in Iowa by Duffy and Webb of Iowa State University compared continuous corn, corn-corn-corn-oats, corn-soybeans, corn-soybeans-corn-oats, corn-corn-oats-alfalfa and corn-oats-alfalfa-alfalfa rotations. Most profitable at $92/A was corn-oats-alfalfa-alfalfa without any N (only $3 less than the 160 lbs/A of N treatment), calculations based on 10-cent/lb N, $1.95 corn, $5.35 soybeans, $1.50 oats and $75/ton alfalfa. The next most profitable rotation was corn-soybeans, applying 160 lbs/A of N on corn. With 20-cent/lb N, the scenario was essentially the same. If 10-cent/lb N was used with $3 corn, $8 soybeans, $2.50 oats and $90 alfalfa hay, the most profitable rotation was still corn-soybeans, with 160 lbs/A of N being applied to corn. On the no N control plots, corn after soybeans produced a yield of 106 bu/A, 56 bu/A more than continuous corn (six-year average). That yield, in terms of nitrogen equivalency on continuous corn, was about equal to 140 lbs of N.

Minnesota

Studies by Crookston and colleagues of the University of Minnesota have shown a corn-soybeans-soybeans rotation to be the most profitable when adequate N is applied on corn. Other long-term (12-year averages) studies by Randall of the University of Minnesota-Waseca indicate that corn after soybeans still responded to over 160 lbs/A of N to produce near optimum profits. Corn after soybeans at that N rate yielded 25 bu/A more than continuous corn. Residual N has not shown any positive effects on soybean yields, which were over 50 bu/A when measured. (One should not confuse residual N with that applied as foliar or N injected during the reproductive stage of growth. The effects can be quite different.)

Don't forget PK maintenance applications

Research has shown that you must pay attention to maintenance applications of phosphate and potash when growing either winter wheat/soybeans or corn/soybeans or risk yield losses.

Tables 3 and 4 show the rates of P and K removal from soils at various wheat and soybean yield levels that must be replaced if fertility levels for both crops are to be maintained. Researchers do note, however, that if P tests in the high range for both crops, you may not have to apply P for several years. Similarly, if soil K levels test in the medium to high range, you may not have to apply potash on winter wheat.

Tables 5 and 6 show biennial rates of P and K removal from soils at various soybean yield levels that must be replaced if fertility levels for both the soybean and corn crops are to be maintained. Note that for a 170-bu/A corn and 60-bu/A bean crop, the every-other-year P and K maintenance applications required would be nearly equal (124 lbs of P_2O_5 and 126 lbs of K_2O/A).

Evidence from 1988 and 1989, drier years in some areas, indicates that row or banded potash was important in ridge-till systems (on high K-testing soils), giving differential response among corn hybrids (Rehm, University of Minnesota).

Table 3

Maintenance levels recommended based on phosphate crop removals at varying soybean and winter wheat yield levels under double-cropping management (Illinois Agronomy Handbook, University of Illinois, 1989-90).

Wheat yield bu/A	Soybean yield — bu/A			
	30	40	50	60
	(P_2O_5 removal — lbs/A)			
40	62	70	78	87
60	80	88	96	105
80	98	106	114	123

Table 4

Maintenance levels recommended based on potash crop removals at varying soybean and winter wheat yield levels under double-cropping management (Illinois Agronomy Handbook, University of Illinois, 1989-90).

Wheat yield bu/A	Soybean yield — bu/A			
	30	40	50	60
	(K_2O removal — lbs/A)			
40	51	64	77	80
60	57	70	83	96
80	63	76	89	102

Table 5

Biennial maintenance levels recommended based on phosphate crop removals at varying soybean and corn yield levels in a corn/soybean rotation (Illinois Agronomy Handbook, University of Illinois, 1989-90).

Corn yield bu/A	Soybean yield — bu/A			
	40	50	60	70
	(P_2O_5 removal — lbs/A)			
120	86	94	103	112
150	98	106	115	124
170	107	115	124	133
200	120	128	137	146

Purdue corn studies

Return on N use as high as $248/A!

In a series of studies on corn by Murrell and colleagues of Purdue on soil textures varying from sand to muck and from loam to silt loam, the most profitable rates of N ranged from 0 to 200 lbs/A. The yields on the no-nitrogen plots ranged from 35 to 163 bu/A — a difference of 128 bu/A.

On most soils, with the exception of muck, optimum N rate was a preplant application at the rate of 160 lbs/A. Yield increases from N at that rate ranged from 43 to 112 bu/A.

Average cost for N per added bushel (using 20 cents/lb of N) ranged from 28 to 74 cents/bu. Using 20 cents/lb of N, the 160 lbs/A rate of N would cost $32/A. On the responding soils, the net added return above its N cost in these 1989 experiments would range from $75.50 to $248/A!

Table 6

Biennial maintenance levels recommended based on potash crop removals at varying soybean and corn yield levels in a corn/soybean rotation (Illinois Agronomy Handbook, University of Illinois, 1989-90).

Corn yield bu/A	Soybean yield — bu/A			
	40	50	60	70
	(K_2O removal — lbs/A)			
120	86	99	112	125
150	94	107	120	133
170	100	113	126	139
200	108	121	134	147

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