# Evaluating Fall N Applications for Corn: 3-year Summary Report, 2002-2004

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## Objectives:

The objective of this study is to evaluate fall N applications in production cornfields over several weather years. This includes:

a. Tracking how much fall-applied N is converted to nitrate and how much is lost from production cornfields.
b. Determining how much yield potential is lost.
c. Determining the economics of additional spring N applications.

## Summary of Accomplishments & Conclusions, 2002-2004:

- A total of fifty experiments were established in production cornfields that had received N applications in fall/winter of 2001, 2002, and 2003 (Figure 1). Most of these experiments were in west-central Missouri, near the Missouri River, and in the claypan region of northeast Missouri. These regions were among the highest in the state for fall application of N. Far northwest and northeast Missouri were also major areas of fall N application, but experiments were not conducted in those areas due to logistics and trying to maximize the number of experiments we could do with project money while still getting a good geographical spread. Several experiments were established in Vernon County because it is a higher-risk area for loss of fall-applied N, though less fall N is applied in that area.
- $NH_3$ was applied after November 1 in all but one of the experimental fields.
- Twenty-one of the 50 fields had N-Serve added to the $NH_3$ (Table 2).
- Reports for individual years contain details of each experimental field.

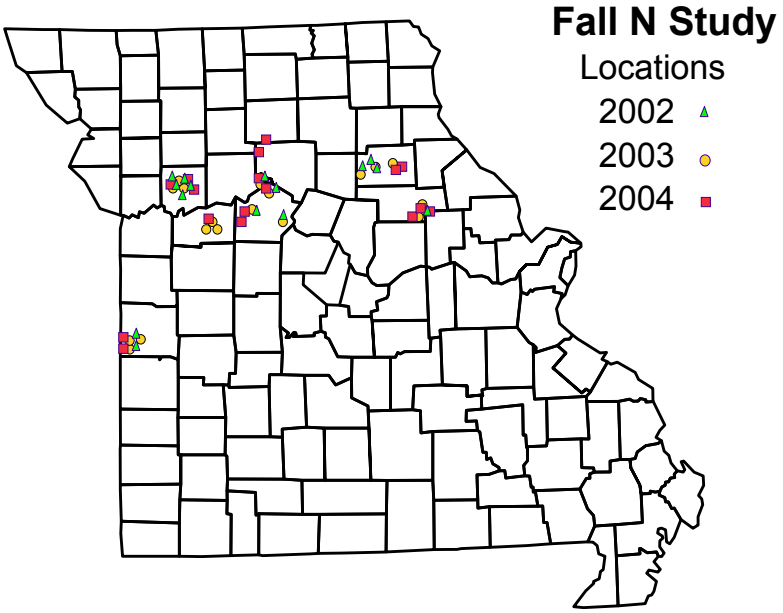


Figure 1. Locations of 50 fall N studies, 2002-2004.

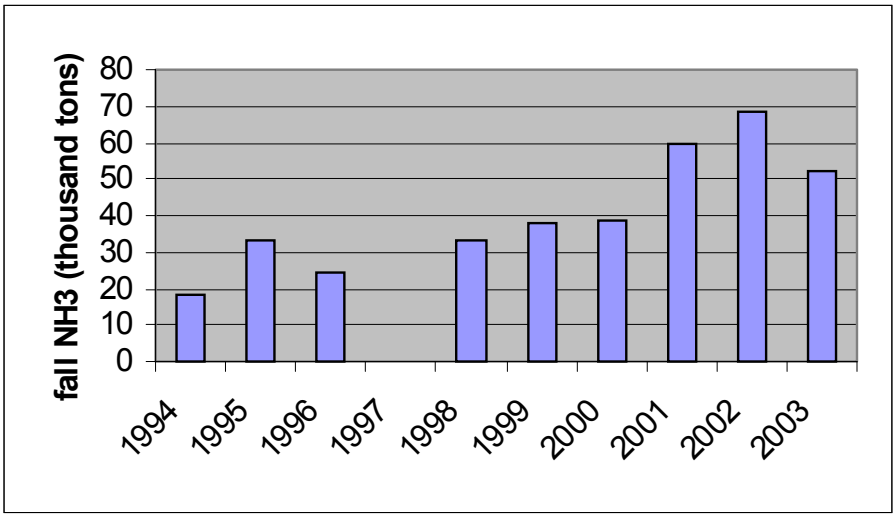


Figure 2. More fall N was applied in Missouri during each of the three years of this study than during any of the seven previous years. Increasing farm size has pressured corn producers to apply N in the fall, leaving more spring work days available for planting and other spring operations.

**Soil samples**

Soil samples were taken in all experiments to a three foot depth in March or April and again in May or June. These samples were analyzed for nitrate and ammonium.

Fertilizer: conversion to nitrate

- All fertilizer N eventually converts to nitrate in the soil. Nitrate is the form of N that is most vulnerable to loss. Anhydrous ammonia converts to nitrate more slowly than any other N fertilizer, which is why it is the only N source that is widely used for fall N applications.
- More than half of fertilizer N had converted to nitrate by the March/April sampling in 28 of 41 fields sampled during these months (nine fields were not sampled until May in 2002, the first year of the study). This indicates fairly high potential for loss of fertilizer N if wet weather occurs after this conversion.
- Conversion to nitrate was greater in 2003 and 2004 than in 2002 (see table), even though 2001-02 was the warmest of the three winters. Warm winters are thought to increase conversion to nitrate, and increase risk of loss. The unusually dry soil conditions due to drought starting in summer 2001 probably slowed down the rate of fertilizer conversion to nitrate, even though soils were unusually warm.

| Year | Month sampled | # Fields sampled | # Fields more than half nitrate | Winter temps | Winter precip |
|---|---|---|---|---|---|
| 2002 | April | 6 | 2 | warm | dry |
| 2003 | April | 18 | 13 | normal | dry |
| 2004 | March | 17 | 13 | normal/cold | normal |

- The amount of N in the nitrate form was related to the date of N application (Figure 3). The later the application date, the lower the percentage of N as nitrate by March or April, and the lower the risk of N loss.

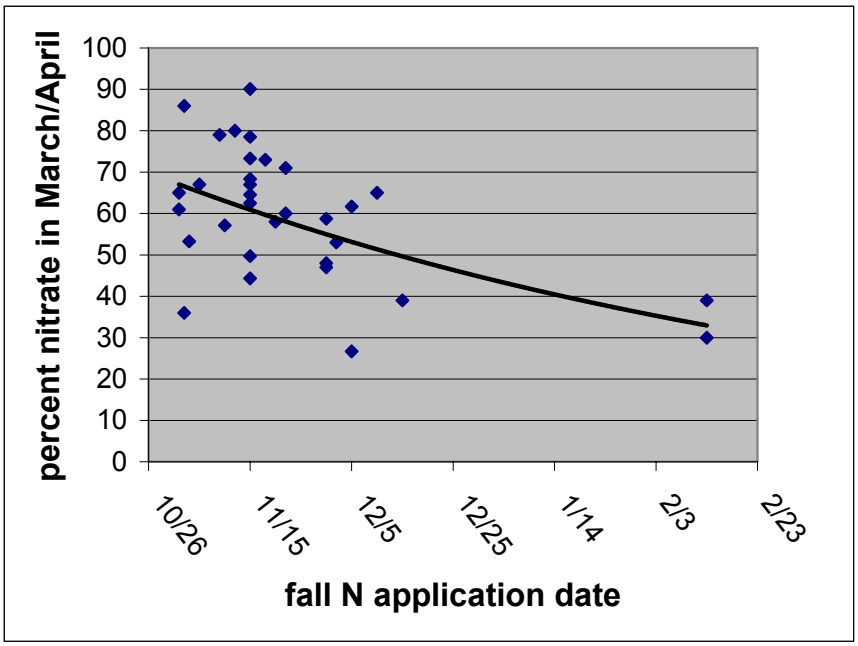


Figure 3. The proportion of anhydrous ammonia that had converted to nitrate by the March/April 2003 & 2004 soil samples was lower for later-applied N. A lower proportion of nitrate means less risk of loss.

- There was some evidence (79% confidence statistically) that N-Serve reduced the percent of N found in the nitrate form in March/April. Fields with N-Serve had an average of 53% of N as nitrate, while fields without had an average of 61% of N as nitrate. This difference carried through to the May/June sampling, but by then soil N was more than 90% nitrate even with N-serve.

Fertilizer loss

- Actual loss of fertilizer N appeared to be minimal in April 2002 and 2003. Both winters were unusually dry, so the nitrate that existed in the soil was not lost.
- Moderate N loss was seen in many fields in March 2004, following a winter with normal precipitation.

**Yield response to supplemental spring N**

Average yield for these 50 experiments was 158 bu/acre. Yield levels were in general good, though yields in some fields were severely drought-limited in 2002 and moderately drought-limited in 2003. Yields in 2004 were excellent in all fields.

When fall-applied N is lost, N availability can limit yields. Each experimental field contained a small yield trial in which some plots received additional spring N. A yield response to these N additions means that yield was N-limited with producer-applied N, and probably that some of the producer-applied N was lost before it could be taken up by the corn.

<u>Average loss of yield potential for a given year was related to weather.</u>

- The winters of 2001-02 and 2002-03 were much drier than normal, with little potential for overwinter loss of N.
  - In these two years, spring soil samples showed that N loss was minimal, and yields were increased very little by additional N. The average 3 bu/acre yield increase in 2001-02 came mainly from two fields where the N loss appeared to happen after May 22.
- In 2003-04, winter precipitation was average, spring soil samples showed some loss of N, and average yield response to the N we added was 8 bu/acre (excluding fields which were sidedressed by cooperating producers due to concern for possible N loss).
  - In 2003-04, the convenience of fall N applications was offset by either an average 8 bu/acre yield loss or the need to sidedress additional N to prevent this loss.
  - However, sidedressing 50 lb N/acre to all fields would have been only about a break-even proposition.
  - In 2003-04, the fields with the greatest loss of yield potential were those that received N the earliest (first week of November).

| **Year** | **Nov-March precip** | **N loss** | **Loss of yield potential** |
|---|---|---|---|
| | *% of normal* | *(from soil samples)* | *bu/acre* |
| 2001-02 | 47% | minimal | 3 |
| 2002-03 | 30% | minimal | 0 |
| 2003-04 | 104% | moderate | 8 |

- An important question that was not answered during the three years of this project was how much fall-applied N, and how much yield potential, would be lost in a year with above-average winter precipitation.
- Until the answer to this question is known, the overall risk level associated with fall N applications in Missouri will not be understood.