Adaptive Management Strategies: Improving Nutrient Management at Farm and Watershed Scales

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Adaptive management: what is it?

How adaptive management can help farmers manage uncertainty in N fertilizer needs of corn at the field level

Results from two adaptive management programs

Adaptive management, adult learning and diffusion of innovation
Adaptive management is a process to better manage our natural resources.

Concept developed by ecologists starting in mid-1970s and is ongoing.

Used mostly in US, Canada and Australia for management of fisheries, forests and waterfowl in large watersheds like the Columbia River Basin.

Not commonly used in agriculture.
Two short definitions of adaptive management

Process of dealing with uncertainty in the management of renewable resources (Adapted from Walters, 1986)

An approach to natural resource policy that states: “policies are experiments; learn from them” (Lee, 1993)
Adaptive Management in Agriculture

Best results when process involves farmer from the beginning and time for learning is build into the process (Gregory et al., 2006. Deconstructing adaptive management: Criteria for applications to environmental management. Ecological Applications 16:2411-2425.)
An ongoing process of developing improved management practices for efficient production and resource conservation by use of participatory learning through continuous systematic assessment. Participants include producers, agricultural service providers, policy makers, regulators, scientists, and other interested stakeholders.
How can adaptive management help manage uncertainty in agriculture?

Provides a process to evaluate management practices at the field level.

The field level is where the farmer has to make decisions about practices that are affected by uncertainty.

Evaluation of practices at field level and discussion of the results by groups of farmers enables learning and improved practices.
Example of uncertainty in agriculture

N needs of corn and other grain crops

N needs difficult to predict for individual fields

Corn is grown on 85-90 million acres in US; Or about 70 times the land area of the state of Delaware

Average rate of N applied in US in 2010 was 157 kg ha\(^{-1}\) (5,014,045,455 kg total application)

Typical recovery rates for N fertilizer in corn plant: 40 to 60\%
Scientists in Corn Belt pooled their N fertilizer response trials for corn; Created large data base of N fertilizer response trials

Calculated economic optimum N rate for trials

Created interactive web site using economic optimum N rates for trials

Data from 7 states, IA, IL, IN, MI, MN, WI, OH

1366 N response trials in data base
N Rate Calculator

Web site: Search for “N Rate Calculator”

Farmers chose rotation, either corn after corn or corn after soybeans, and enter price of N fertilizer and expected price of corn.

Provides a range of mean economic optimum N rates based on a maximum return to N within $1.00/acre of maximum return.
# Corn Nitrogen Rate Calculator

**Finding the Maximum Return To N and Most Profitable N Rate**

**A Regional (Corn Belt) Approach to Nitrogen Rate Guidelines**

- **State:** Illinois - Central
- **Number of sites:** 188
- **Rotation:** Corn Following Soybean
- **Non-Responsive Sites Included**

**Nitrogen Price ($/lb):** 0.50  
**Corn Price ($/bu):** 6.00  
**Price Ratio:** 0.08

<table>
<thead>
<tr>
<th>MRTN Rate (lb N/acre)</th>
<th>176</th>
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<tbody>
<tr>
<td>Profitable N Rate Range (lb N/acre)</td>
<td>163 - 189</td>
</tr>
<tr>
<td>Net Return to N at MRTN Rate ($/acre)</td>
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<tr>
<td>Percent of Maximum Yield at MRTN Rate</td>
<td>99%</td>
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<tr>
<td>Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre)</td>
<td>215</td>
</tr>
<tr>
<td>Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre)</td>
<td>$88.00</td>
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Most profitable N rate is at the maximum return to N (MRTN). Profitable N rate range provides economic return within $1/acre of the MRTN.
On average the N rate calculator provides a reasonable value for N rate

Based on 188 N fertilizer response trials for corn after soybeans in Central Illinois:

- Economic N rate: 176 lbs N/acre
- Range: 163-189 lbs N/acre
Frequency distribution of N rates makes it difficult for farmer to chose what rate to apply

- Economic N rate: 176 lbs N/acre
- Range: 163-189
- Percent of sites in recommended range: ~20%

188 trials in Central Illinois

No manure history
Adaptive management process to manage uncertainty of N

Three main concepts:
1. Objective evaluation of N at field level
2. Use results in a participatory education program
3. Involve agricultural community and environmental community (Need support for changes to nutrient management from both agricultural and environmental community)
On-Farm Network

Purpose: Use concepts of adaptive management to improve N management

Process:
1. Results from corn stalk nitrate test, aerial images of corn fields and replicated strip trials in farmers’ fields
2. Field-by-field records of N practices
3. Group meetings of farmers to discuss data
4. Data summarized by practice, location and time
Locations of On-Farm Network Programs

Iowa
Minnesota
Missouri
Illinois
Indiana
Ohio
Pennsylvania
Maryland
Delaware
North Carolina
Virginia

About 900 farmers and 600,000 acres
Corn Stalk Nitrate Test

Postmortem assessment of N management

Procedure:
- Sample between ¼ milkline and 3 weeks after black layer
- 8” piece of stalk 6” above the ground
- Optimum 700-2000 ppm NO$_3$-N
Steps to adaptive management of nitrogen

1. Evaluate rate of current practice (stalk test)
2. Evaluate uniformity of application (aerial image)
   (Replicated strip trials for evaluations 3 to 6)
3. Evaluate intensively the rate of current practice
4. Evaluate alternative practice (form, timing, place)
5. Evaluate rate for alternative practice
6. Evaluate potential for spatial management

Results from evaluations analyzed, summarized, discussed with farmers and shared with NRCS, extension, other farmers, SWCD and others.
1. Evaluate Rate of Current Practice

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<th>Yr</th>
<th>N fert (lb/a)</th>
<th>Fa</th>
<th>Sp</th>
<th>CSNT</th>
<th>PSU</th>
<th>Till</th>
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1. Rate evaluations 2007
One farm - 41 fields – Lancaster, PA

Stalk Nitrate (ppm)

Optimum range (700-2000)

Manure 2/4 years

No Manure Hog Poultry Steer

Field Number
2. Evaluate uniformity of application

Manure application
2. Evaluate uniformity of application

Anhydrous application
3. Intensive evaluation of rate using strip trials

80-acre field in Iowa

Numbers show sampling locations for corn stalk nitrate test

Yields collected by combine with yield monitor and GPS
Results from On-Farm Network

Iowa: 80% of farmers improved N practices
  Reduced N 36 kg ha\(^{-1}\)

Chesapeake Bay: Net reduction of 31 kg N ha\(^{-1}\)
  Small % of fields N increased

Other On-Farm programs only 1-2 years old;
  requires 2-3 years for farmers to adopt

90-95% attendance at winter meetings
Adaptive management based on adult learning principles

Four key principles of adult learning:

1) Adults need to be involved in the planning and evaluation of their instruction

2) Experience (including mistakes) provides the basis for learning activities

3) Adults are most interested in learning about subjects that have immediate relevance to their job or personal life

4) Adult learning is problem-centered rather than content-oriented

These principles effective in all cultures and situations
Diffusion of innovation concept

Targeting early adopters, using supportive communication networks, building social networks for support of new practice (5-step process)

Has worked well for adoption of production practices such as hybrid seed corn or advanced technology such as new machinery

Not sure diffusion of innovation concepts will work well for adoption of environmental practices
John C. van Es results from study about adoption of environmental practices

Farmers readily adopt high profit production and environmental practices, and low profit production practices.

Farmers adopt few environmental practices with relatively low profit.

Production high profit: drying corn on the farm.
low profit: using narrow-row corn.

Environmental high profit: sod waterways.
low profit: planting trees to conserve soil.

John C. van Es hypotheses

Environmental practices lack a network of supporting institutions, (commercial enterprises, mass media, advertising, etc.) that supply information at various stages of the farmer’s decision-making process.

Slow adoption, concern about regulation, and lack of ‘bragging’ rights, doesn’t allow for a peer-to-peer social, or community networking to support adoption of environmental practices.

Results of some environmental practices are not visible.
Adaptive management is an effective process for adoption of improved practices or fine tuning of existing practices.

Process may provide better support for farmers to adopt environmental practices.
References


