

A Framework for Nutrient Management – Adaptive Management

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Outline of Talk

1. Why need framework – existing state of art for nutrient management
2. Defining a new state of the art
3. Components of the framework
4. Adaptive Management requires cooperation among farmers, researchers, extension, NRCS, EPA, DNR, Soil and Water Conservation Districts, etc.

Current State of the Art – Nutrient Management

Proscriptive

Based on Land Grant Recommendations

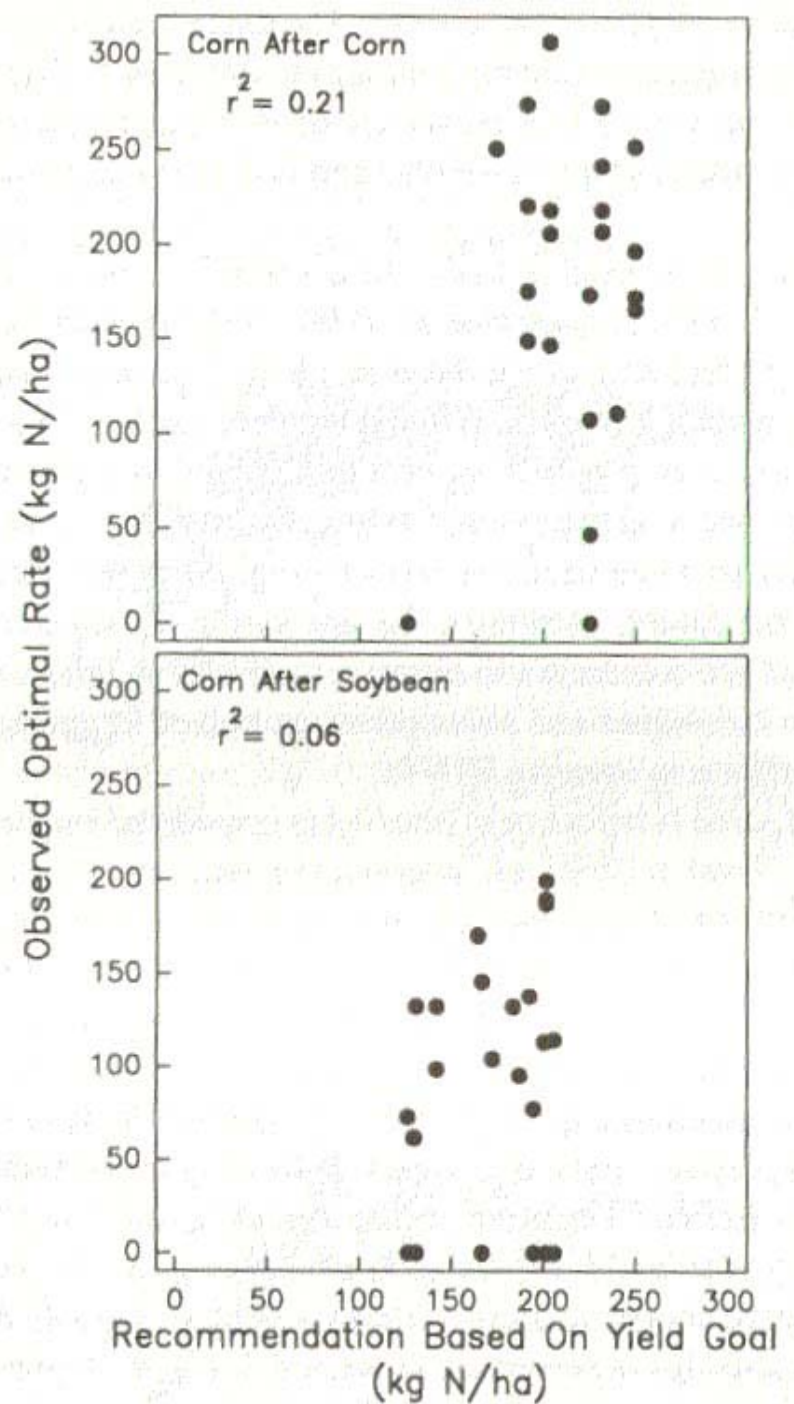
Nitrogen Recommendations

In Corn Belt based on N Rate Calculator

In many other states still based on yield goal times a factor (1.2 lbs N/bushel yield)

Neither system accurately predicts N needs of corn on individual fields

Accuracy of Yield Goal based recommendations In Iowa



Blackmer, Morris and Binford, 1992

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: Iowa

Number of sites: 188

Rotation: Corn Following Soybean

Non-Responsive Sites Included

Nitrogen Price (\$/lb): 0.50

Corn Price (\$/bu): 7.00

Price Ratio: 0.07

MRTN Rate (lb N/acre):	137
Profitable N Rate Range (lb N/acre):	126 - 148
Net Return to N at MRTN Rate (\$/acre):	\$300.99
Percent of Maximum Yield at MRTN Rate:	99%
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre):	167
Anhydrous Ammonia (82% N) Cost at MRTN Rate (\$/acre):	\$68.50

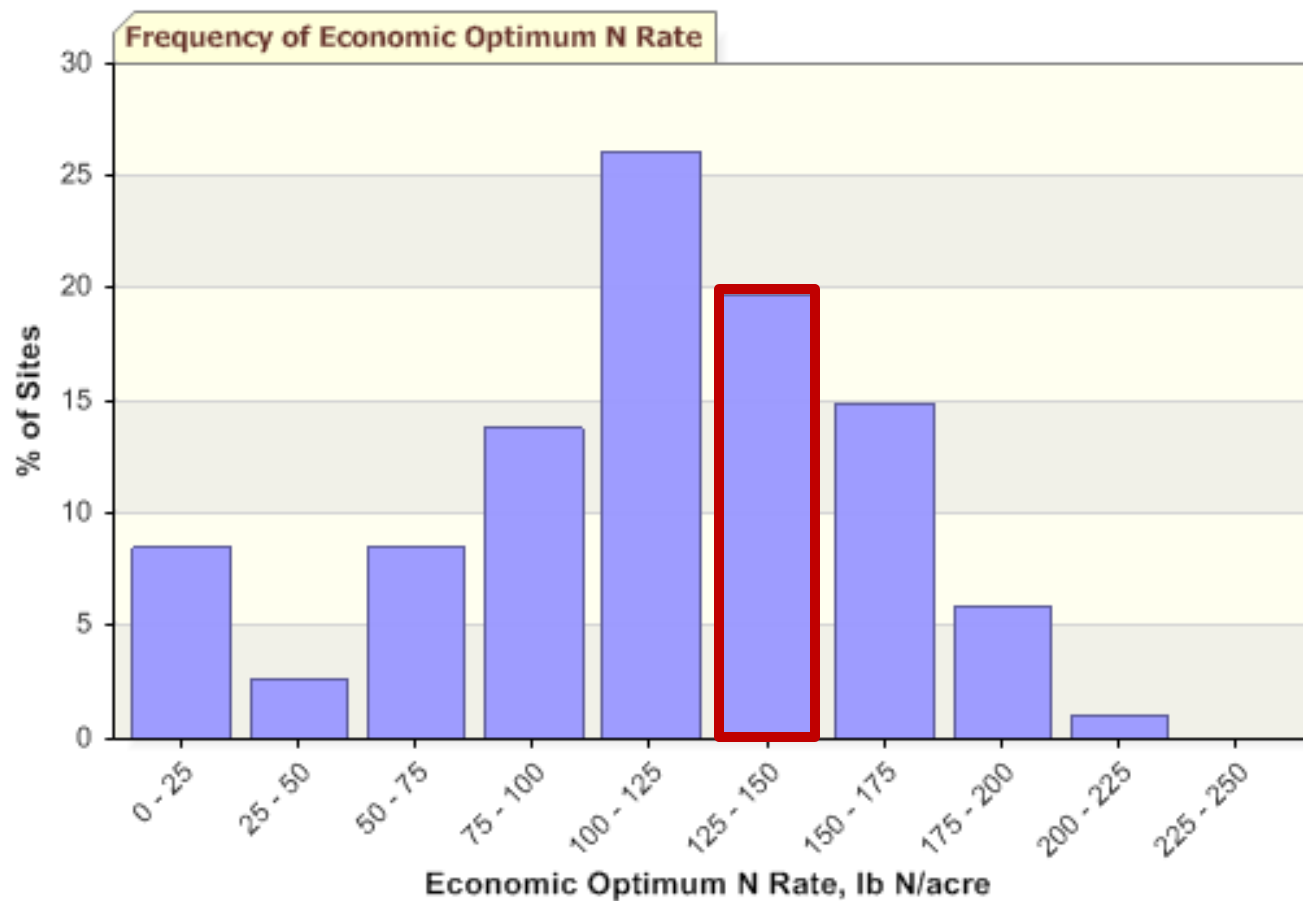
Most profitable N rate is at the maximum return to N (MRTN).
Profitable N rate range provides economic return within \$1/acre of the MRTN.

On average the N rate calculator provides a reasonable value for N rate

Based on 188 N fertilizer response trials in Iowa

Economic N rate
137 lbs N/acre
Range: 126-148

Percent of sites
in optimum
range: 20%



Injected liquid swine plus 50, Corn after Beans, 2010

Trial ID	County	Manure Total N Rate	Additional N	Form	Rainfall			Yield		Yield Difference
					Spring	June	July	Manure plus 50	Manure	
		lb N/acre			in			bu/acre		
ST2010312A	Chickasaw	215	50	UAN	9.9	7.7	7.1	195	196	-0.5
ST2010135A	Hancock	178	50	UAN	6.7	7.6	7.3	187	186	0.8
ST2010022B	Buchanan	234	50	NH3	8.4	8.8	9.3	208	206	2.2
ST2010136A	Hancock	178	50	UAN	7.1	7.8	8.0	210	205	4.8
ST2010139A	Hancock	178	50	UAN	7.1	7.8	8.0	205	197	7.8
ST2010078A	Humboldt		50	UAN	7.6	13.6	7.4	186	175	11.1
ST2010141A	Hancock	178	50	UAN	8.2	7.6	8.9	209	196	13.2
ST2010008C	Hardin	162	50	NH3	8.5	7.2	7.9	238	190	48.2
Average		189	50		7.9	8.5	8.0	205	194	11.0 S

All trials received manure in the fall 2009.

S: Statistically significant at 10% probability level.

How Improve the State of the Art?

Not easy

Answer imbedded in:

1. Institutions (Land Grant; NRCS; Grower organizations; etc)
2. Current understanding of factors affecting N availability

Institutions

Should be leading the way to solve problem

Institutions are people

All people change slowly

Groups of people change more slowly

Director of Soil Test Lab

Like a deer in a headlight

Expected to recommend accurate N rates

Can't deliver, but can't fix problem either



Soil Fertility Specialist

Not well trained for developing new “state of the art”

Requires scientific skills not taught

Requires people skills not taught

Little reward and many headaches

Other Institutions

NRCS

SWCD

Land Grant Administrators

Fertilizer dealers

Farmer organizations

Regulatory agencies

Non-profit organizations

Others

How Improve Understanding of N Availability?

What framework will allow us to do better?

A group of us have chosen the framework
named Adaptive Management

Iowa Soybean Association's On-Farm
Network started this process

Adaptive Management (Draft definition)

An on-going 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.

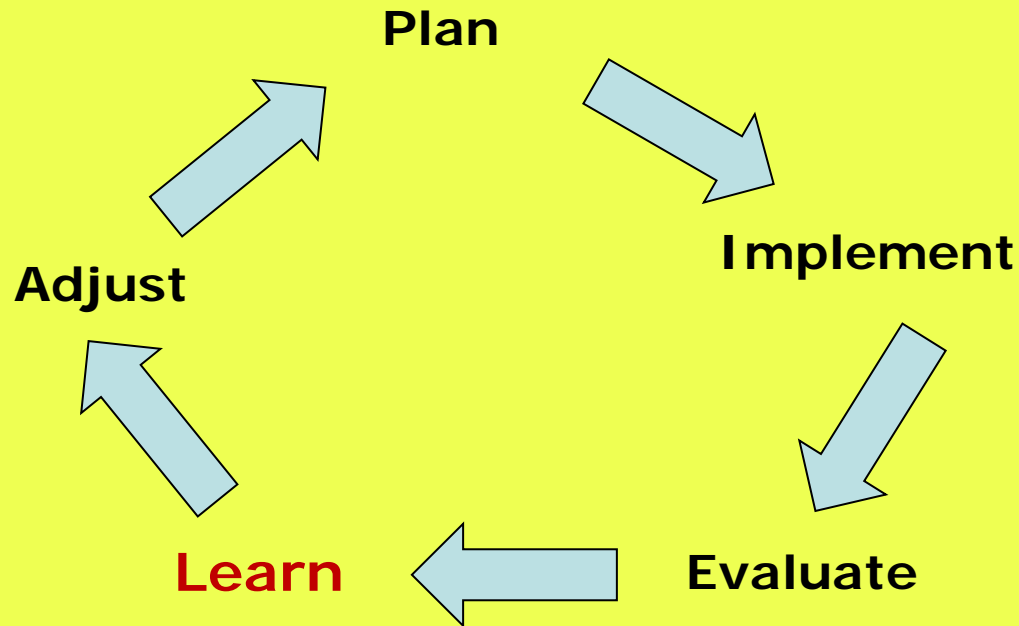
USDA Multistate Coordinating Committee: “Adaptive Management for Improved Nutrient Management” (NEERA 1002)

Assumptions of Adaptive Management

1. Knowledge will never be adequate
2. Many questions can only be answered by experience and experiment
3. Analyses get simplified
4. Nothing is certain
5. Much of what we know is wrong; we just don't know it

(Adapted from Walters, 1986)

Adaptive Management in Agriculture



Process requires active participation of all interested parties from the beginning to create the continuous loop.

Adoption of policies (experiments) requires learning.

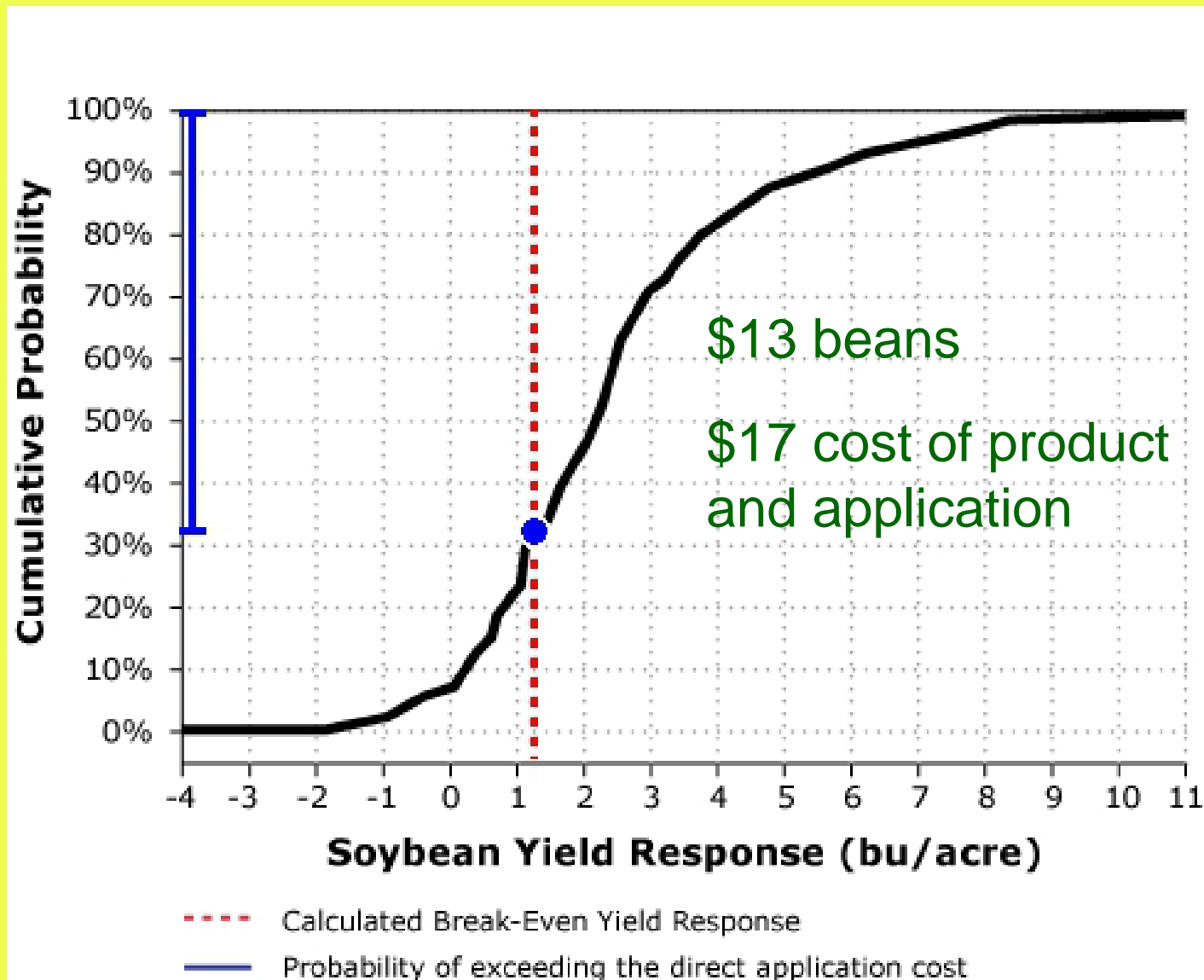
What Steps to Adaptive Management of Any Practice?

Adaptive Management not only for nitrogen

Can develop steps for an adaptive approach for improved management of phosphorus, potassium, disease, insects,

Iowa Soybean Association is developing adaptive management guidelines for numerous topics

Headline on Soybean: 2005-2009 (282 trials)*



Headline on Soybean: 2005-2009 (282 trials)*

\$13 beans; \$17 cost of product and application

1.3

bu/acre

Yield increase (break-even) required to pay for the treatment without profit

68%

Probability of exceeding the direct application cost

\$10.30

\$/acre

The expected average profit exceeding the direct application cost (based on the 5-yr average yield increase (2.1 bu/acre is a median) across all trials)

5

out of 5 years

A number of years with the expected average profit exceeding the direct application cost

Adaptive management for N

Working towards same type of guidelines

XX bu/acre: Yield increase (break-even) required to pay for an extra 50 lbs of N

XX%: Probability of exceeding the cost of extra N

\$XX acre: The expected average profit exceeding the cost of N (based on the X-yr average yield increase (XX bu/acre is a median) across all trials)

X out of X years: Number of years the expected average profit will exceed the cost of N

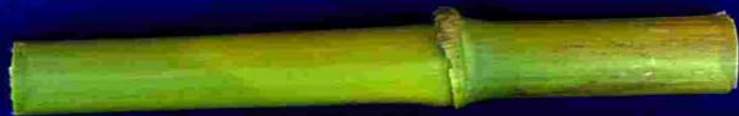
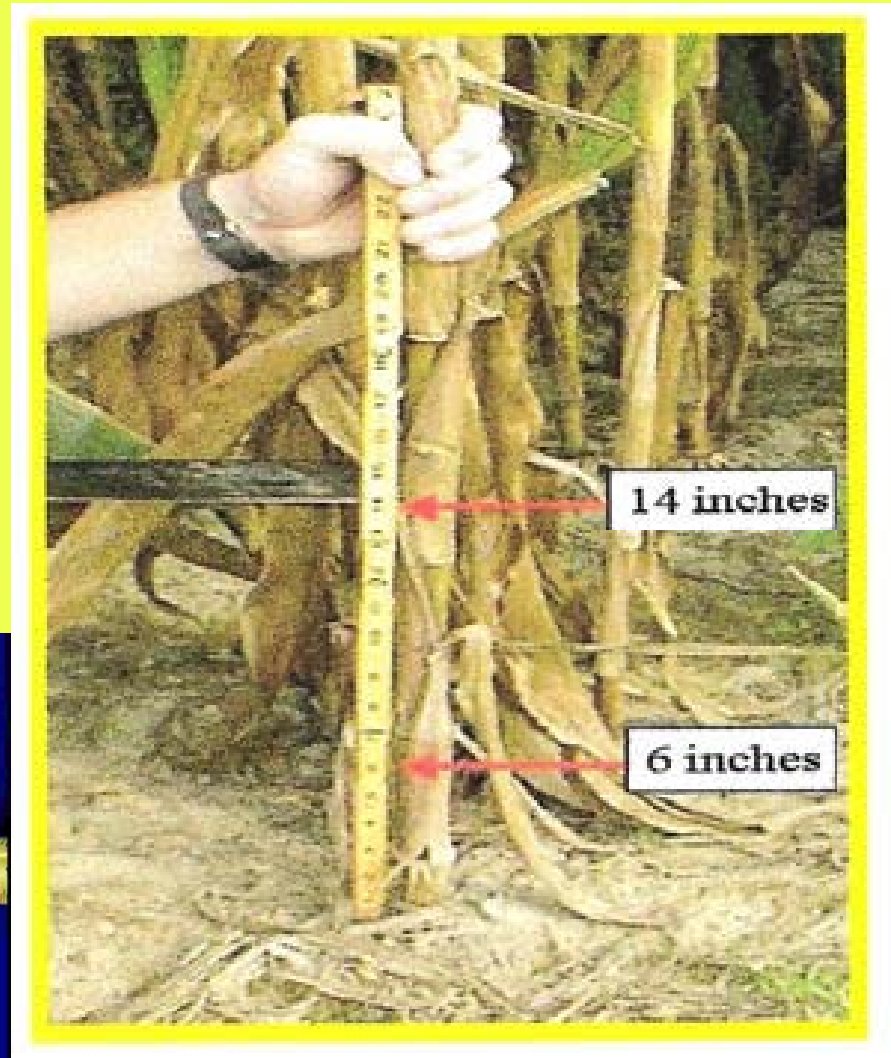
What Steps to Adaptive Management of Nitrogen?

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

Results from evaluations analyzed, summarized discussed and published

1. Evaluate rate of current practice

Corn Stalk Nitrate Test

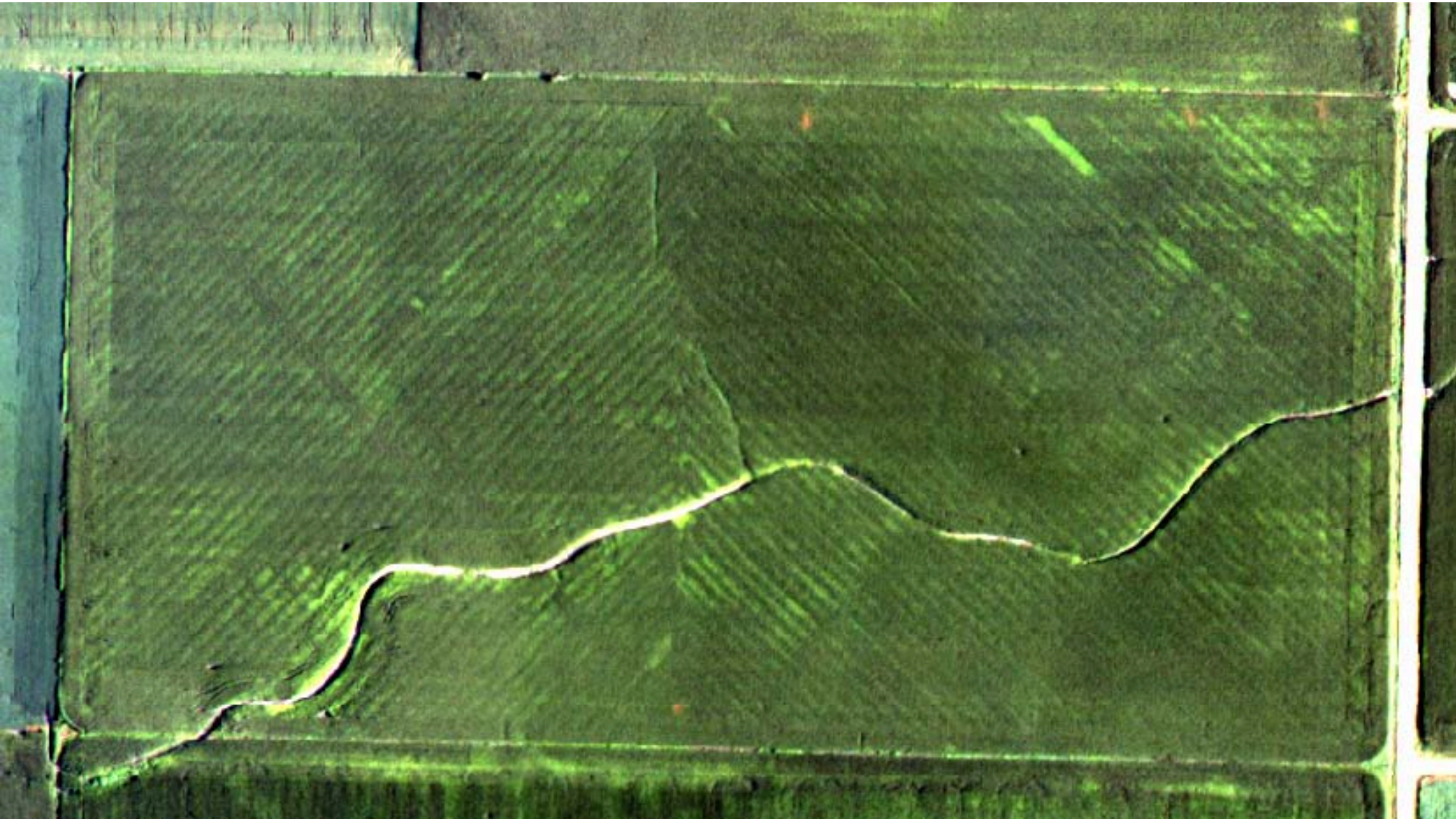




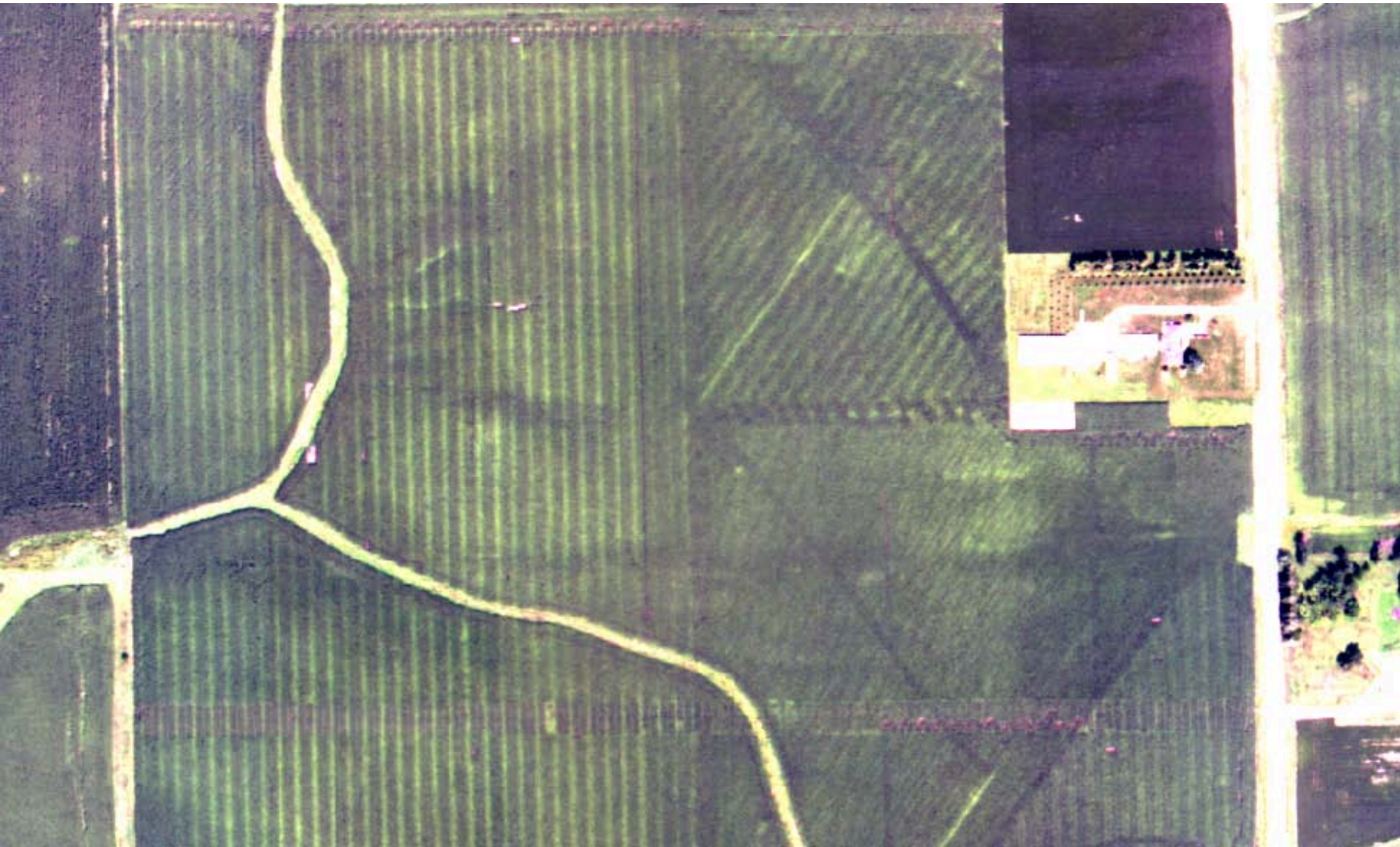
CORNSTALK NITRATE-N (NO₃⁻)
mg kg⁻¹ (ppm)

2. Evaluate uniformity of application

Manure application



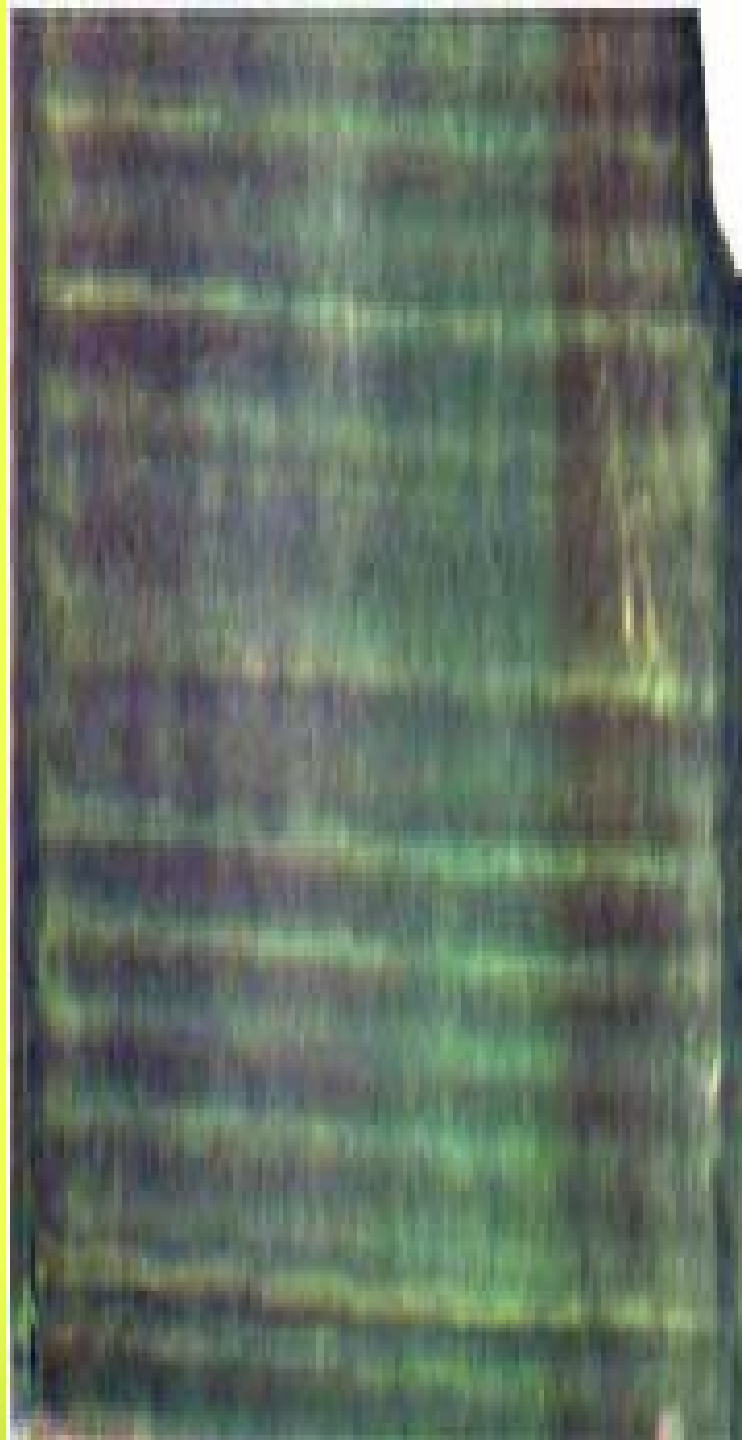
Anhydrous application



Uneven application of poultry manure

The difference in yield between the lighter and darker portions of a stripe was over 30 bu/a

A significant portion of the field was deficient in nitrogen, resulting in a major yield loss in this field





The stripes from left to right across the field illustrate the variation from pass to pass. This example was hog manure from a pit applied with a tank equipped with disc coverers.

3. Evaluate rate of current practice

Replicated strip trials comparing rates

Two rates of N

Usually one treatment is normal rate,
and other treatment is plus or minus 50 lbs
from normal – or 25 lbs plus or minus

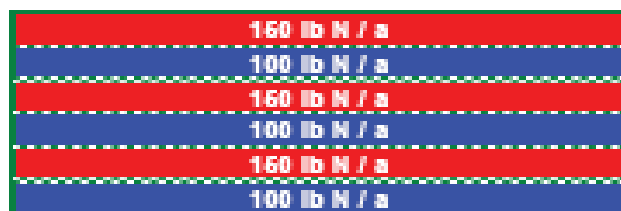
Replicated strip trials

Repeated strip testing is a methodology for comparing yields from two different management practices across a field. These strips of alternating N management are harvested with combines equipped with GPS and yield monitors. Management practices may focus on differences in rate, timing, and source of N.

Guidelines on replicated strip testing

The basic premises for replicated trials used in the Iowa Soybean Association On-Farm Network® studies are:

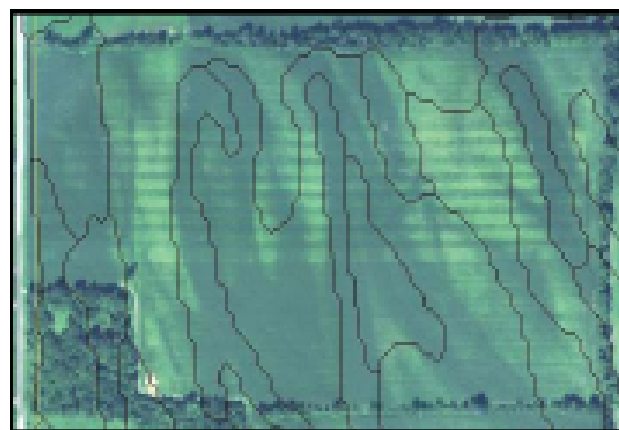
1. Keep it simple, just compare two management practices in a given trial.
2. Keep all other practices the same (i.e., same hybrid, seed treatment, planting date).
3. Replicate it at least three times, in side-by-side strips across the field at least the width of your combine header. More replications are better.
4. For N rate differences, 50 lbs. N/acre difference is recommended. If a smaller difference is used, more replications are needed.



Selecting a field

Unlike small plot research, field variability can make a trial more valuable. Because GPS and yield monitors permit yield measurements in site-specific places, a single trial could characterize a number of different soil types or landscape positions.

Fields that have significant soil or landscape varia-



Above is an example of an aerial image of a replicated strip trial with two different rates of N. The black lines are the soil map units.

tion that lies perpendicular to the treatments are preferred. This way both treatments are affected relatively the same.

Fields with frequent terraces or point rows are less suitable for strip testing because of the difficulty in finding an area large enough and similar enough to make multiple side-by-side passes.

Yield summaries

From the yield of each strip, the average yield difference for each N rate is easy to calculate. In addition, both yields and difference in yields between N management practices can be calculated for each soil type as shown in the above summary comparing replicated strips of 140 lbs. of N to 110 lbs. of N.

Types of comparison

While there are many different types of comparisons that can be made using replicated strip trials, here is a list of some of the most popular N trials:

- Normal N rate vs normal N rate minus 50 lbs

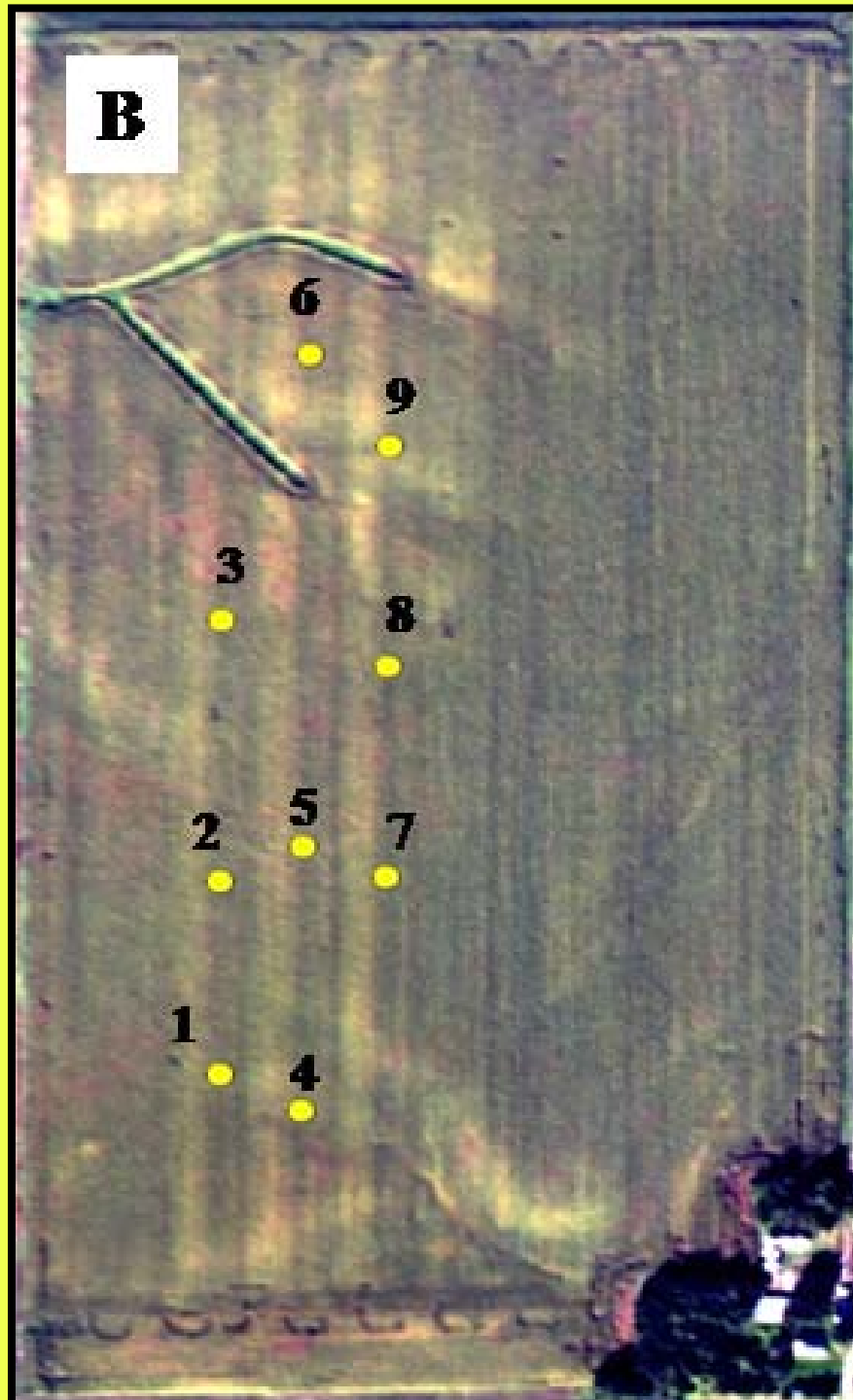
4. Evaluate alternative practice

In group meetings notice results showing a N practice you don't use is more efficient

You establish strip trials comparing the alternative practice

Two treatments: Compare normal practice to alternative practice at same rate

Maybe test
anhydrous in spring
vs UAN in spring



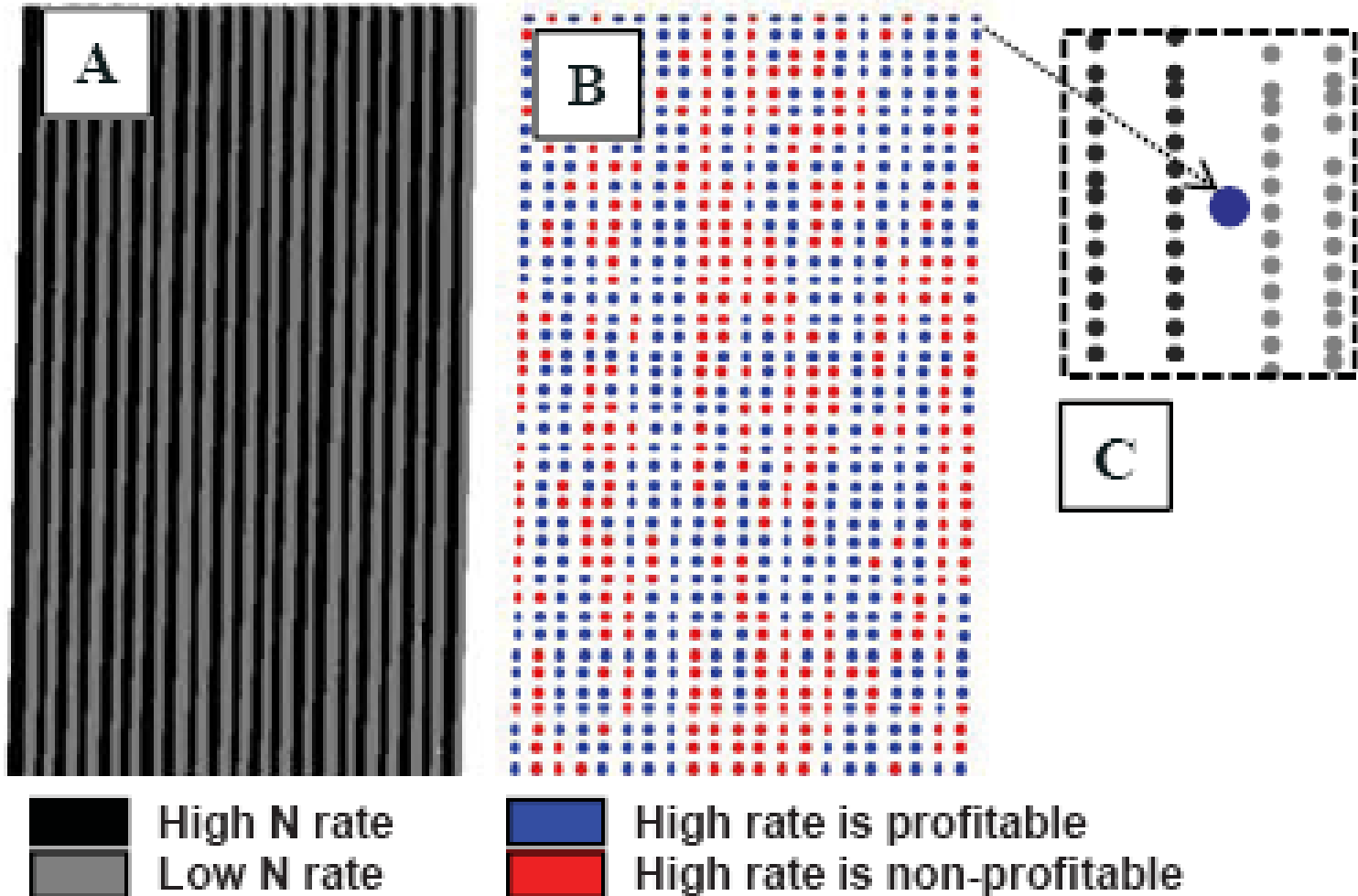
5. Evaluate rate for alternative practice

Same as step 3, except testing for the optimal rate for the alternative practice, if you decide to change

Replicated strip trials comparing two rates of N

One treatment is rate used in strip trial to evaluate alternative treatment and other treatment is minus 25 to 50 lbs

6. Evaluate potential for spatial management



Other Components Needed for Adaptive Management

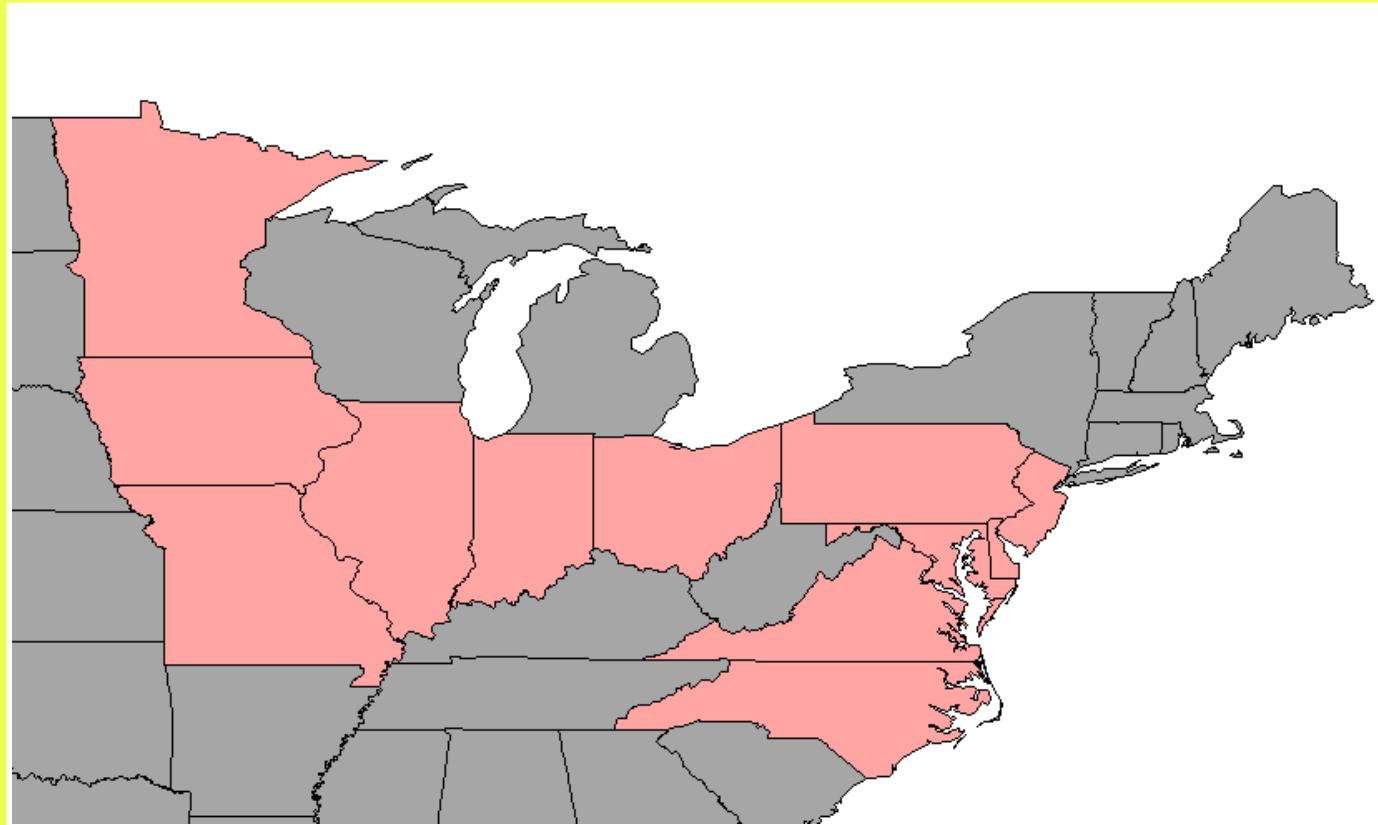
Need an On-Farm Network of farmers

Need capability to analyze, summarize, publish large amounts of data

Need cooperation of many institutions; ideally all institutions with an interest would be part of an On-Farm network

Locations of On-Farm Network Programs

Minnesota
Missouri
Illinois
Indiana
Ohio
Pennsylvania
Maryland
Delaware
North Carolina
Virginia



New Questions Arise When Many Institutions/States Involved

Who handles the data

Confidentiality of data

What practices to evaluate

Protocols to evaluate the practices

How many sites/years/conditions needed to evaluate practices

Best way to communicate results

Funding (Money)

Key to Cooperation of Institutions (People)

Need a common definition of what is a legitimate problem (yield goal and N)

Need to develop credible solutions to the problems (Adaptive Management for N)

Goal is adoption of a solution by farmers that benefits farmers and society

Progress with Adaptive Management

A USDA national coordinating committee for adaptive nutrient management was formed 2 years ago - NEERA 1002

One of the main objectives of committee was to include adaptive management in the NRCS Code 590 Standard for Nutrient Management

Code 590 Standard

Changed to include adaptive management

Standard now has two options: Proscriptive nutrient management and Adaptive nutrient management

Public comment period closes on Friday

Bigger Picture Advantages of Adaptive Management

Creates a data base of information

Allows continual improvement

Allows continual education

Enables discussion with environmental community about efficient and inefficient practices based on data owned by farmers

One example of use of data

Table 2. Effects of explanatory variables on the cumulative probability of corn stalk samples to test in a higher stalk test nitrate category as observed in the guided corn stalk nitrate survey of 683 fields across Iowa in 2006 and of 824 fields in 2007.

Factor	Management category [†]	2006		2007	
		Odds ratio [‡]	95% Confidence interval	Odds ratio	95% Confidence interval
N form [§]	AA Fall	0.84**	0.71-0.99	0.60***	0.50-0.72
	UAN SD	0.54***	0.42-0.68	0.54***	0.48-0.67
	UAN Spring	0.53***	0.43-0.65	0.58**	0.48-0.71
	LSM Fall	0.72***	0.68-0.87	0.28***	0.22-0.35
	<u>AA Spring</u>				
AA Fall vs LSM Fall		1.17*	1.00-1.38	2.17***	1.72-2.83
UAN SD vs UAN Spring		1.01	0.78-1.32	0.93	0.74-1.15
Previous crop	Soybean <u>Corn</u>	1.15	0.96-1.37	0.72***	0.62-0.83
Soil drainage	Well	1.32**	1.10-1.59	1.62**	1.34-1.45

Adaptive Management

Is a process not a practice

An open process to evaluate practices

Process enables development of credible solutions

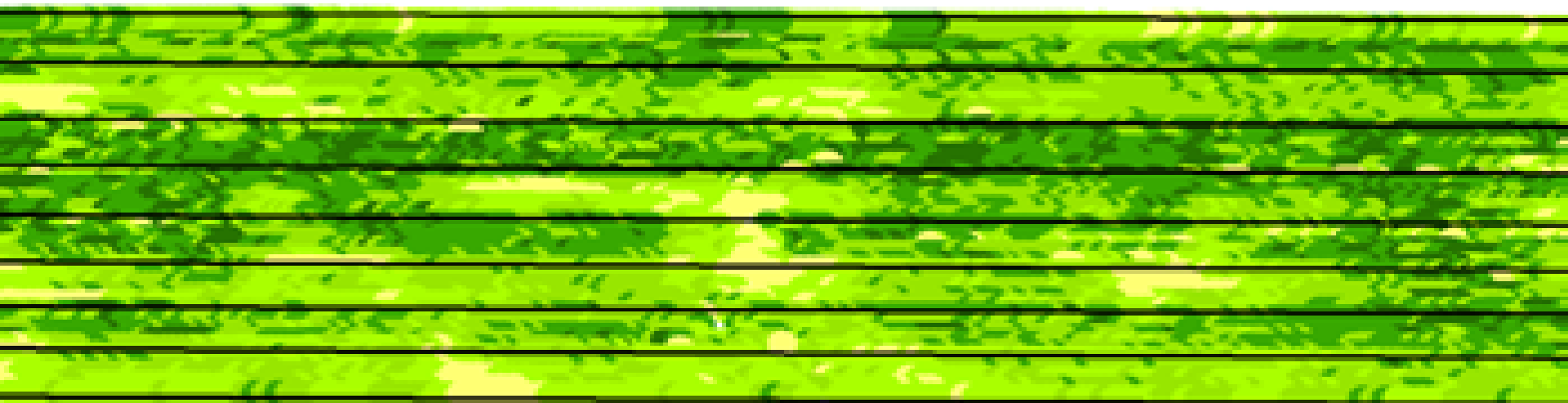
We are still defining the process of Adaptive Management for agriculture



Liquid swine plus 50, Corn after Beans, 2000-2010

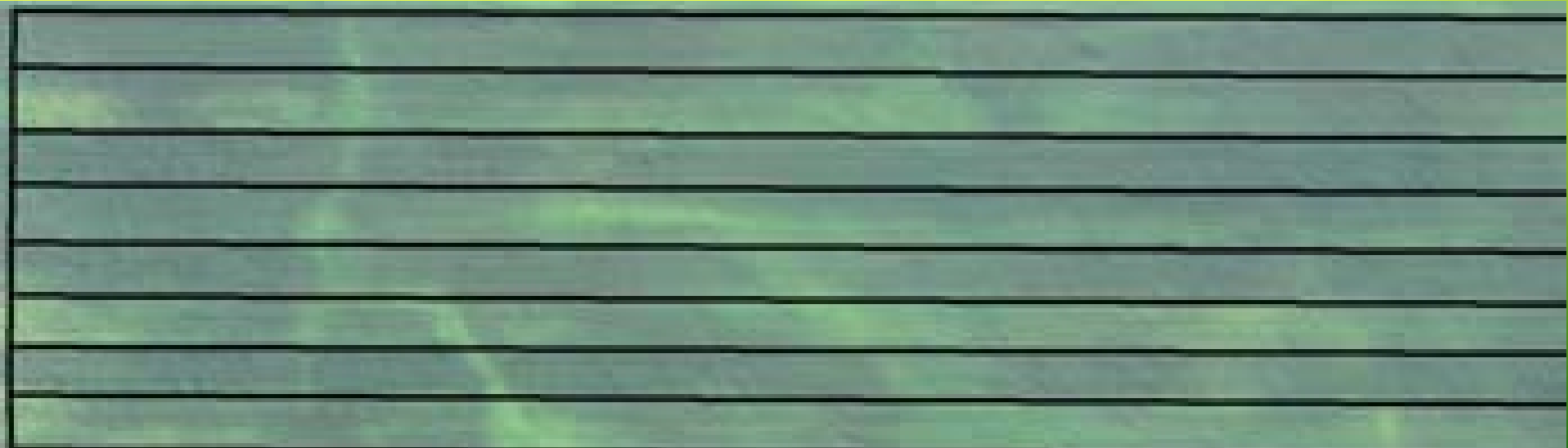
Year	Number of Trials	Spring Rainfall	Manure Total	Yield	
			N Rate	Manure	Response
		in	lb N/acre	bu/acre	
2000	11	6	195	153	2
2001	17	12	163	157	5
2002	16	8	168	189	3
2003	6	9	165	189	0
2004	12	14	156	200	8
2005	15	9	187	198	2
2006	15	10	163	188	5
2007	11	11	145	187	15
2008	7	12	165	195	9
2009	19	11	176	198	8
2010	8	8	189	196	11
Total	137				
Average			170	186	6

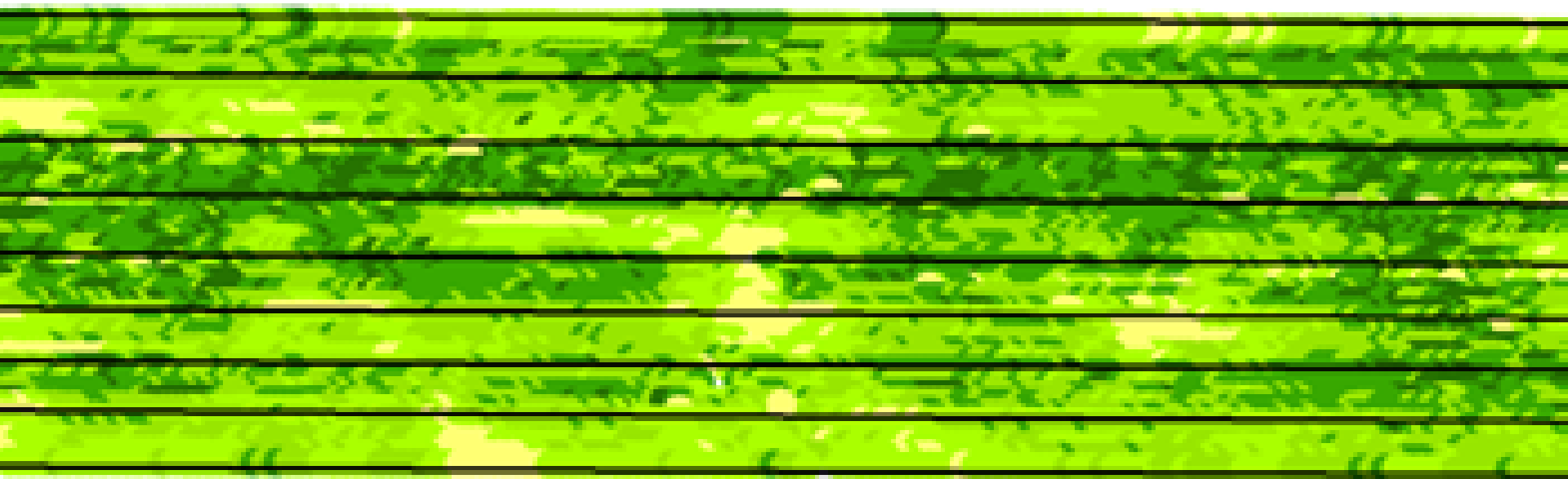
6. Evaluate potential for spatial management



Grain yield map

Aerial image





Grain yield map

Manure hog from web site managing manure; use in manure talk

Aerial image



