Adaptive Nutrient Management Process

Agronomy Technical Note No. 7

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What is adaptive nutrient management?

Process to evaluate and adjust nutrient application and utilization strategies

Done over time (years)

Adjust CPS Standard 590, Nutrient Management

Promotes 4Rs to minimize nutrient losses

Why use adaptive nutrient management?

Replicated strip trials provide scientifically sound data for:

- **Verification of the accuracy of nutrient recommendations for individual fields**

Overall process for adaptive nutrient management

1. Develop plan for evaluation of a practice in the NMP
2. Implement NMP
3. Learn from the results of evaluation of practice in the NMP
4. Adjust the plan

Two major parts to the adaptive nutrient management process

1. Develop program
   a. Recruit farmers
   b. Implement plan
   c. Analyze and summarize data
   d. Conduct meetings

2. Develop protocol to obtain reliable results from evaluation

Recruit

The core of the adaptive nutrient management process is the evaluation and learning process

Recruitment of farmers willing to discuss results of the evaluations on their farms increases the adoption of the results

Meetings can be one-on-one or in groups

Implement plan

Discuss practices to evaluate

Obtain field history and machinery information

Implement practice to be evaluated based on the protocol developed for farmers who want to evaluate the same practice

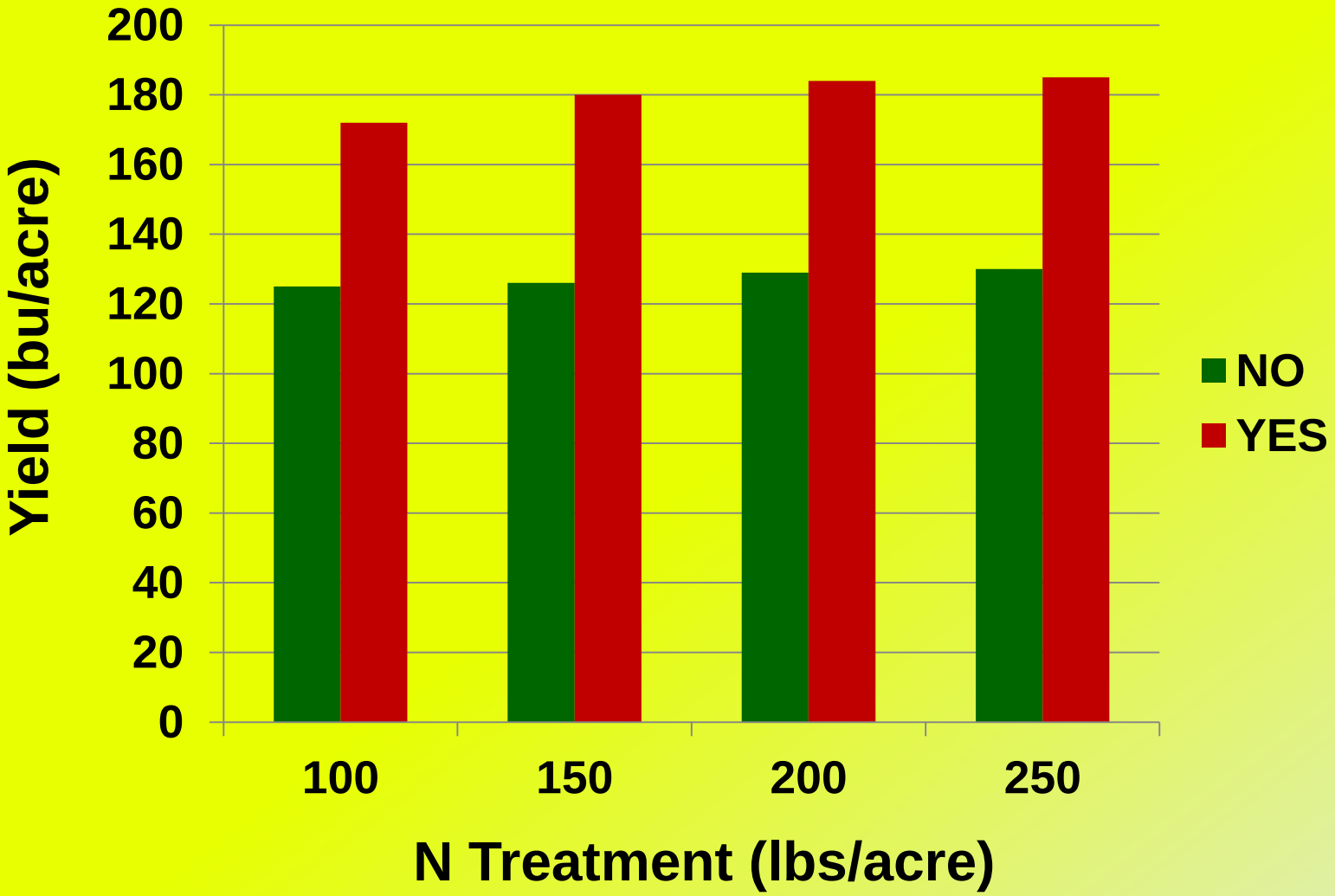
Analyze and summarize data

Make tables and graphs:

- **for individual farms**
- **for the group, region and state – summaries of data for comparison to individual results**

Summarize results by practice, field history, environmental factors, years

Strip trial yields for 28 trials by treatment
Irrigated vs non-irrigated - SW MI Adapt Network - 2012

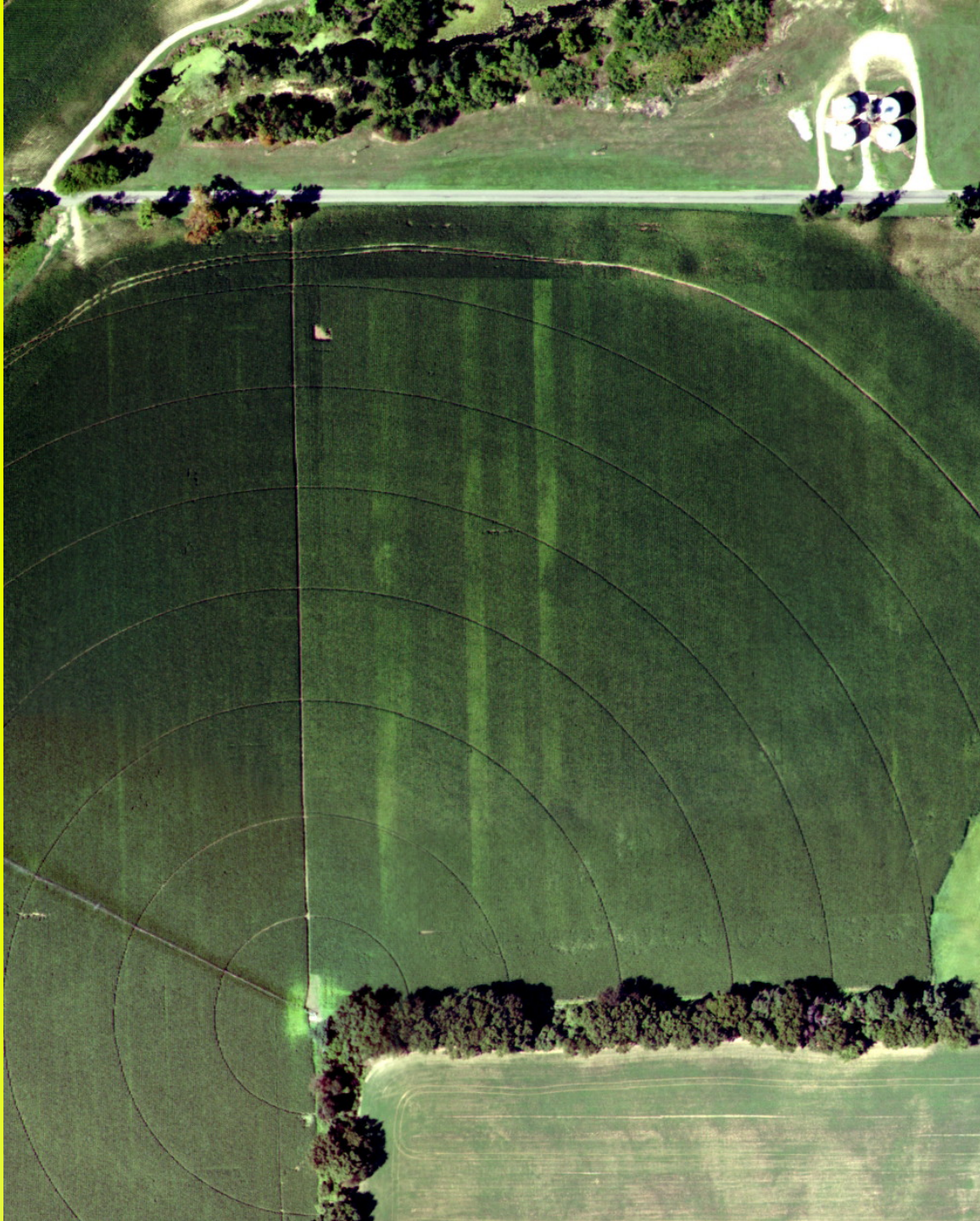


ST12MISW124

TRT	Yld	Stalk	$
lb N/a	bu/a	ppm	
100	210	40	0
150	244	103	174
200	290	561	246
250	296	2571	6

Need 5 bu to pay for 50 lbs of N

$0.60 N and $6.00 corn



Conduct meetings

<u>Group meetings</u> – more learning in interactive group meetings than one-on-one or in lecture-format meetings

- **8-30 farmers for 2-4 hours**
- **First year more information provided in lecture format**
- **Second year and later mostly discuss results with farmers**
- **Encourage farmers to answer own questions**

Conduct meetings

One-on-one meetings - can be held before or after the group meetings

Some Adaptive Nutrient Management programs have had good success with only one-on-one meetings

Key is get the farmer to review results before meeting

Part 2 – Develop protocol for evaluations

Steps to develop protocol

1. Decide question – what compare? - treatments
2. Design of trial – replications, randomization
3. Establish trial in field
4. Collect data
5. Statistical analysis of data
6. Learn from the data

How obtain reliable data for evaluations of nutrient practices?

First need to decide what question you want to answer - what is your hypothesis?

Generic question is: If I make this change, what benefits can I expect?

Answer question by establishing a replicated strip trial

Decide question

Develop question and strip trial with farmer. Keep it simple! Use Tech Note and info in this webinar to design trial.

Compare two, or at most 4 treatments:

Two N rates; two timings of N application; two forms of N; 4 rates of N

Need for a control treatment – usually the farmer's current practice - but can be no application

No application examples: no starter P for a starter P vs no starter P evaluation; no N fertilizer application when testing need for N fertilizer on manured fields

Design of trial

Replication

Need at least 4 replications of all treatments

Replications allow measurement of variability in yield caused by factors other than treatments

Replications enable separation of effect of treatments on yield from other factors that affect yield in the field

Design of trial

Randomization

Randomize the treatments within the replications

Can flip coin to randomize within a rep.

Minimizes bias

Helps eliminate yield differences caused by machinery; population differences; influence of drainage tile; human error

Need for randomization
Yields with no treatments

Wheat yields (bu/A) in Side-by-Side Combine Strips

70
68
66
64
55
59
56
60

Winter wheat yield of 500-foot-long combine strips in a seemingly uniform area of a field near Moscow, ID (1992). Full header-width cuts 20 feet wide were harvested in each side-by-side 25 ft X 500 ft plots. Yields of adjacent strips varied as much as 9 bu/A or 14.4%.

http://pnwsteep.wsu.edu/tillagehandbook/chapter10/100999.htm

Example: Plot Layout and Design

Farmer's question:

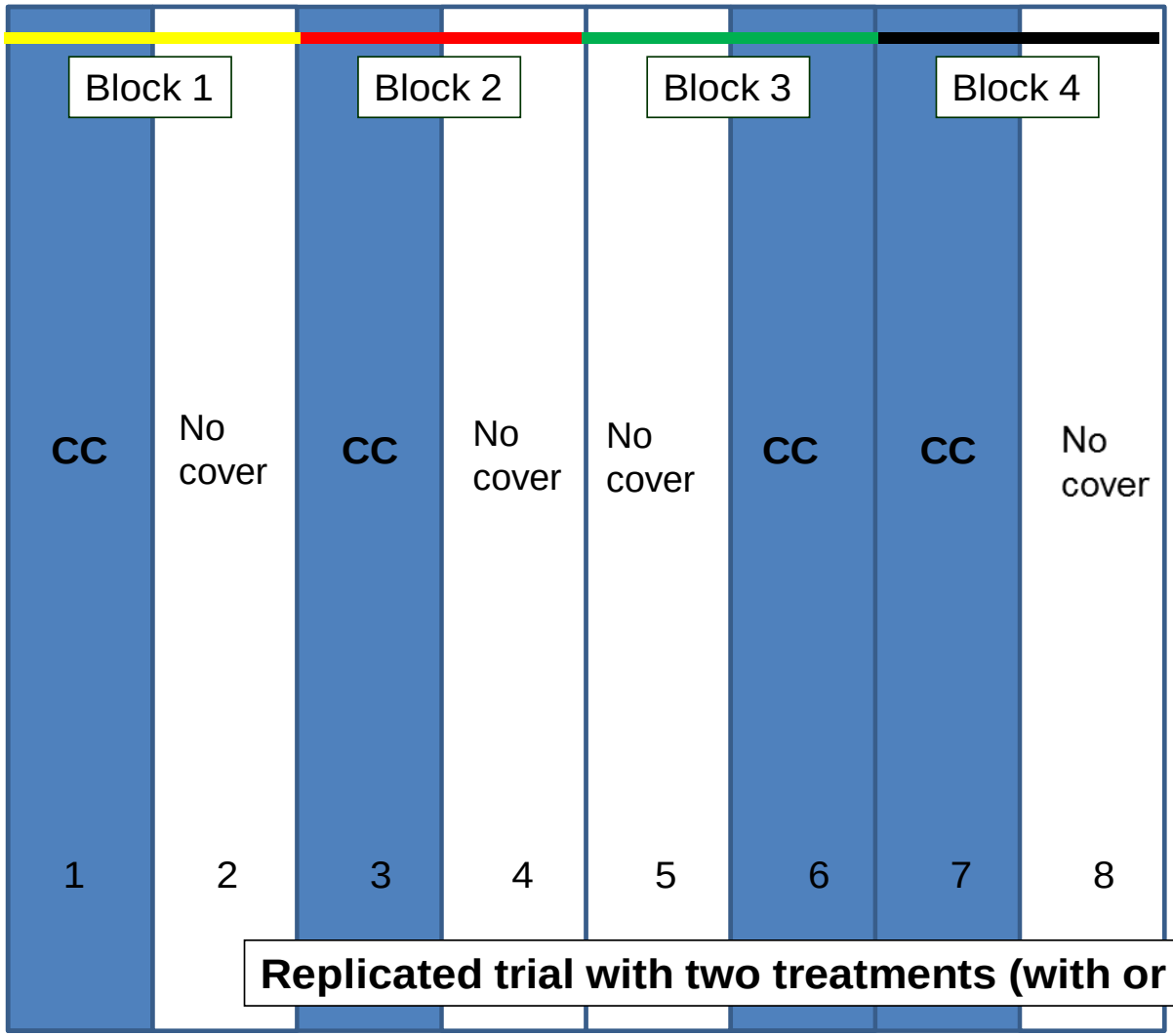
Does having a cover crop in the rotation increase yield of the following corn crop?

Design:

- Two treatments
  - With or without a cover crop
- Replicated 4 times, so 8 strip plots total
- Organized in sets of two (blocks)
- Randomized (with/without) in each set of two

Diagram of a Strip Trial

(complete randomized block design)



- Two treatments (with/ without cover crop).
- Four replications Organized in sets of two (blocks)
- Randomized within each set.
- Mark front+back corners of each plot (**plastic** flags!)
- Use extra markers (distance from road, tree, etc.).
- Mark with GPS coordinates if sufficient resolution).

How Wide Should Each Plot Be?

- Border rows are needed on each side of the plot to avoid edge effects. Plot width depends on farm equipment:
  - Often plots that are two times the chopper or combine header width, but width of application equipment also needs to be considered

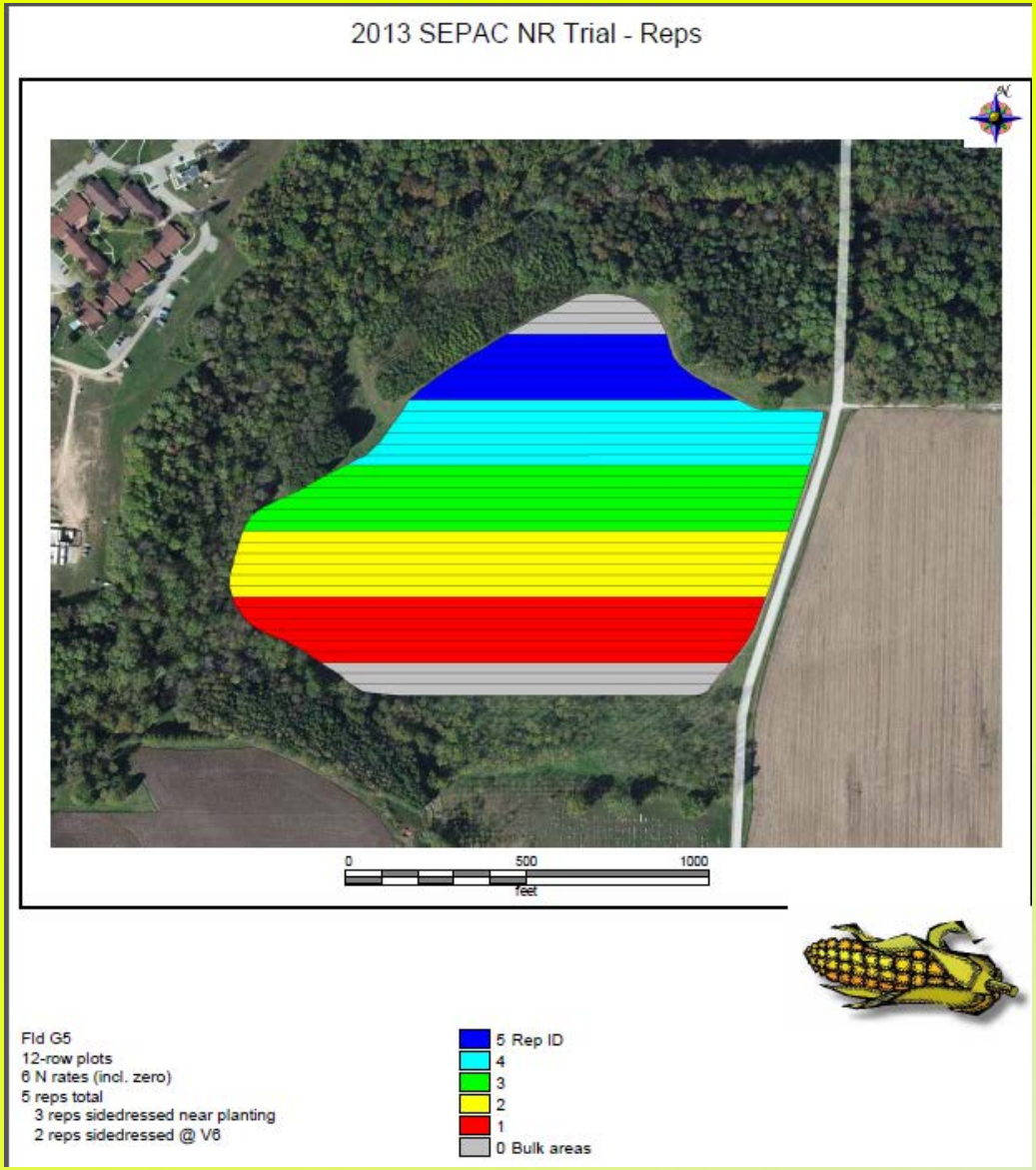
Table 1. Plot width options for different combinations of planter width, N applicator width, and combine header width. Examples are for 30-inch row spacing equipment.

Implement	Example 1	Example 2	Example 3
Planter:	12 row	16	12
Applicator:	12 row	8	12
Combine:	6 row	8	8
Compatible plot size:	12 row	16	24

How Long Should Each Plot Be?

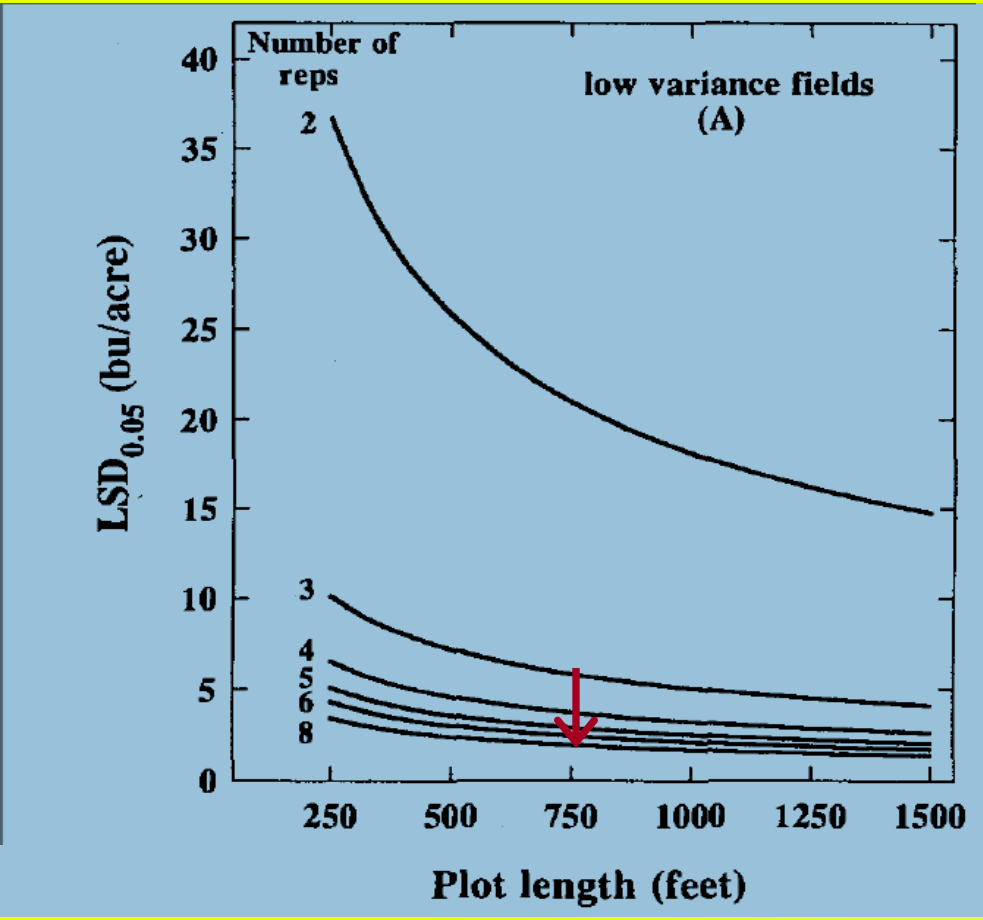
– Yield variability determines strip length and number of reps

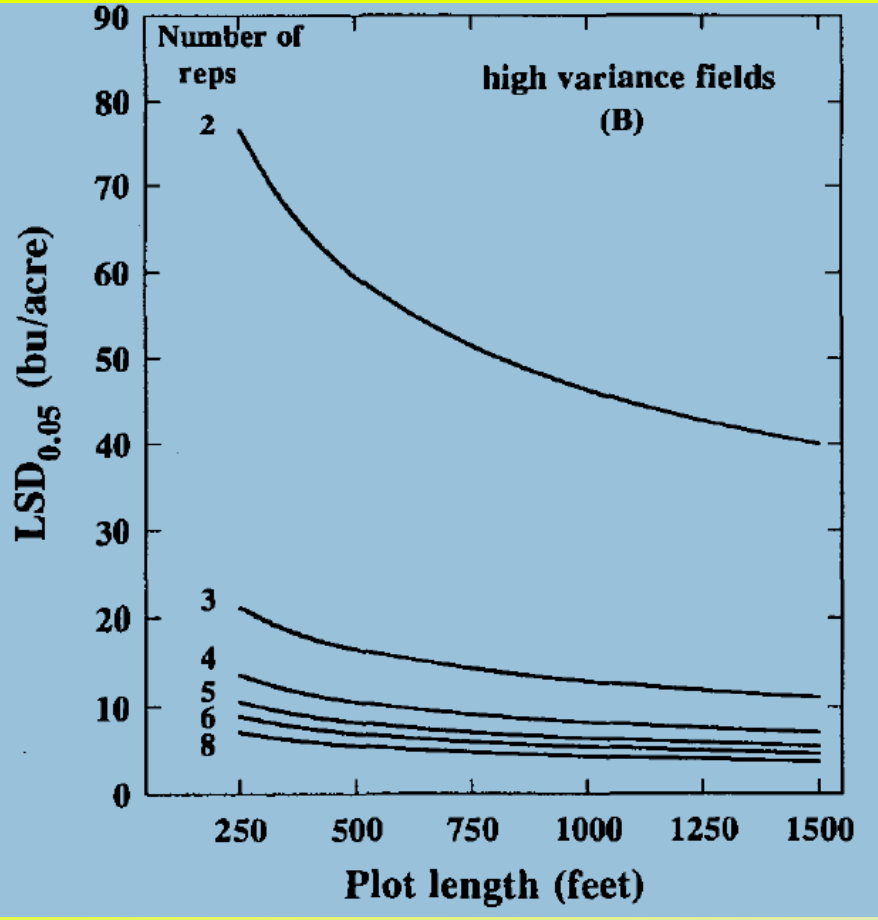
– Usually a “sweet spot” where increasing number of reps or length of strips does not increase ability to measure differences due to treatments



Effect of plot length on LSD values

Low variance fields vs high variance fields





Wuest et al., 1994. J. Prod. Agric: 7:211-215.

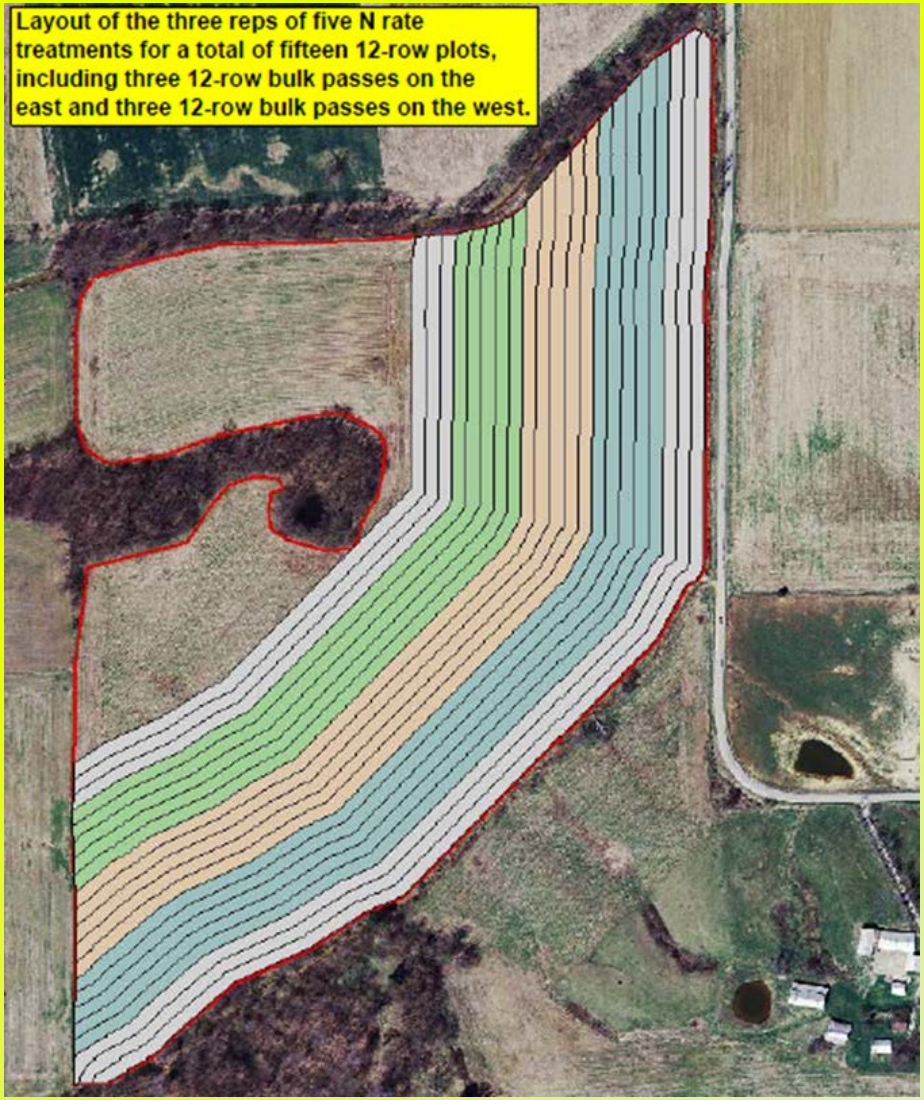
Data valid only for wheat in Pacific Northwest.

Establish trial in field

Long narrow treatment strips best, 400'+

If don't use entire length of field need capability to cut off the ends of plots manually or electronically

Most convenient to harvest middle half of plot, anything less and gleaning is needed



Collection of data

Usually measuring yield data from center of plot

Combine yield monitor must be calibrated

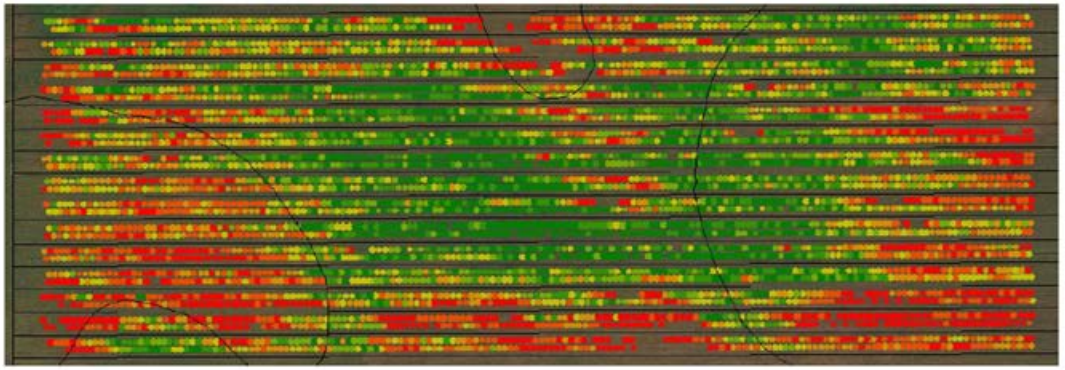
Or weigh wagons, truck scales in field or scales at granary, fertilizer dealer….

Be ready - plot maps, flags, harvest data sheets, scales, grain catcher, moisture meter, power inverter….

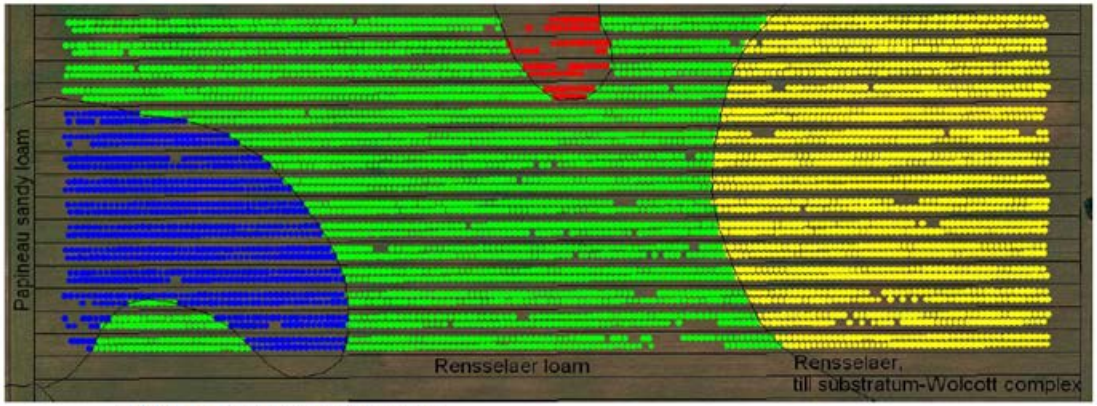
Collection of data

Need to collect soil type, field history, and current practices for each trial area

This information used to better understand results of study and application to other situations



Average yield for only plot passes = 207.9 bpa
Color scheme: Red = low yield, Green = high yield



3 major soil types in trial area
Papineau sandy loam (blue), Rensselaer loam (green), &
Rensselaer-Wolcott loam / sandy loam / clay loam complex (yellow)

3 major soil types varied in yield from 196 to 214 bu/a, none of which responded to N rates varying from 100 to 200 lb/acre

Statistical analysis of data

Perform simple statistical analyses of data using procedure shown in Tech Note

Example calculation shown in Tech Note

Summarize results by category of practices – e.g., one category: corn after beans, all N preplant as UAN, no manure history, no-till

Strip Trial Result

Significant at 0.05; LSD = 4.3 bu/a

2 treatments: 84 and 168 lbs N/acre; 84 lb difference

Yield increase = 9 bu/a or $36.00 at $4.00/bu

Cost for 84 lbs N at $0.40/a = $33.60

Strip	N (lbs/A)	Yield (Bu/A)	Stalk (ppm)
1	168	249	5700
2	84	242	1810
3	84	238	634
4	168	249	2230
5	84	237	230
6	168	250	2020
7	84	238	884
8	168	244	4450
Avg	84	239 a	890 a
Avg	168	248 b	3600 b

Net return to N = $2.40/acre

Learn from data

Create an open discussion of the results

Encourage farmers to discuss their results in the context of field history/their knowledge about the field

Questions:

1. Why does incorporation of manure increase yield?
2. Why the yield difference between incorporation with aerator and chisel?
3. Why does injected manure yield more than incorporation with aerator and chisel?

Treatment	Corn Silage Yield (tons/acre)
1. Surface applied manure	20 c
2. Spring incorporated with aerator in one hour	23 b
3. Spring incorporated with chisel in one hour	24 b
4. Injected	28 a

Part 3: A Statewide Network Approach to Adaptive Nutrient Management

- **Diverse Partnership** – Local, State, and Federal conservation agencies, university extension, environmental organizations, state grain commodity groups and farmers all working together towards a common goal = **Improved nutrient management driven by better field scale, locally relevant data**
- **Power in numbers** - Aggregation of field level data within groups, across multiple groups, and across the state
- **Flexible structuring** - A combination of multiple county and watershed based groups linked together, using standardized protocols and sharing data with one another
- **Science based, farmer driven** - Building a large field-level data set over multiple years, encompassing the majority of state soil types and geographic regions
- **Apples to apples** - Standardization and uniform protocols are key for field comparisons

Statewide ANM Network Establishment

2010

- Indiana partnered with Iowa to pilot ANM in a small county based network
- 1 group,14 growers

2011

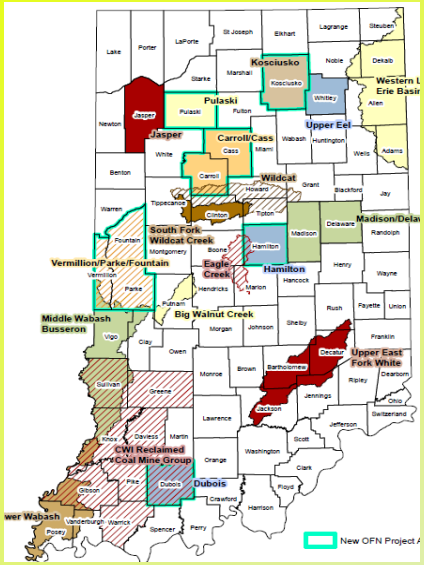
- Indiana receives a Conservation Innovation Grant to initiate the Indiana On Farm Network laying the groundwork for a multi partner statewide ANM network
- 10 groups,132 growers, 322 fields

2012

- 12 groups, 162 growers, 419 fields

2013 *Projections*

- 18 groups, >200 growers, >500 fields



Statewide ANM Network Timeline of Activities

Timeframe	Ongoing	Spring-Summer	Fall	Fall-Winter	Winter

Grower

Group Leader

IN Conservation Partnership Staff

State Coordinator

Enrollment of growers

Enrollment and collection of field information

Field boundary .shp files for both GSS and RST fields collected

GSS registration form
-Complete
-Enter data onto Iowa/AgTech website
-Scan hard copy and upload to IN SharePoint website

RST registration form
-Complete and email to state coordinator

RST As Applied Maps (.shp files) collected

Aerial imagery of all fields flown (after pollination)

Send equipment to groups
-GPS
-Loppers
-Bags
-Shipping labels
-Field sampling points
-Imagery

Collection of stalk samples (CSNT)

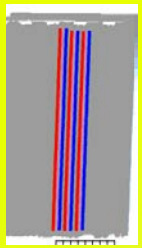
Collection of yield maps for RST's (.shp files)

Summary, analysis and preparation of data for presentation at farmer winter discussion sessions

Final field reports generated

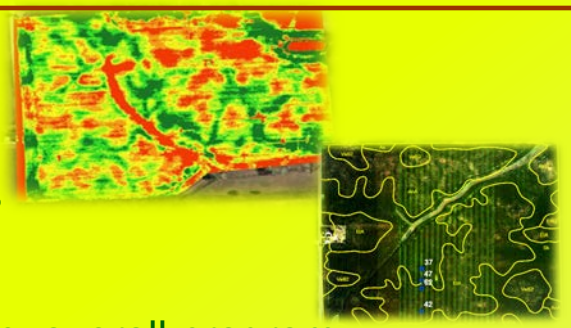
Grower meetings

Results posted to web

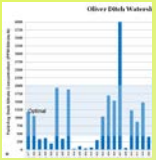






Statewide ANM Network Support

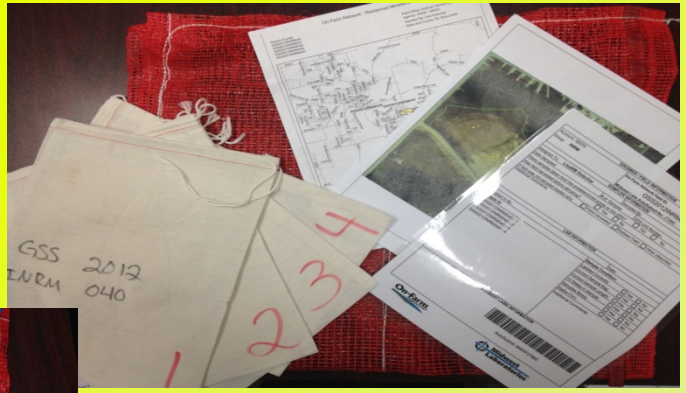


- Aerial imagery vendor
- Lab capable of handling large volumes of samples
- Survey mechanisms
  - Evaluates grower management changes, nutrient reduction, overall program effectiveness
- Website
  - Outreach/promotion
  - Platform for publically posting results
- Data management
  - Secure online software applications with standardized forms for data collection
  - Host server(s) for data storage
  - Confidentiality
- Data analysis
  - Turns raw field level data into easily understood, standardized reports that growers can act on
  - Aggregate data for comparisons within the group, across multiple groups, and across the state



Statewide ANM Network Equipment

- GPS's – handheld and on farmer equipment
- Stalk samplers, soil sample probes
- Standardized sample collection supplies – labeled and bar-coded collection bags, lab shipping labels



Statewide ANM Network Challenges

- A variety of different types of GPS equipment and output formats in use on farms
- Data ownership, sharing, confidentiality, misinterpretation
- Network administration and field tasks can be highly concentrated in certain times throughout the year (sidedress, black layer before harvest, etc.)
- Budgeting when field enrollment numbers are difficult to predict at the beginning of the year
- Spring weather can play a big role in enrollment numbers
- Scheduling across different planting dates and crop maturities

Statewide ANM Network
Tips and Lessons Learned

- Structure network for growth and constant upgrades to stay relevant to management trends and the questions growers have
- Structure for multiple funding/payment methods as simultaneous options (EQIP, Federal/State grants, grower out of pocket, etc.)
- Barcodes are your best friend when dealing with large volumes of anonymous data
- The Adaptive Nutrient Management network needs to be able to adapt itself to incorporate new technologies, methods, tools, and management practices
- Needs to be grower focused and grower driven

Part 4: Experience with EQIP and Adaptive Nutrient Management

- Difficult to make best use of EQIP funds for Adaptive Nutrient Management if a process is not established for creating networks of farmers to learn from the evaluations of practices
- Experience in Lancaster County, PA indicates farmers learn more and make more improvements in practices when a network is established to discuss results of evaluations
- How could networks of farmers be established to make efficient use of EQIP funds in an Adaptive Nutrient Management contract?

Link to Agronomy Technical Note No. 7

http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=33791.wba

Questions and Discussion