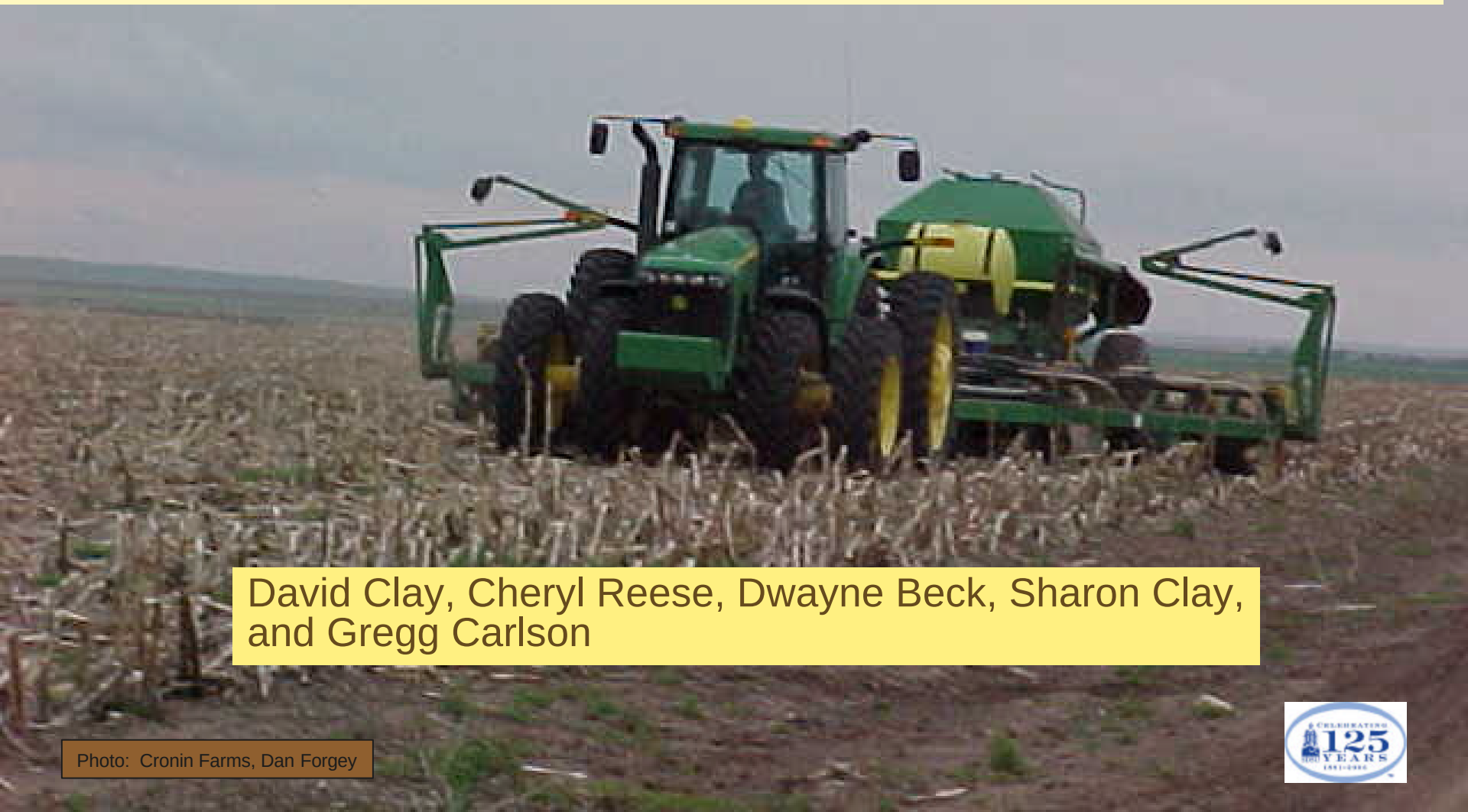
Risk Going from Point Data to the Field Scale



David Clay, Cheryl Reese, Dwayne Beck, Sharon Clay, and Gregg Carlson

Photo: Cronin Farms, Dan Forgey

Partners

Producer Collaborators

- Dan Forgey, Cronin Farms
- Ralph Holzwarth
- Bill Ferguson
- Ryan Patterson
- Lannie Mielke
- David and Larry Diedrich
- Dale Tjarks
- Gordan Anderson
- Scott Carlson

Back ground

- Most water quality programs rely on volunteer adoption of BMP’s
- Many BMP’s are not widely adopted.

Why BMP's are not followed

Dr. Robin Shepard, Why do people not take nutrient credits from manure?

To improve resource management starts with an understanding of the resource manager.

Perhaps it also starts with an understanding of the system that the resource manager is managing, and if the BMP can be used to accurately predict resource requirements.

BMP's adopted rates

- Crop consultants-zero tolerance for errors.
  - No treat or no-fertilizer recommendations contain risk; and
  - Economic losses can be realized if point data is incorrectly extended to the field scale.
  - One of the most common BMP's is whole field soil sampling for fertilizer recommendations.

Introduction

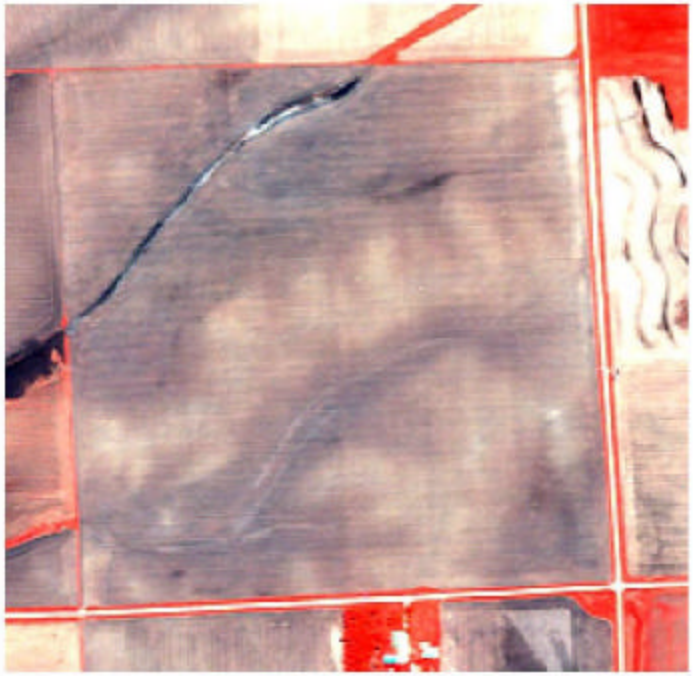
- Risk is the direct result of landscape and human factors that influence nutrient distribution and biological processes.
- To assess risk we must understand the systems that we are measuring,

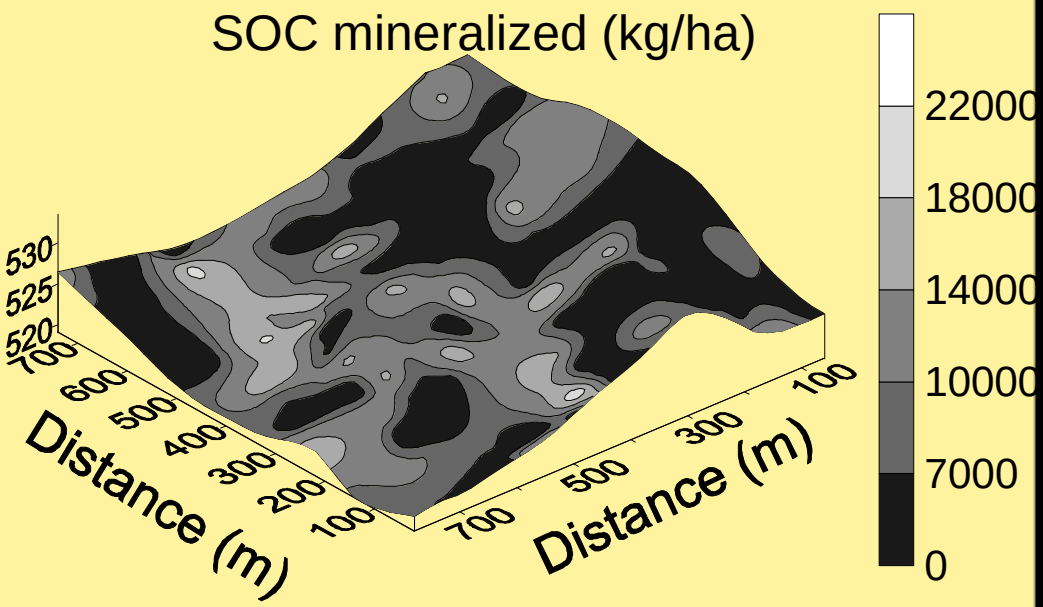
Landscape position impacts soil processes

- Landscapes
- Fields are a mosaic of habitats,
  - each having unique characteristics that influence
    - soil properties and
    - crop yields.

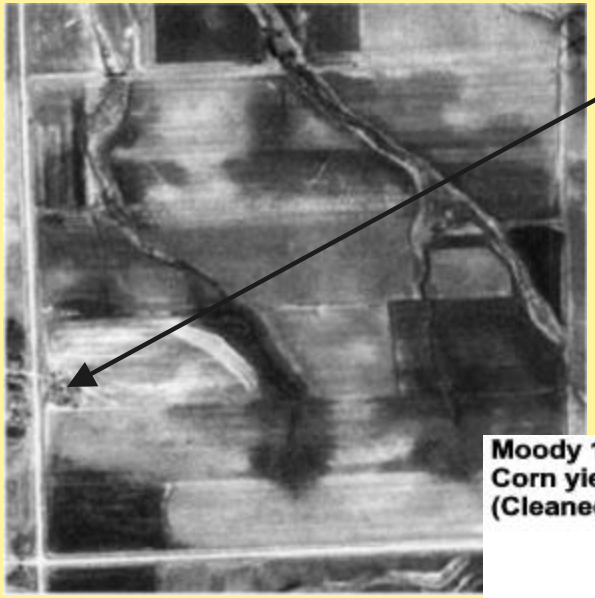
Landscape effects

Bare soil IKONOS 2001

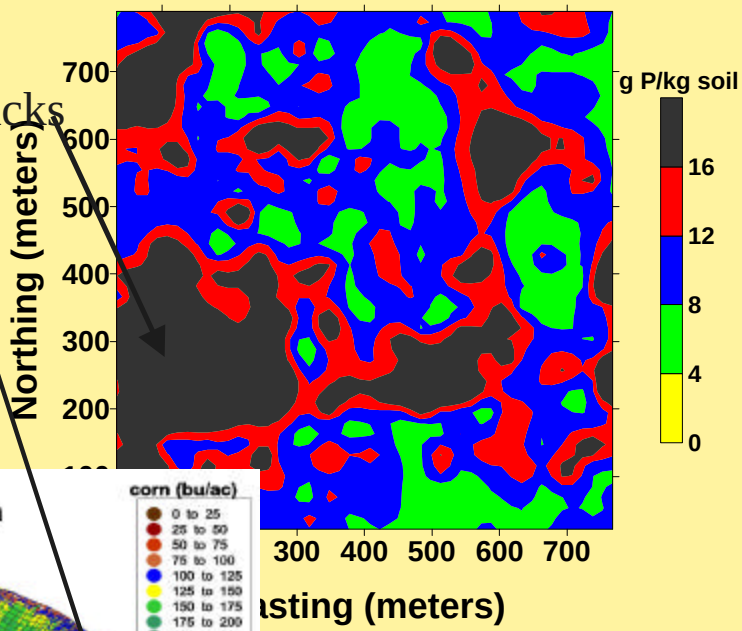


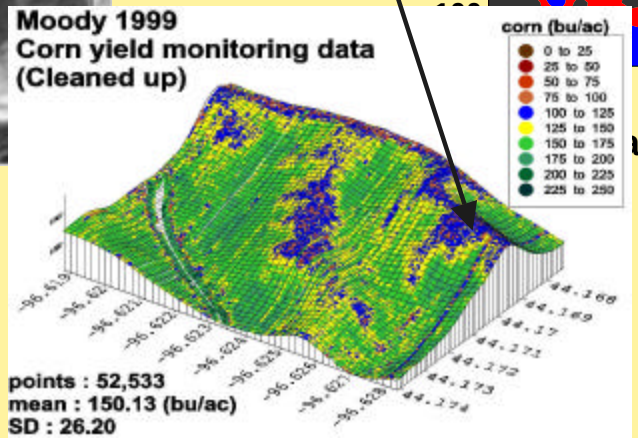


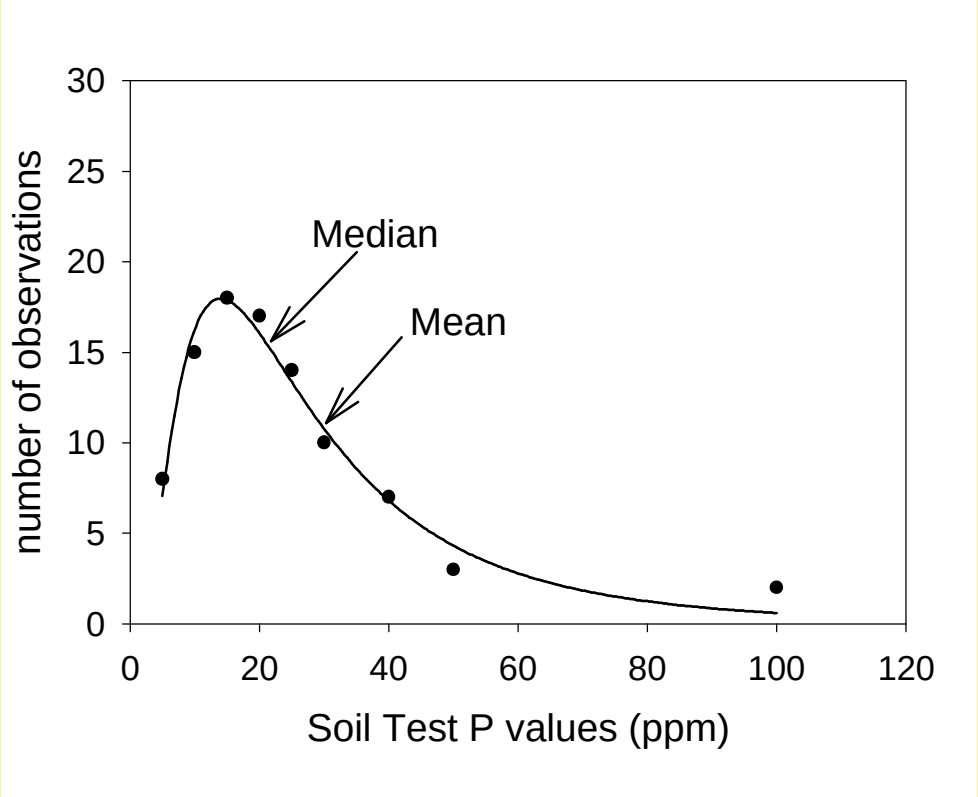
Human effects



Old hay stacks







Because whole field management based on a single soil sample contains so much error, to implement BMP's we will need some form of geospatial management.

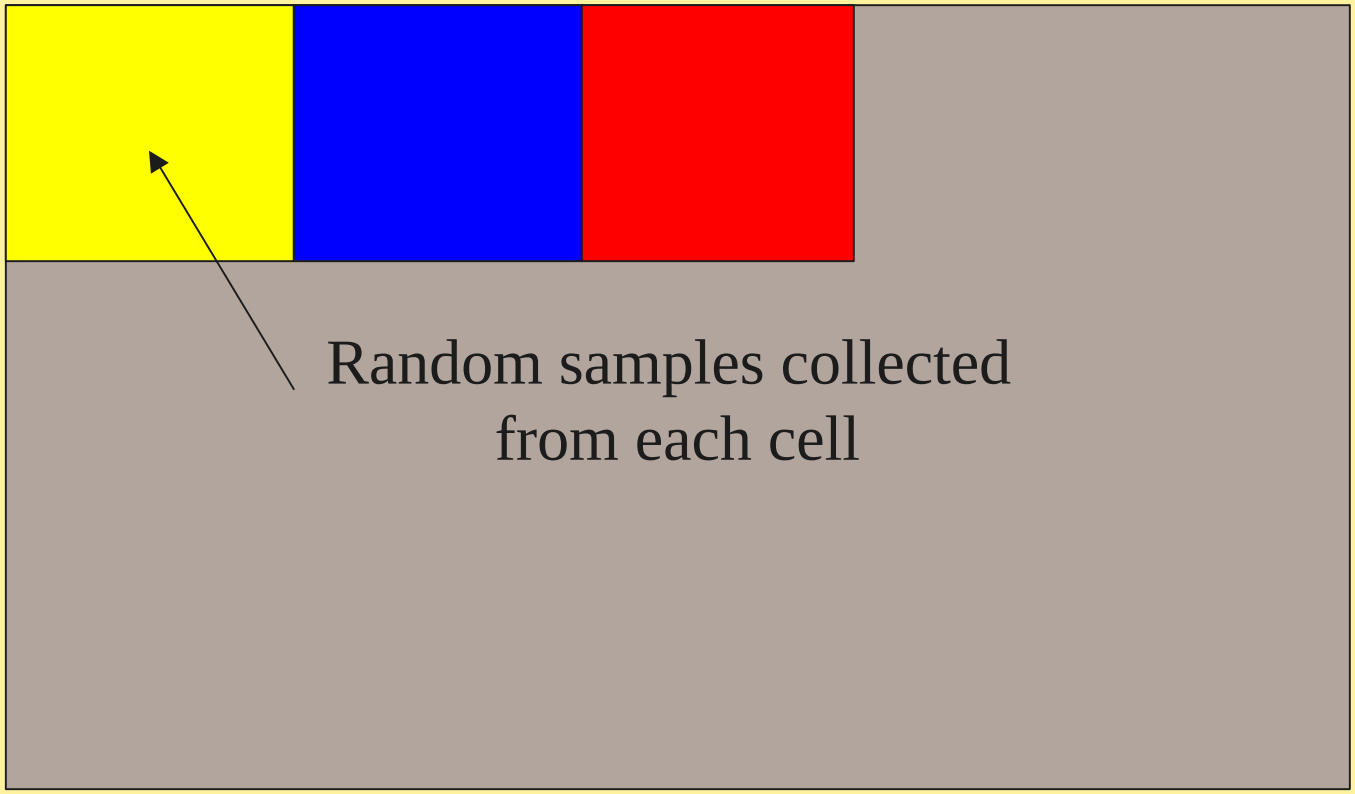
So how do we sample fields to minimize error?

- Early precision farming conferences talked about 3-4 acre grids not providing enough information.
  - 4 acre grid is 40 samples in 160 acre field
- There are not many growers that are willing to collect this many samples.
- Ask the question how do I reduce my error by 50%.

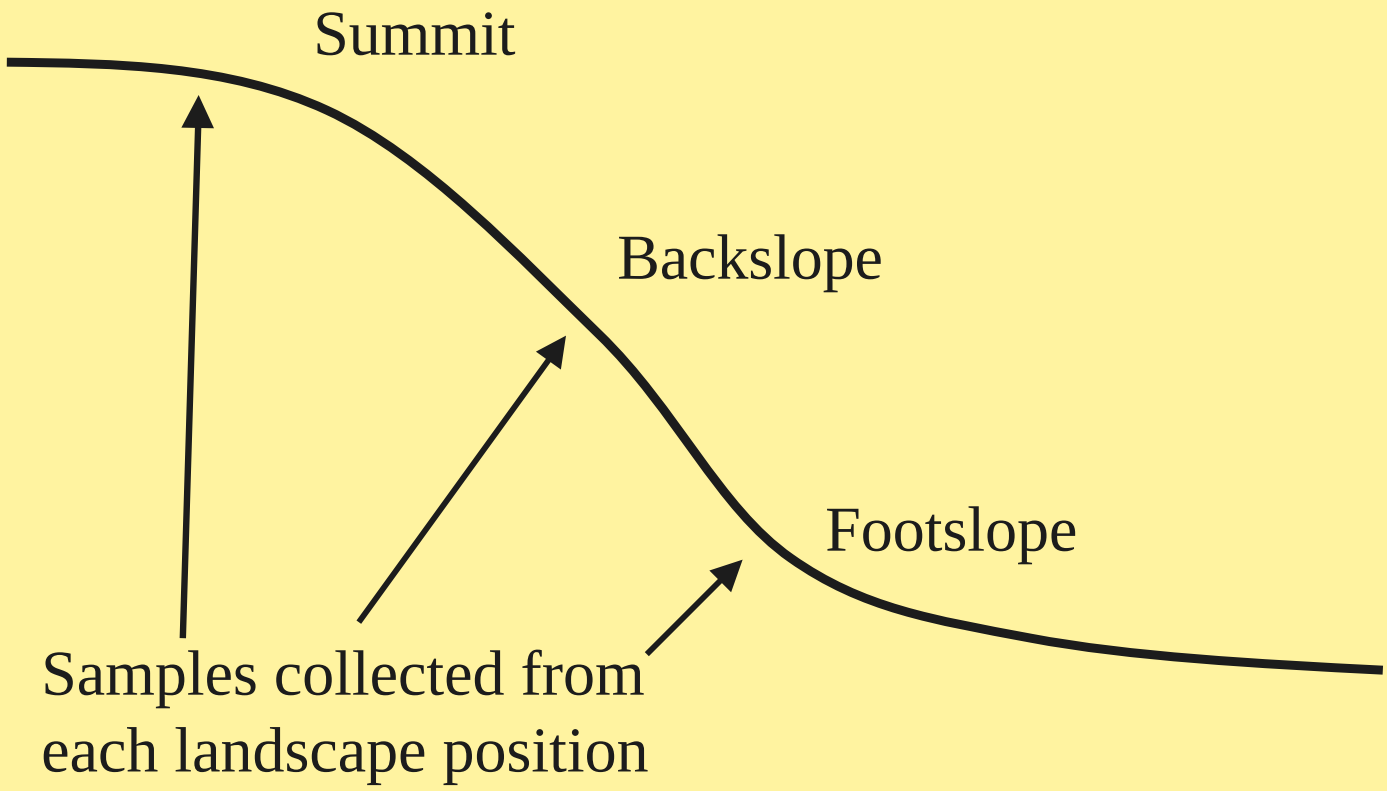
Soil sampling approaches

- Whole field
- Sampling based on human activity
- Grid cell
- Landform sampling
- Soil type
- Producer selected
- Computer classification
  - Cluster analysis

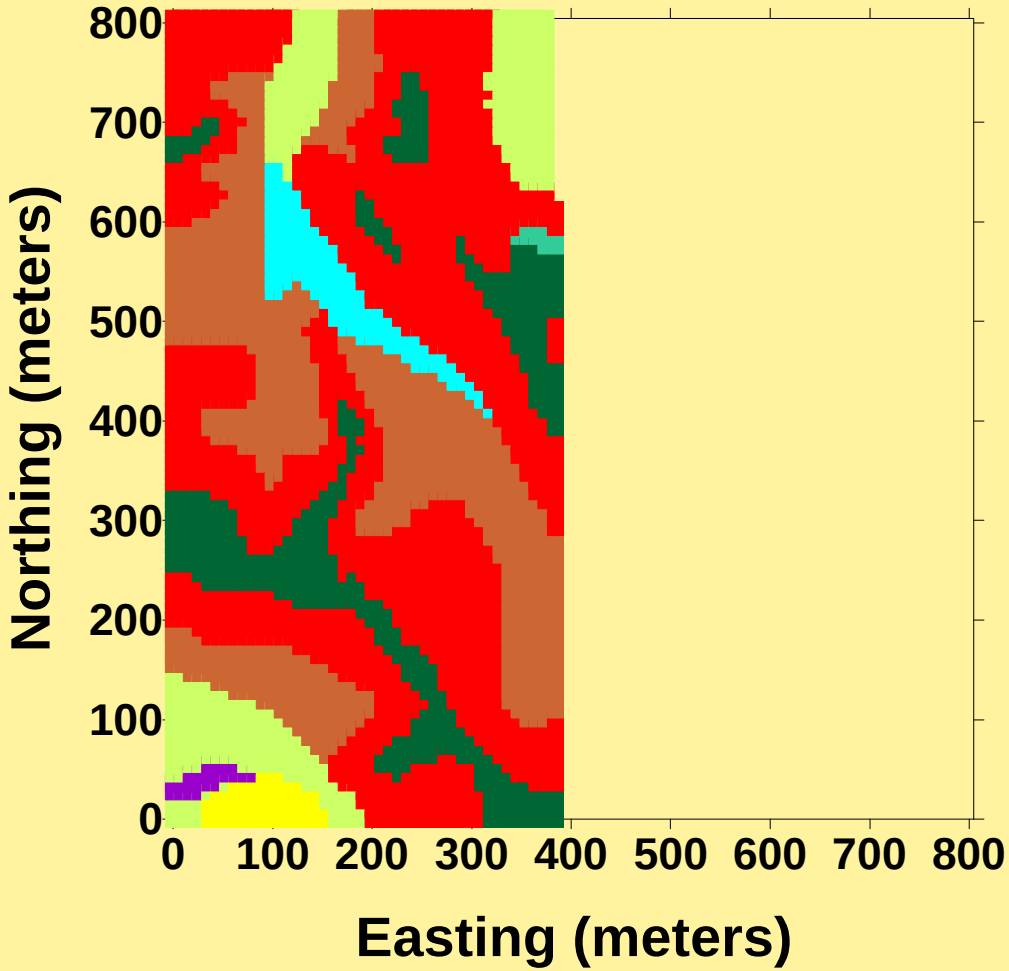
Grid Cell



Landform sampling



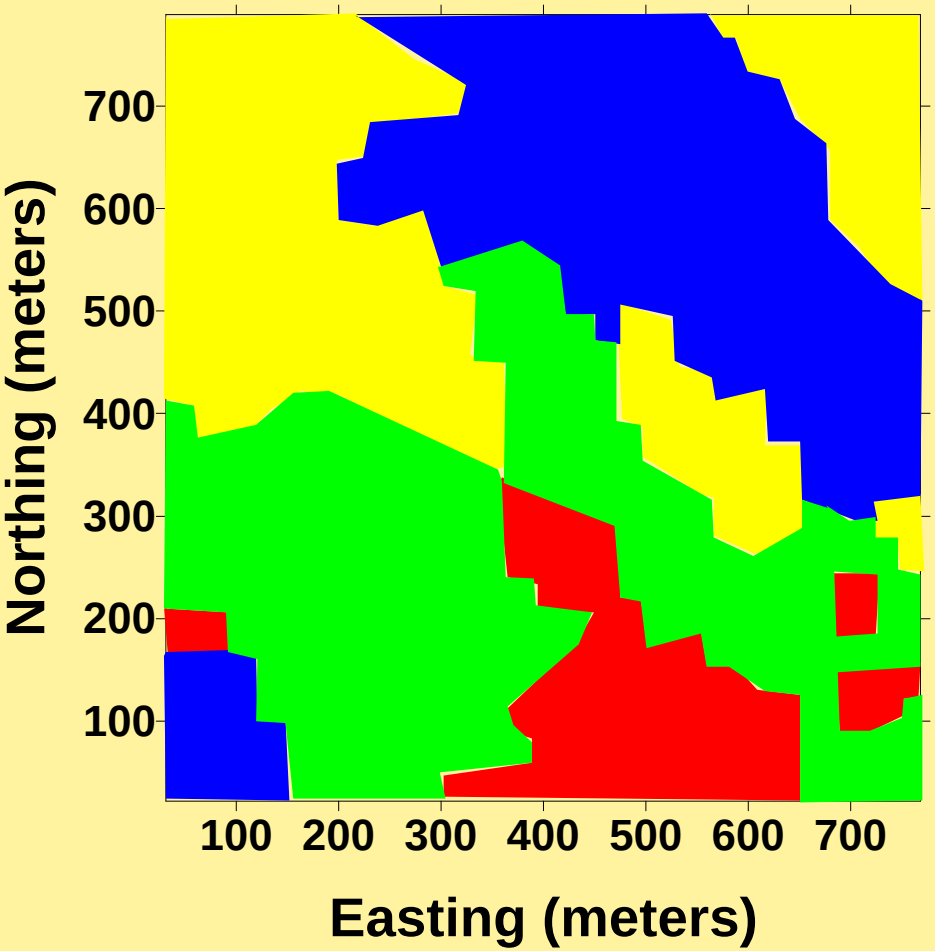
Soil Type



Order 1 soil survey: scale = 1:3960

Order 2 soil surveys can be personalized using EC data or prior knowledge.

Computer Classification



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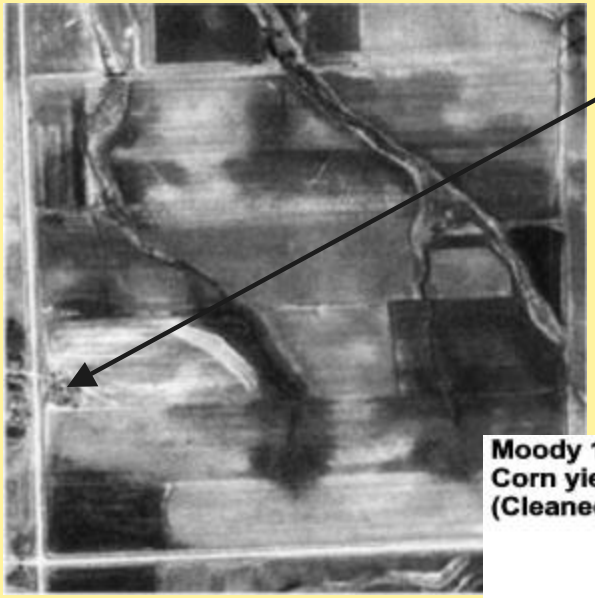

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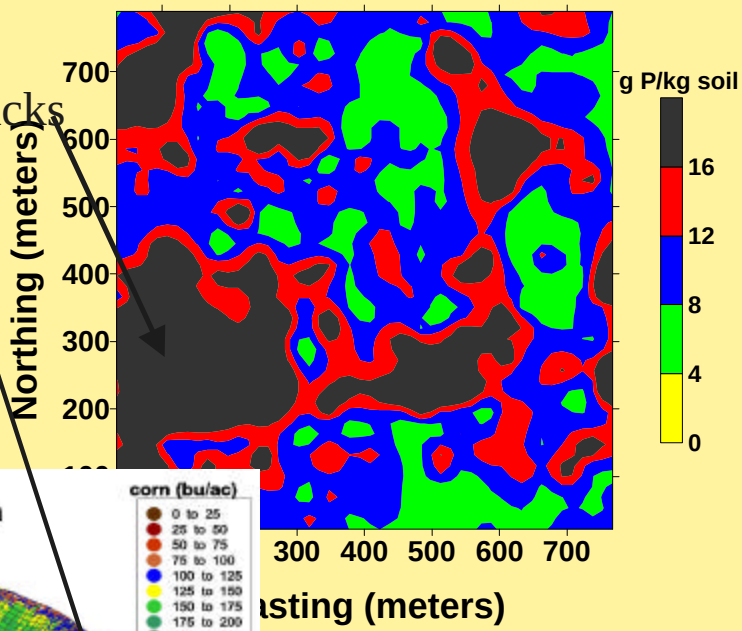
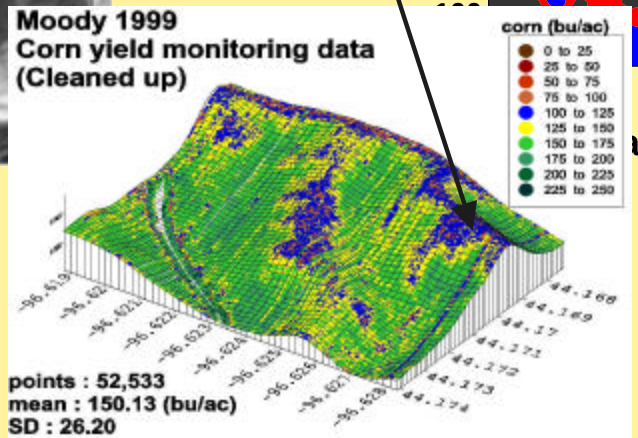
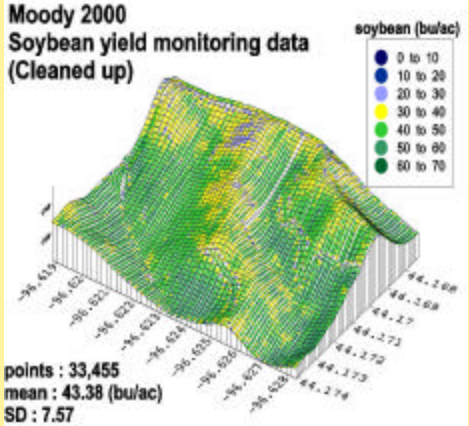
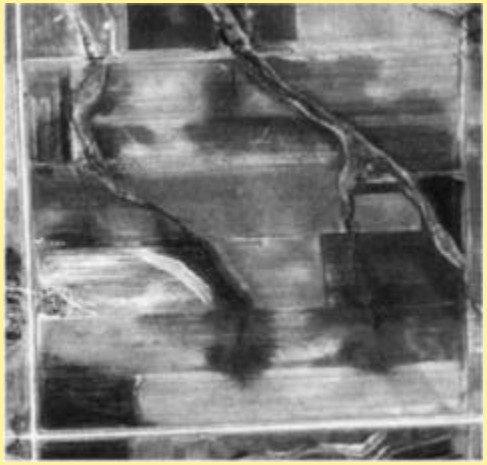
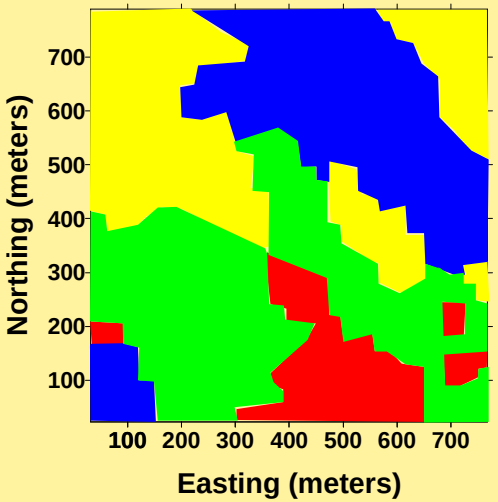


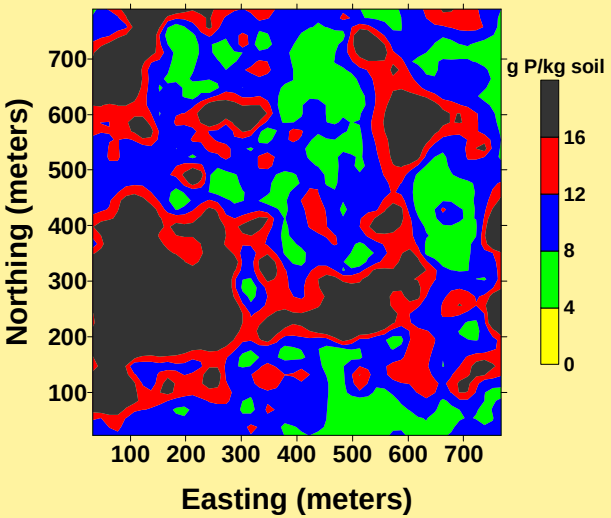


Which is best ?









Which is Best ?

- The answer as to which is best will depend on the criteria selected.
- At least three different criteria have been used to assess zone boundaries
  - Minimize soil sampling error
  - Maximize yield variability explained
  - Minimize fertilizer recommendation errors

Minimizing Fertilizer Recommendation Error

Fertilizer error =

$$? \frac{(\text{Predicted-measured})^2}{n}$$

Relative error = $\frac{\text{measured fertilizer error}}{\text{whole field management}}$

% Fertilizer error

	Land-scape	Multiple goals	County Average	Single yield goal
Sampling	P	N	P	N
Whole field	94	48	100	100
W. F. – home	81	52	86	96
Grid Cell	65	41	71	71
Soil survey	79	52	84	89

Recommendations

- Based on this case study,
  - Yield goals in footslope areas should be around 200 bu/a.
  - Yield goals in summit areas should be around 135 bu/a.

Take home measage

- Following BMP’s like soil sampling for fertilizer recommendations contain risk,
- This risk is the direct result of spatial variability.
- Over 50-60% of a field will have a nutrient concentration less than the soil test value.
- If fertilizer is applied to a field with a soil test greater than the recommended level, a response might be observed.
- By accounting for variability risk can be reduced.

Cronin Farms: Corn NH3 Application (11/1/05)

N management

- Yield goal driven
- Change gears from corn to wheat

Change: drivers

- Why important?
- Some years, paid premium for high protein wheat
- Docked if below 14%

Protein Percent	$ / bushel 7/8/2004	9/8/2004	10/26/2004	Fall 2005
10.0%	-0.80	-0.90	-0.70	-1.20
13.4%	-0.12	-0.15	-0.24	-0.18
14.0%	0.00	0.00	0.00	0.00
15.0%	0.35	0.40	0.85	0.40

Drivers: Changes

- N fertilizer costs have increased
  - 2001 urea was $181/ton
  - Fall 2005 urea was $360-380/ton
- Stream bar technology (new last 5 years)
  - Directed nozzles
  - Tubes
- Remote sensing?

Drivers: Changes

- Opportunity to manage water (yield goals)

Moisture Variable

Sept-July	Rain (in)	2 in 10 years		1 in 10 years	1 in 10 Years
County	Ave.	Less than	More than	Less than	More than
Potter	15.1	14.2	22.0		
Sully	13.8			11.7	19.7
Hughes	14.5			11.4	22.1

To produce 60 bu wheat takes 18 inches of water

Detailed experiments are conducted on small plots.

Dakota Lakes 2003 and 2004

lbs N/Acre Pre-emerg.	lbs N/Acre 5-6 leaf	lbs N/Acre Flag	Yield bu/A	% Protein Harvest	% Lodge at harvest
0	0	0	59^{bc}	11.1^{c}	0^{c}
90	0	0	62^{ab}	13.8^{b}	27.5^{b}
180	0	0	56^{c}	15.6^{a}	42.5^{ab}
60	120	0	60^{abc}	15.4^{a}	50^{a}
0	120	0	63^{a}	14.9^{ab}	30^{b}
0	180	0	59^{bc}	15.3^{a}	55^{a}

lb N / A Pre-emerg.	lb N / A 5-6 leaf	Flag	bu/A	Harvest	at Harvest
0	0	0	55^{bc}	12.7^{d}	0^{e}
90	0	0	53^{c}	15.1^{c}	58^{c}
180	0	0	51^{c}	15.9^{a}	82^{a}
60	120	0	53^{c}	16.1^{a}	75^{ab}
0	120	0	63^{a}	15.5^{b}	31^{d}
0	180	0	60^{ab}	15.9^{a}	25^{d}
30	120	30	54^{ab}	16.0^{a}	62^{bc}

Conduct on-farm-research

- Proves that the system is culturally compatible
- Dan Forgey (Cronin Farms)

N response results 2005

Soil N (lbsN/a)	Pre-plant (lbsN/a)	V5-V6 (lbsN/a)	Yield Bu/a	Protein %
40	40	0	37	13.3
40	80	0	43	14.0
40	0	80	40	13.9
40	40	40	40	14.4

Standard practice N = 60*2.5-40 = 110lbN/a

Results

- Participatory research conducted by three producers showed that over 50% of the years, N rates could be reduced upto 50%, without a loss of yields or N rates.
- Risk is associated with moving from the from point to the field,
- Because of this risk, producers have adopted strategies that many would not consider BMP’s
- New technologies provide the opportunity to implement BMP’s and reduce inputs.

On-farm research

- These guys are pumped
  - They have made numerous presentations on their findings.
- They are now looking into the option of purchasing slow release N.

Spring wheat after winter wheat

Next Step

- Helping producers implement management that will increase profits and reduce chemical inputs.

Comments

Ryan Patterson,

“So that all I did was prove to myself that I wasted money applying full rate….

I realize a different year might give different results but in a year with this much rain …it would be this year.

Ryan Patterson

- “our costs for equipment and software was about $2,700 and our saving over the 1150 acres was at least $5 to $6/acre.”

- “This is something that must fit into your operation and does require some skill and time”

Presentation Ryan

- Feb 2005, UMAC Annual meeting, Implementing management zones
- Jan, 2006 SDSU, Soil & Moisture Clinic, Soil conservation efforts on our farm.
- Jan-Feb 2005, Shared results one-on-one with Hutterite SunSet Colony.
- Feb. 2006, UMAC Annual meeting, Implementing management zones.

Presentations

Presentations by Dan Forgey

Jan 20 Rexburg Idaho, Kick off 2006, 250 John Deere Employees

Jan 30-31 2005, No-till on the Great Plains, Farming for the Future Conference, Penn State.

Success of on-farm research

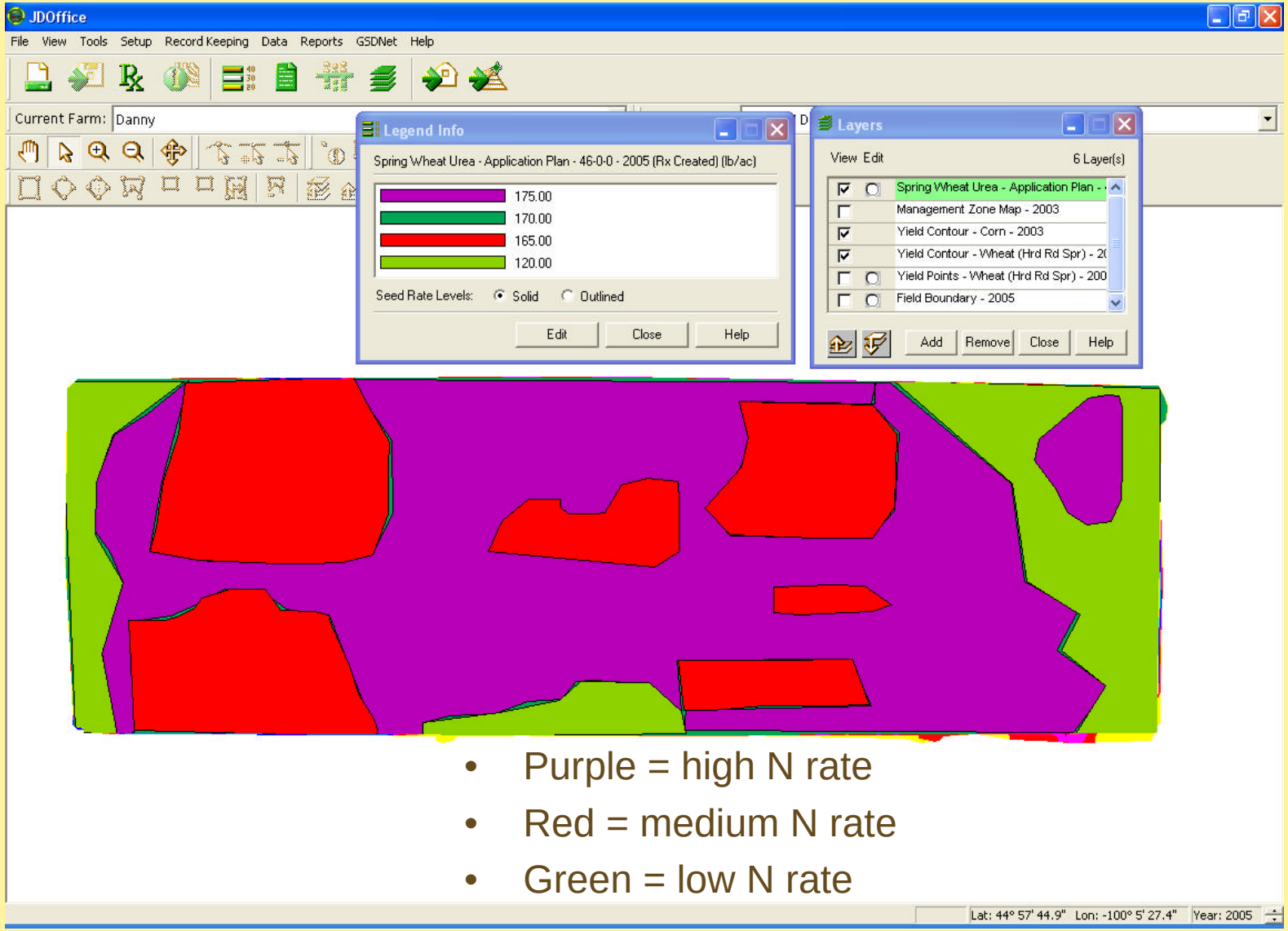
- Changing farmers attitude is not easily accomplished.
- Learning groups work
- Farmers share what they learned with neighbors
- Many feel as that working through data makes them better managers
- Farmers enjoy doing collaborative on-farm research

Wheat planted spring 1895 Drill (March-April 1)

Harvesting wheat

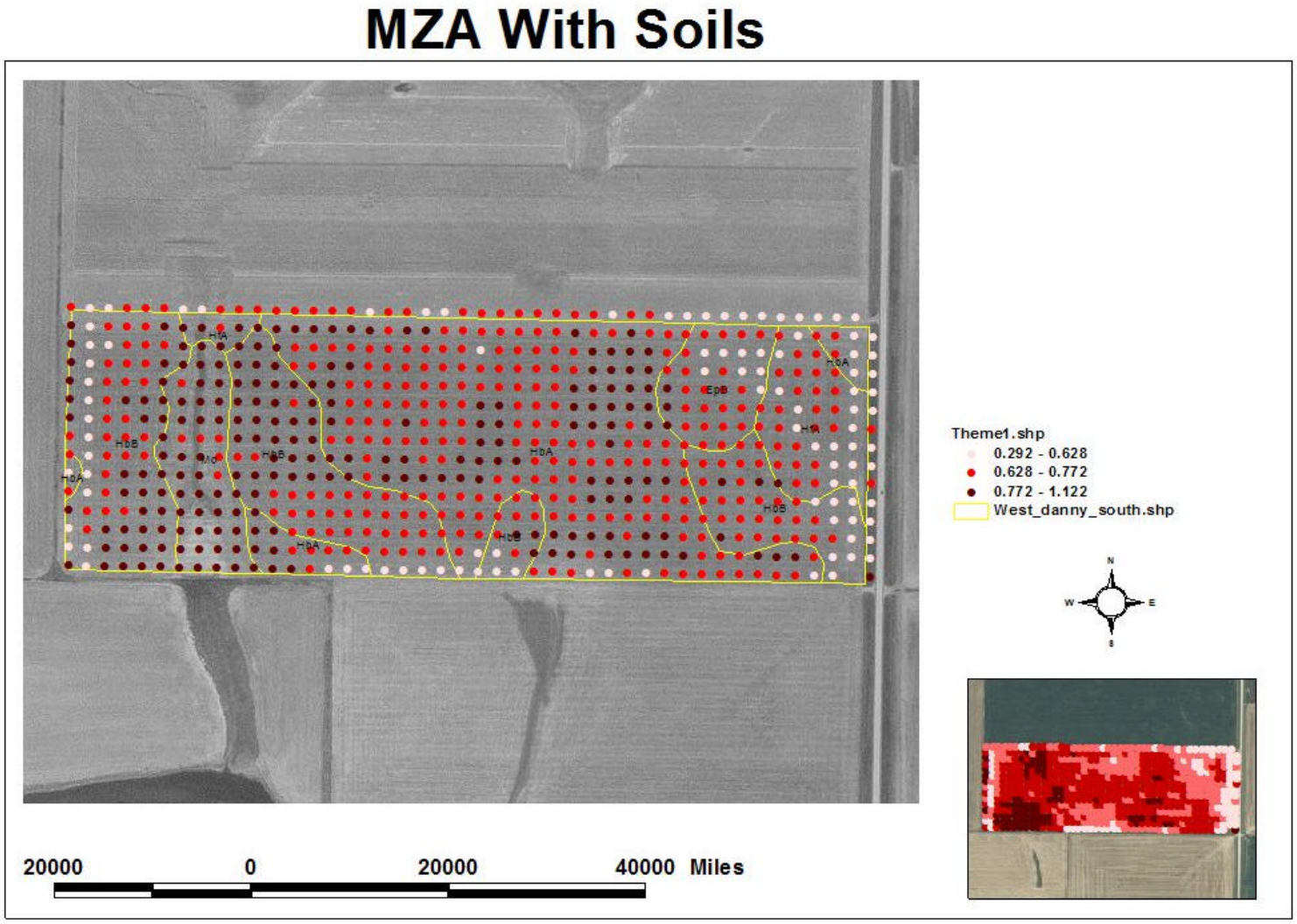
Differences in field

N application map

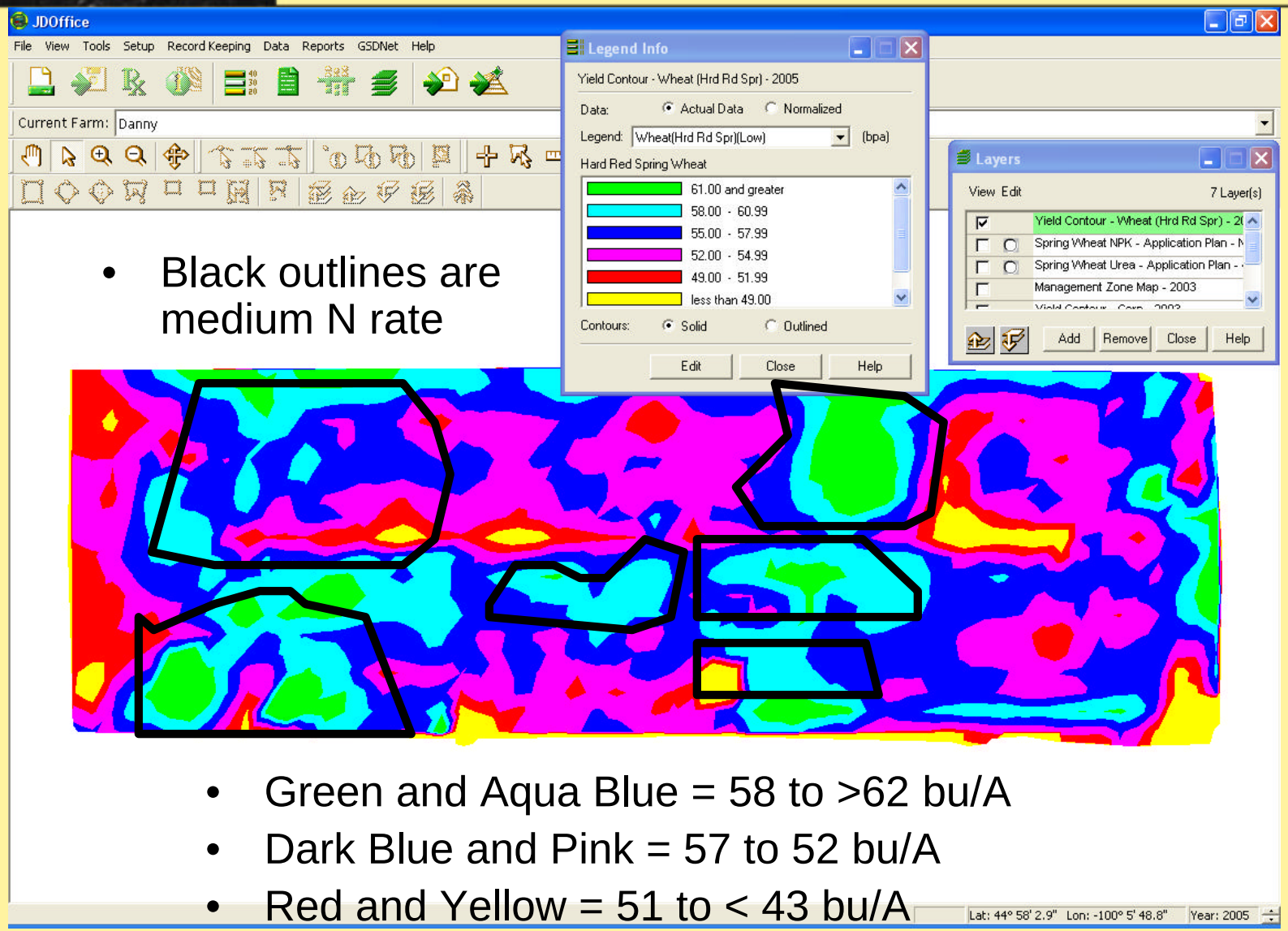


- Purple = high N rate
- Red = medium N rate
- Green = low N rate

MZ map from process



Yield map



- Black outlines are medium N rate

- Green and Aqua Blue = 58 to >62 bu/A
- Dark Blue and Pink = 57 to 52 bu/A
- Red and Yellow = 51 to < 43 bu/A

On Farm Research 2006

1. Design experiment using slow release poly coated urea
   - Same increase in protein as 28% N due to N released slowly over time?
   - Spring wheat and winter wheat
2. Timing N study in winter wheat
   - Hopefully hard white and hard red winter wheat

Image: http://www.agrium.com/ESN.jsp

Image: Dan Forgey / Cronin Farms