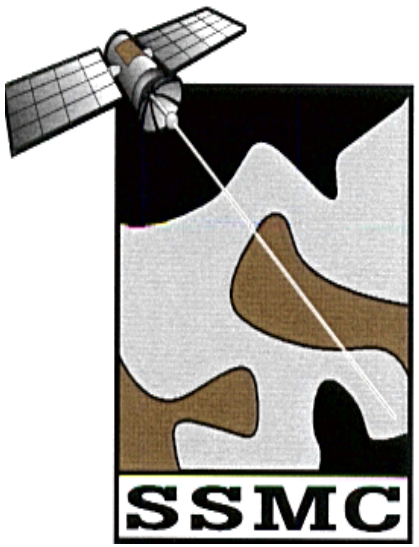
Precision Farming Overview

- Current Status of Precision Agriculture
- Overview of Economic Studies of Precision Ag
- Site Specific Management Center (SSMC)



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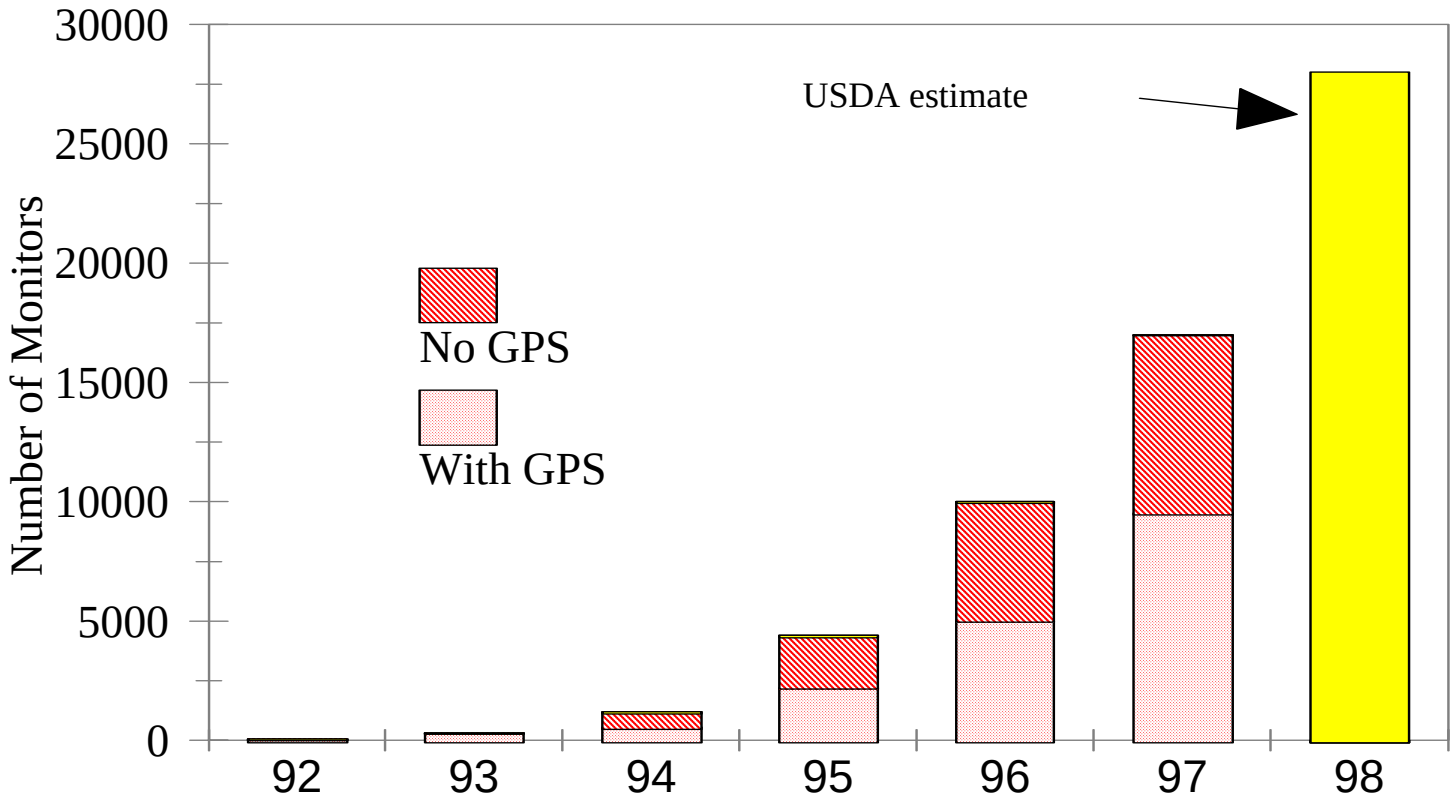
Definitions:

- **Site Specific Management - doing the right thing, at the right place, at the right time**
- **Precision Agriculture - automates site specific management using computers, sensors and other electronics.**

Status of Precision Farming in North America

- Roughly 28,000 yield monitors in use for the 1998 harvest in the US
- About 18% of corn and soybean area harvested with a yield monitor in 1998

Combine Yield Monitors in the U.S. and Canada



Source: Mangold, 1997, Daberkow & McBride, 2000

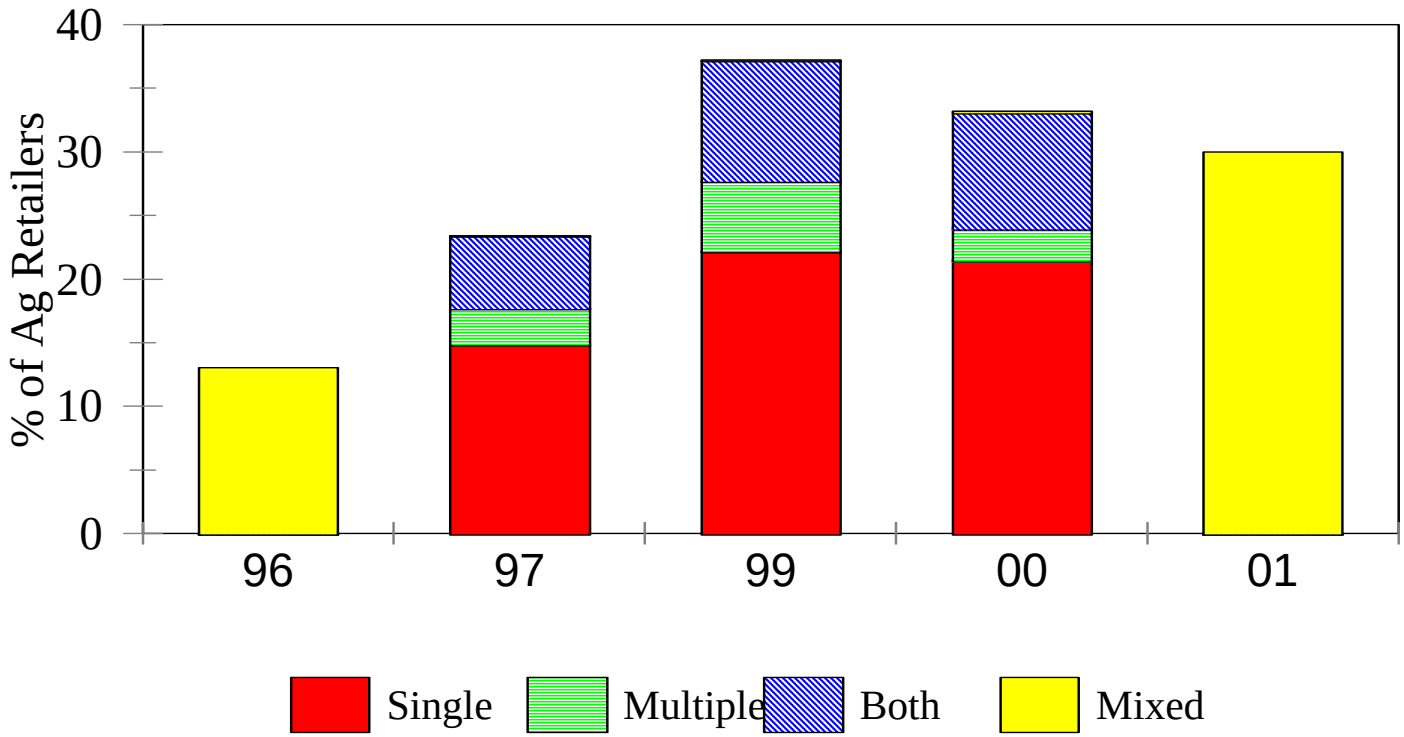
Yield Monitor Use Highest on Larger Farms in the Corn Belt

- USDA researchers showed that 60% of U.S. farms using precision agriculture are in the Corn Belt.
- In a 1999 survey, Ohio researchers found that only 6% of all farmers use yield monitors, but over 50% of farms with gross sales over $1 million.
- In general, larger farms are more likely to use yield monitors, but the likelihood of adoption peaks at about 1600 acres.

Precision Farming Services in the U.S.

- In 2001 the growth in variable rate application services seems to be leveling out.
- 36% of all fertilizer retailers nationwide offered soil sampling with GPS, mostly 2.5 acre grids. This compares with 45% in 1999.
- 30% of all dealers offered computer controlled variable rate application services, compared to 38% in 1999.
- Over 50% of all dealerships in the Midwest offer these services.

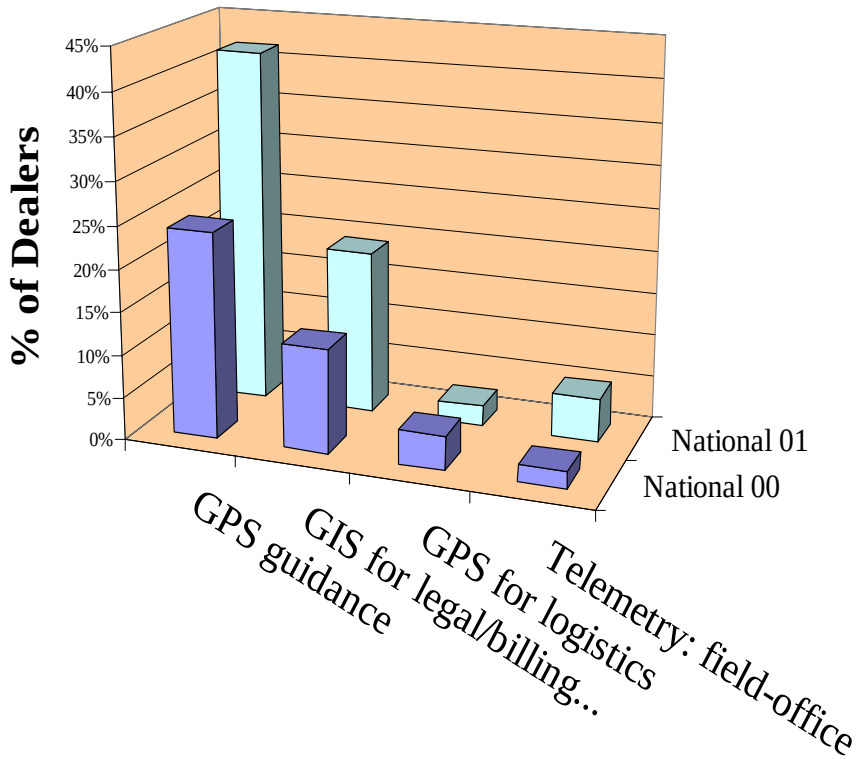
Percentage of U.S. Ag Retailers Providing Variable Rate Application



Source: Akridge & Whipker, 1997, 1999, 2000; Whipker and Akridge, 2001

Growing Use of Precision Ag Tools by Dealers to Provide Traditional Services

From fall 1999 to spring 2001 use of GPS guidance by custom applicators grew from about 5% to over 42%. Growth was especially strong in the Midwest



Source: Akridge and Whipker, 2000, Whipker & Akridge, 2001

Farm Level Adoption of VRT in the U.S.

Widespread use of VRT on some higher value crops, but in bulk commodities farmers try it on a small proportion of crop area.

- **About 40% of sugar beet acreage in Minnesota and North Dakota received VRT nitrogen in 1999**
- **About 14% of farmers in Iowa, Illinois, Indiana and Wisconsin used some GPS soil sampling in 1997. About 12% made some VRT fertilizer application.**
- **The percent of acreage with VRT fertilizer is less than the percent of farmers.**
- **VRT lime is becoming standard practice for many eastern Corn Belt producers**

Economic Studies of Precision Agriculture

- Most focus on variable rate fertilizer because it was the first commercially available precision ag technology
- “Stand alone” systems with one or two inputs
- Usually had variable rate application equipment with whole field recommendations
- Most studies on bulk commodities because this is the “mass market” sought by manufacturers and retailers

Many Articles and Websites Report Profitability of Precision Agriculture

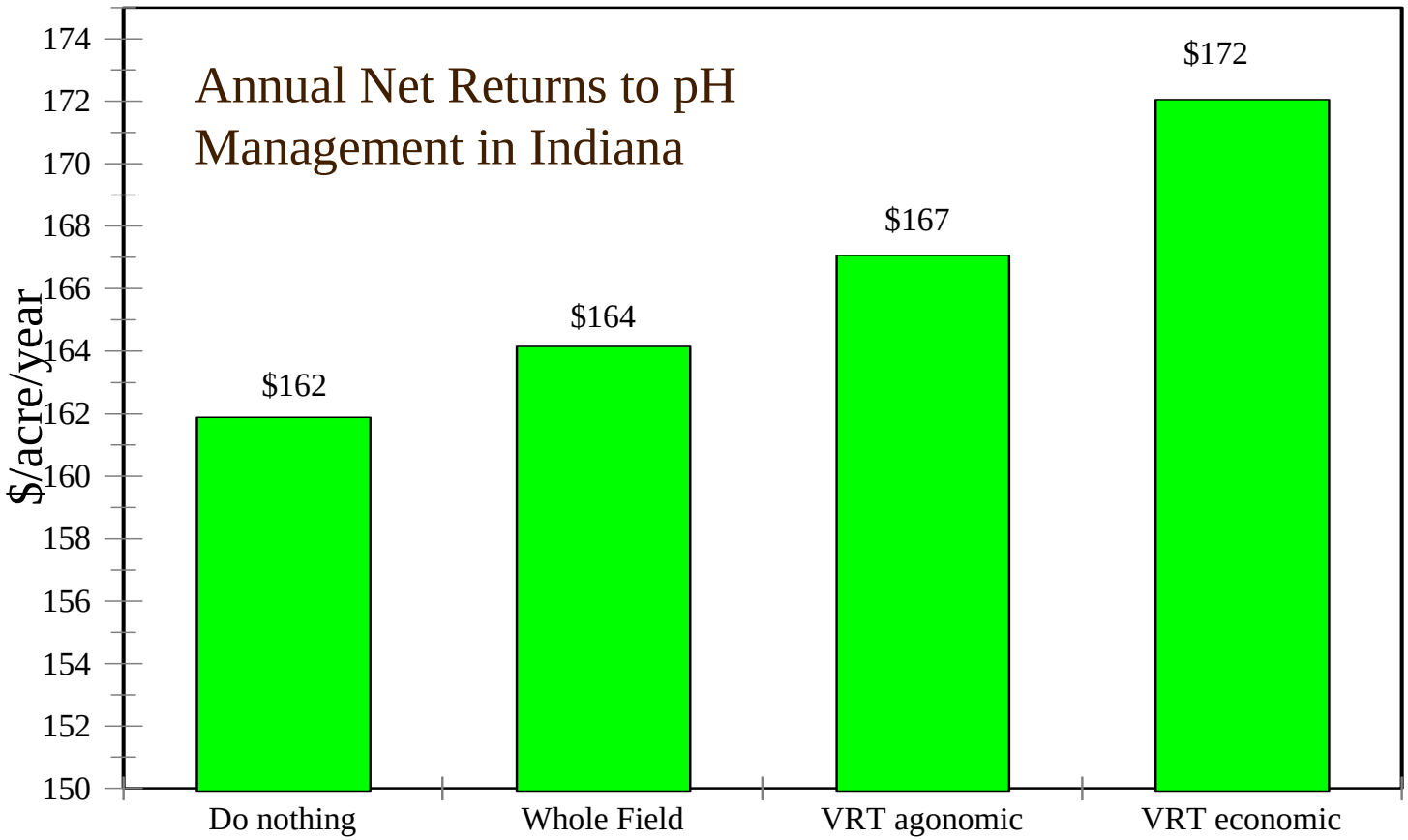
- Lambert and Lowenberg-DeBoer reviewed 108 articles reporting economic results related to precision ag. Some 63% reported profits. (http://mollisol.agry.purdue.edu/SSMC/)
- Many of these studies omit important costs including: soil testing, data analysis, training.
- Other studies overstate yield benefits and/or cost savings.

Variable Rate Profitability in Nine U.S. Studies with Standardized Budget Methods

Crop	Inputs	Grid ha	Site-years Profitable
Higher Value Crops:			
Sugar Beets	N	1.1	100%
Extensive Dryland Crops:			
Wheat, Barley	N,P,K	soil type	20%
Wheat	N	1.2	0
Wheat, Barley	P,K	soil Type	0
Corn and Soybeans:			
Corn	P,K	1.2	42%
Corn	P,K	soil type	50%
Corn, Soybean	P,K	1.2	42%
Irrigated Corn	N	0.3	50%
Corn	P,K	1.0	50%
Corn, interpolated	N,P	0.85	100%
Corn, grid average	P,K	1.0	0

Source: Swinton & Lowenberg-DeBoer, JPA, 1998.

Variable Rate Lime Seems Consistently Profitable the Eastern Cornbelt



Source: Bongiovanni and Lowenberg-DeBoer, 1998

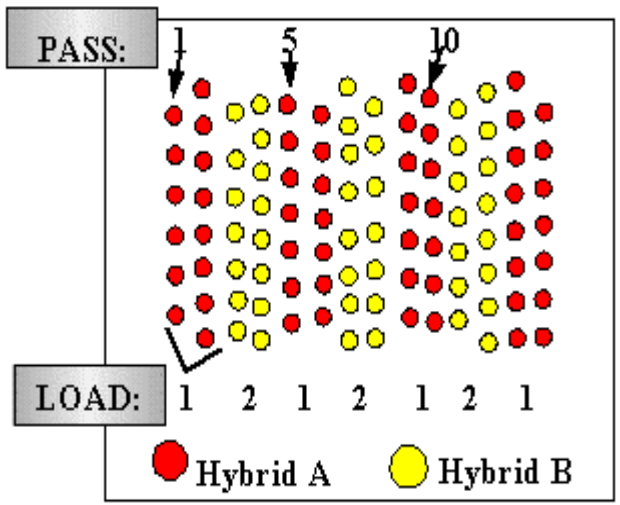
Profitability of Yield Monitors

Profitability depends on:

- **Use in diagnosing problems such as pests, drainage, tillage, fertility and**
- **Improving input decisions (e.g. hybrid, varieties, herbicides)**

Yield Monitor Profitability Example

- A 2000 acre grain farm
- Purchases a yield monitor and GPS for about $7000
- Uses yield data to choose better corn hybrids and soybean varieties.
- Improves average yields by 1 bushel/acre
- Almost pays for yield monitor first year



Are Integrated Precision Ag Systems More Profitable?

Best example of an economic study on an integrated precision farming system were the Sauder Farm trials done in central Illinois, 95-97 (Finck, *Farm Journal*, Mid-January, 1998). Treatments:

1) whole field management

2) manual variable rate for N,P,K and corn seeding rate

3) GPS controlled variable rate for N,P,K and corn seeding rate.

Equipment Cost Estimated

Yield Monitor	$4000
GPS (Coast Guard)	$6000
Planter and Anhydrous Controllers	$5000
Laptop Computer	$3000

Note:

- Assumed three year life on all precision ag equipment
- Interest rate 10%/year

Other Costs:

Soil Type GPS Soil Type Spreading	$5/acre
Soil Sampling	$5/acre
Consulting Fee	$650/farm
Repair and Maintenance	2% of Purchase Price
Property Tax & Insurance	0.9% of Purchase Price

Yield, Seed and Fertilizer

- Average corn yield increase for GPS treatment was 15.32 bu./a
- Seed use increased only slightly
- NPK fertilizer was down overall, micronutrients up on average:
  - Nitrogen -0.44 lbs/a
  - Phosphorous -14.66 lbs/a
  - Potassium -3.33 lbs/a
  - Sulfur +2.17 lbs/a
  - Zinc +0.11 lbs/a
  - Boron +0.05 lbs/a

How to put this information together?

A simple spreadsheet budget can be helpful!

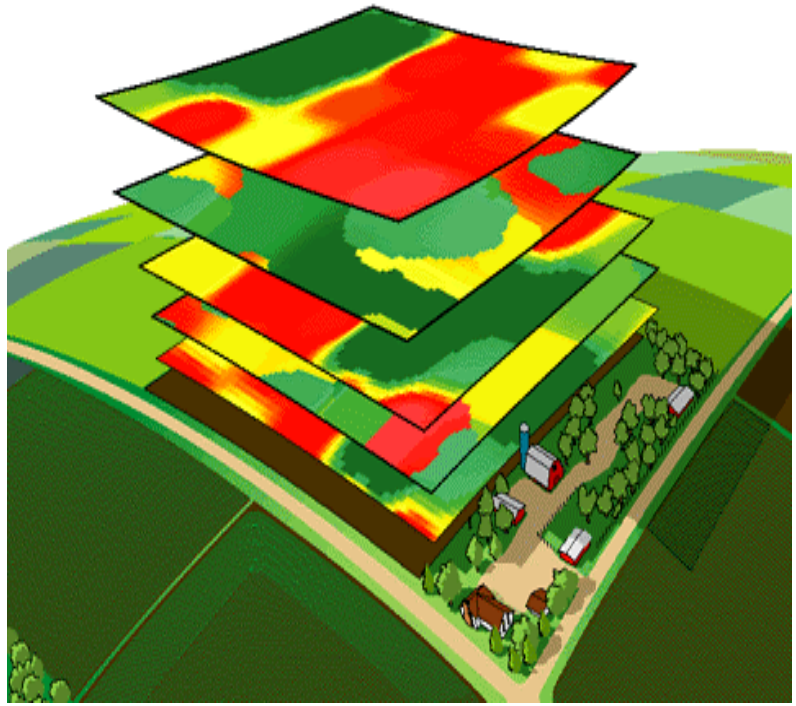
Table 2. Partial Budget Example for Site Specific Management of Corn in Central Ilinois, $/acre

Item	Unit	Quantity	Price	Amount
Change in Yield	Bu./a	15.32	$2.30	$35.24
Change in Equipment Cost				
Yield Monitor	Item	1	$4,000	$1.42
GPS	Item	1	$6,000	$2.13
Plant & Anhydrous Controllers	Item	1	$5,000	$3.56
Laptop Computer	Item	1	$3,000	$2.13
Total Increase in Equipment Cost				$9.25
Change in Fertilizer Cost				
Nitrogen	lbs/a	-0.44	$0	-$0.11
Phosphorous	lbs/a	-14.66	$0	-$4.40
Potassium	lbs/a	-3.33	$0	-$0.43
Sulfur	lbs/a	2.17	$0	$0.46
Zinc	lbs/a	0.11	$2	$0.26
Boron	lbs/a	0.05	$7	$0.36
Total Change in Fertilizer Cost				-$3.87
Change in Seed Cost	Bags/a	0.01	$90	$0.48
Change in Soil Sampling Cost	Acre	1	$5	$5.00
Change in Fertilizer Application Cost	Acre	1	$5	$5.00
Consulting Charge	Farm	1	$650	$0.50
Net Return to Site Specific Management				$18.88

Source: Precision Farming Profitability, Lowenberg-DeBoer & Erickson, 2000

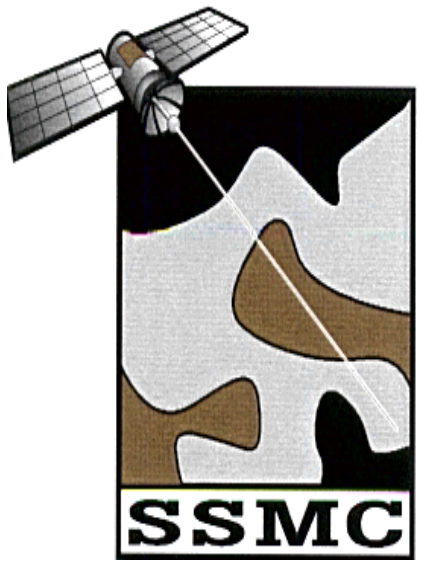
Summary of Economic Studies

- Economics of precision agriculture are site specific
- Profitability of precision agriculture linked to higher crop value
- Integrated systems managing multiple inputs tend to be more profitable
- In the longer run precision agriculture profits will come from whole farm information systems not VRA

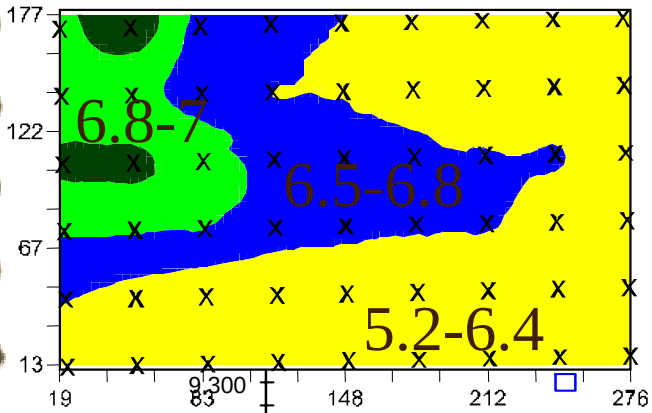


Site-Specific Management Center Mission:

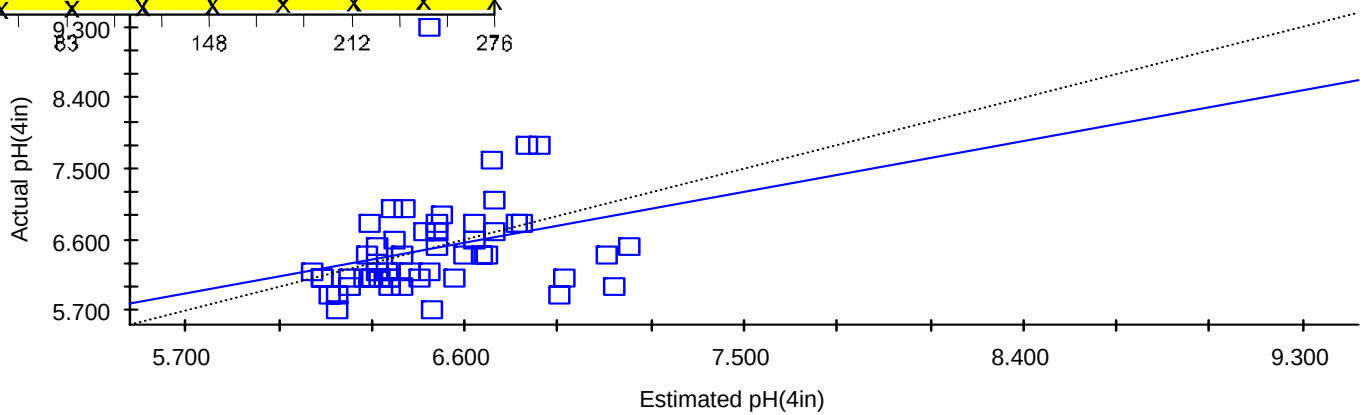
To develop and disseminate information about site-specific management methods that are both practical and profitable for farmers, and those who supply inputs or process farm products.



Sylvie Brouder, Agronomy, works on site-specific soil fertility management

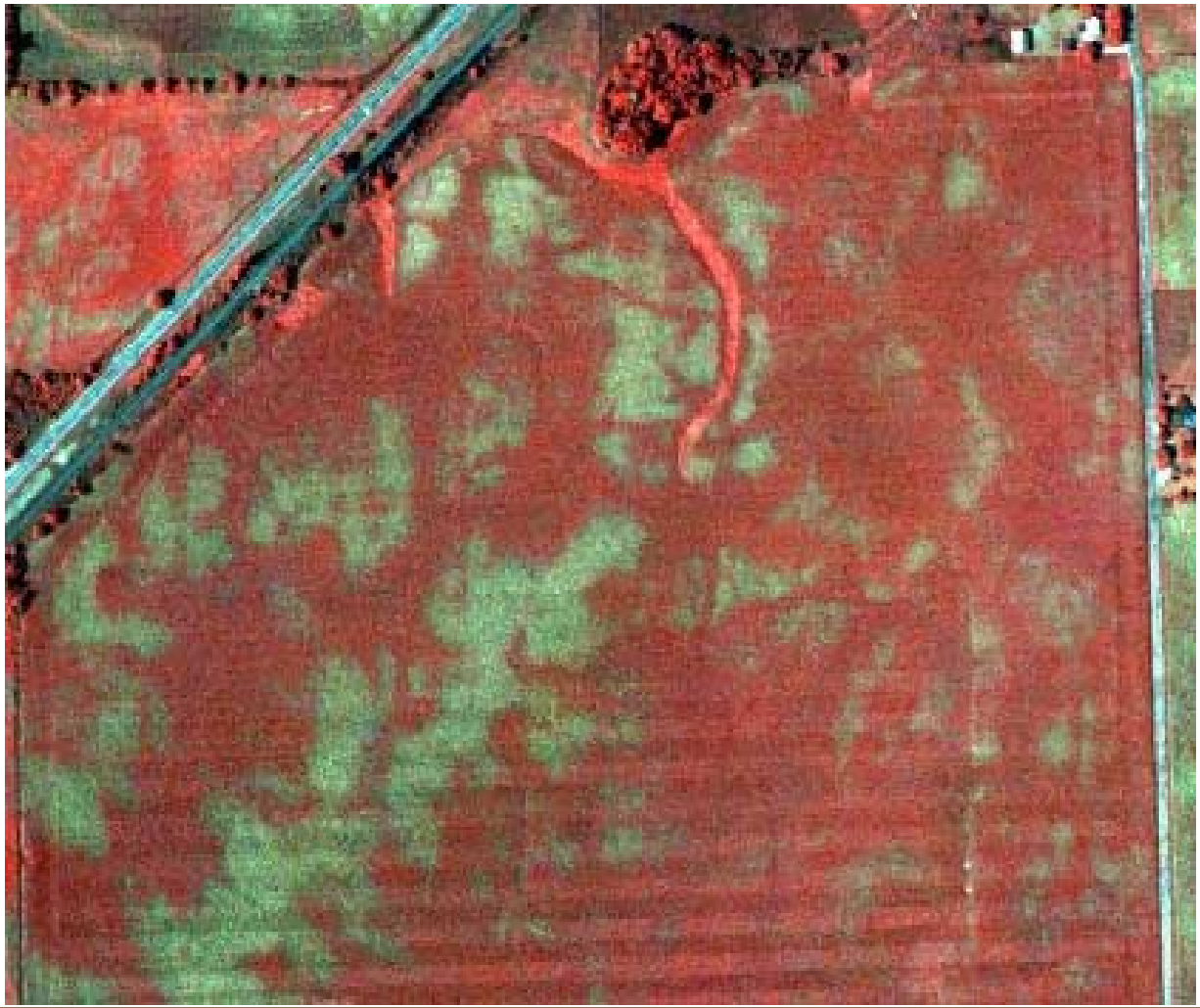


- How well can you predict the value of any sample point from the others…?



Regression coefficient = 0.716 (SE = 0.326 , r2 =0.085,
y intercept = 1.831, SE Prediction = 0.584)

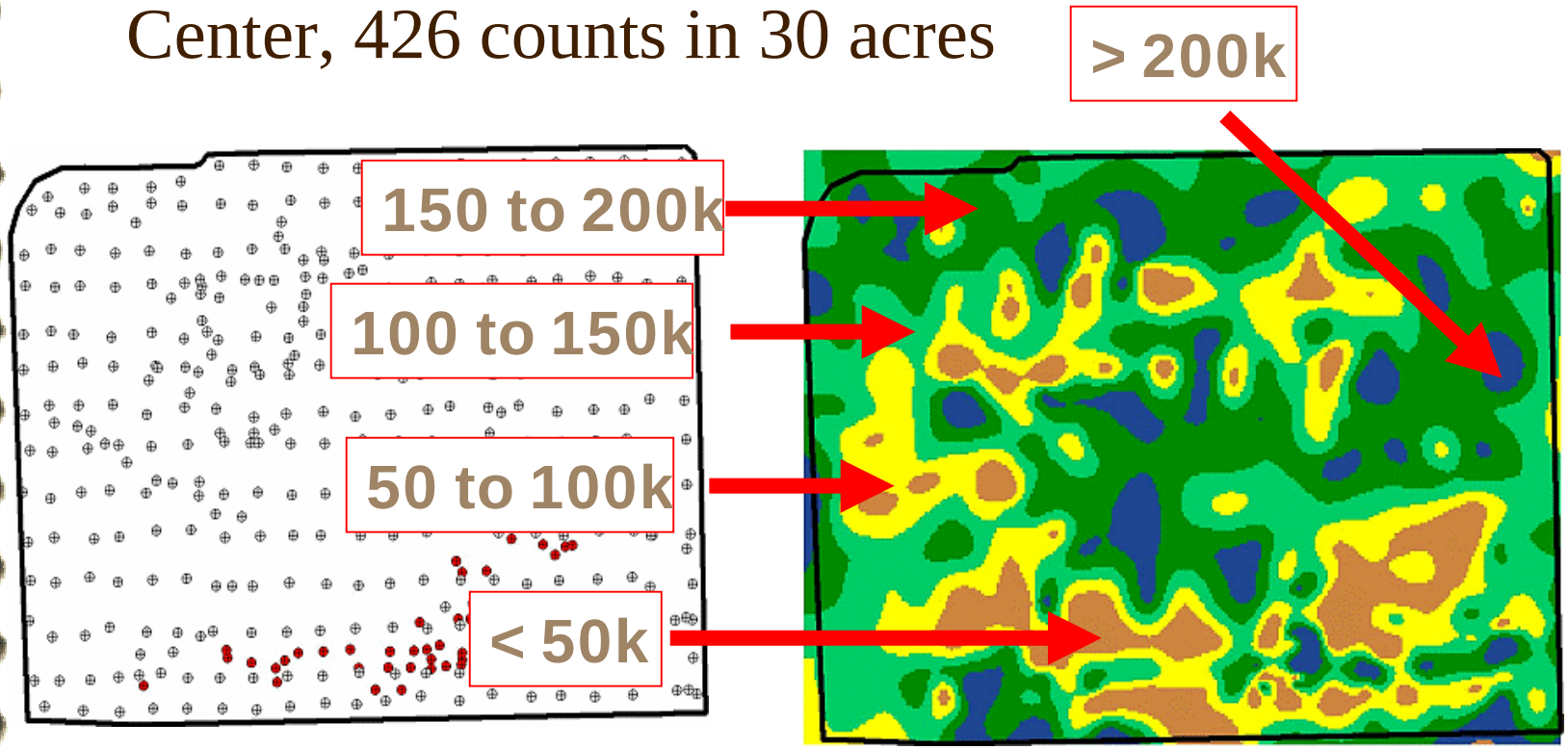
Chris Johannsen, Agronomy, is internationally known for his research on remote sensing for agriculture



Eventually, we may use remote sensing to scout our field for weeds, pests and other problems

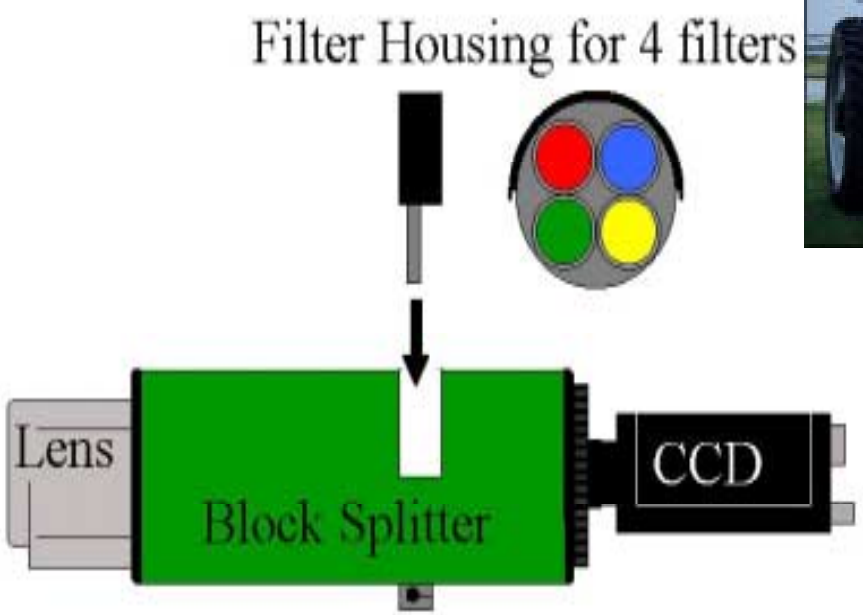
Bob Nielsen, Agronomy, is focusing on factors lead to low yield areas and how to change that.

Example: Soybean seedling counts at Davis-Purdue Ag. Center, 426 counts in 30 acres



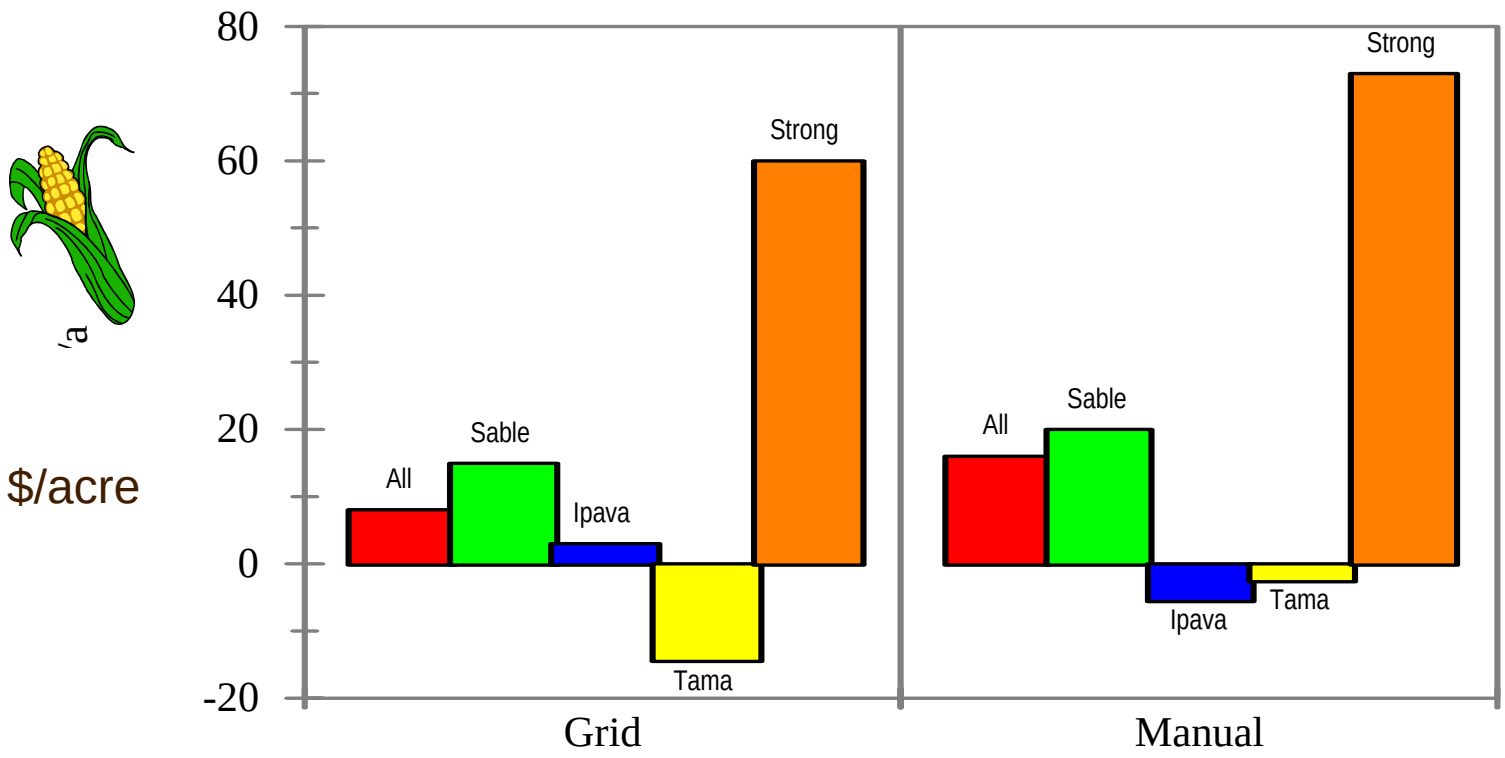
Mark Morgan, ABE, is developing soil sensors. Below experimental pH sensor on a toolbar.

Gaines (Buddy) Miles is working on optical sensors that can recognize weeds and crops



Miles also teaches Purdue's Precision Ag Technology Course, ASM322

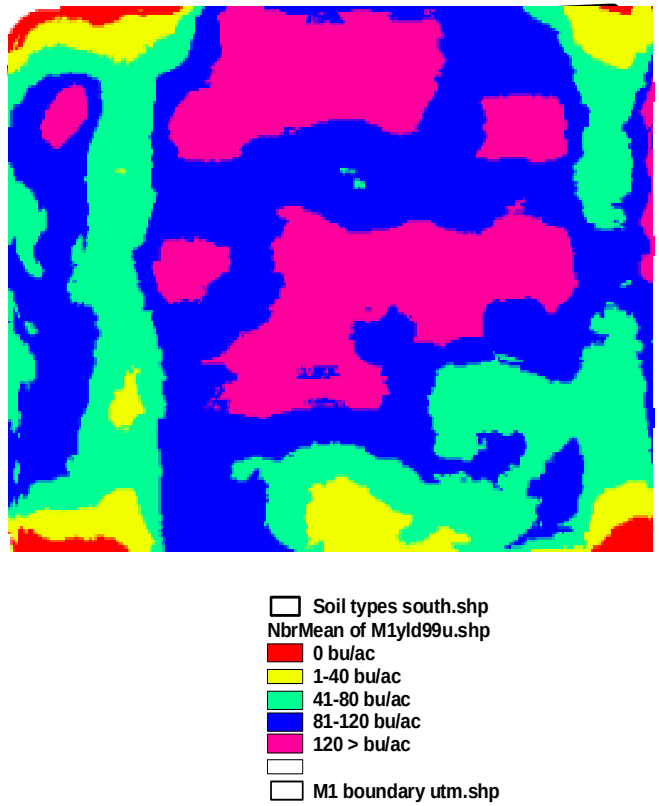
J. Lowenberg-DeBoer has been doing research on the profitability of site-specific management since 1992



Change in corn return by soil type on the Sauder farm, 1995-97, with GPS and manual site-specific management

Other applied research and extension topics

- Farm GIS software - Mack Strickland
- Site-specific weed management - Case Medlin
- Site specific tillage - Tony Vyn
- Optimizing equipment systems - Dan Ess
- Soil classification - Gary Steinhardt



Precision Farming Profitability: A manual for putting the pieces together

Chapters:
1 - Information Technology Profits
2 - Choosing Better Hybrids and Varieties
3 - Making Drainage Decisions
4 - Managing Soil Fertility
5 - Increasing Cost Effectiveness of Weed Control

Plus Reference Section

Edited by J. Lowenberg-DeBoer and K. Erickson

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Summary

- The profitability of precision agriculture is site specific.
- So far only a few precision agriculture technologies have proven generally profitable for farmers (e.g. yield monitors, VRT lime in the Eastern Corn Belt).
- Profitability of variable rate input technologies depend largely on yield increases.
- Long term whole farm information system uses are likely to drive the economics of precision ag.
- The Purdue Site-Specific Management Center exists to help make precision agriculture more practical and profitable for producers, input supplies and processors.

Any Questions?