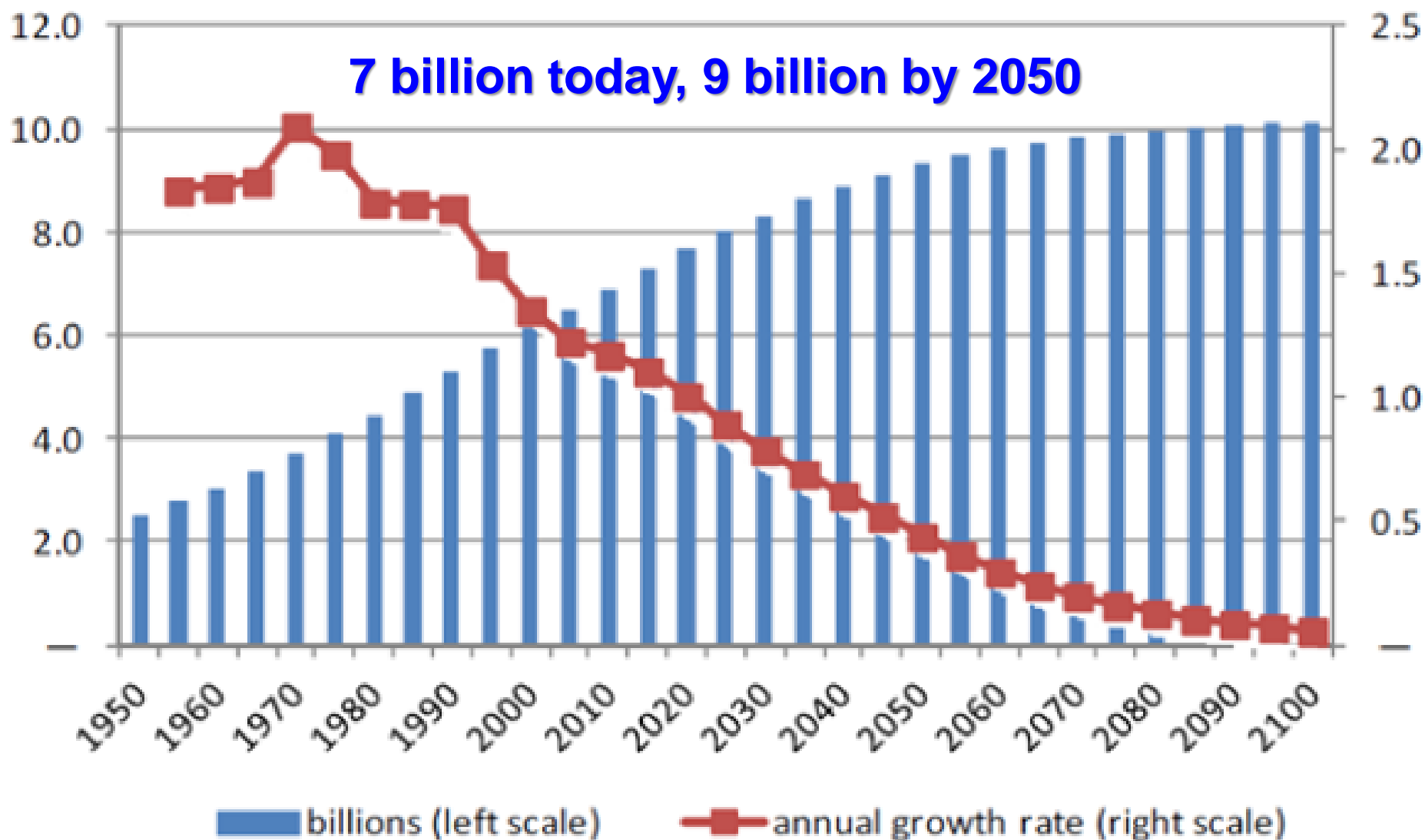


Leading Crop Production into the Future with Precision Agriculture

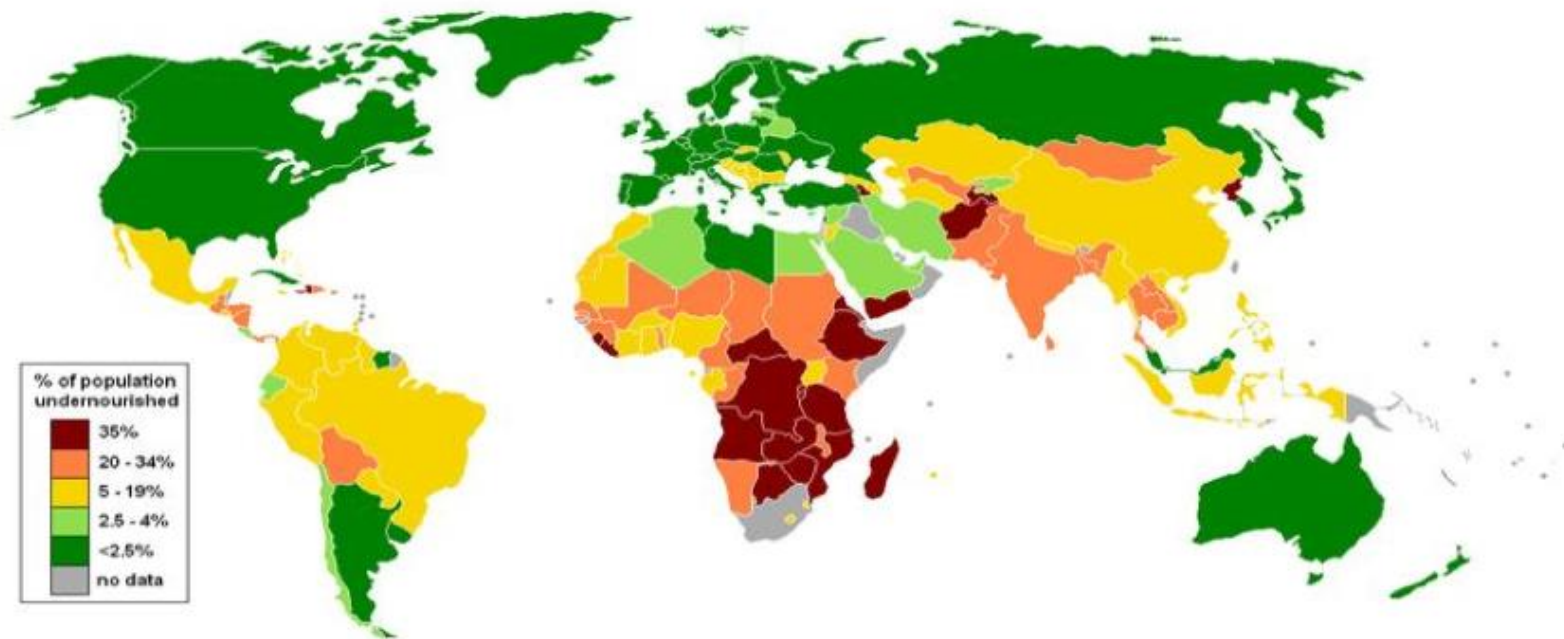
Steve Phillips, Ph.D.
Director, North American Program



World population prediction to 2100 (UN, 2010)



Global Population and Food Security



- Population increases are placing greater pressure on the food security of certain regions of the world
 - Potential food security challenges are going to affect all world residents, regardless of their location.
-
- **Food production will have to increase 50 to 70% to meet global demand**
 - **Fertilizers are responsible for 50% of food production and will likely increase**





The fertilizer industry contributes to meeting the goals of the Zero Hunger Challenge



ZERO
stunted
children
less than
two year



100%
access
to adequate
food
all year rounds



ALL
food
systems
are
sustainable



100%
increase in
smallholder
productivity
and income



ZERO
loss
or
waste
of food

The fertilizer industry contributes to better nutrition for all, improving the nutrient quality of food through micronutrient fertilization. This benefits children under the age of two, as well as women from the beginning of pregnancy.¹

The products supplied by the fertilizer industry help increase food production and provide nutrients essential for human health.

The fertilizer industry promotes agricultural best practices and nutrient use efficiency. Using extension services, it helps provide products and knowledge to farmers around the world to reduce their environmental impact. Through efficient use of fertilizers and the mitigation of nutrient losses, the carbon footprint of agriculture is reduced and the quality of water, oceans, soil and air is protected.

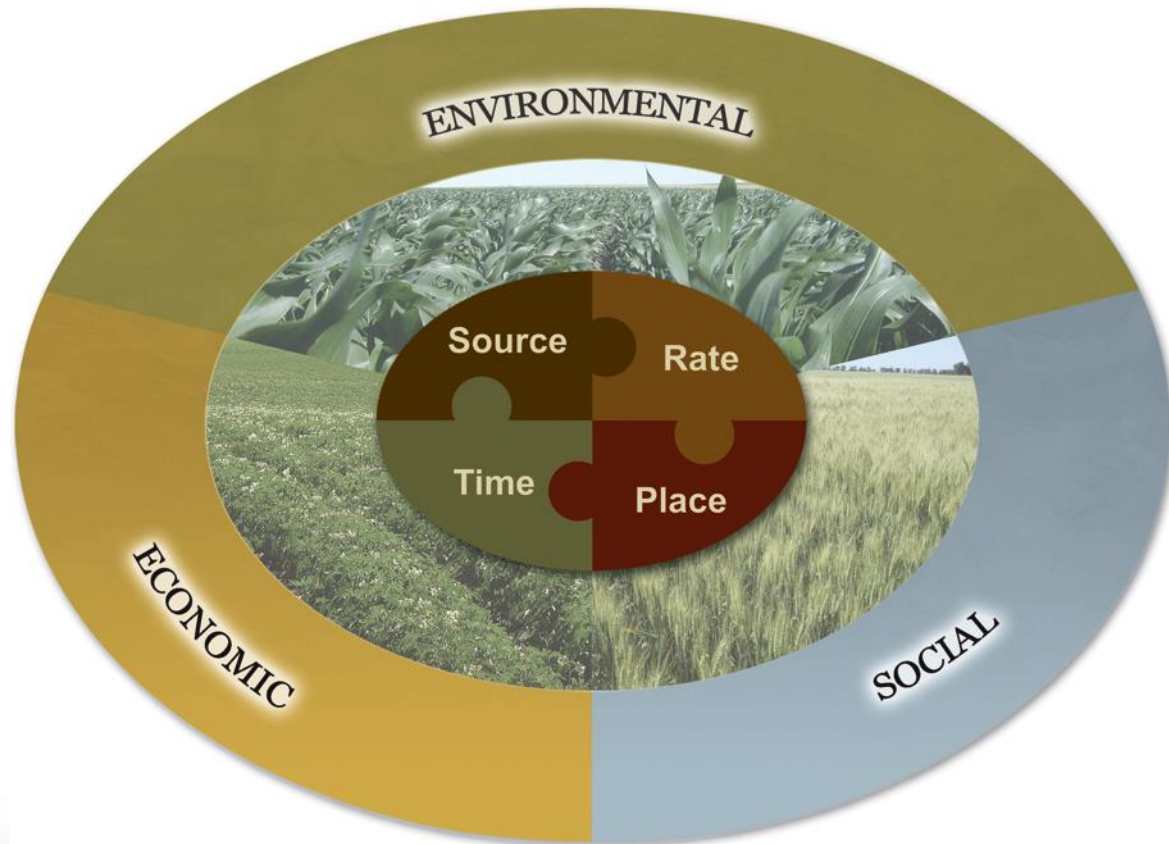
The fertilizer industry puts the needs of smallholder farmers at the centre of its activities. Through public-private partnerships, and extension and rural advisory services, the industry helps smallholder farmers increase their productivity and incomes.

The fertilizer industry develops products and systems to extend the life cycle of food, particularly through the use of calcium-based and boron-supplemented fertilizers to improve the post-harvest integrity and nutritional quality of most crops.

- Micronutrient fertilization can improve nutrient quality of food
- Fertilization can increase food production (50 to 70% more food by 2050) – highest food insecurity is in regions using least fertilizer
- Promotion of fertilizer BMPs
- Focus on small-holder systems
- Fertilization can improve post-harvest integrity and nutritional quality

- The foundation of fertilizer BMPs and efficient nutrient management can be aptly described as following the “4Rs” ...

Applying the *Right Source*
at the *Right Rate* at the
Right Time
and in the *Right Place*

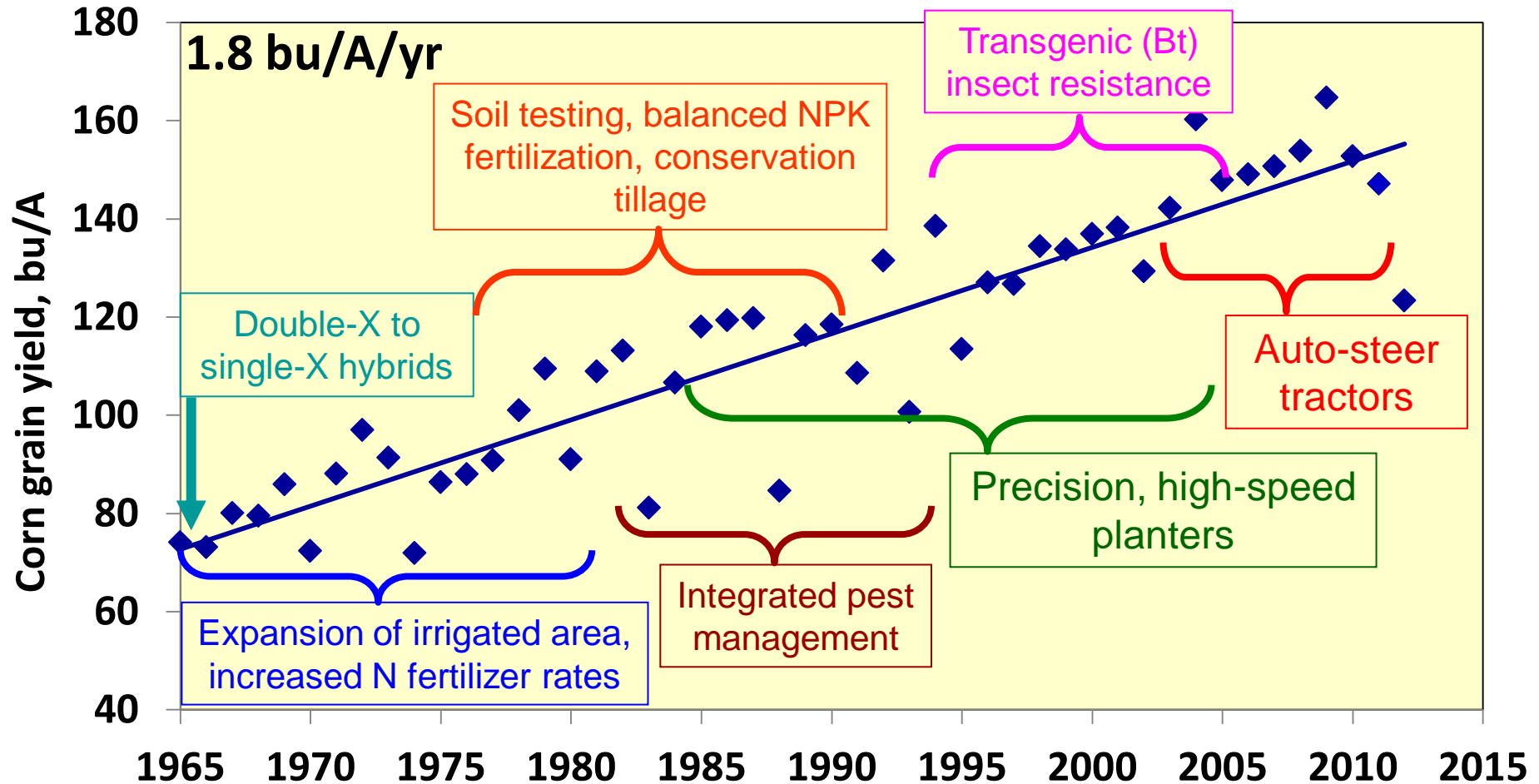


Global Food Security

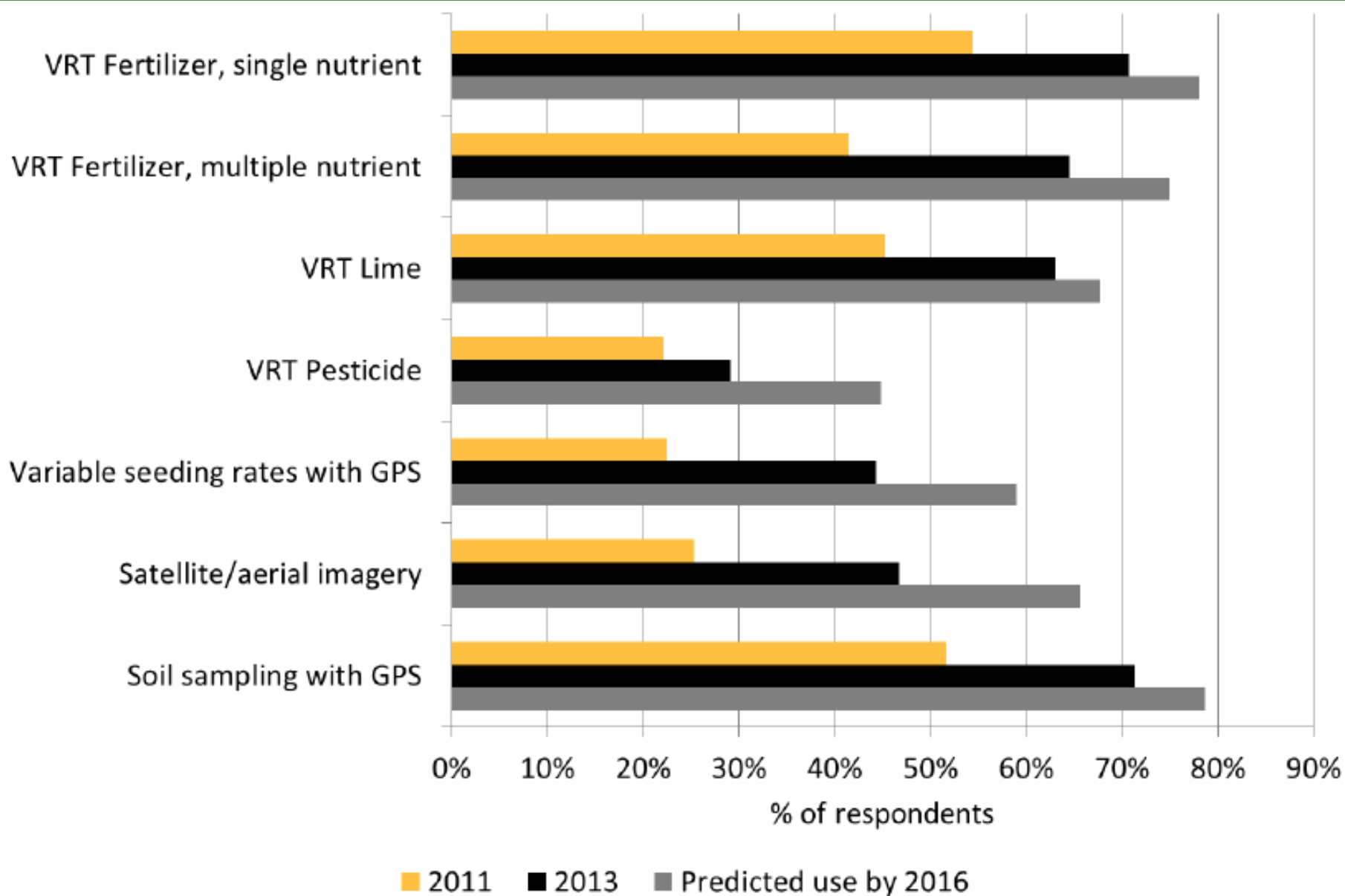
- Recent study by the International Food Policy Research Institute (IFPRI) estimated that stacking agricultural technologies could increase global crop yields as much as 67% and cut food prices nearly in half by 2050.
- Key areas for prioritized investments:
 - No-till farming
 - Integrated soil fertility management
 - Improved crop protection
 - Irrigation
 - Precision agriculture



US average corn yields, 1965-2012



Precision Agriculture

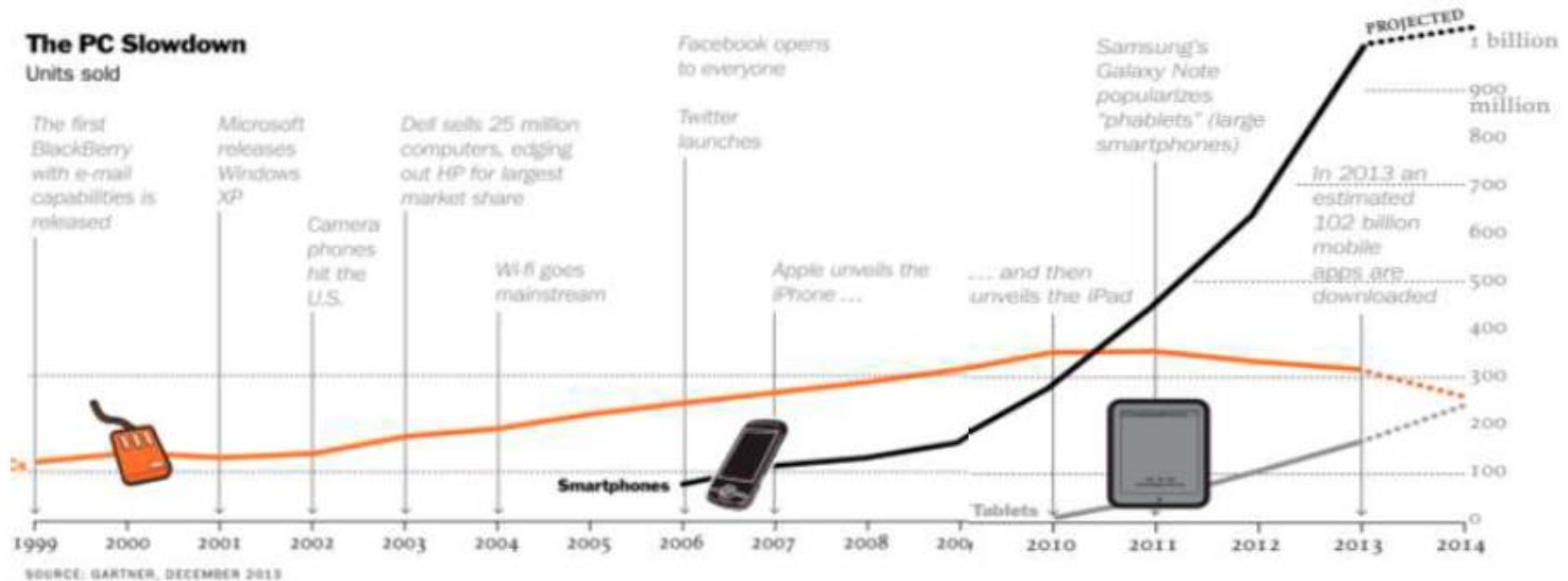


Top Five Trends in Precision Agriculture - 2013

1. Mobile Devices
2. Database Integration
3. Variable-Rate Applications
4. In-Cab Solutions
5. Unmanned Aerial Vehicles

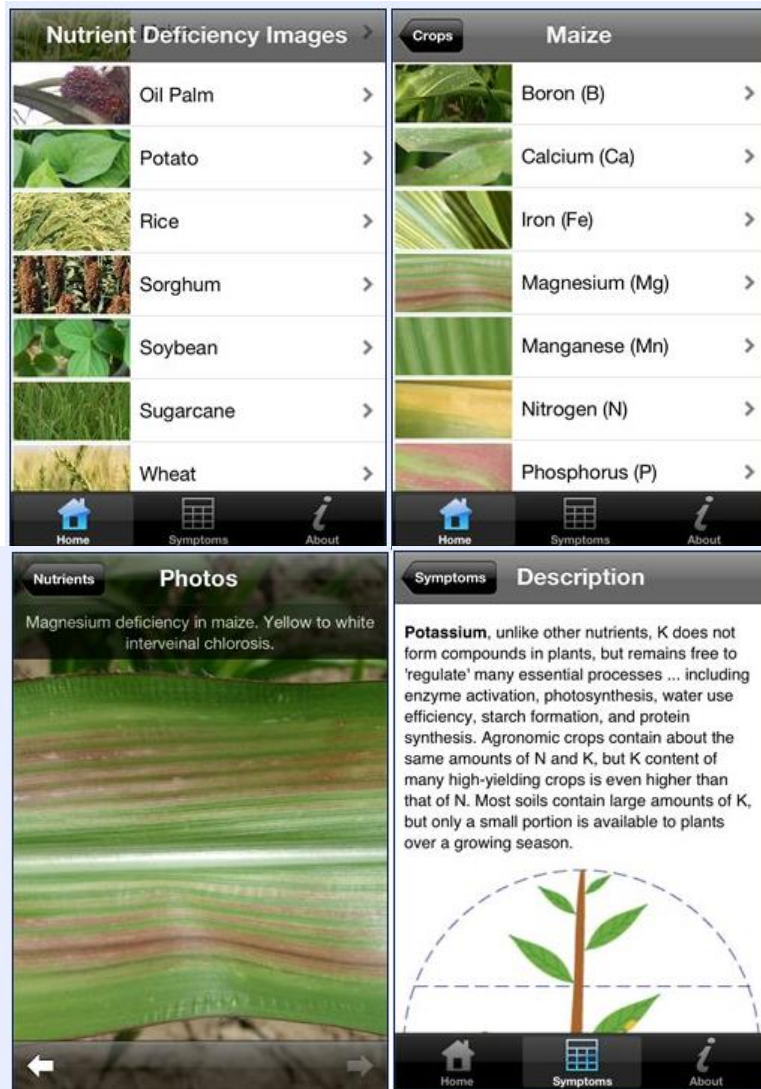


Top Trend #1: Mobile Devices

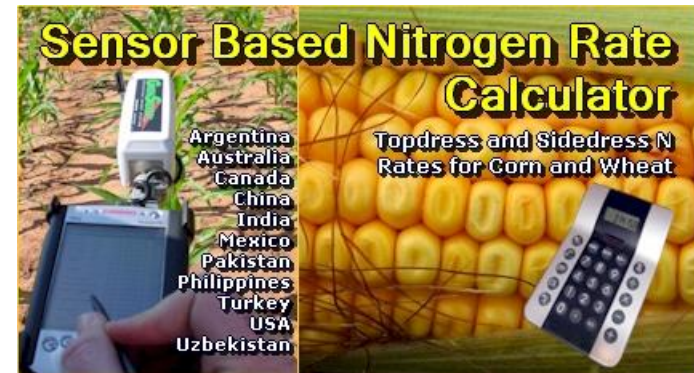


Source: Time, January 13, 2014

Agricultural Applications



- Identification tools
 - Weeds, Nutrient Deficiency, Pests
- Input Calculators
 - Seed, Chemical, Fertilizer



- News, Weather, Market Updates

The screenshot displays the DTN/The Progressive Farmer mobile application interface. The top navigation bar includes the app name, a location pin icon, and the current location (74370). The main content area is divided into several sections:

- Latest:** A vertical list of news items with thumbnails and titles, including "Urban Chickens: The Po...", "Soybean School: Intro...", "Soybean School: Aph...", "Tractor Boy Song Is A...", "Canola School: The Bas...", and "Corn School - Using Fu...".
- Post:** A featured article titled "Corn School: How to Scout for & Control Western Bean Cutworm" dated Jul 5, 2013, 10:48 AM. The article text discusses the pest's impact on corn crops and provides a link to more episodes.
- POWERFUL PROTECTION:** An advertisement for Guardol, a liquid "tanker" protection additive for shields engines from wear.
- It's That Time:** A section with a video thumbnail and text about the release of three "tiger" USB reports.
- Midwest Urged to be Alert:** A section with a video thumbnail and text about soybean rust and its early appearance in southern growing regions.
- Conservation Works Where Used:** A section with a video thumbnail and text about a new report on how calls have been severely damaged during heavy rains.
- RMA Acreage Deadline Re:** A section with a video thumbnail and text about the USDA RMA.
- Weather:** A section showing current conditions for Stillwater, OK (74370), with a sunny forecast and a temperature of 97°F. It also includes a 5-day forecast and a map of the region.
- Markets:** A section showing market data for various commodities, including Corn, Soybeans, Wheat, and Lean Hogs, with their respective prices and changes.
- AGWEB:** A section with the text "POWERED BY FARM JOURNAL" and a link to "Latest News".
- Final Chapter on Yields is Yet to Be Written:** A section with a video thumbnail and text about the second Friday in a row, corn and soybean values were pounded lower.

The bottom navigation bar includes icons for Home, Search, and other app functions.



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- **Other Calculators**
 - Plant Population, Nutrient Removal

AG-PHD Corn

Seeds per pound: 1450

Seeds per square foot:

Crop Price (\$):

Mosaic

Select Crop	Select Yield	Results in lb/A	
Alfalfa	60 Bushels	Canola - 60 Bushels	
Apples		Nutrient	Total
Barley		N	113
Bell Peppers		P205	55
Bermudagrass (Coastal)		K20	28
Bermudagrass (Turf)		Mg	25
Cabbage		S	20
Canola		<input type="button" value="E-mail"/> <input type="button" value="Save"/>	

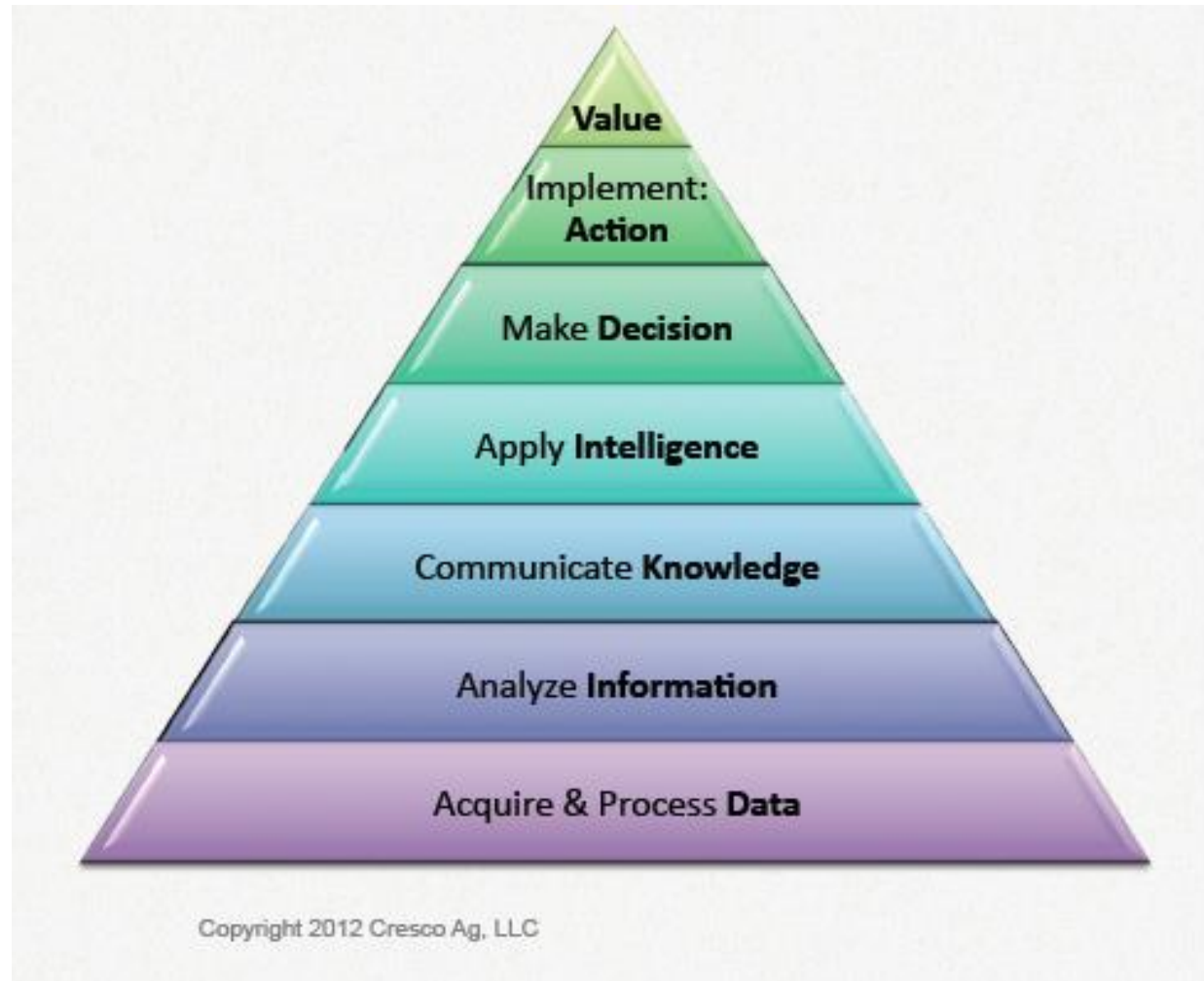


Top Trend #2: Database Integration

- Compatibility of tools
- Integration of outside data
- Improvements in decision making
- Wireless data transfer

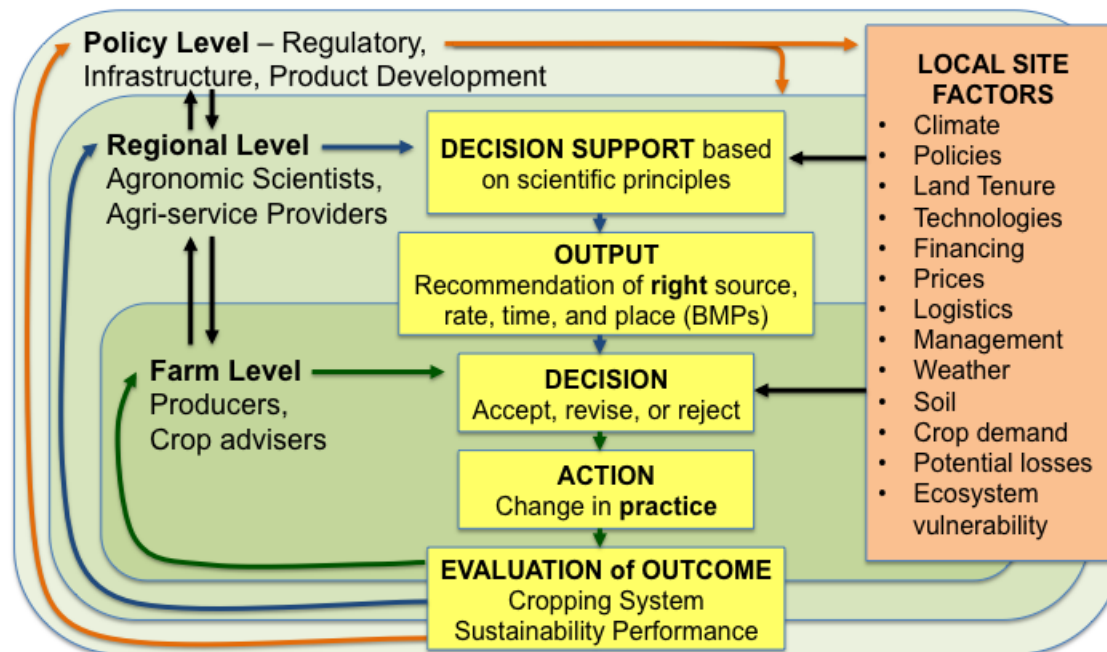


Data have no value...



Accountability

- The inclusion of accountability is another way 4R stewardship moves beyond traditional nutrient management. One of the main ways this is accomplished is through the inclusion of a dynamic feedback mechanism.
- Precision agriculture tools can provide the feedback and recordkeeping necessary for the accountability that is needed in nutrient management.

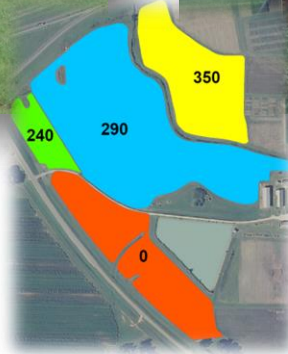


Top Trend #3: Variable Rate Applications

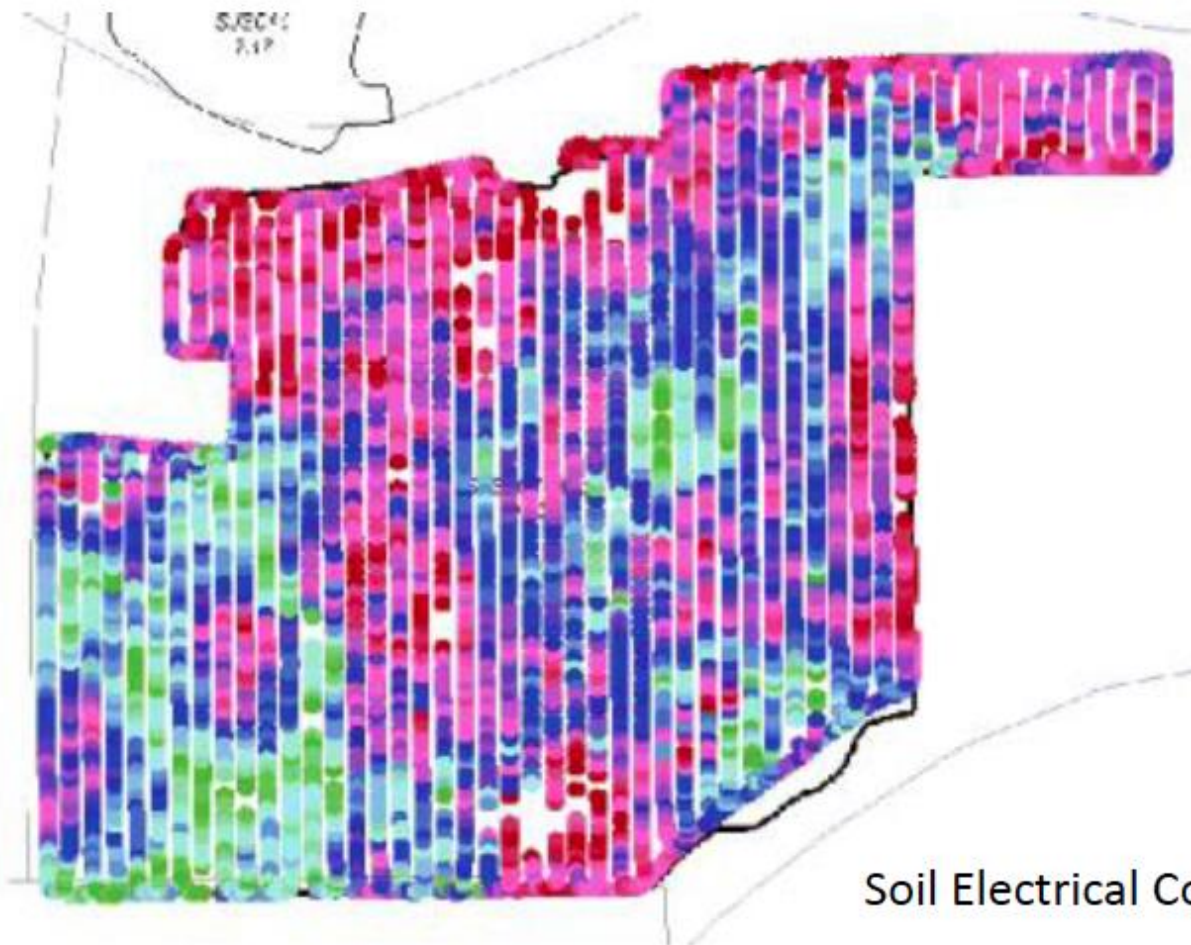
- Application based on field and crop variability
- Apply only what is needed
- Deliver inputs more accurately



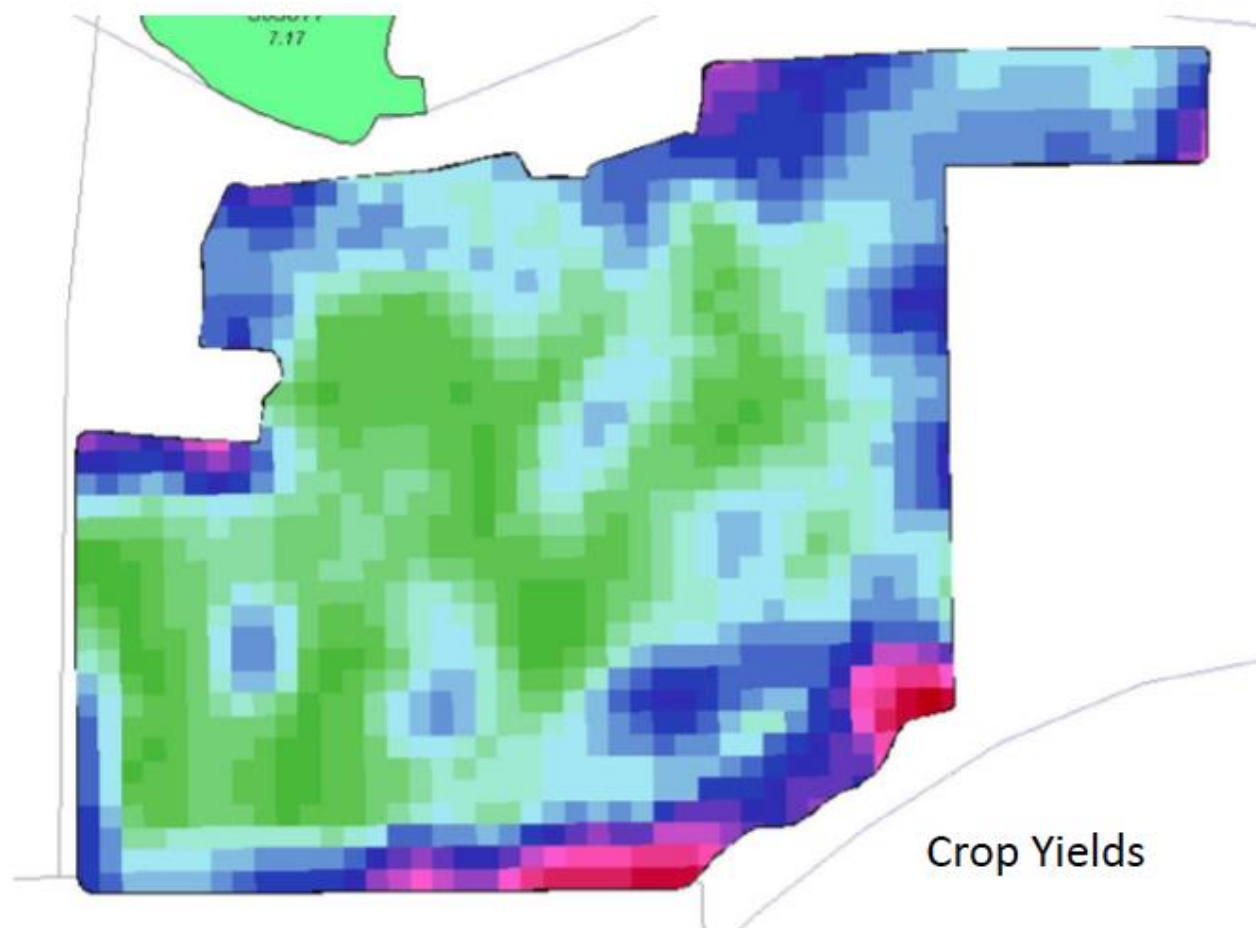
Applying only what the plant needs,
or soil can handle.



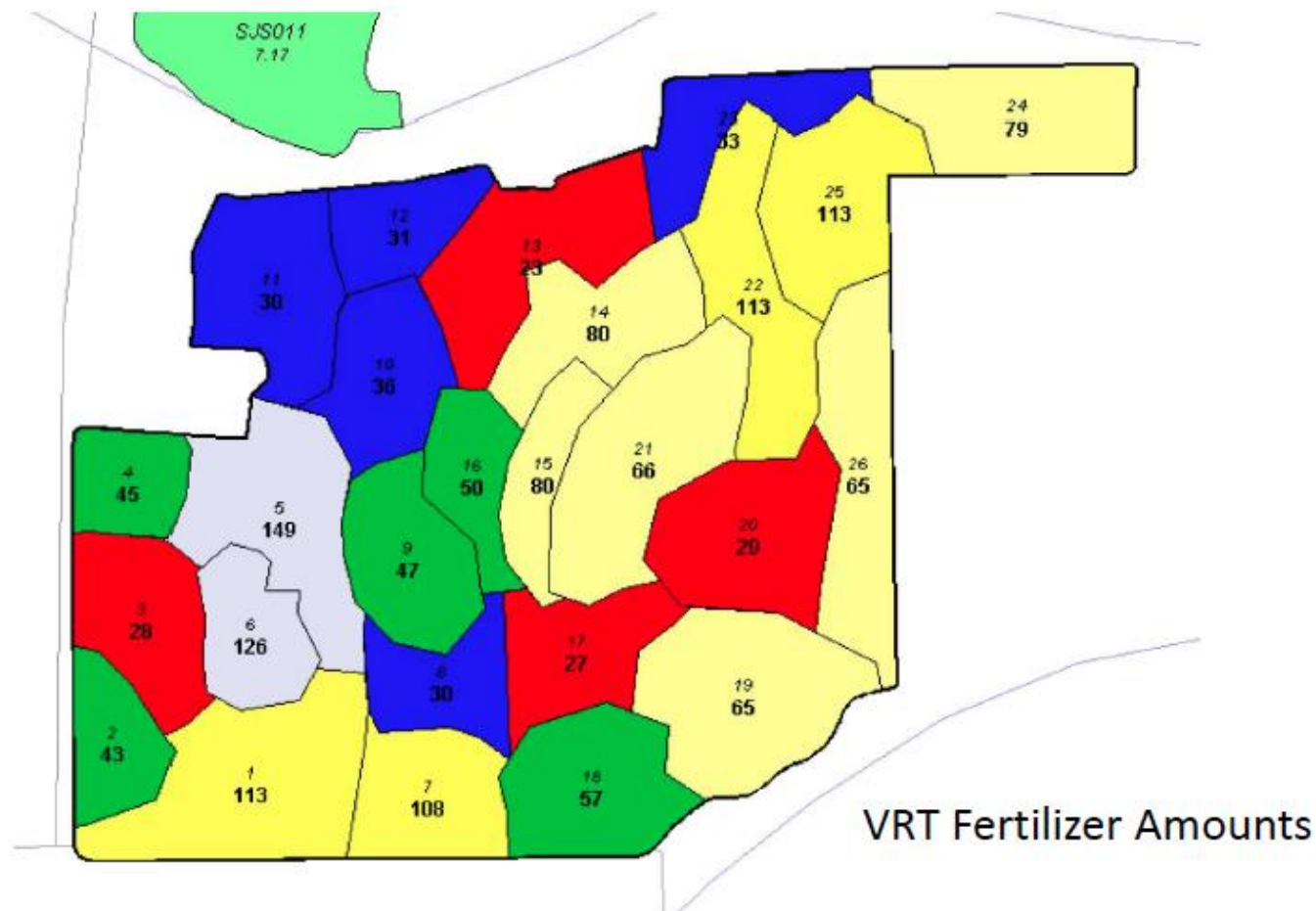
Crop Environments are Variable



Crop Outputs are Variable



Crop Inputs are Variable



Precision Planting



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Variable Hybrid Planting

Defensive Soils

+6.8 Bu/A +\$40.12



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Variable-Rate Seeding

VR seeding as opposed to planting
whole field at 64K

% of land with
low yield
potential

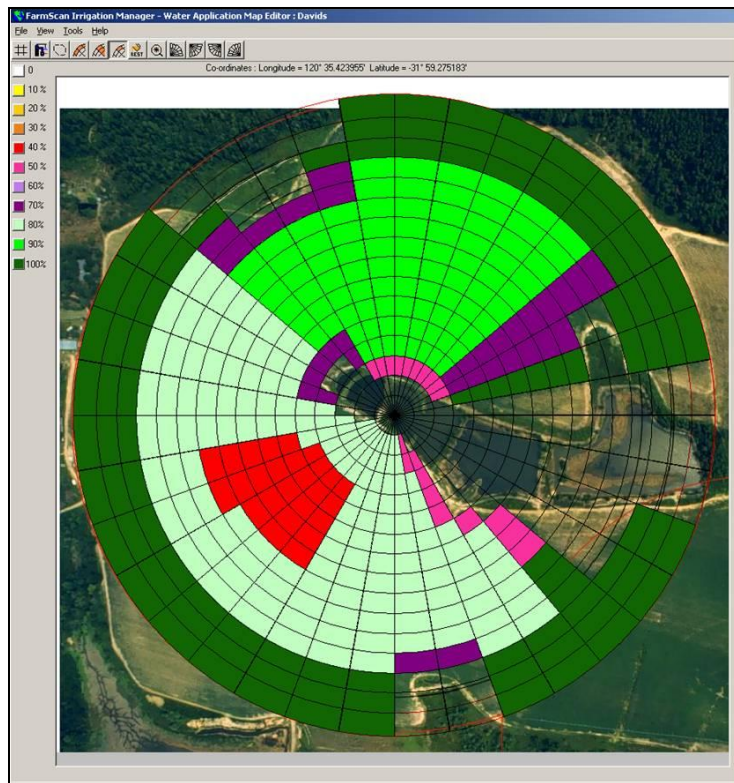
VR Seeding
Savings

-----\$/ha-----

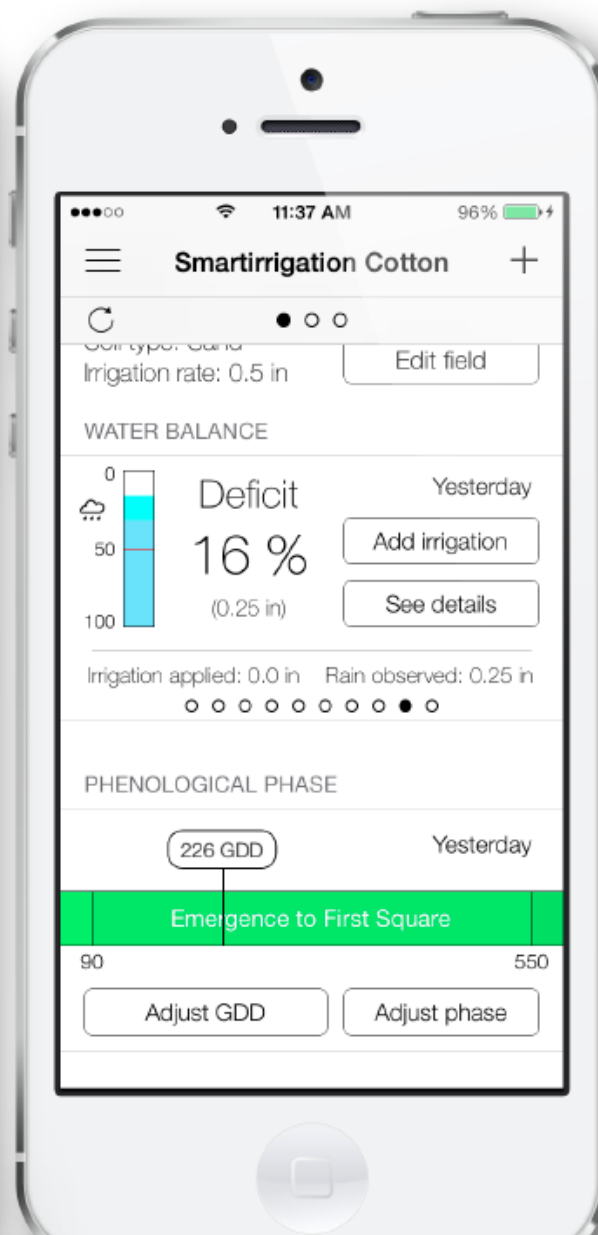
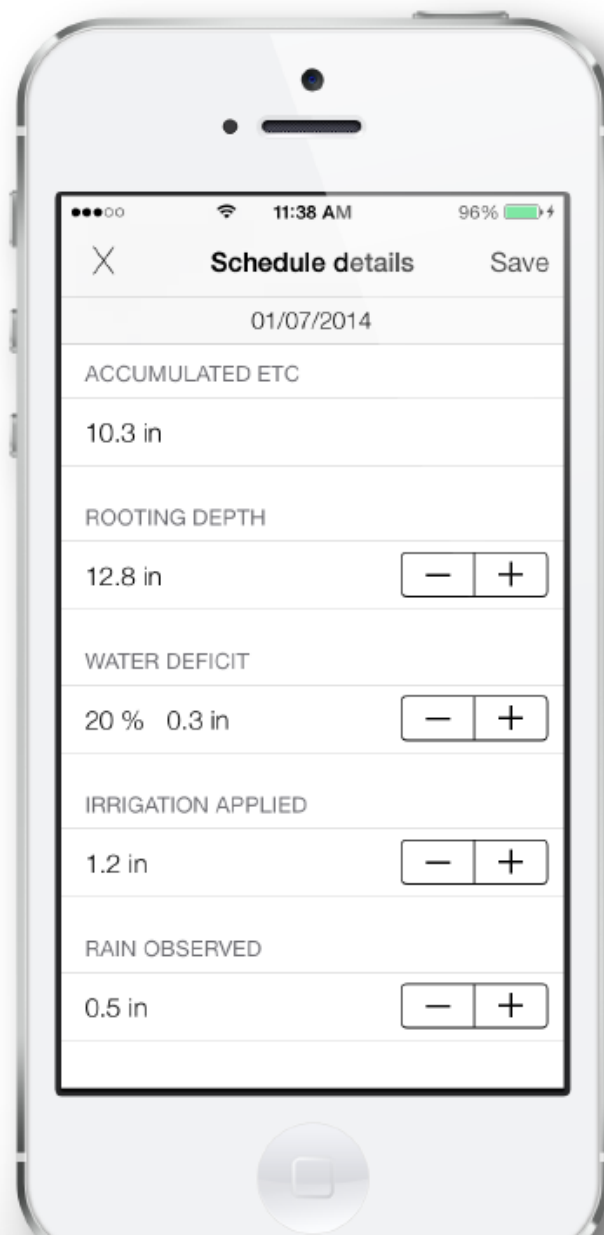
5%	0.32
10%	0.74
25%	11.68
50%	30.01
75%	48.04



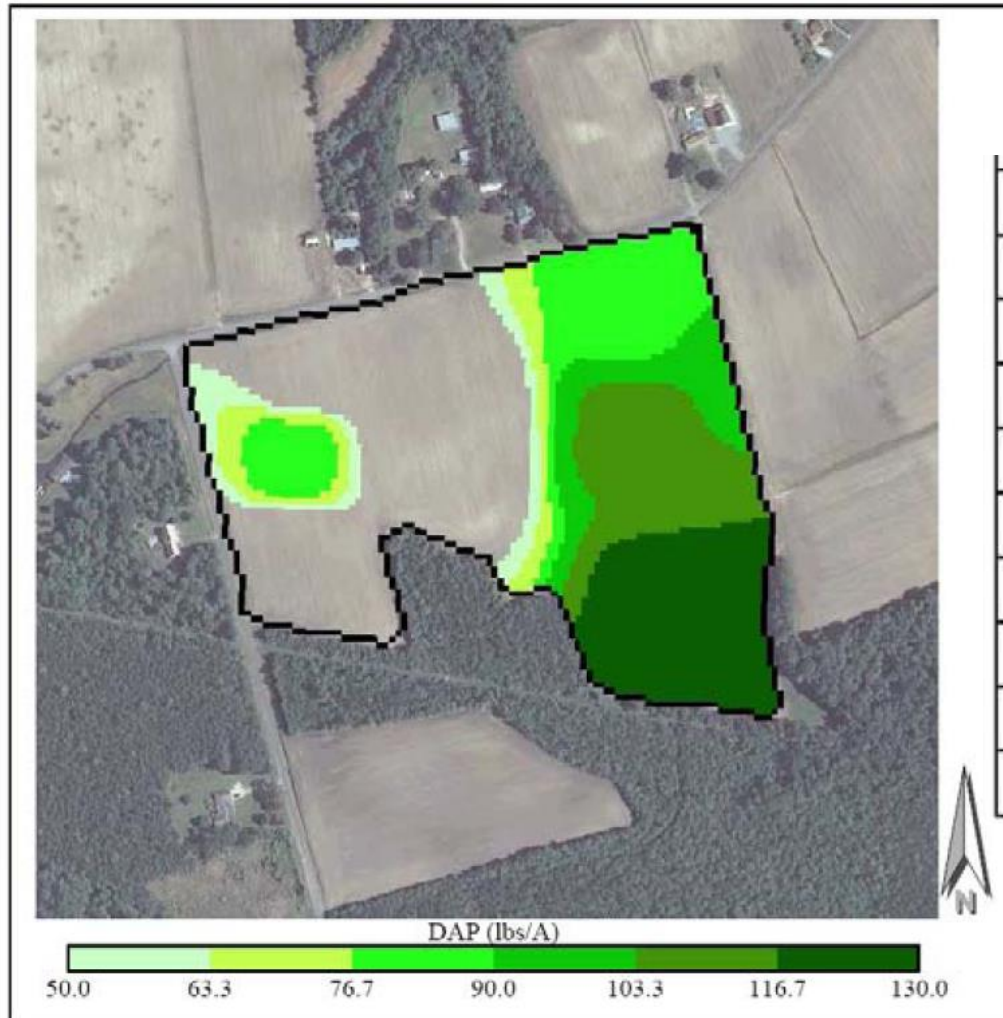
Precision Water Management



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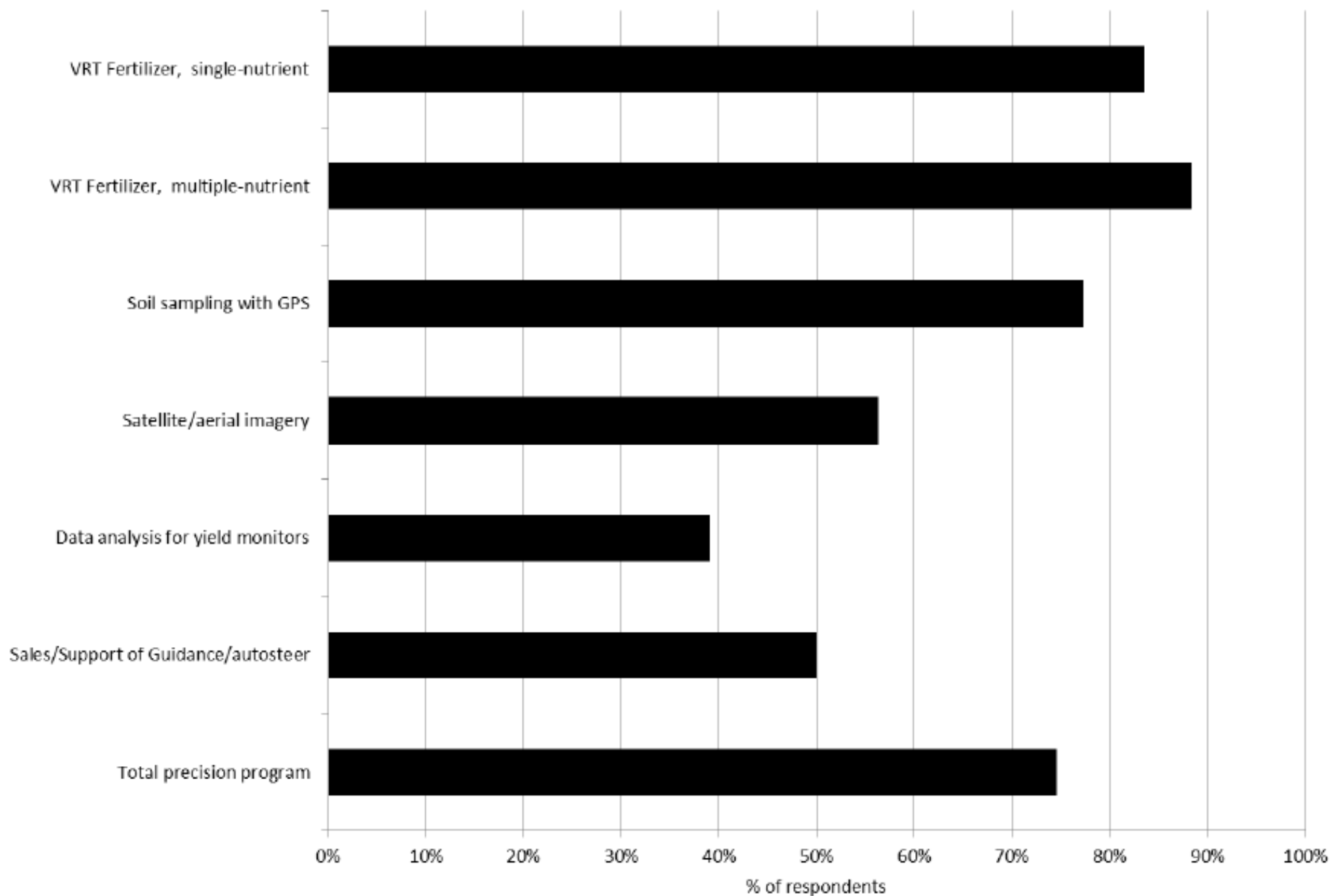


Map-Based VR Nutrient Application

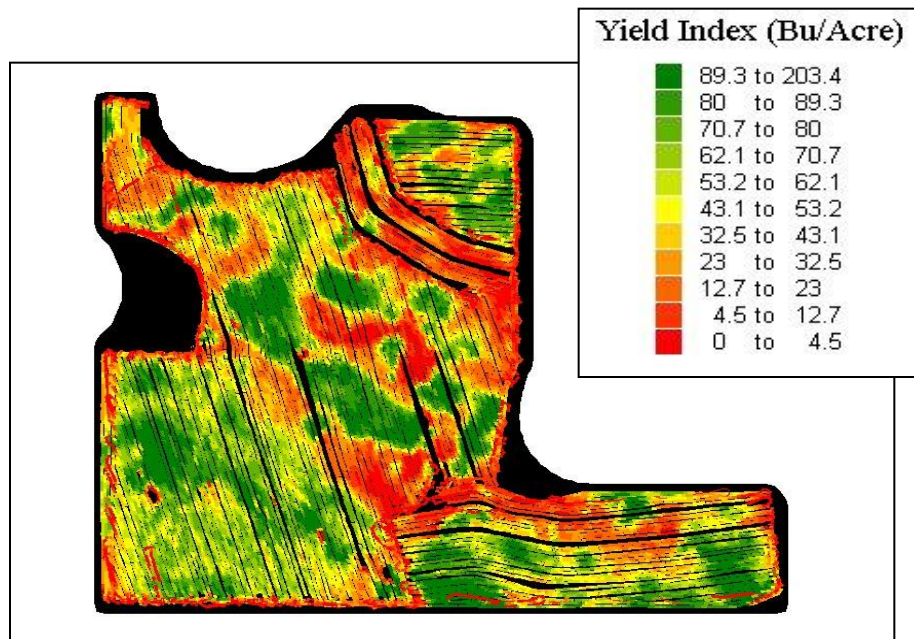


Product	
Addition/Deduction(lbs/ac):	None Entered
Percent of Original App:	100%
Minimum Application Rate:	54 kg/ha
Maximum Application Rate:	145 kg/ha
Field Average Rate:	108 kg/ha
Total Applied Acreage:	8.3 ha
Total Field Acreage:	13.1 ha
Total Field Acreage(lbs):	2001.6
Total Field Acreage(tons):	1.00

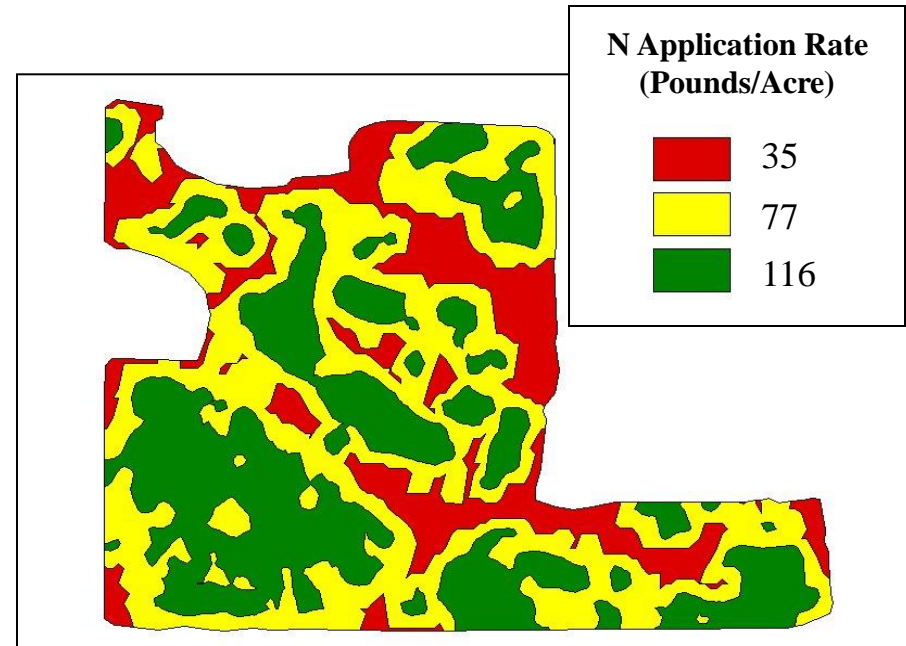
Figure 3. Dealerships Generating a Profit for Precision Services



Yield Monitoring

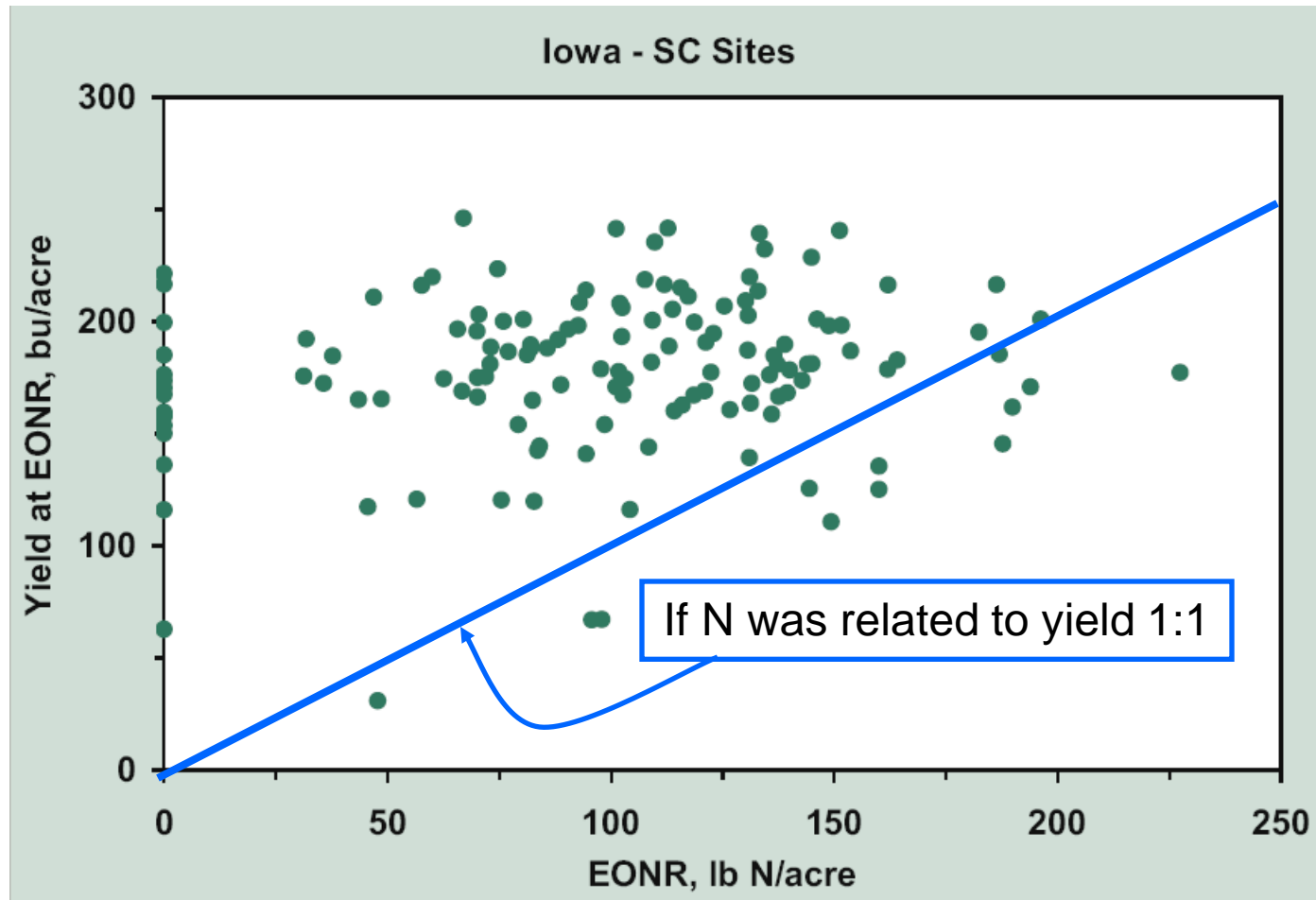


Yield Map



Following Year
Nitrogen Application Map

How does yield relate to N rate?



Up and Coming Technology: Crop Sensors



GreenSeeker®
Variable Rate Application and
Mapping Systems



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Estimated acreage of N-Sensor based fertilization in main European markets (2013)

Country	No. of N-Sensor units	Acreage with N-Sensor fertilization
Germany	640	700,000 ha
UK	260	350,000 ha
Sweden	110	65,000 ha
Czech Republic	55	45,000 ha
France	55	35,000 ha
Denmark	55	30,000 ha
Total	1175	1,225,000 ha

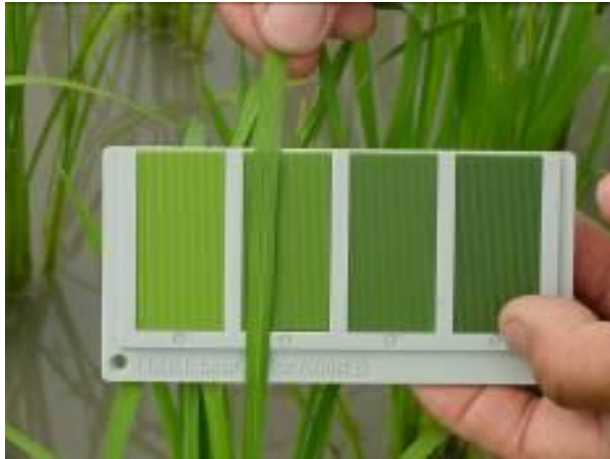


Crop Sensor Uses

- Nitrogen application in corn and wheat
- Weed pressure mapping
- Plant growth regulator and defoliant applications in cotton
- Stress and damage in soybeans and peanuts



Decision Support Tools integrate the numerous site factors used in making decisions about nutrient management practices...



Nutrient Expert™ for Wheat

South Asia (Version 1.0, March 2013)

[Settings](#) [About](#) [Help](#) [Exit](#)

First time user? Working in a new location? Make sure to have the 'Settings' right!

Nutrient Expert for Wheat is a decision support tool for developing farmer-specific fertilizer recommendations. It helps you to:

- evaluate current nutrient management practices
- determine a meaningful yield goal based on attainable yield
- estimate fertilizer (NPK) rates required for the selected yield goal
- translate fertilizer NPK rates into fertilizer sources
- develop an application strategy for fertilizers (right source, right rate, right time, right place), and
- compare the expected or actual benefit of current and improved practices.

To start, click a button

Current
FFP & Yield

➔

SSNM
Rates

➔

Sources &
Splitting

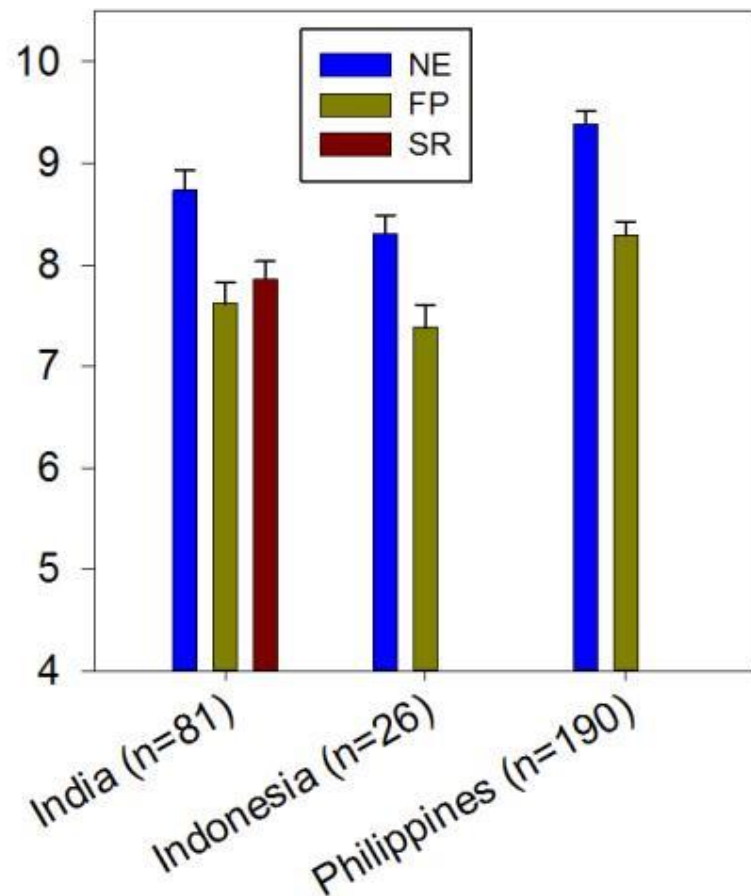
➔

Profit
Analysis

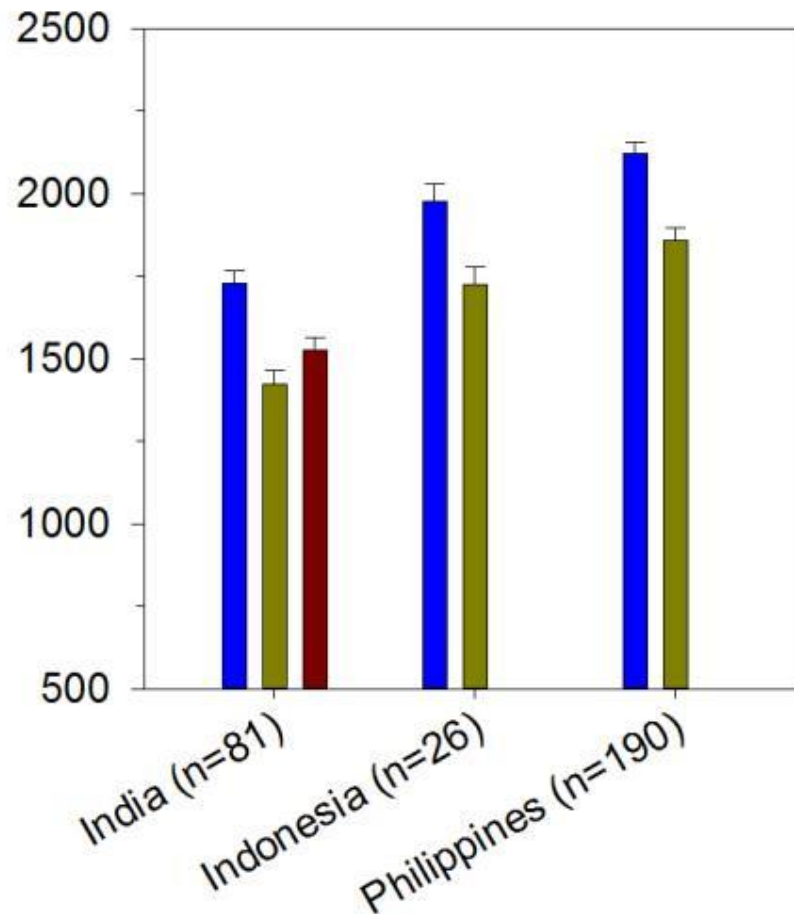
Field validation results of Nutrient Expert for maize

India, Indonesia, Philippines (2010-2013):
Farmers' current yield level < attainable yield

Grain yield (t/ha)



GRF (USD/ha)



GRF = gross returns above seed and fertilizer costs

NE for maize performance across 24 sites in the Philippines

Parameter	Unit	FFP	NE	Difference (NE – FFP)
Grain yield	t/ha	7.49	9.16	1.67 ***
Fertilizer N	kg/ha	114	132	18 ns
Fertilizer P ₂ O ₅	kg/ha	26	36	10 ***
Fertilizer K ₂ O	kg/ha	18	35	17 ***
Fertilizer cost	USD/ha	176	241	65 ***
Gross return above seed & fertilizer	USD/ha	1730	2126	395 ***

***, **, *: significant at <0.001, 0.01, and 0.05 level; ns = not significant

Data from 24 farmers' fields in six regions under favorable rainfed (maize-maize, rice-maize) environments, dry season 2010-2011

Price of seeds, fertilizer, and maize grain are based on actual local prices; USD 1 = Php 43

FFP vs SSNM (NE) in Iloilo, Philippines



NE for maize performance across 27 sites in India

Andhra Pradesh (n = 27)

Parameter	Unit	FP	NE	NE – FP	
Grain yield	kg/ha	8568	9699	1131	***
Fertilizer N	kg/ha	288	203	-85	**
Fertilizer P ₂ O ₅	kg/ha	153	54	-99	***
Fertilizer K ₂ O	kg/ha	68	74	6	ns
Fertilizer cost	INR/ha	9509	5459	-4050	**
GRF ¹	INR/ha	76167	91770	15603	***

***, **, *: significant at <0.001, 0.01, and 0.05 level; ns = not significant

¹ GRF = gross return above fertilizer cost

Prices (in INR/kg): maize = 10.00; N = 11.40; P₂O₅ = 32.20; K₂O = 18.80

Top Trend #4: In-Cab Solutions

- Automated Guidance
- Boom Section Control



Automated Guidance

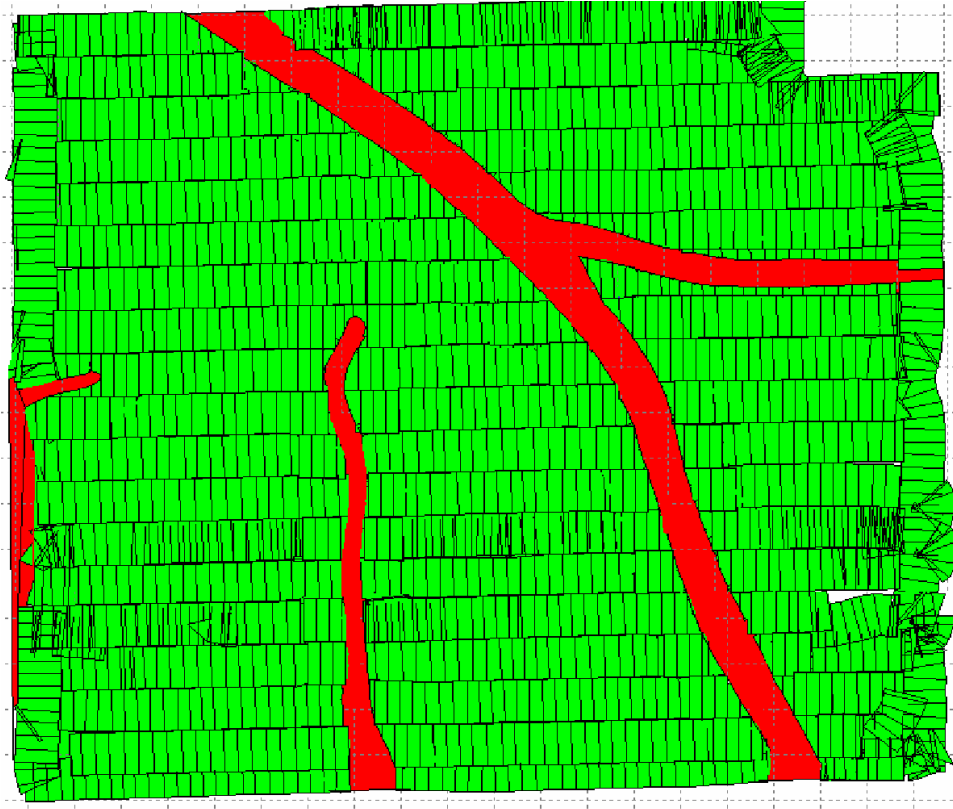


Boom Section Control

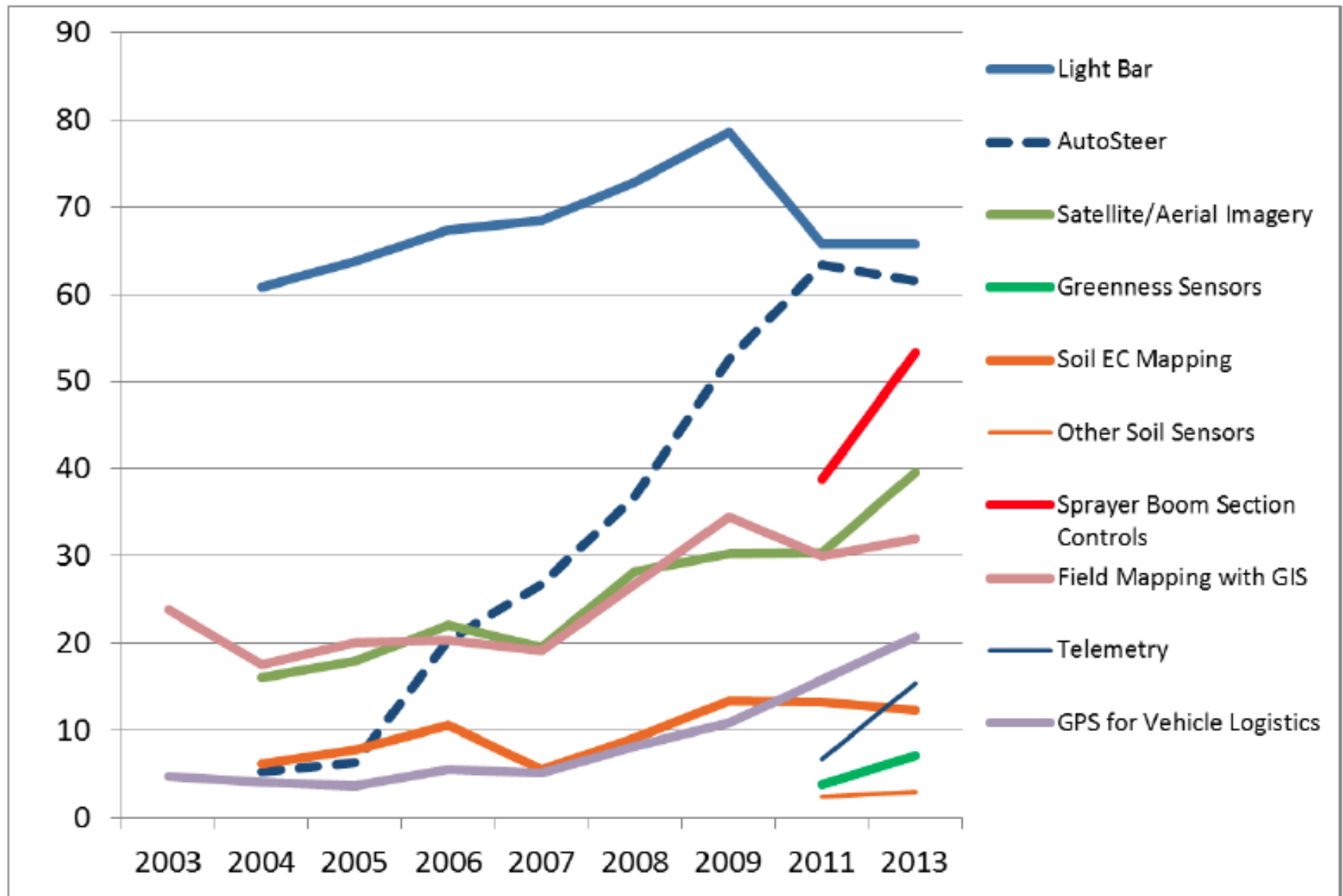


Improved Field Management

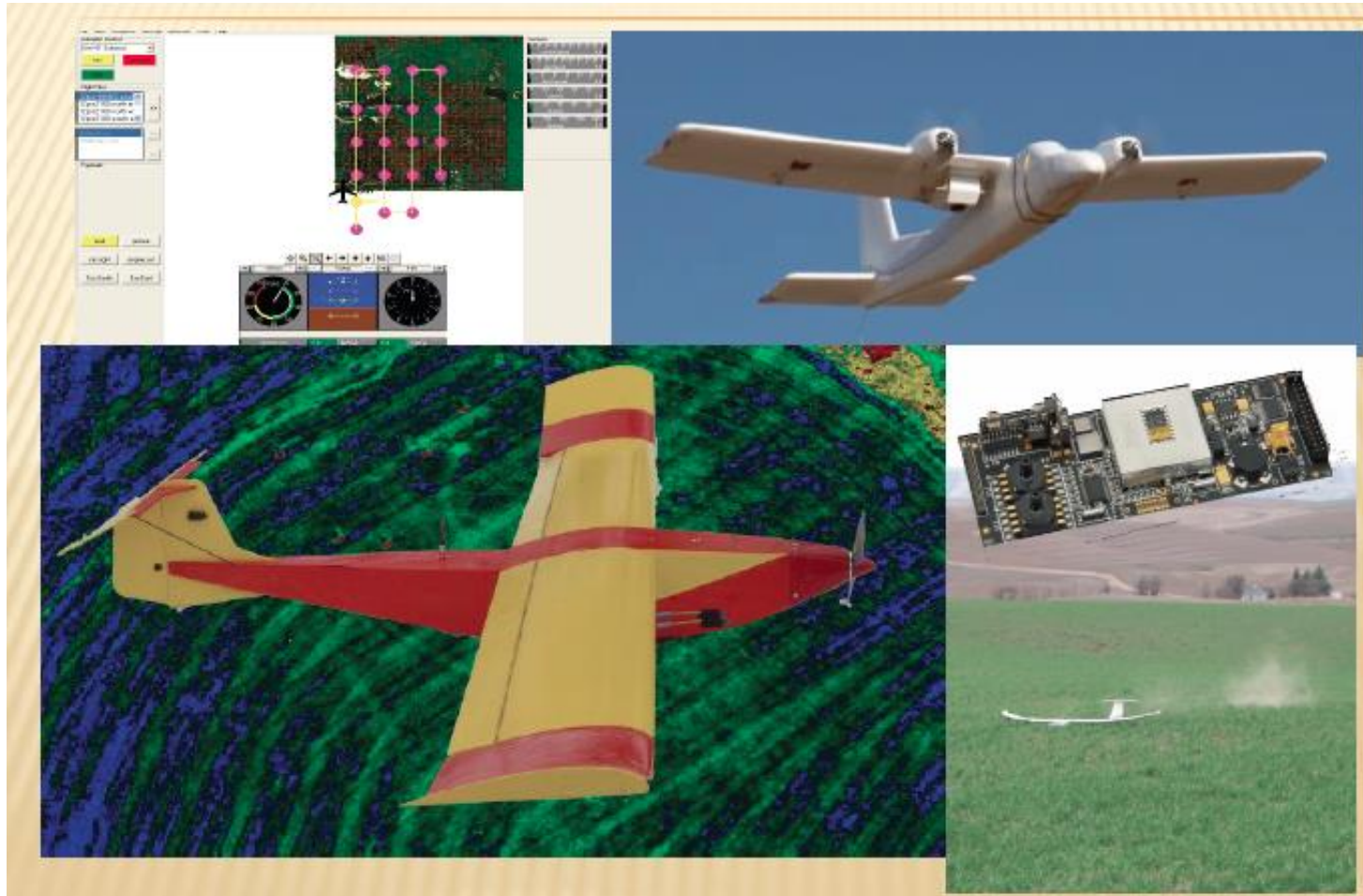
Preservation while Maintaining Production



Dealer Use Over Time



Top Trend #5: Unmanned Aerial Vehicles (UAV)



Unmanned Aerial Vehicle



DraganFly X6

<http://www.draganfly.com>



eBee

<http://www.sensefly.com>



MicroDrone MD4-200

<http://www.microdrones.com>



Yamaha

Fixed-wing



Cropcam



Raven



WASP III

NDVI Camera



UAV Sensors



Tau 640 thermal
imaging camera



Multispectral camera array
(MCA) imaging sensor



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Potential Applications

- ☐ Crop Scouting
- ☐ Bare soil imagery
- ☐ Irrigation and drainage planning
- ☐ Yield estimation and monitoring
- ☐ Inventory
- ☐ Diagnostic of herbicide injury in crops
- ☐ Selection of plants for further breeding
- ☐ Sampling plant pathogens in the air
- ☐ Academic and extension education

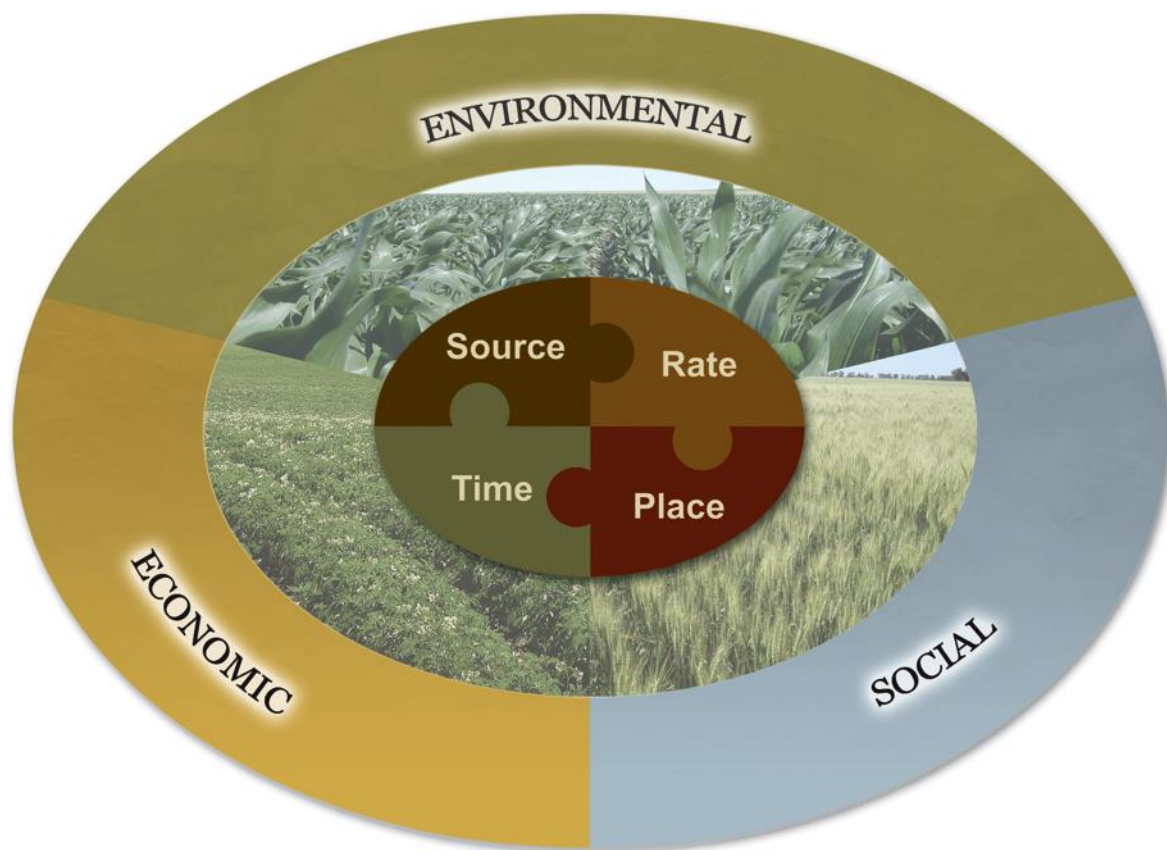
Future for UAVs

- UAV has a lot of potential applications in agriculture and horticulture crops
 - Small farms
- More research is needed
 - Develop tools and techniques
- Rules and regulations are not clear
- Lots of excitement among growers



4R is Precision Nutrient Management

- Implementing precision agriculture technologies within the context of 4R nutrient stewardship is an efficient and effective way to help meet the environmental, economic, and social goals of sustainable agricultural systems



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IPNI Member Companies and Industry Associations



Agrium Inc.



Arab Potash Company



Belarusian Potash Company



CF Industries Holdings, Inc.



ANDA - Associação Nacional para Difusão de Adubos



Arab Fertilizer Association (AFA)



Canadian Fertilizer Institute (CFI)



The Fertiliser Association of India



Compass Minerals Specialty Fertilizers



International Raw Materials LTD.



Intrepid Potash, Inc.



K+S KALI GmbH



The Fertilizer Institute



International Fertilizer Industry Association (IFA)



International Potash Institute (IPI)



The Mosaic Company



OCP S.A.



PotashCorp



Qatar Fertiliser Company (QAFCO)



Simplot



Sinochem Holdings Limited



SQM



Toros Tarım



Uralchem



Uralkali



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