Precision Nutrient Application Technologies

John Fulton

Associate Professor

Food, Agriculture and Biological Engineering Department

The Ohio State University

2015 USDA NRCS Training Webinar

Lake Erie Algea Bloom

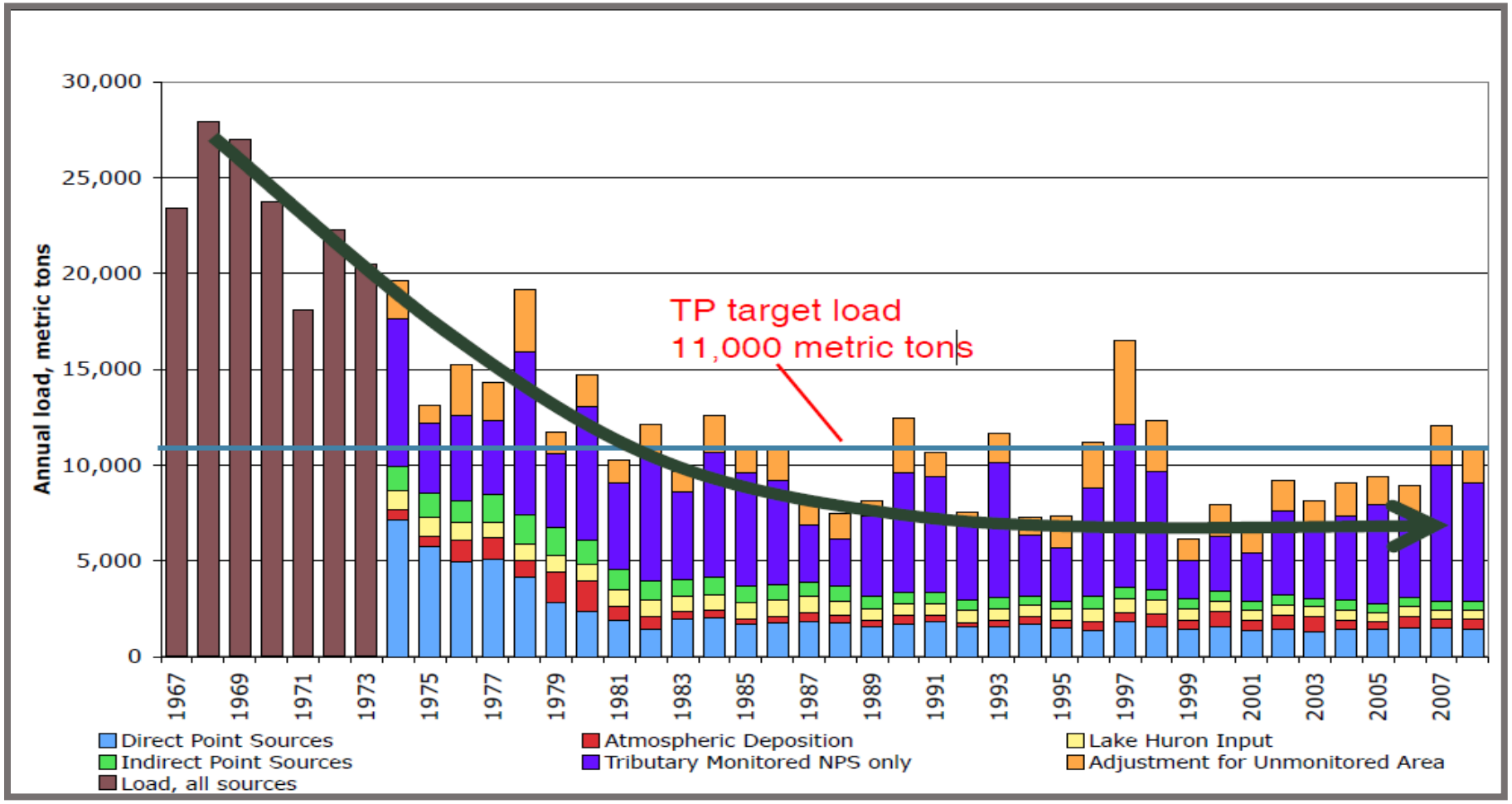
(Low P Loads: *< 2 lb/ac - 3 to 5% of application rates)*

	DRP (lb P/ac)	TP (lb P/ac)
Maumee	0.27	1.10
Sandusky	0.31	1.38
Honey Cr.	0.36	1.27
Rock Cr.	0.25	1.35

(Source: Smith, USDA-ARS)

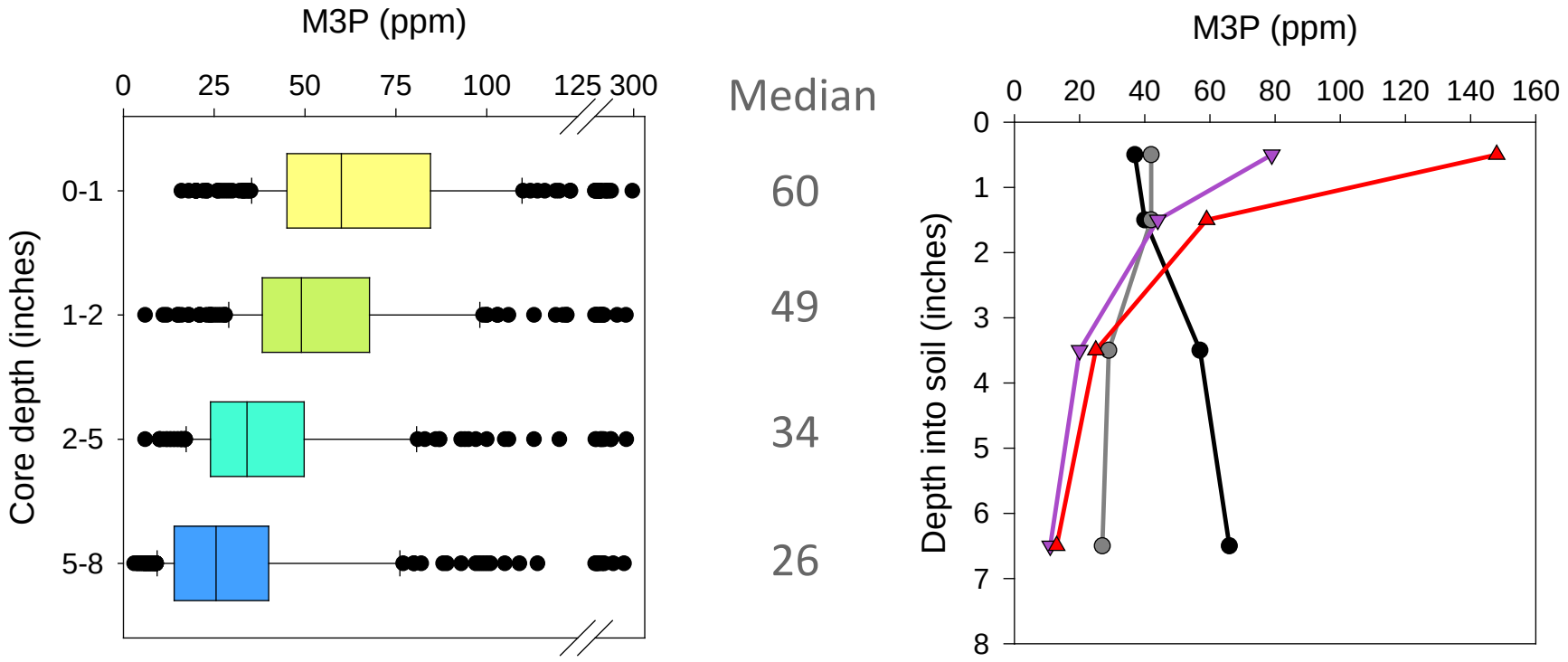
Lake Erie Eutrophication

(Historical Success)



Source: Baker and Richards, Heidelberg University

Soil Nutrient Stratification



- Stratification evident in the top 1 in. of soil (ANOVA, P<0.001, n=232)
- Although the degree of stratification varied some, 85% of the samples had some degree of stratification.

Source: Laura Johnson, Heidelberg University, Tiffin, Ohio

Today's Discussion

Placement, Rate & Timing Opportunities

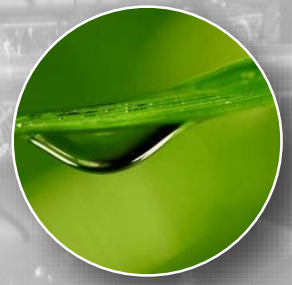
- Precision technologies and benefits
- Basic precision nutrient management (e.g. grid, zone, etc.)
- Nutrient placement and timing options today with available equipment and technology
- Future advancements for in-season nutrient / crop management

Measuring Farm Success

1) Farm profitability
2) Nutrients and water applied
3) Crop yield







Precision Ag Technologies

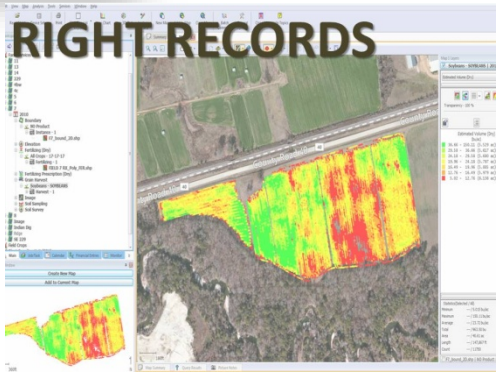
4Rs of Nutrient Stewardship

Tools to ensure accurate

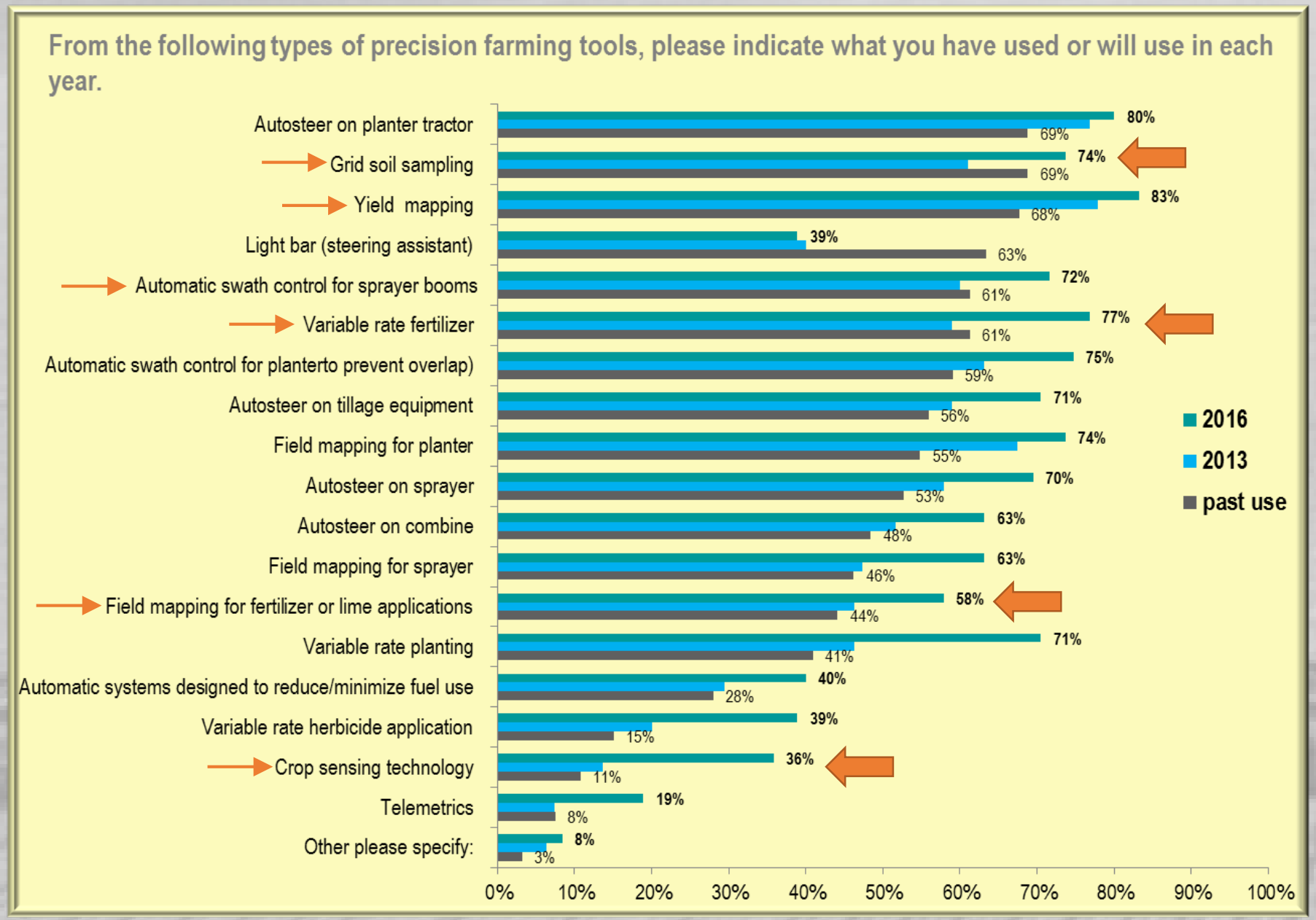
- Metering of inputs
- Placement of inputs
- Timing of inputs (*influenced by environment*)

Tools to enhance

- Nutrient management planning and field execution
- Field documentation/verification
- Record keeping



Variable-rate Application: Corn Growers



Source: PrecisionAg Institute, 2013

Modern Crop Nutrition Equipment

Field Computer

Telematics

GPS

Weather Station

Direct Injection

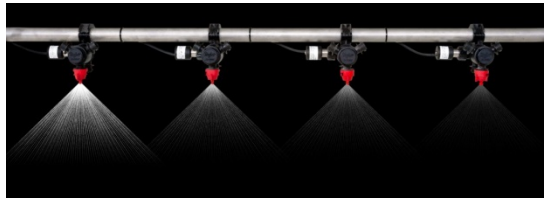
Boom height Control

Steering

Liquid Product Controls

Section Control

Nozzle-by-Nozzle



Technology

- Product control
- Array of sensors
- Displays / Data Visualization
- Wireless communication

Source: Raven Industries

Preservation of Conservation Structures

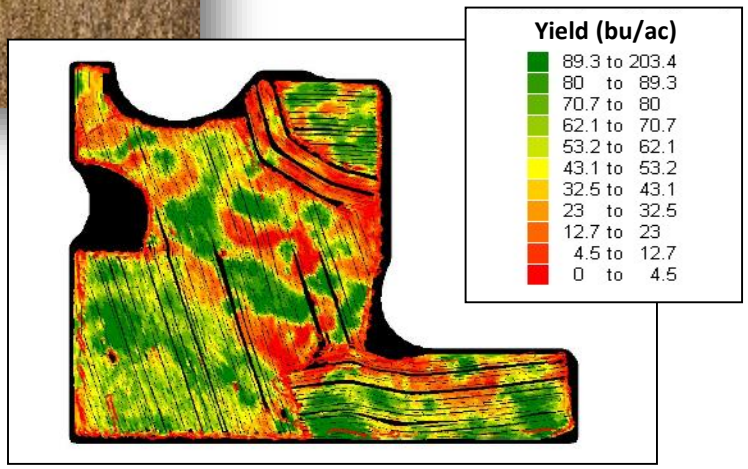
Example during Herbicide Application

Automatic Section Control

Yield Mapping

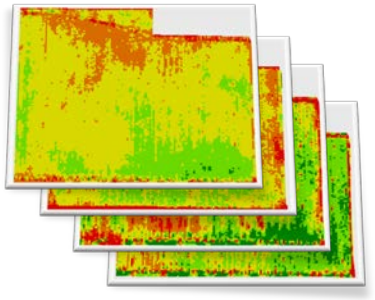
Building Knowledge

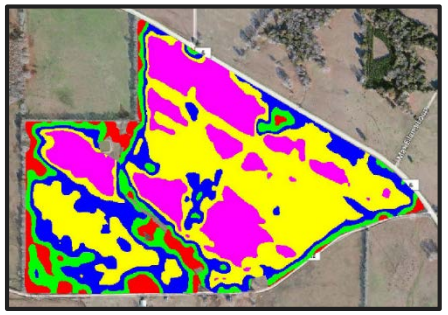
Crop performance in a spatial context



Understand

- Variability
- Nutrient removal
- Multi-year production history
- Costs / efficiency for improving nutrient management (VRA - MZs)





Variable-rate Application of Nutrients

Work Plan (Rx)

- **Must have correct technology /expertise in-place**
  - Rate control (VR) and proper display
  - Agronomic Consultant (spatial)
  - Experience with data management – define zones
- Management zones different from grid approach
  - Both provide beneficial start to site-specific management.
- Nutrient management is dynamic over time
  - Evaluate annually & adjust
- Variable-rate technology improves field execution / placement

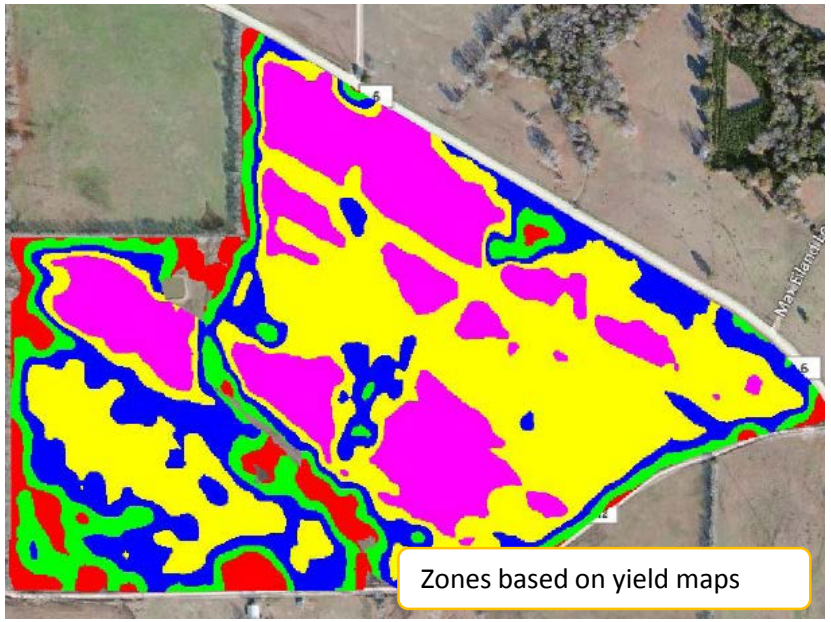
As-applied Documentation

Precision Soil Sampling and Nutrient Management

- A sound precision soil fertility strategy **starts with a quality soil testing program**.
- Precision Ag strategies usually require **more intensive soil sampling** (*common - 2.5 ac; 1-ac or smaller needed based on research*).
- DGPS soil sampling equipment document sample location allowing test results to guide nutrient management decisions plus permit analyses identifying relationships with yield maps, soil maps, and other data layers.

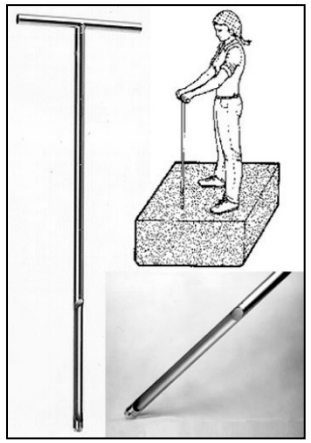
PUBLICATION: **Soil Sampling to Develop Nutrient Recommendations**, LaBarge and Lindsey, 2012 Ohio State University Extension

Precision Soil Sampling - Grid versus Zones



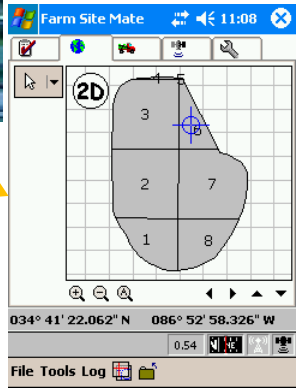
- There is no “best” method for developing management zones.
- Research indicates grid or zone strategy improvement over traditional uniform approach **if field variability exists**.
- **Zones / Grids must be analyzed, evaluated and adjusted over time.**
- Soil lab results can be easily linked to the sampling points using an AgGIS or GIS program
- What makes sense?

Precision Soil Sampling



Precision Sampling

- Small vehicle
- DGPS receiver
- Field Computer / iPad
- Bags / Boxes / Buckets
- Soil sampler, etc.



WINTEX 1000 Soil Sampler

Depth of 25-cm

http://wintexagro.com

AgRobotics RapidProbe

www.agrobotics.com

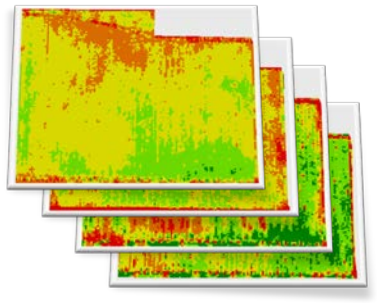
Quality fertilizer recommendations depends on quality soil samples.

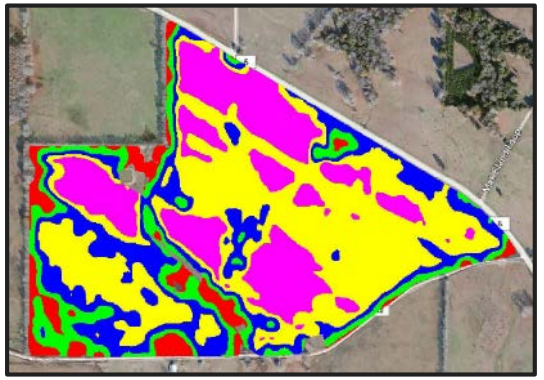
- Sampling depth depends on the crop and the tillage depth.
- Soil samples collected and handled correctly.
- Use reputable soil test lab for analysis.
- Soil test results reviewed and understood.
- Recommendations are generated from research calibrated to the same test that was used for the soil analysis (e.g. Melich-1 versus Melich-3) .

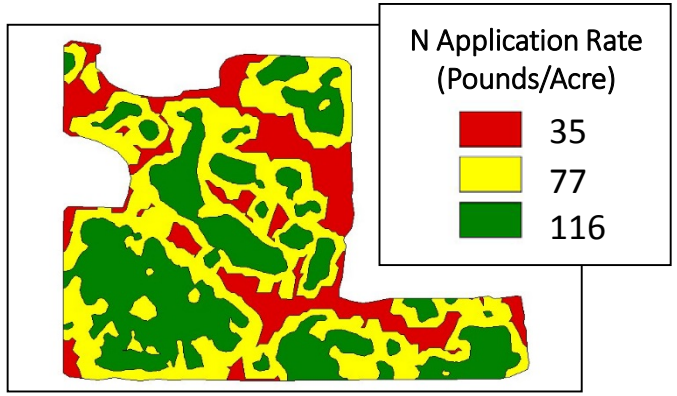
Today's Nutrient Management

Rate, Placement & Timing

- Retailers and agronomists offering **precision agriculture services** and developing innovative nutrient management strategies.
  - **DATA LAYERS:** Successive sampling maps + fertilizer application RXs + crop removal + additional layers provide development of a farm GIS database (field level).
  - **DATA ANALYSIS:** These data layers provide further analysis to compute details for fertilizer recommendations, nutrient use-efficiency, benchmarking and sustainability measures permitting fine-tuning of nutrient management decisions.
- **Equipment** (*high clearance, subsurface placement*) **+ Technology providing new opportunities** for accurate placement and application windows.







Fertilizer Placement Options

Broadcast - fertilizer is broadcast on the soil surface, usually some incorporation with either primary or light tillage.

Starter - fertilizer placed in a band near the seed in the planting operation (2x2), band can be placed at various distances from the seed.

Pop-Up - fertilizer placed in contact with seed, liquid and dry materials can be used as “pop-up” fertilizer.

Relay – fertilizer placed using a combination of starter (2x2) and pop-up.

Deep Band (injection) – fertilizer placement in a band at a depth of 4 to 6 inches below the soil surface, frequently used in conservation tillage systems.

Surface Band - fertilizer placed in a band on the soil surface, incorporated with either a primary or secondary tillage operation.

Dual Band - combination of a pre-plant application of anhydrous ammonia and liquid fertilizer, two lines attached to one shank.

Source: George Rehm, Soil Scientist, University of Minnesota Extension

Nutrient Management in Corn

Traditional Application Timing Windows

Phosphorus Windows
(Fall or Early Spring)

Pre-plant Application
(Fall or Spring)

Starter @
Plant

Side-dress

Nitrogen Windows

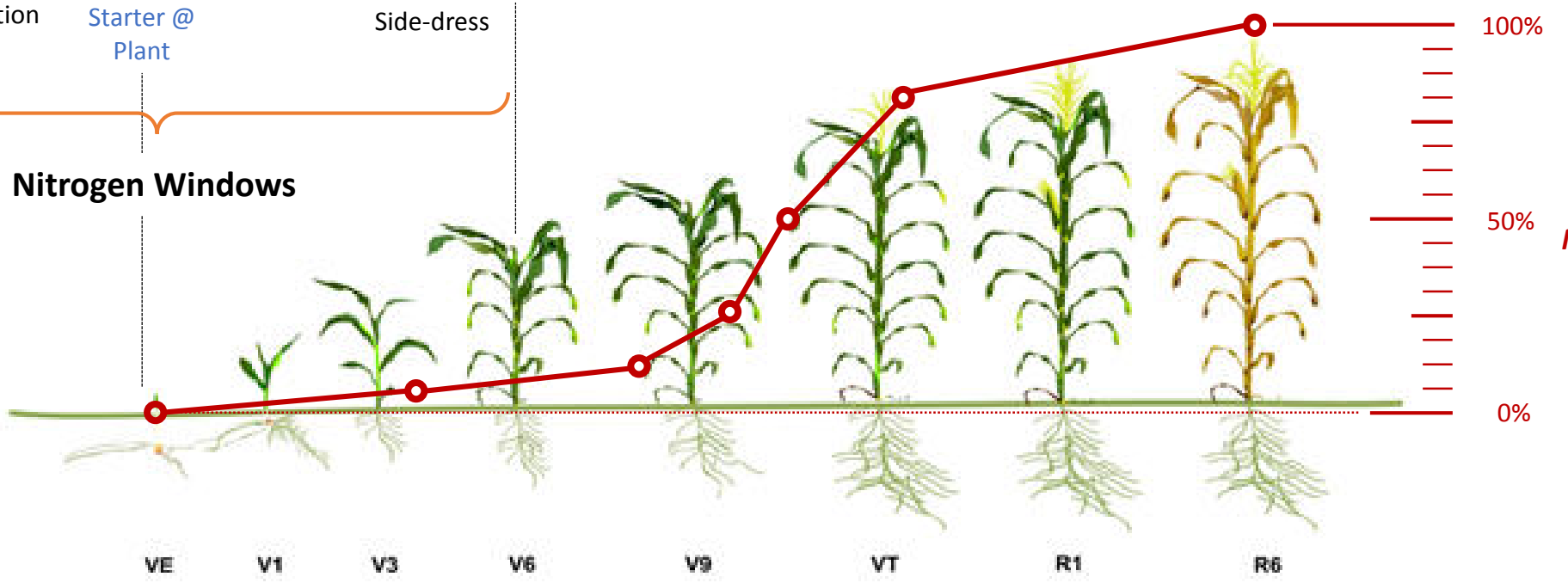


Image Source: www.Pioneer.com

Corn Stages by N Uptake

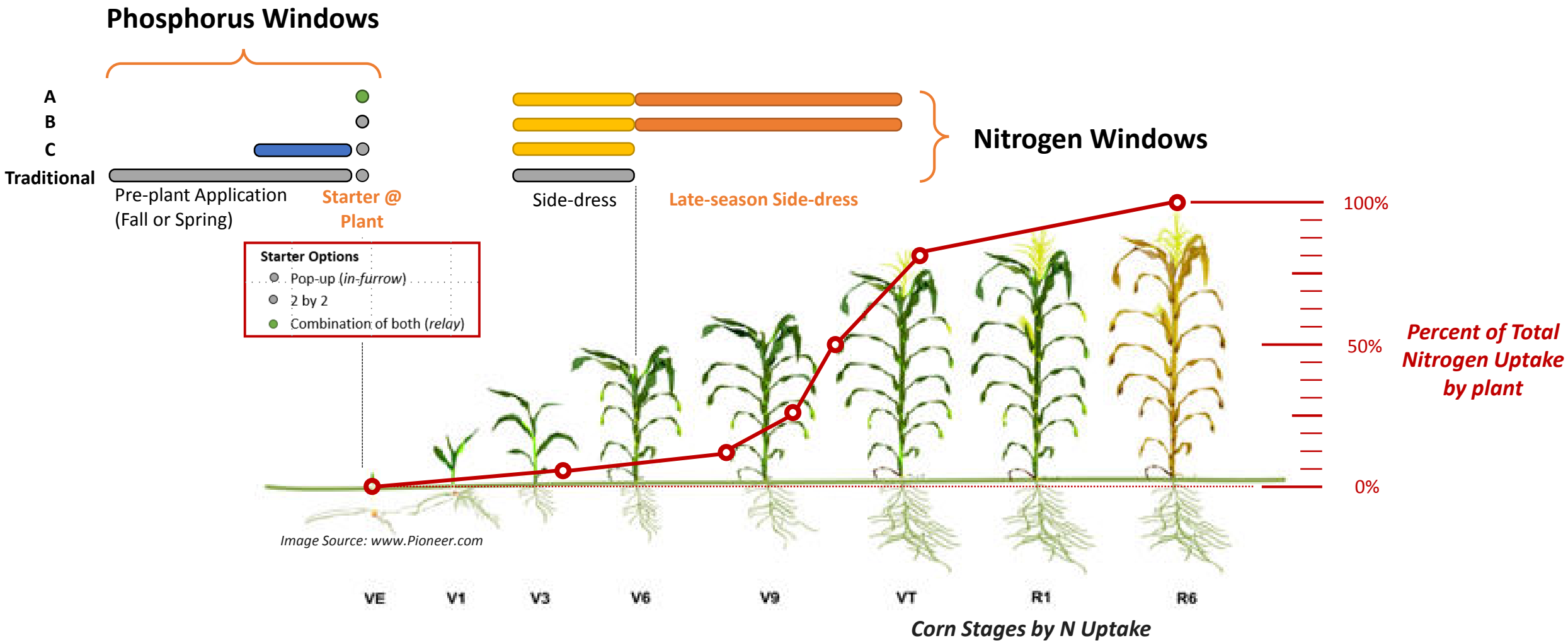
Traditional N Side-dress in Corn

Research Studies

- Split N applications generally provide yield benefit with reduce run-off / leaching.
- Side-dress N applications between V4-V6 corn delivered N more effectively; at times can provide higher yields with lower N rates.
- Most profitable N rate varies significantly from field-to-field and within fields.

Nutrient Management **Opportunities** in Corn

Alternative Application Windows & Techniques



High Clearance Spreader

Extend in-season application window

Dual or multiple hopper setups

Late Season Application

High Clearance

Y-Drop

Hagie NTB
40 or 60-ft width

Strip-till / Injection Technology

Orthman 1tRIPr (one-tripper) strip-till machine

Strip-till Considersations

- **Proper P placement** – universal solution may not be possible w/ varying soils and terrain
- **Proper P mixing** - may require correct shanks/attachments for soil type
- **Ground speed** – field capacity (ac/hr) must not be compromised or limited adoption
- **RTK GPS Correction** – recommended to either center planted row within strip or relative to nutrients

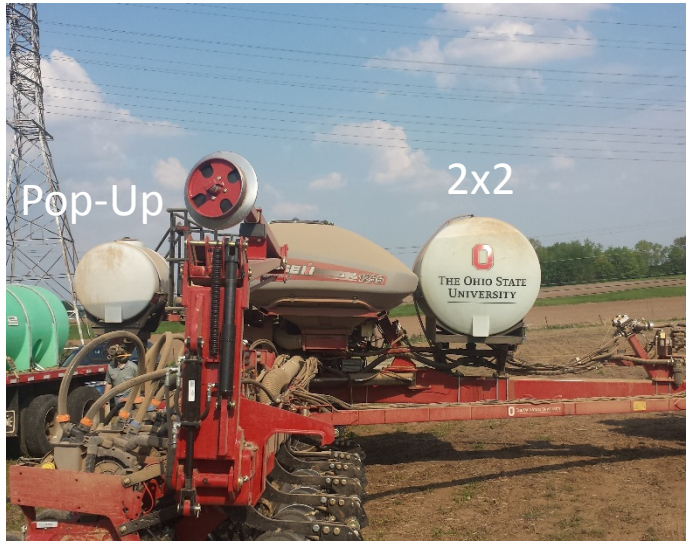
Current Planter Offerings

Source: www.kinze.com

Source: www.deere.com

Source: www.caseih.com

Starter Fertilizer Storage & Placement Options



Planter Frame Storage

Tractor Storage

Towed Cart

Planter Placement Options

Source: http://www.schaffert.com

Next steps to fine-tune mngt…

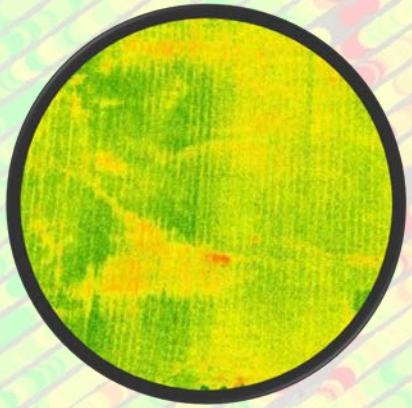
Crop Sensors for In-season N Management

- Active crop reflectance sensors.
- Requires N-rich strips
- Better assess crop N status and apply rates on-the-go.
  - Can improve efficiency of N use.
- Corn studies have shown benefits when used at V8-VT in conjunction with split applications:
  - Improved N applications over traditional, uniform practices
  - Reduced N rate applied without sacrificing yield, OR
  - Increased yield with more N applied at correct rates.
  - Minimize N loss to the environment

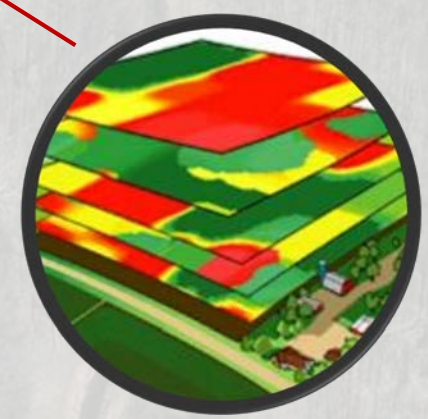
Producer Value:

Identify and quantify limiting productivity variables.

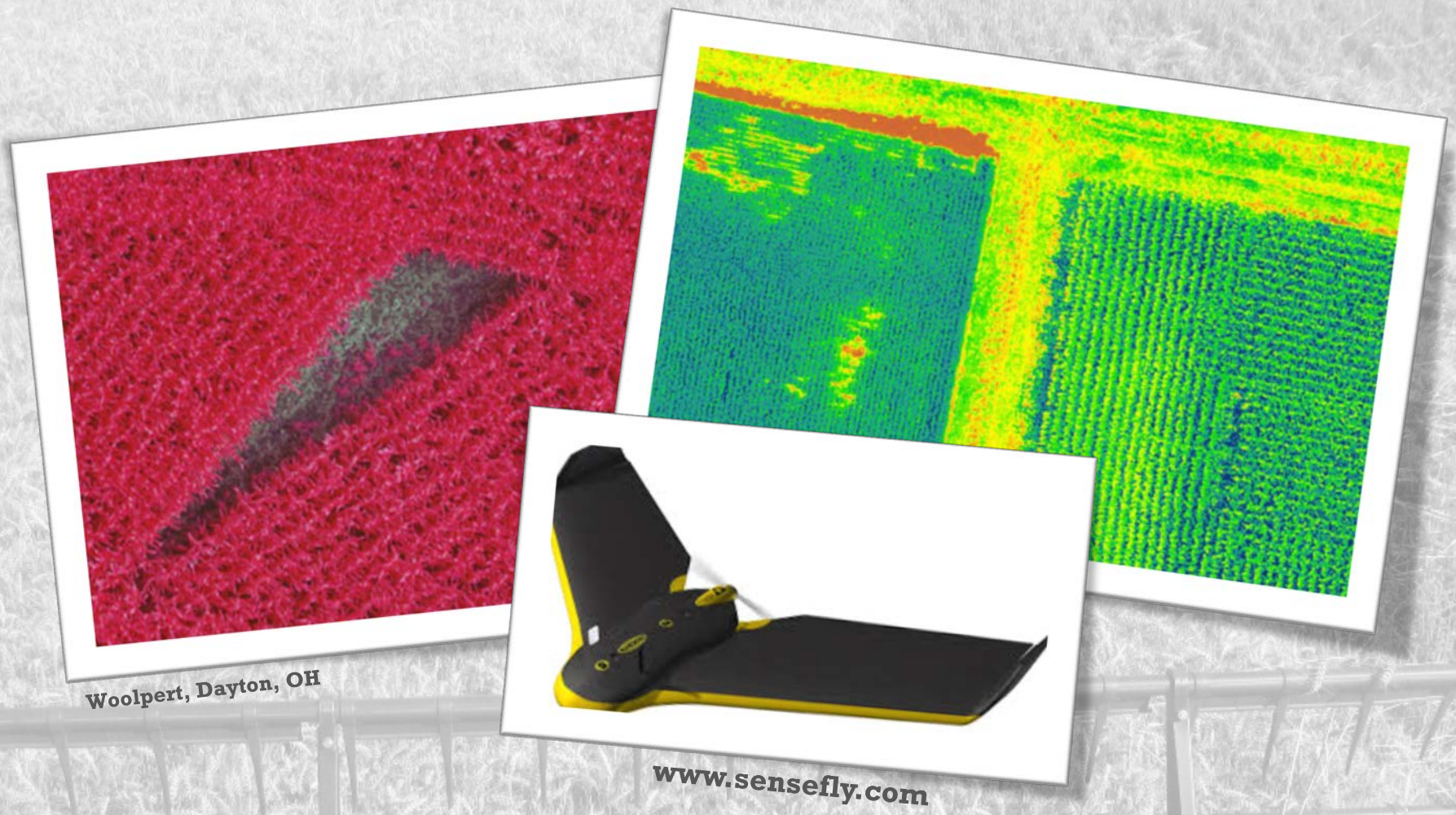
Crop Status



Data Analytics



Using Farm Data to Drive Input Management & Other Farm Decisions



UAVs & Remote Sensed Imagery to Support Decisions and Nutrient Management


About perspective…
Washout
Washout
Producer Value:
Identify and quantify equipment / management issues

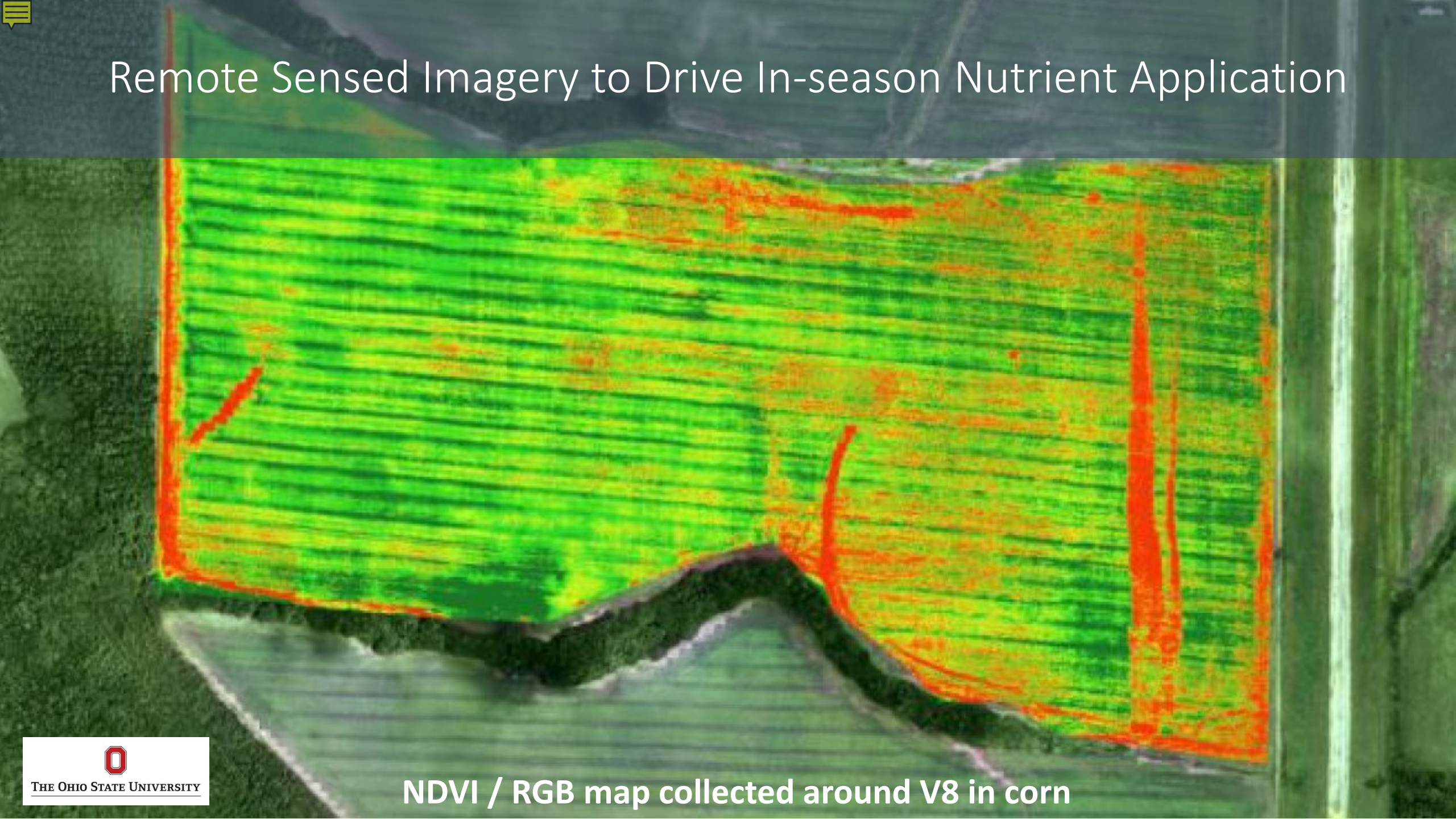
Producer Value:

Identify and quantify equipment / management issues

Producer Value:

Identify and quantify equipment / management issues

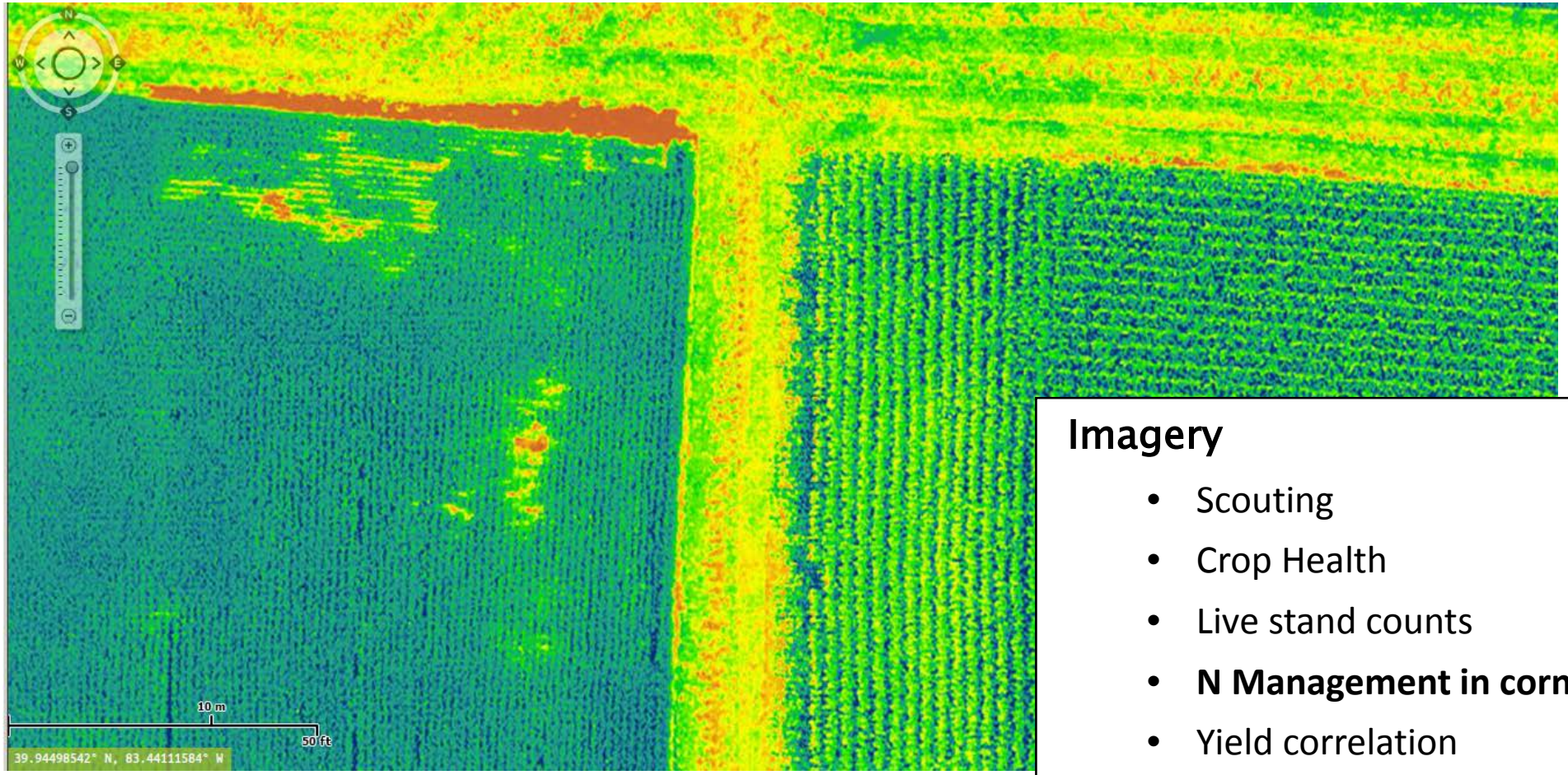
Remote Sensed Imagery to Drive In-season Nutrient Application



NDVI / RGB map collected around V8 in corn

THE OHIO STATE UNIVERSITY

UAS Delivered Imagery



Ohio State University, Woolpert and the Air Force Research Laboratory.

Imagery

- Scouting
- Crop Health
- Live stand counts
- **N Management in corn**
- Yield correlation
- Equipment / management issues
- Much more…

Final Comments…

- **Technology and data services continues to advance rapidly & at a lower price point.**
  - Select equipment, technology & services that meets you farm operation nutrient strategies.
- **Today's equipment + technology provide additional placement and application windows.**
- **Remote sense imagery can help fine-tune nutrient management + identify issues.**
- **Manage field-by-field**
  - Some fields fixed rate
  - Variable rate: Increase production in good zones / Manage bad yielding zones *(improve or manage to potential)*

Value of Precision Nutrient Management

- **Improves field execution and enables on-farm research**
- **Input savings / Overlap reduction**
- **Enhancing nutrient management** (*address variability*)
- **Documentation / certification**
- **Advancing farm business and sustainability**

NRCS FY15 EQIP Funding (Ohio)

- **Residue and Tillage Management, No-Till/Strip Till/Direct Seed** (329 – $13.90/ac)
- **Residue and Tillage Management, Mulch Till** (345 - $3.85/ac)
- **Nutrient Management, Deep Placement** (590 - $43.62/ac)
- **Controlled Traffic Farming, 36%-50%** (720 - $34.22/ac)

Digital Agriculture

Providing solutions to meet world demand

Dr. John Fulton

Fulton.20@osu.edu
334-740-1329
@fultojp