Technology for Monitoring Nutrient Applications

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Outline for Today

- CURRENTS TRENDS IN FERTILIZER APPLICATION
- BROADCAST SPREADER TECHNOLOGY TODAY
- OHIO STATE UNIVERSITY RESEARCH ON-THE-GO SENSOR FOR FERTILIZER APPLICATION
- AUTOMATION FOR FERTILIZER PLACEMENT…

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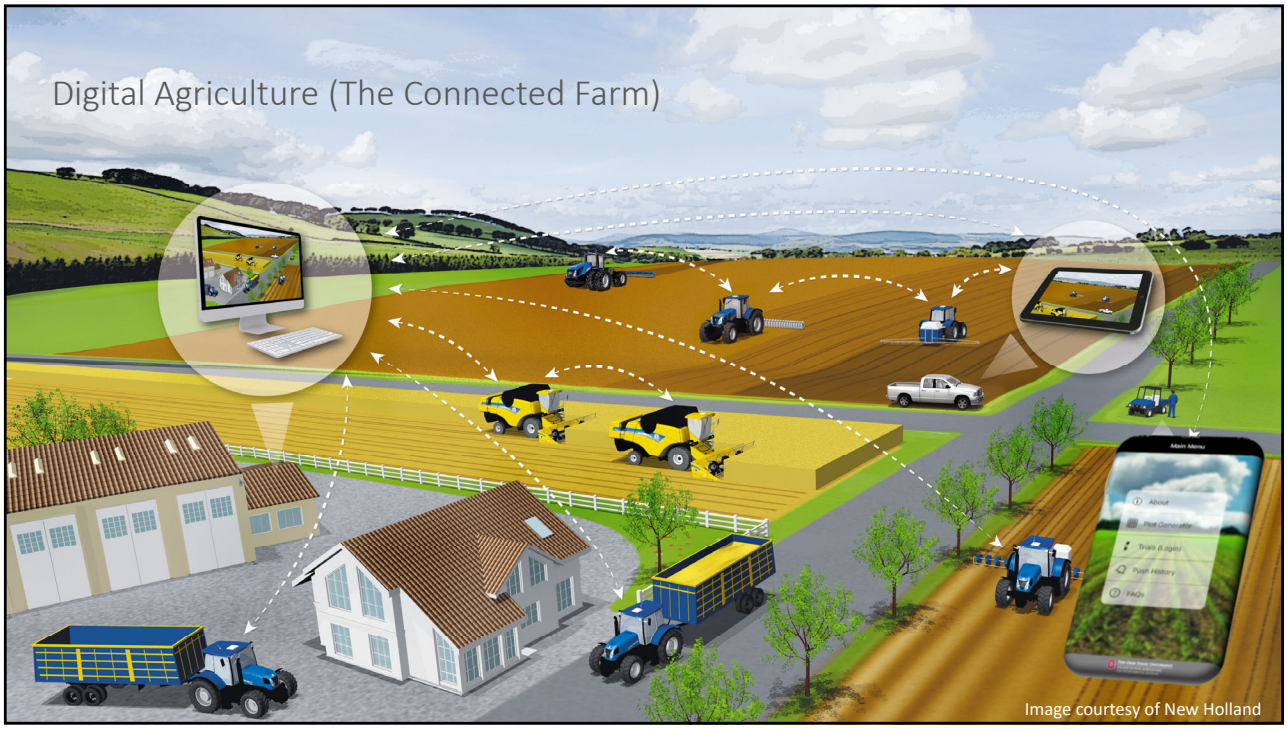

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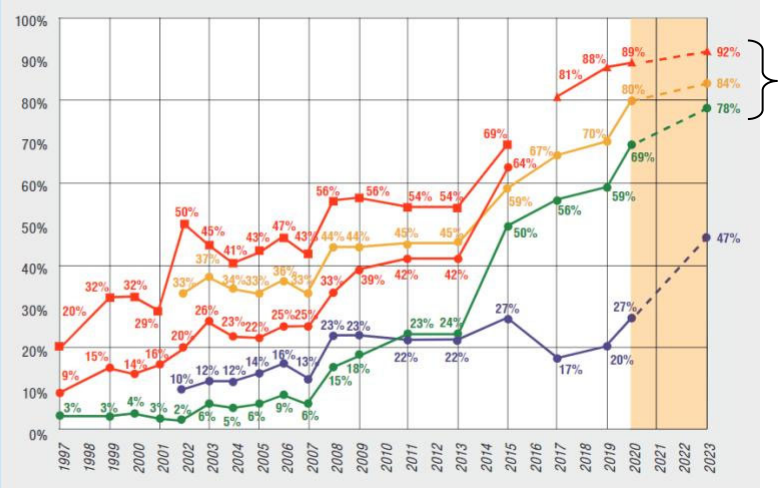
VRT RETAIL SERVICES: CropLife-Purdue University Precision Agriculture Dealership Survey.

Fig. 2. Dealer offerings of variable-rate technologies. 2023 are projections.

- VRT Fertilizer Application
- VRT Fertilizer, Single Nutrient
- VRT Fertilizer, Multiple Nutrient
- VRT lime application
- VRT pesticide application
- VRT seeding prescriptions

Source: *CropLife*-Purdue University Precision Agriculture Dealership Survey



Fertilizer, Lime & Seeding

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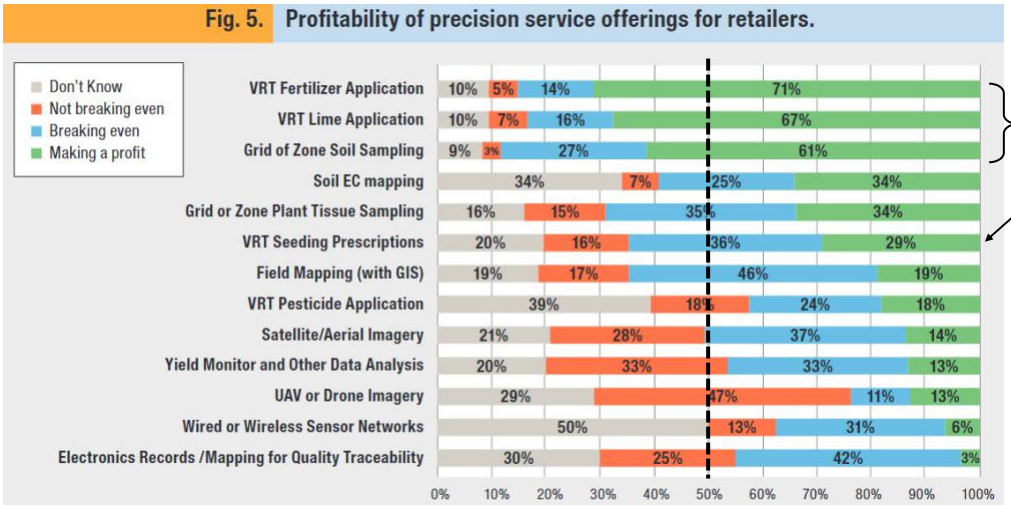
RETAIL PROFITABLITY: CropLife-Purdue University Precision Agriculture Dealership Survey.



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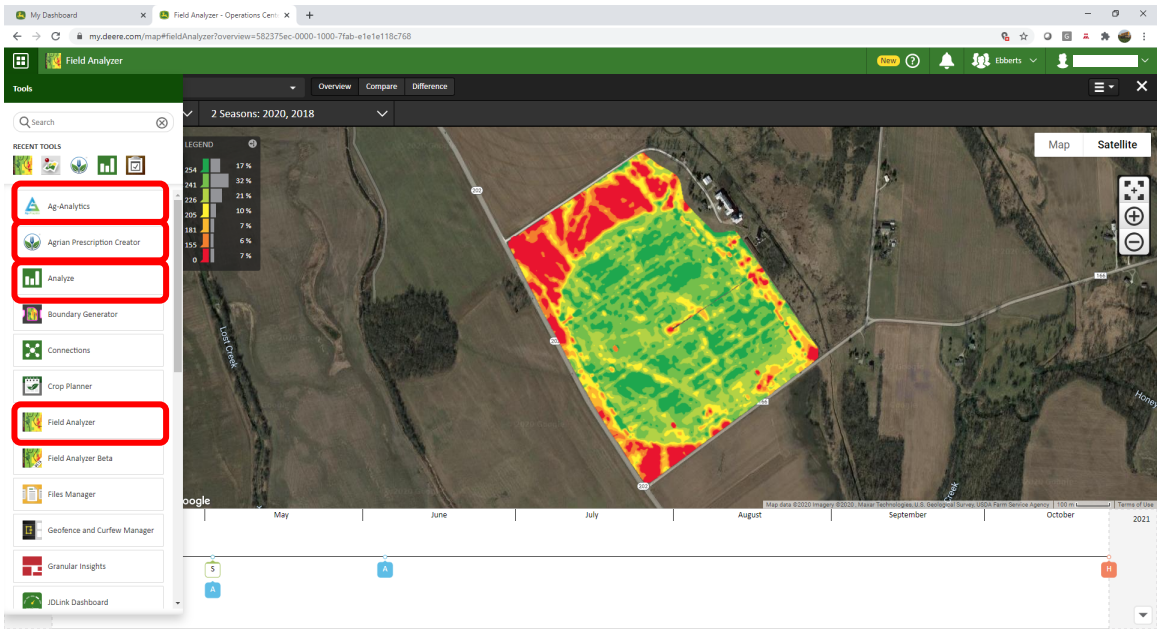
Example Software Platform – John Deere Operations Center



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Issues

- Rural broadband / Access to Internet
- Data sharing / connectivity between platforms

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Application Technology and OSU Research

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Fertilizer Placement Tools

Surface Application

Broadcast

- Cost-effective
- Cover large acres in short period of time.
- Multi-bin / product setups

Late-season N Application

- Surface application ~V10 thru R growth stages.
- Requires high-clearance applicator
- Delayed total N decision
- Provide late boost

Sub-surface Application

Planter Banded Starter

- 2x2 and/or in-furrow starter fertilizer.
- New technology available such as 2x2x2 and in-furrow placement.
- Easily installed on existing planter.

Side-dress

- Coulter-style injection.
- Typically liquid product
- V2 through V5 timing
- Good nutrient uptake efficiency and a profitable application.

Injection (Liquid or Dry)

- Injection through Strip-till, shank, or coulter-style units.
- Place fertilizer accurately within the soil profile.
- Potential for reducing pre-plant passes.

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Modern Broadcast Application Technology

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Surface application options

AGCO AgChem AirBoom

Kuhn

New Leader

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European Broadcast Spreaders

- Designed for fertilizers only
- Unique material delivery to discs-fins.
- Setting recommendations by fertilizer source.
- Wide spread widths
- VRT and section capabilities offered

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High Clearance Options Today

- Applying granular up to about V10 in corn.
- Sprayers with 72”+ clearance for liquid application.

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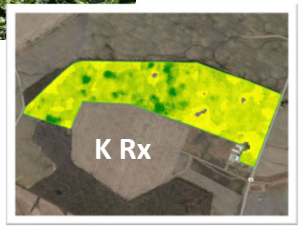
Dual-bin spreader

Dual or multiple bins



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AGCO Air-Max

- 2-Bin setup
- VRT capabilities

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SPINNER SPREADER TECHNOLOGY

Automatic Section Control

- 12+ sections versus full-width
- Eliminate overapplication (2X / 3X)
- Eliminate application in conservation structures (grassed waterways, buffers, etc.)

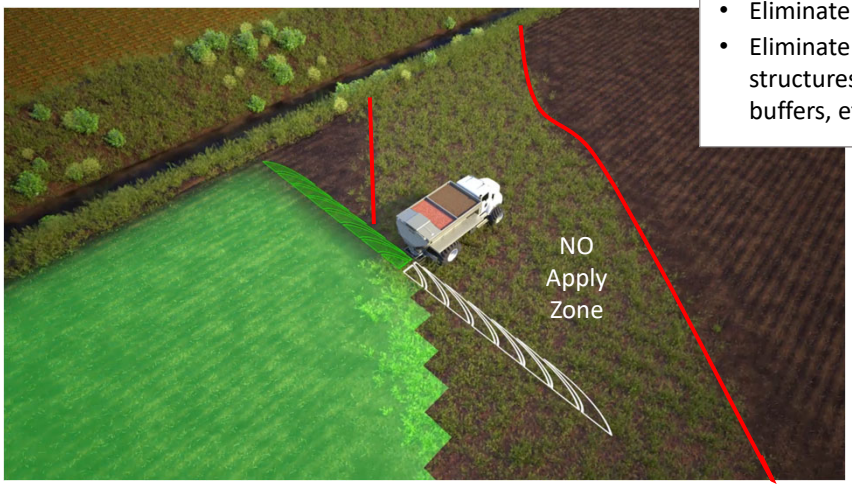

Image Source: New Leader

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#AgTech automating the planting operation…

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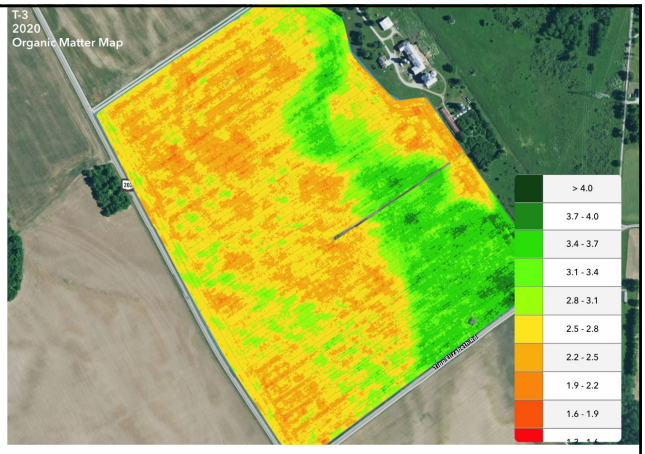

On-the-Go Field Sensors

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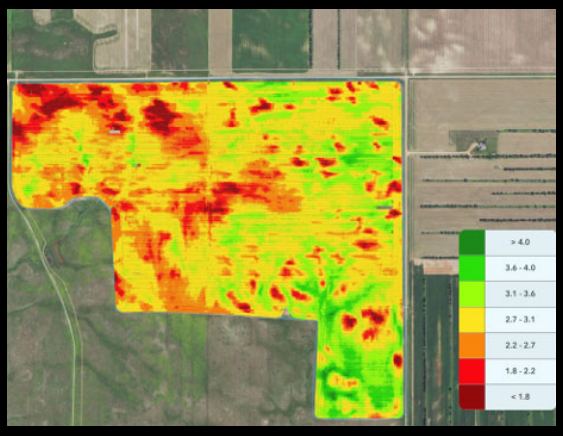
Precision Planting SmartFirmer

- Provides high resolution spatial mapping of organic matter
- On-going research into potential utility for:
  - Seeding rate changes
  - Nitrogen management
  - Depth adjustment (moisture)



eFields Research led by Dr. Elizabeth Hawkins

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SmartFirmer Seeding Rate

Corn | Soybean | Small Grains | Forages | Water Quality | Tech | Other

OBJECTIVE

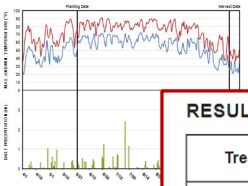
Determine the feasibility of using Precision Planting SmartFirmer organic matter estimates to select corn seeding rates on the go.

eFields Collaborating Farm
OSU Extension
Fayette County

STUDY INFORMATION

Planting Date	6/1/2021
Harvest Date	11/19/2021
Variety	Seed Consultants 1105AM
Population	See Treatment
Acres	11
Treatments	5
Reps	4
Treatment Width	40 ft.
Tillage	Vertical
Management	Fertilizer, Herbicide
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Brookston Silty Clay Loam, 62% Crosby Silt Loam, 34%

WEATHER INFORMATION

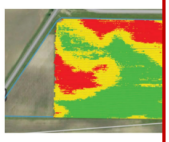


Growing Season Weather Summary

	APR	MAY	JUN	JUL
Precip (in.)	2.12	3.74	3.89	7.12
Cumulative GDDs	232	618	1284	1985

STUDY DESIGN

The trial was designed to compare three corn seeding rates across the field and a variable rate treatment that was determined by the SmartFirmer organic matter estimates on the go. A low, medium, and high seeding rate were chosen. The treatments were replicated five times in a randomized complete block design. This study used a Case IH 380 Magnum tractor pulling a Case IH 2150 Early Riser 16-row 30 inch planter.



Organic matter estimate map generate

OBSERVATIONS

Planting was delayed at this location; however, due to warm soil condition, emergence was rapid and even. Weather conditions were favorable throughout the growing season, with timely rainfalls in June and August. The site received above average rainfall in July, but this did not appear to negatively impact yield.

SUMMARY

- No statistically significant yield response was observed at this location.
- Due to good weather conditions, yields trended higher as population increased.
- Allowing the SmartFirmer organic matter readings to drive the prescription on-the-go resulted in yield parity at this location in this year.
- This technology can make prescription generation easier.

RESULTS

Treatments	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
28,000	28,792	14.3	209 a
32,000	32,792	14.2	216 a
36,000	36,959	14.2	215 a
SmartFirmer Variable Rate	35,833	14.1	223 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.			LSD: 14.0 CV: 5.2%

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On-the-go liquid nutrient sensing

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NIR Sensing for Manure Application

Corn | Soybean | Small Grains | Forages | Water Quality | **Tech** | Other

OBJECTIVE

Understand how Near Infrared sensors can be utilized to estimate as-applied manure nutrients during liquid manure application.

eFields Collaborating Farm
OSU Extension
Statewide

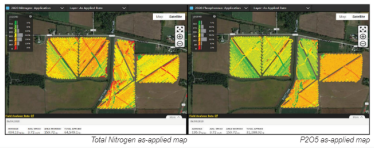
STUDY DESIGN

An on-farm collaboration was set up between Ohio State, eFields collaborating farms, and John Deere to use the Harvest Lab 3000. The Harvest Lab 3000 is an NIR sensor that senses as-applied manure nutrients within slurry manure which can be installed on any liquid manure application equipment equipped with a flow meter. During application the sensor communicates with a GPS receiver mapping as-applied manure nutrients. The sensor displays all readings on the in cab display similar to the yield results in a combine. For this study, a calibration curve developed for swine manure was used to determine as applied nutrients. Throughout application samples were collected at the toolbar and then compared to the sensor readings looking for trends/bias and to see if the nutrient changes from beginning to end were captured in the maps.

Cab display screen of the sensor during application.

OBSERVATIONS

There were visual differences in the manure during application at each location. As seen in the difference between Figures 1 and 2 if a single pit sample could be relied upon to predict the nutrients during application the maps should be the same. A singular pit sample concludes that all nutrients vary proportionally to each other but the Figures below show how the nutrients vary independently of one another. NIR sensors by design are very precise but are only as accurate as the calibration curves the sensors are referencing to determine nutrient value. The NIR calibration curves calibrated for the livestock production system here in North America are still be updated and developed to become as accurate as possible. With time the sensors could be as accurate as a lab but by creating a compact and mobil sensor, labs have an advantage in computing/processing capacity. As technology continues to progress so will the calibration curves and capacity of the sensor increasing the accuracy of this system. Of note, pit 2 was a mixed manure source 85% beef manure and 15% swine manure which a calibration curve does not exist for.

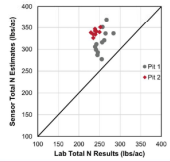


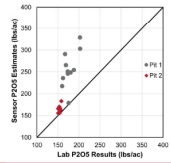
Total Nitrogen as-applied map *P2O5 as-applied map*

SUMMARY

- The sensor calibration curves used in this study were not developed for the mixed manure sources that were field applied.
- Results indicated the NIR sensor did a good job of relatively estimating the P2O5 and Total Nitrogen variations during field application.
- Calibration curves for the type of swine/beef manure mix applied during this study would adjust the results more to the 1:1 line.
- A value of the technology was the feedback with the in-cab display to the operator during application to show changes in N and P concentrations allowing an operator the opportunity in the field and at the pump to adjust or maintain the recommended N and P rates (see as-applied maps).
- The variation in Total Nitrogen and P2O5 within the as-applied maps illustrates the challenge of a single point pit sample to inform field application.

RESULTS





TOOLS OF THE TRADE

Near-infrared (NIR) liquid manure sensors provide the capability to estimate NPK, DM and more during the pumping of pits and field applications. The sensor technology provides operators real-time feedback during field application especially indicating changes in nutrient concentrations at the time of application. This technology also generates as-applied maps for target NPK recommendation.

PROJECT CONTACT

For inquiries about this project, contact Chris Shoup (shoup.83@osu.edu) or John Fulton (fulton.20@osu.edu).

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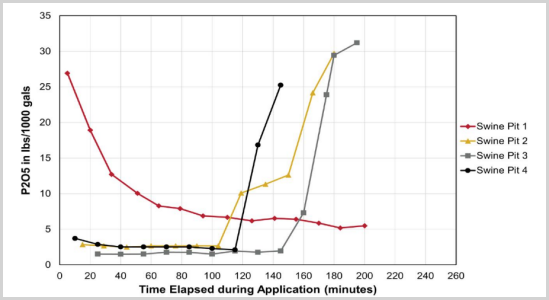
P2O5 results from unagitated swine pits

- P2O5 concentration can change as unagitated pits were emptied.
- Currently, no feedback to operator to understand if P2O5 changes over time during field application.



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John Deere NIR Sensor

- Provides
  - NPK estimates
  - Dry Matter
- Mounts directly on pipe.
- Requires calibration.

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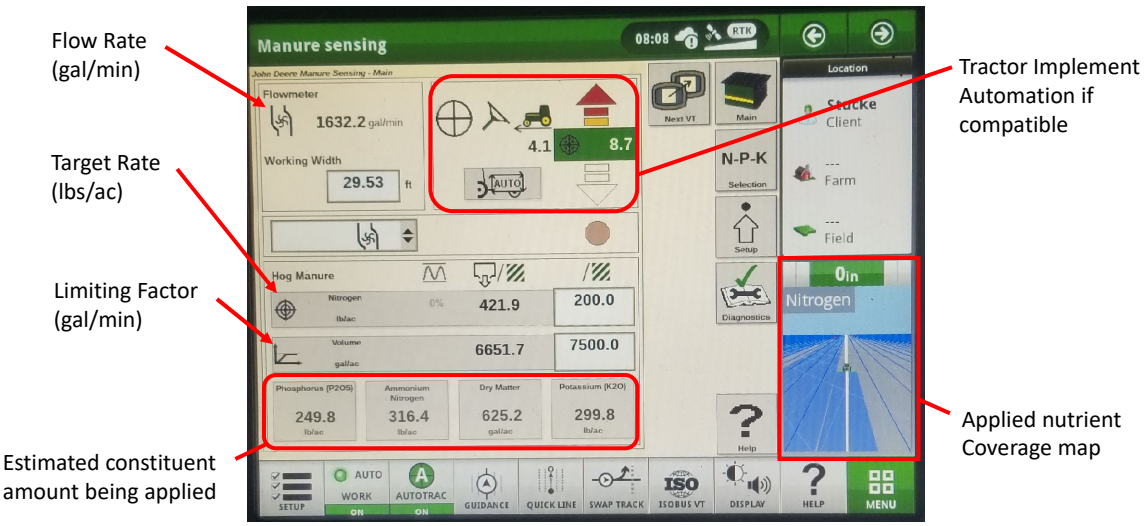
Operator Feedback



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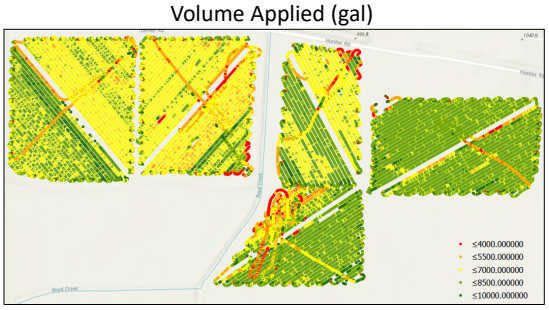
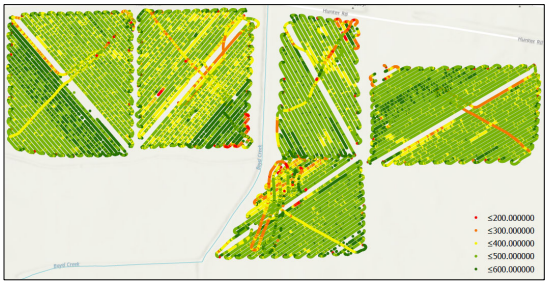
Nutrient and Volume Maps

- 1.2 million gallons applied
- 50,450 measurements collected

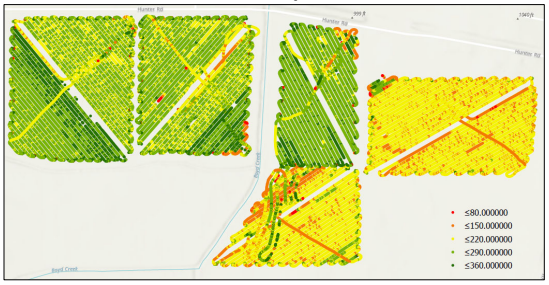
Volume Applied (gal)



Total Nitrogen



Phosphorus



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Results To-date

- P and N concentrations change during application.
  - Sensor provided valuable feedback to the operator.
  - Sensor calibration curves still needed for manures in Ohio.
- As-applied maps served as verification for application

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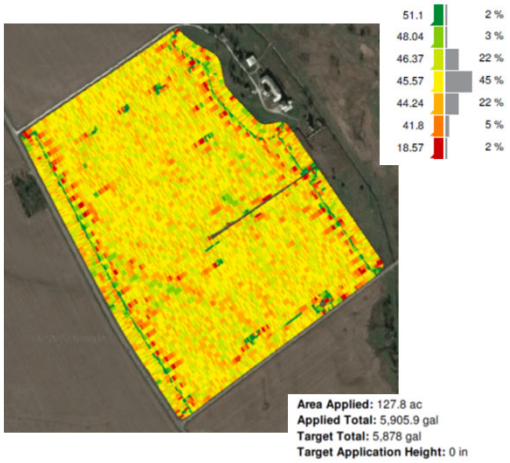
As-Applied / Coverage Maps



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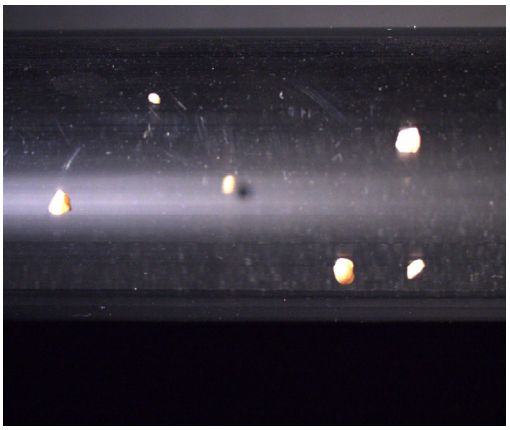
Sensor - Image Analysis

Applied Mass

- 2.2 m/s (5 MPH) for 0.76-m row spacing
- Particle speed 36 m/s (80 mph)
- Image value held constant for 1 sec.

Application Rate: 105 kg/ha



4.7 Grams of Potash

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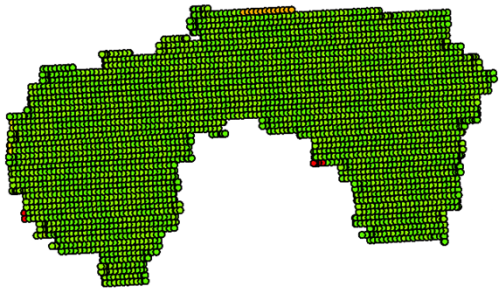
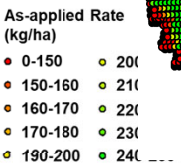
As-applied Coverage Map Comparison

Precision Ag In-cab Display

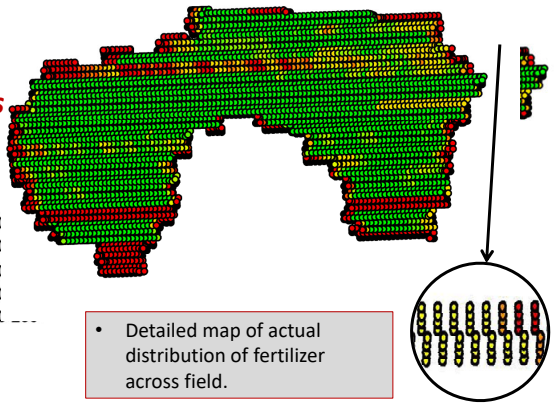


- Average across applicator
- Based on metering device RPM only.

versus



OSU Flow Monitoring System



- Detailed map of actual distribution of fertilizer across field.

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Drone Spraying

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Drone Spraying Video

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Autonomy
John Deere @ 2019 Agritechnica

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eFields
connecting science to fields

eFields is an Ohio State University program dedicated to advancing production agriculture through the use of field-scale research.

https://digitalag.osu.edu/efields

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Digital Agriculture
Providing solutions to meet world demand

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