@OhioStatePA

TRANSLATING DATA INTO INFORMATION USING AI WITHIN CROP PRODUCTION

Dr. John Fulton

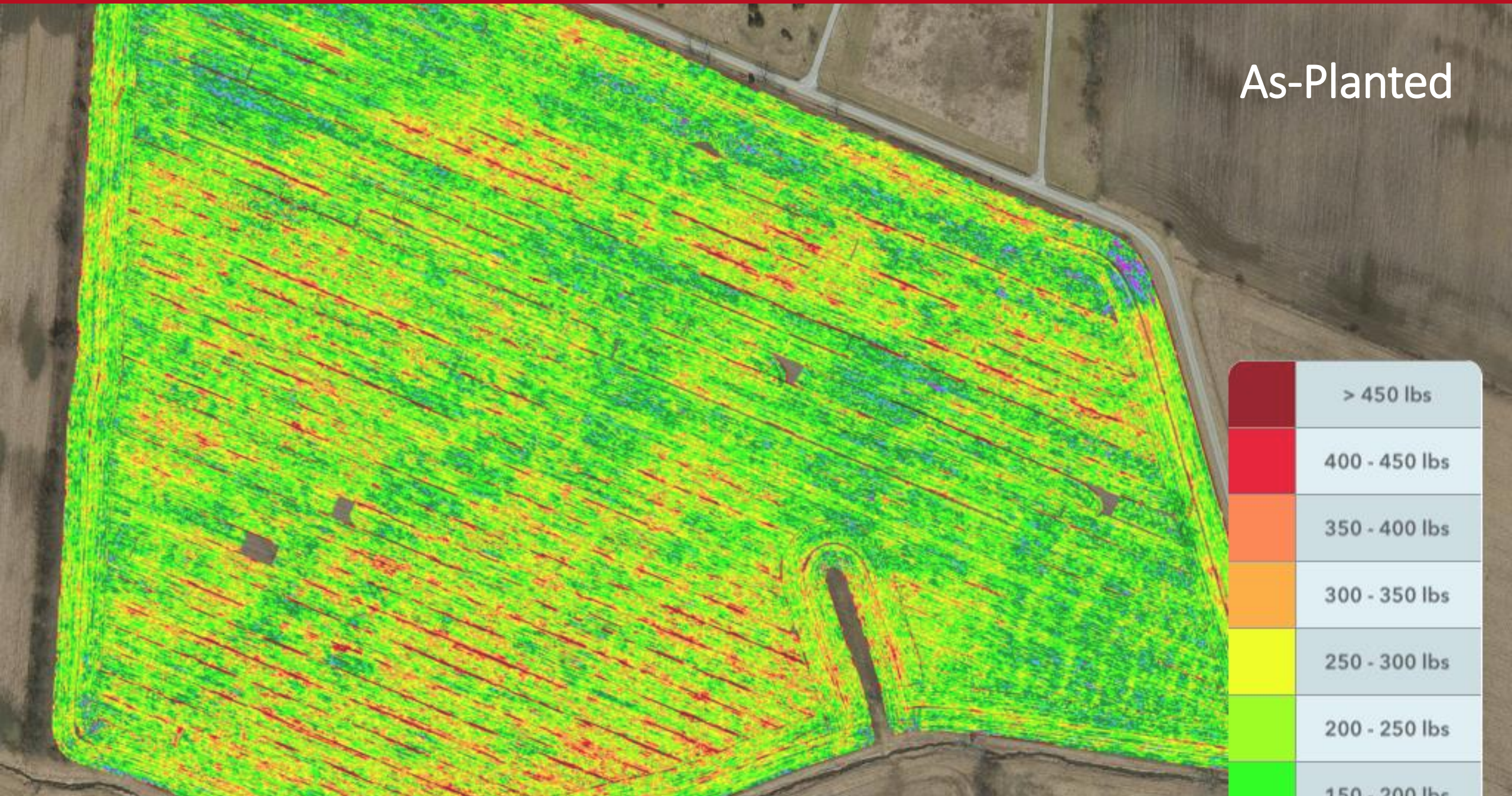
The Ohio State University

2019 Soybean Summit, Springfield, IL

#AgTech that enables higher planting speeds…

#PrecisionAg

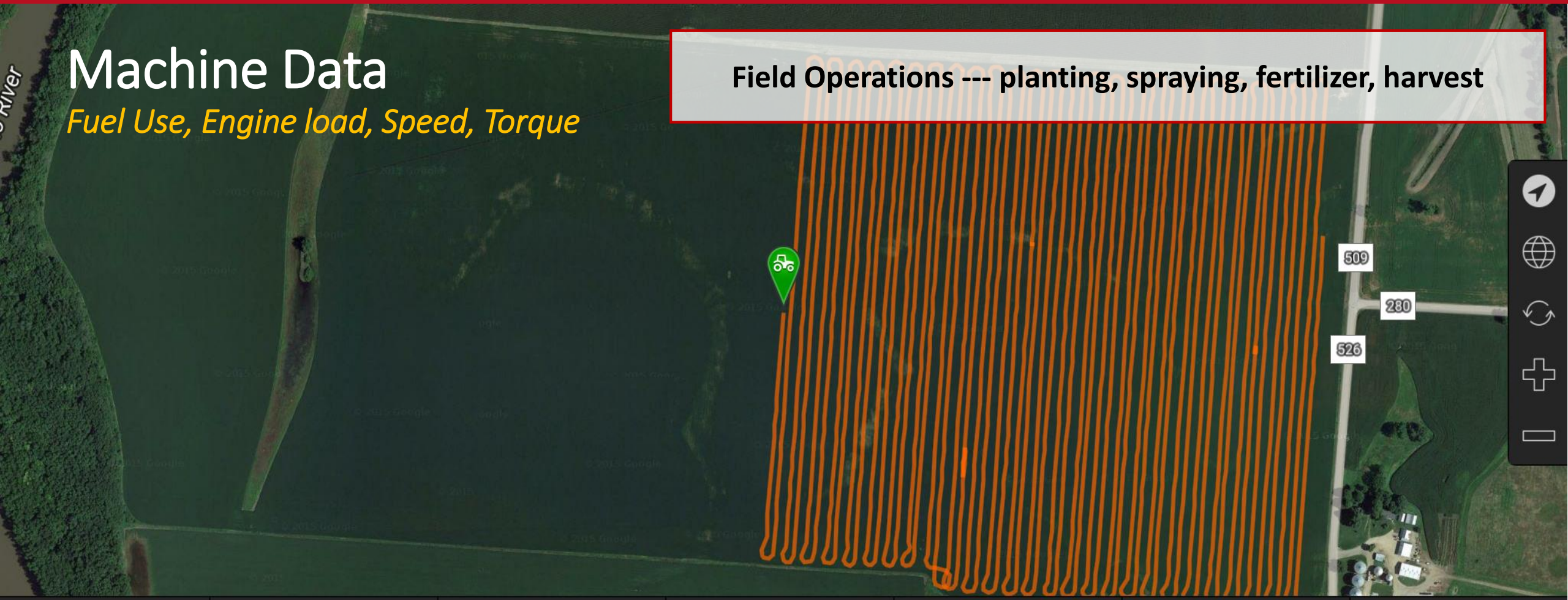
As-Planted


> 450 lbs
400 - 450 lbs
350 - 400 lbs
300 - 350 lbs
250 - 300 lbs
200 - 250 lbs
150 - 200 lbs

Machine Data

Fuel Use, Engine load, Speed, Torque

Field Operations --- planting, spraying, fertilizer, harvest



Engine load	Oil Pressure	Speed	Fuel Rate	Engine Torque	Engine Speed	Engine Temp
84 %	76.6 psi	10.4 mph	18.02 gal/hr	81 %	1729 rpm	198 °F

Digital Agriculture (IoT in Ag)

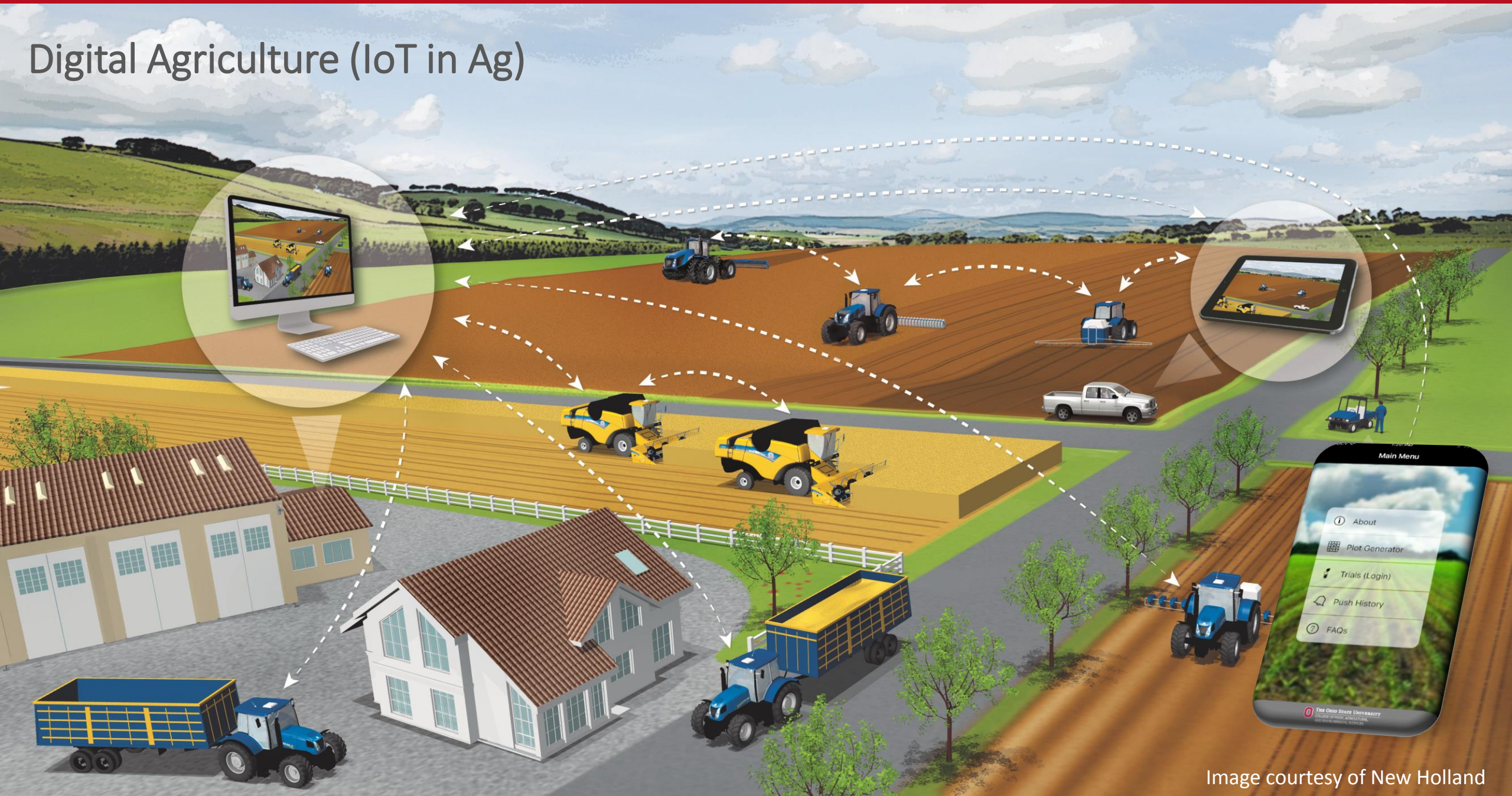


Image courtesy of New Holland

Data Exchange for Growers

Producer

Recommendations

- **Preseason Fertility Management**
  - Prescription P and K application (Precision Crop Services)
- **Tillage Management**
  - Prescription tillage maps (AGCO; CNH)
- **Multi-Hybrids**
  - Prescription seeding of multi-hybrids (Beck's; Pioneer)
- **SCN Management**
  - Prescription application/use of nematicides (FMC)
- **In-Season Fertility Management**
  - Prescription N application (Encirca; Climate Corp)
- **Irrigation Management**
  - Prescription Irrigation (AgSmart)
- **Disease Management**
  - Prescription fungicide application (BASF)

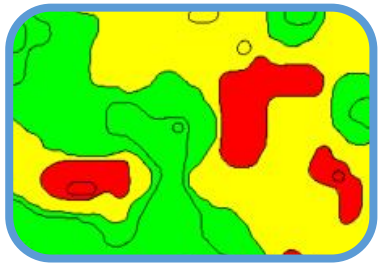
Data will need to move through multiple organizations and each organization will need different data sources.

Data Types

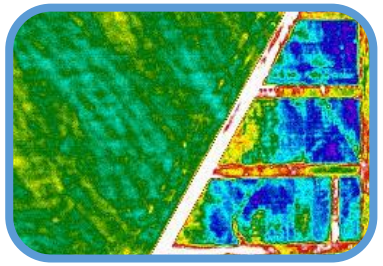
On-farm data comes from a variety of sources

Agronomic
Yield
As-Applied
As-Planted

Machine
Fuel Usage
Engine Speed
Engine Load



Prescription
Seeding
Fertilizer
Multi-hybrid
Fungicide



Remote Sensed
Visible (RGB)
IR
NDVI
Thermal

Production
Weather
GDD
Dates
Markets

Identify what data is being generated on-farm.

"Terra" Project

18.4 GB per plant

39 different file types

2475 different files

60.2 Petabytes for the field

- *.TXT
- Shapefile (*.shp)
- *.XML
- *.DAT
- *.agdata
- *.yld
- *.gsd
- *.rbin
- *.log
- Many others…

Farmers actively using digital technologies…

92% Sharing Data today

- 66% sharing data with 2 or more people
- Seed Rep and Agronomic Consultant (>60% sharing with both)

77% view variety results online (67% with a smartphone or tablet).

96% are using data collected as a direct input for management decisions.

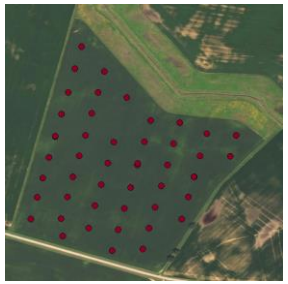
(2017 USB farmer survey on Digital Technologies)

Traditional PA Approach

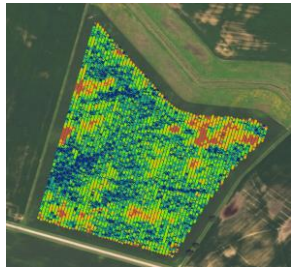
Conventional Approach



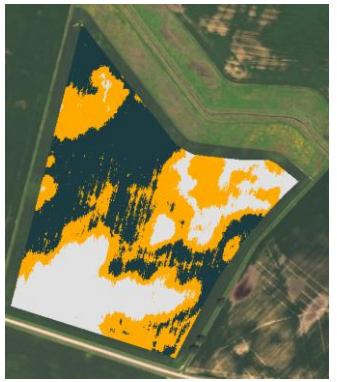

Grid Soil Sampling



Yield Monitor Data



Prescriptions for Planting, Fertilization, Irrigation, and others

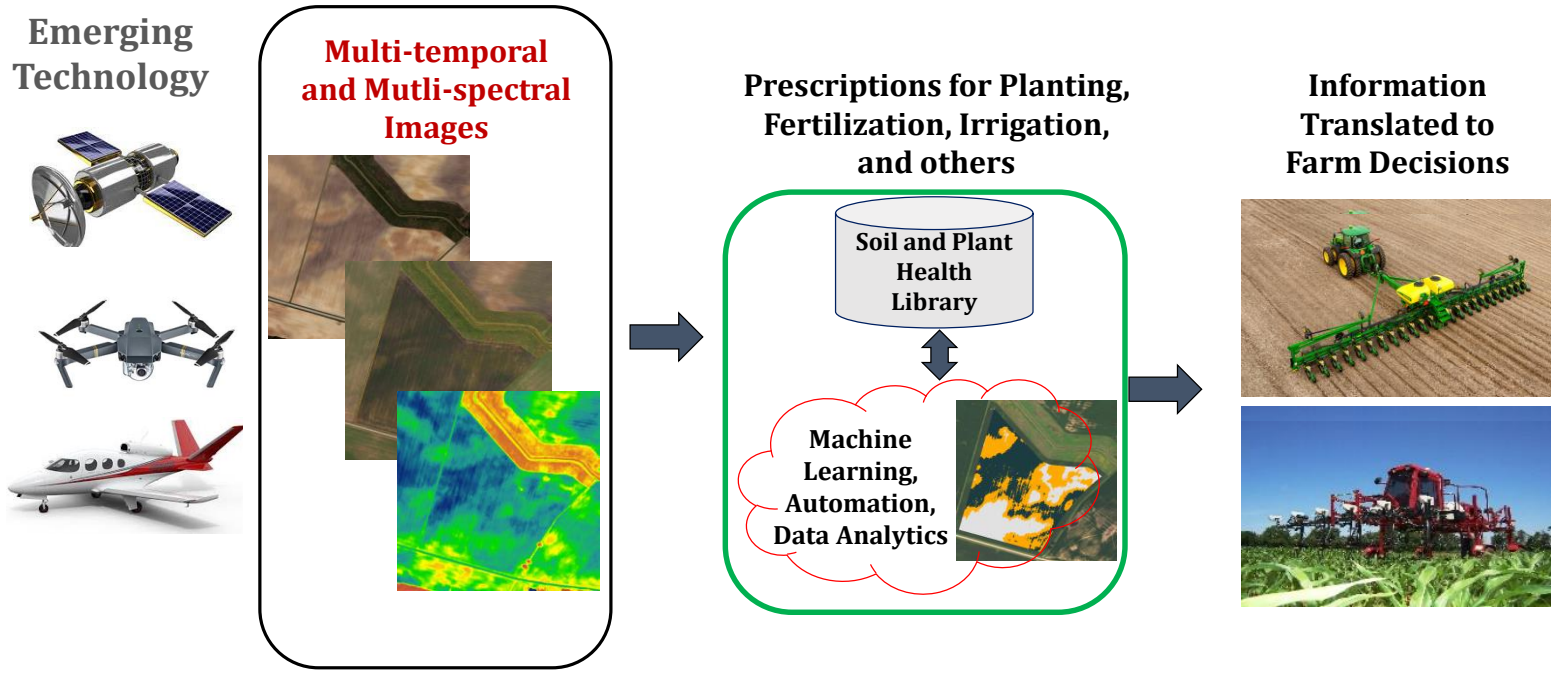


Information Translated to Farm Decisions


Limitations to this type of data collection approach

- Labor Intensive, Costly, Data Quality Issues, Time Consuming

Alternative PA Approach



Advantages – Cheaper long-term, Faster, Efficient, and Reliable
Disadvantages – Requires large data sets

Models and data analytics that not only recap what is already occurring between water and plants within corn fields, they are beginning to predict field-level outcomes in the hours, days and weeks ahead.

Tremendous Investment in Industry and Academia in (Ag) Data Analytics

United States Patent **9,519,861**
Gates , et al. **December 13, 2016**

Generating digital models of nutrients available to a crop over the course of the crop's development based on weather and soil data

Abstract

A system for generating digital models of ***nitrogen*** availability based on field data, weather forecast data, and models of water flow, temperature, and crop uptake of ***nitrogen*** and water is provided. In an embodiment, field data and forecast data are received by an agricultural intelligence computing system. Based on the received data, the agricultural intelligence computing system models changes in temperature of different soil layers, moisture content of different soil layers, and loss of ***nitrogen*** and water to the soil through crop uptake, leaching, denitrification, volatilization, and evapotranspiration. The agricultural intelligence computing system creates a digital model of ***nitrogen*** availability based on the temperature, moisture content, and loss models. The agricultural intelligence computing system may then send ***nitrogen*** availability data to a field manager computing device and/or use the ***nitrogen*** availability data to create notifications, recommendations, agronomic models, and/or control parameters for an application controller.

Inventors: **Gates; John** (San Francisco, CA), **De Gryze; Steven** (San Francisco, CA)

Applicant:

Name	City	State	Country	Type
THE CLIMATE CORPORATION	San Francisco	CA	US	

Assignee: ***The Climate Corporation*** (San Francisco, CA)

Family ID: **57483990**
Appl. No.: **14/842,321**
Filed: **September 1, 2015**

Related U.S. Patent Documents

Application Number	Filing Date	Patent Number	Issue Date
62192754	Jul 15, 2015		

Current U.S. Class: **1/1**
Current CPC Class: G06N 5/02 (20130101); G06F 17/5022 (20130101); G06F 15/18 (20130101); A01C 21/007 (20130101); G01N 15/0826 (20130101); A01G 7/06 (20130101)
Current International Class: G06N 5/02 (20060101); G06F 17/50 (20060101)

References Cited [Referenced By]

U.S. Patent Documents

United States Patent **9,076,118**
Mewes , et al. **July 7, 2015**

Harvest advisory modeling using field-level analysis of weather conditions, observations and user input of harvest condition states, wherein a predicted harvest condition includes an estimation of standing crop dry-down rates, and an estimation of fuel costs

Abstract

A modeling framework for evaluating the impact of weather conditions on farming and harvest operations applies real-time, field-level weather data and forecasts of meteorological and climatological conditions together with user-provided and/or observed feedback of a present state of a harvest-related condition to agronomic models and to generate a plurality of harvest advisory outputs for precision agriculture. A harvest advisory model simulates and predicts the impacts of this weather information and user-provided and/or observed feedback in one or more physical, empirical, or artificial intelligence models of precision agriculture to analyze crops, plants, soils, and resulting agricultural commodities, and provides harvest advisory outputs to a diagnostic support tool for users to enhance farming and harvest decision-making, whether by providing pre-, post-, or in situ-harvest operations and crop analyses.

Inventors: **Mewes; John J.** (Mayville, ND), **Salentiny; Dustin M.** (Grand Forks, ND)
Applicant:

Name	City	State	Country	Type
***ITERIS*, INC.**	Santa Ana	CA	US	

Assignee: ***ITERIS*, INC.** (Santa Ana, CA)
Family ID: **53492024**
Appl. No.: **14/603,378**
Filed: **January 23, 2015**

Current U.S. Class: **1/1**
Current CPC Class: G06Q 50/02 (20130101); G06Q 10/0631 (20130101); G06N 5/04 (20130101); G06N 99/005 (20130101); G06Q 10/067 (20130101); A01G 22/00 (20180201); A01G 9/00 (20130101); Y02A 40/12 (20180101)
Current International Class: G06F 15/18 (20060101); G06Q 10/06 (20120101); G06Q 50/02 (20120101); A01G 9/00 (20060101)
Field of Search: ;706/12,45,62

References Cited [Referenced By]

U.S. Patent Documents

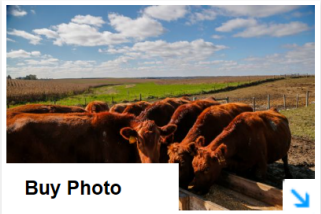
2007/0239337	October 2007	Anderson
2011/0313666	December 2011	Hirvi et al.
2013/0332205	December 2013	Friedberg et al.

Summary of Current Ag Intellectual Property based on AI

- **Weather Forecast Model Calibration -** auto-calibration using past performance plus ground truth data with dynamic weighting.
- **Irrigation and Water Management** - understanding soil moisture coupled to rain and irrigation events for different crops, soils, and environmental conditions.
- **Crop Modeling** - predictive crop models that use crop stage, weather and more.
- **Field Accessibility** – understanding field conditions to deploy or not deploy machinery to an individual field.
- **Harvest Decision Support** – predict crop moisture content coupled with historical weather and soil information.

Our nation needs to accelerate artificial intelligence for farm tech

Tom Vilsack and Danielle Nierenberg, Iowa View contributors Published 10:34 a.m. CT Nov. 26, 2018 | Updated 10:34 a.m. CT Nov. 26, 2018

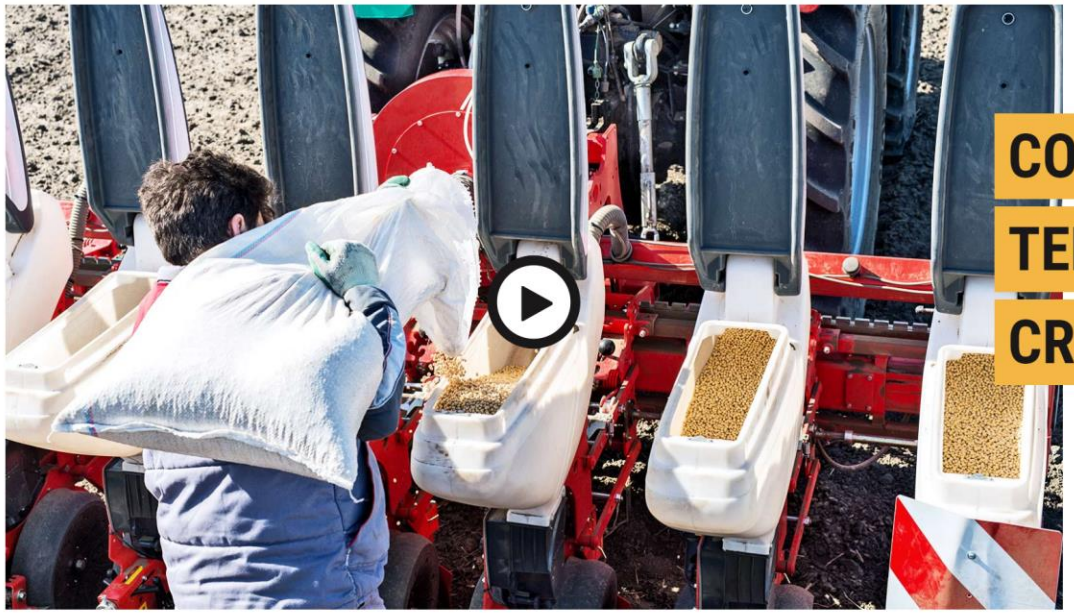


(Photo: Zach Boyden-Holmes/The Register)

Melissa Brandao, a former Apple engineer, wanted to find ways to give back to her rural agricultural community in southern Oregon. Rather than traditional farming, though, she began designing robots to provide farmers with extra sets of eyes, ears and wheels out in the field.

Brandao developed such breakthrough innovations as the first autonomous ATV for hauling loads and navigating narrow rows between tightly planted crops. Most recently, she created the HerdDogg system of smart wearable devices for cattle management, which was first piloted with the Dairy Farmers of America. Today, more than 50 farmers nationwide use these tools to monitor and improve the health of their herds.

Her story shows how emerging technologies are not just the province of Silicon Valley or major metropolitan centers; nor are they only for the benefit of major corporations and investment firms. Rather, independent farmers and merchants alike are helping to drive new innovations across the nation's food supply chain, as stated in the recent "Refresh: Food + Tech, from Soil to Supper" report produced by Google, Food Tank, Swell Creative Group and their partners. It features more than 20 concrete examples of the ways technological innovations are helping not only food producers, but distributors



(Credit: Getty Images)

COMPUTER MODEL CAN TELL FARMERS WHAT CROPS TO PLANT

APRIL 18TH, 2018

POSTED BY CHUCK FINDER-WUSTL

A new computational model could help farmers and seedmakers take the guesswork out of what to plant each year.

It's simple enough that a farmer could receive a recommendation containing the five best seed types to grow given the average yields, weather conditions, and soil composition of his or her region—

SimSoy

- A web tool that can help farmers optimize their crops.
- Washington University
- Utilizes descriptive analytics and predictive analytics (machine learning models) to make predictions

- **INPUT:** 27-Variables: latitude, longitude, area, soybean varieties, irrigation, soil types and depths, acreage, yields…
- **Predictive OUTPUT:** individualized varieties for a farmer.

https://www.futurity.org/computer-model-farmers-agriculture-crops-1733622/

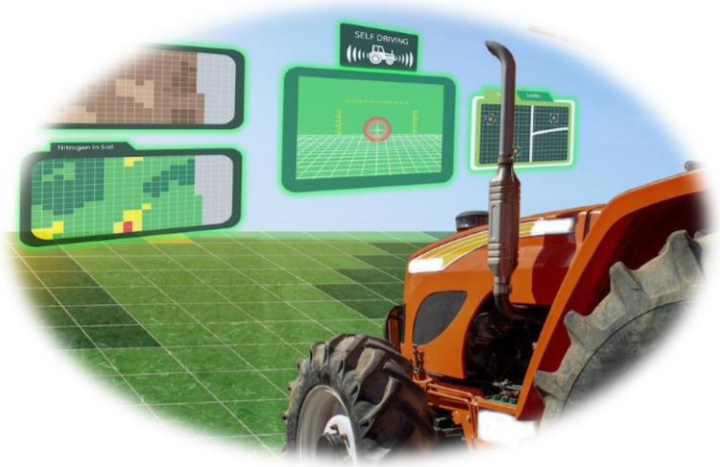
FRESHAI

Program (AI-based) used to reduce perishable food waste to under 10% by using algorithmic software to redistribute perishable food rather than allow it to spoil on the shelf (Fed40 app).

https://freshai.farmsteadapp.com/

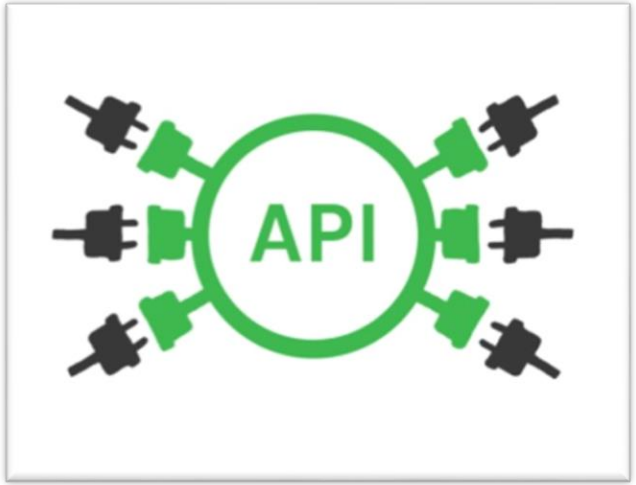
Definitions

- Application Program Interface (API)
- Artificial Intelligence (AI)
- Machine Learning



Application Program Interface (API)

- Set of programming instructions and standards for accessing a web-based software application or web tool.
- A software company releases its API to the public so that other software developers can design products that are powered by its service.



Artificial Intelligence (AI)

- Intelligence demonstrated by machines that mimics the human decision making process.
- Any “device” that understands its environment and takes actions that maximizes its chance of successfully achieving its task.
- Much broader than machine learning

AI Examples

- planning,
- problem-solving,
- understanding languages,
- recognizing voices and images,
- learning,
- any tasks that would be considered “smart”

If you surf the internet then you have experienced AI applications.

Machine Learning

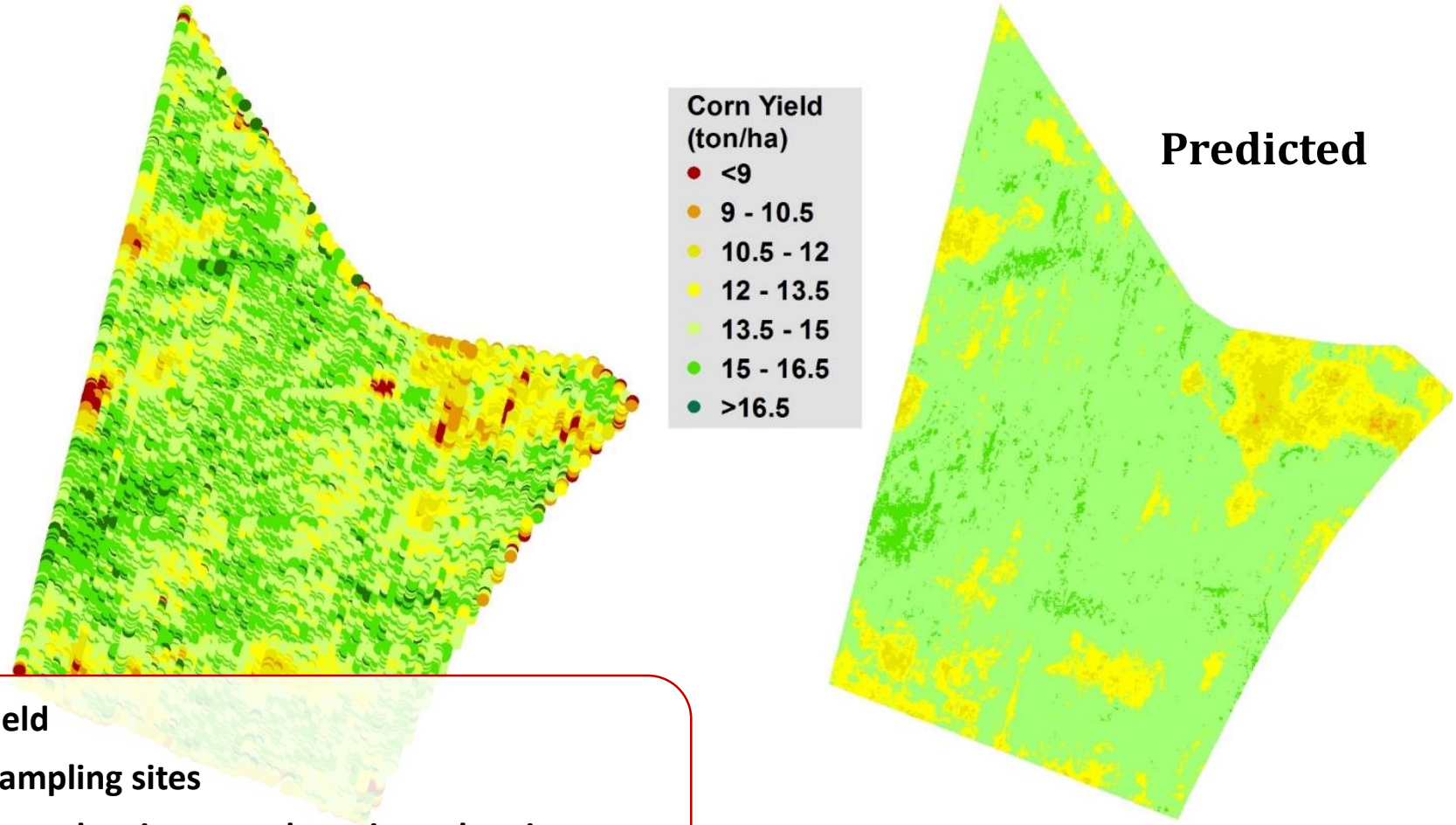
- **Means of "learning" that enables an algorithm to evolve**.
  - Designed to constantly and consistently self-improve.
  - **Requires mass amounts of data** for the algorithm to learn and then adjust.
- Specific subset of algorithms for AI.
- Common analytical technique used in agriculture by technology companies.

Ag Examples

AI and Machine Learning Applications

- **Yield Prediction** - based on weather and historical yield data
- **Genetic & Plant Breeding Research**
- **Image Recognition -** detect pest and plant diseases
- **Autonomy / Robotics -** harvest
- **Automated Machinery Adjustments -** fine-tune field operations
- **Soil Properties -** improved classification of properties
- **Commodity Marketing**
- **Field Conditions** - deployment of machinery

Decisions – Predicted Corn Yield

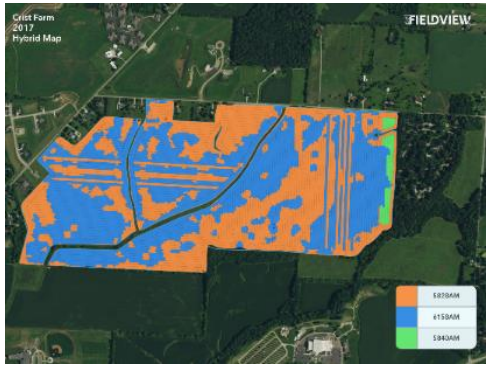


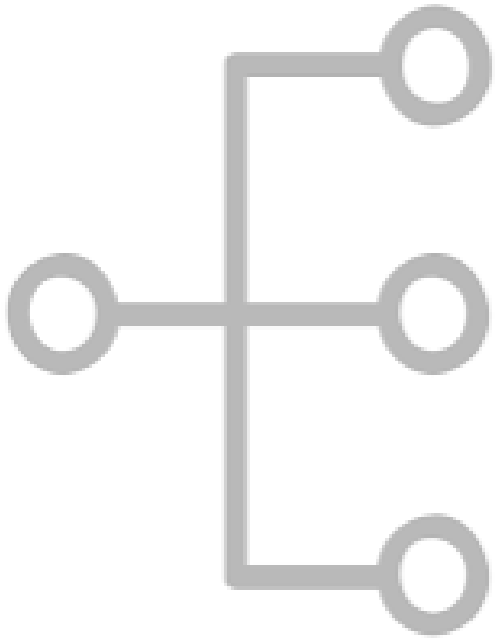
- Field-by-field
- Plan soil sampling sites
- Early P removal estimate and nutrient planning
- Evaluate marketing plan

Current Ag Applications of AI

- **2019 New Holland Combine** – proactive adjustments to field conditions
- **Planter setting adjustments** - on-the-go (downforce) based on sensors and weather
- **Prescription maps** – based on field variables and harvest data
- **Variable tillage** – sensors evaluating % surface residue, clod size, and soil color.
- **Fertility tools** – weather, soil and field characteristics, plant growth stage…
- **Field accessibility tools** – weather, localized environment, soil characteristics…

SUMMARY





Tremendous volume of data beig collected today with a focus on AI in agriculture

Machine learning performed well in predicting soil properties and corn yield.

SUCCESS of New Agtech -benefits farmers and consumers alike

@OhioStatePA

eFields
connecting science to fields

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

https://digitalag.osu.edu/efields

Digital Agriculture

Providing solutions to meet world demand

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