

The Future On Farm Automation

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How Do We Define On Farm Automation?

- Fully robotic or autonomous without humans?
 - Typically when we hear the term autonomous we “automatically” think about robots and robotic control
 - i.e. humans are not involved in the process anymore.
- But what is automation really?
 - The automatic control of a task or a function?

Where Do we Currently Stand?

- If we're going to talk about what the future looks like, we need to decide what our current benchmark is.
 - What percentage of farms already have automation?
 - Who has automation on their operation already?
 - Who is interested?
 - Why are you interested and what is the incentive?
 - What hinders adoption?
 - Are certain operations/production systems/crops more conducive to automation than others?

How Do We Define On Farm Automation?

- Do you automatically think about a robot when automation is mentioned?



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What Typical Operations Have the Opportunity For Automation?

- Field Operations
 - Tillage
 - Spraying
 - Planting
 - Fertilizer Application
 - Irrigation Management
 - Harvest
- Processing
 - Sorting
 - Grading
 - Quality
 - Sizing
 - Packing
 - Transporting in facility

Let's Step Back to Basic Operations

- Are there other opportunities for control and automation without removing the operator?
 - Let's revisit typical field operations and discuss where automation makes tasks easier/more efficient to complete.
 - Tillage
 - Spraying
 - Planting
 - Fertilizer Application
 - Irrigation Management
 - Harvest
 - The most common type of automation is Autosteer, which is used in almost, if not all, field operations.

Spraying

- Spray control systems such as overlap control, rate control, PWM, and see and spray technology all are automatic control systems on sprayers that utilize a feedback system to automatically make adjustments on the machine without input from the operator.

John Deere launches See & Spray™ Select for 400 and 600 Series Sprayers



See & Spray™ Select can help farmers reduce their herbicide use by 77% on average by targeting and spraying only weeds on fallow ground.

Planter Technology

- One of the most important tasks in a production season is planting the seed, which requires proper seed placement based on crop, soil moisture, soil texture, and other environmental factors.
 - A planter is a complex machine that has many moving components and opportunities to better move the seed from system into the soil.
 - Metering system
 - Downforce Control
 - Depth

Metering System

- **Seed metering system (Seed tube, hopper)**
 - Hydraulic/Electric Seed Metering
 - Gravity tubes, speed tubes, brush belts



Downforce Control System

- Downforce can easily be tested independent of the type of system.
- Ensures the planter is capable of maintaining the set depth.
- Downforce requirements usually change with changing field conditions.
 - Soil texture/type, moisture



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Seed Depth Placement



Precision Planting SmartDepth

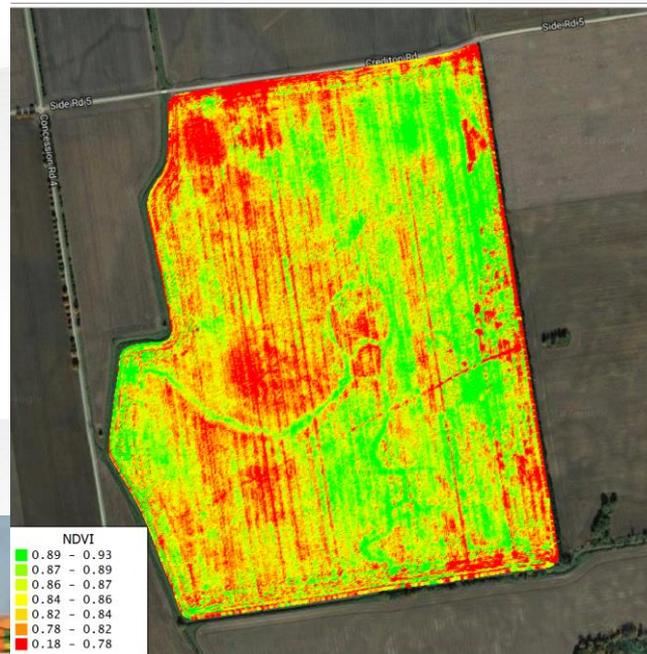


Precision Planting SmartFirmer



Sensor-Based Fertilizer Application

- While not a widely adopted technology there are control systems available that can measure and estimate, and apply in-season fertility requirements for crops.



Irrigation Management

- Remote Pivot/System Control/Monitoring
- Real time VRI Models
- Remote Soil Moisture Monitoring



Why use FieldNET Advisor?

Better-informed decisions

Get simple, science-based irrigation recommendations from field data, cloud-computing capabilities, machine learning, and more than 40 years of crop and irrigation research.

Maximize yields

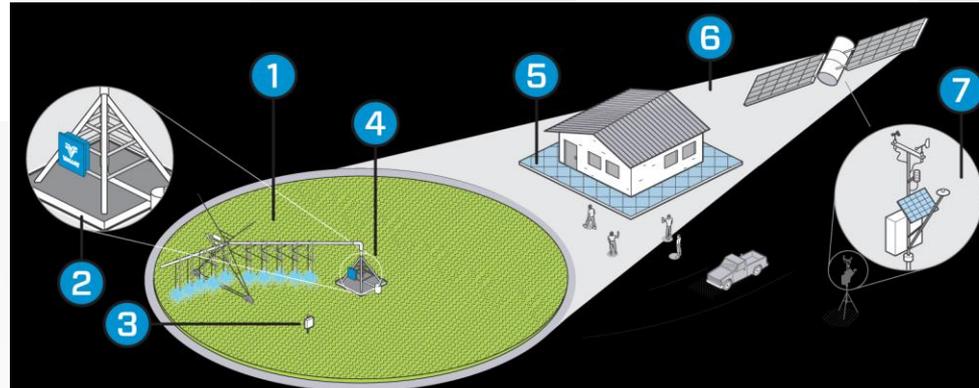
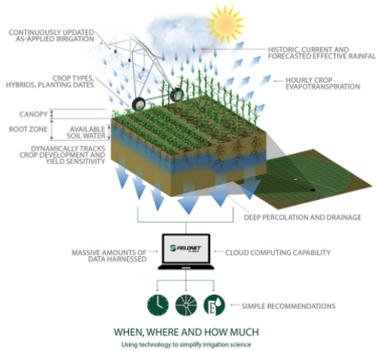
Irrigation recommendations help maximize yield output and crop performance by reducing water stress and nutrient leaching, without the cost of installing additional sensors or probes in the field or the need to visually inspect every crop.

One easy-to-use tool

Seamlessly integrated into FieldNET's remote monitoring and control platform, growers can quickly put irrigation decisions into action and monitor their progress from one place.

Improve sustainability

Status alerts help reduce input costs and conserve water by reducing the likelihood of overwatering and the resulting loss of key nutrients.



Harvest

New system adjusts combines on the fly



The latest in combine technology from makers can automatically control grain quality and flow, including Case IH's line of Class 7, 9 and 9 machines. | Robin Booker photo

The AFS Harvest Command on Case combines keeps track of a machine's settings to improve quality and savings

CES honors John Deere for X Series combines in Robotics category



John Deere X9 1100 combine harvesting wheat.

- X Series combines equipped with ActiveVision cameras, can help farmers see inside the combine's grain tank and observe tailings so they can monitor the condition of harvested grain, down to individual kernels. The combines make automatic adjustments so they can run at peak levels, even as harvesting conditions change.
- X Series combines feature proprietary artificial intelligence, computer vision, in-field machine-to-machine communication and integrated sensors for connectivity and self-driving capabilities.
- X Series combines can monitor themselves and enable farmers and service technicians to manage issues remotely, minimizing downtime and supporting profitability.

Now Let's Move Forward and Discuss Integration of Robotics

- As previously discussed there are opportunities for robotics to cover specific areas such as:
 - Repetitive Operations
 - Dangerous Operations
 - Efficiency Improvements
 - Replace Humans in time consuming tasks
 - Agronomic Management Changes

Repetitive Operations

- Crop Harvest
 - Specialty Crop Harvesters
 - Strawberry, apple, citrus etc.
 - Spraying
 - Planting/Transplanting
 - Sorting, grading, sizing
 - Vision Sorting
 - Quality Sorting



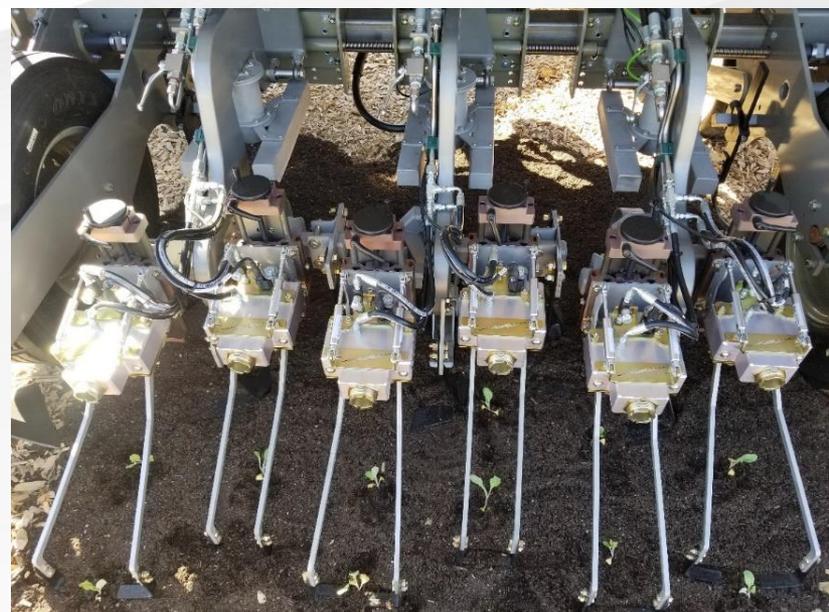
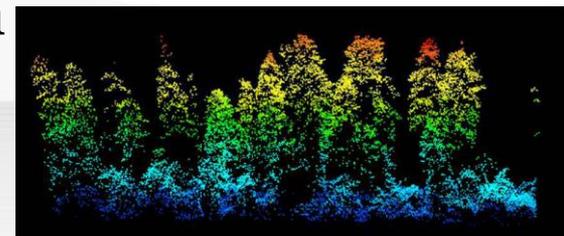
Dangerous Operations

- Reduce Chemical Exposure
 - Autonomous Sprayer
- Reduce sun/environmental exposure
 - Autonomous or assisted harvesting/trucks/tractors
- Reduce proximity to dangerous equipment
- Reduced strain/fatigue



Improvements in Efficiency

- More precise chemical application
 - Canopy detection and volume estimation
- Precision Irrigation
 - Sensors and remote control
- Precision Planting
- Precision Weeding
- Potential lower downtime



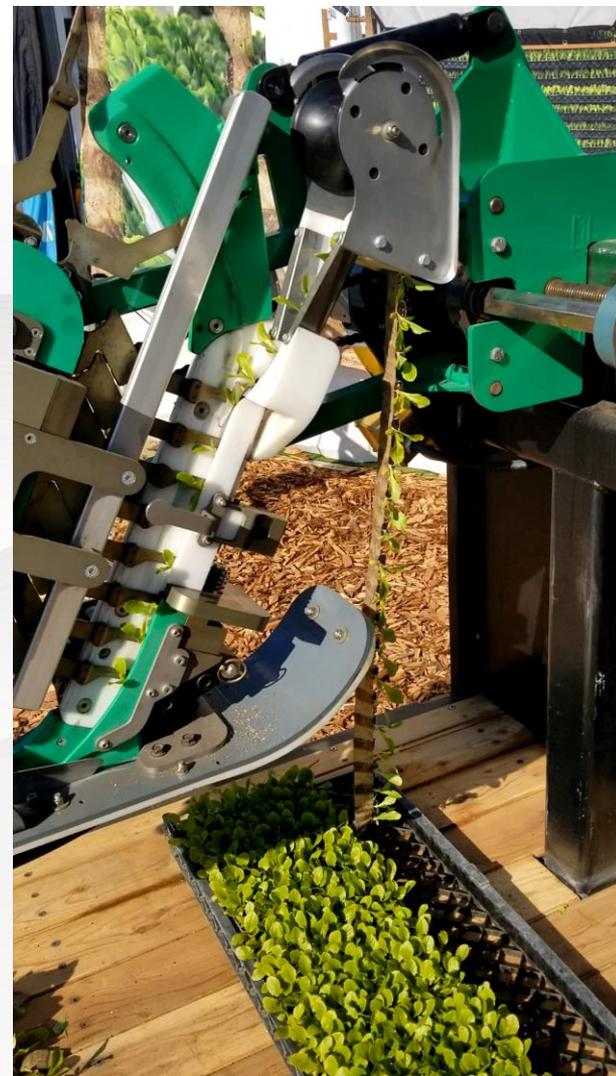
Replace Humans in Time Consuming Tasks

- Spraying for pests
 - UAS Spraying
 - Unmanned Sprayers
- Sorting
- Weeding



Agronomic Management Changes

- Potential shifts to organic?
 - Mechanical Weeding
 - Precision Management of inputs
- Different planting patterns
 - Transplanting
 - PlantTape
- Different Crops



Conclusions to Automation

- Don't sell yourself short on current levels of on farm automation and control systems.
 - There are more automation and control systems available and currently implemented than we usually realize and take advantage of.
- Robotics are being developed and field tested at a rapid pace and are nearing full scale commercialization.
 - They have the ability to aid in production if properly utilized.

What Lies Beyond 2022?

- Remote Sensing/Drones/UASs?
 - Continued interest in UASs
- On farm automation?
 - I would argue there are currently high levels of on farm automation. However, we are continually moving towards complete automation, but when will that be adopted?
- What else?

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THANKS! & DISCUSSION

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