Update on Drone Technology — Where Are We Today?

Kent Shannon
Field Specialist in Agricultural Engineering
Boone County
Update of Drone Technology

- Drone Technology
- Image Processing / Analysis
The eBee SQ has a flight time of up to 55 minutes allowing to cover areas of up to 500 acres in a single flight.

Parrot – eBee SQ - $12,000
Scout Drone – Event38 - $3,096.00

https://event38.com/product/scout-drone/

120cm Wingspan, 56cm Length (47 x 22 inches)
1.37kg -weight

Flight time 60 minutes
FireFLY6 PRO

- Wingspan: 60" (1524mm)
- Length: 32.6" (828mm)
- Weight: 8.4-9.9lbs (3.8-4.5kg)
- Flight Time: 40-50min with payload*

$6,700
Quantix - AeroVironment

$16,500.00
Action Drone, Inc. - AD2 AG

$3,869.00 - $7,077.00

Up to 45 minute flight time
Totally Autonomous Drone

American Robotics, an industrial drone developer specializing in agricultural automation, has unveiled its flagship product Scout. It is a self-charging, self-managing drone system capable of autonomously carrying out daily scouting missions.
DJI – The Main Source

Phantom 4 Pro or 4 ProV2 - $2300 / $2800

Matrice 100 - $6000

Inspire 2 - $5200
Newer Compact Drones from DJI

- DJI – Mavic Pro - $1,439
- DJI – Spark - $600
- DJI – Mavic Air - $1105

JUST RELEASED DJI MAVIC PRO 2 - $2,099.00
Corn – Cover Crop Plots - Image Captured on June 23, 2014

Could easily be Captured with a DJI Spark Drone
Capture Images via Autonomous Flight

Mosaic of 215 images taken on March 21, 2016 – flying at 80 meters – 60 acres
Map Pilot for DJI App - $9.99
Turning Drone Image into N Application Map

utilizing

[Image of drone image and map]

Legend:
- UAN 32% N, g/acre
- 0
- 0 - 14
- 14 - 24
- 24 - 34
Turning Drone Image into N Application Map utilizing [NVisionAg Logo]

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sidedress N Rate – lbs/acre</th>
<th>Corn Yield – bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer</td>
<td>40</td>
<td>207</td>
</tr>
<tr>
<td>Nvision</td>
<td>48</td>
<td>209</td>
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<tr>
<td>OptRx</td>
<td>48</td>
<td>206</td>
</tr>
</tbody>
</table>
UPDATE ON CHARITON COUNTY DEMO FARM NITROGEN TRIALS MU STRIP TRIAL PROGRAM

Kent Shannon
Extension Ag Engineer – University of Missouri Extension
Boone County
Drone Imagery from April 23, 2018 taken at 100 m AGL
Drone Imagery from June 11, 2018 taken at 75 m AGL
Drone Based N Application 2018 - All Fields

Sidedress Nitrogen Map Developed from June 11, 2018 Drone Imagery
Sidedress Nitrogen Treatments Made

Fixed Rate – 50 lbs-N/acre
Drone Based VR – 38 lbs N/acre

Preplant – 150 lbs-N/acre

Fixed Rate – 50 lbs-N/acre
Drone Based VR – 38 lbs N/acre

Fixed Rate – 50 lbs-N/acre
Drone Based VR – 40 lbs N/acre

Sidedress Nitrogen Treatments Made
Drone Imagery from June 29, 2018 taken at 100 m AGL
Drone Based N Need Assessment 2018 - All Fields

Nitrogen Need Assessment on June 29
Fixed Rate – 122 bu/acre
Drone Based VR – 120 bu/acre

Fixed Rate – 142 bu/acre
Drone Based VR – 142 bu/acre

Fixed Rate – 130 bu/acre
Drone Based VR – 124 bu/acre
What Drone Should I Use?

DJI Phantom 3 Professional
DJI Phantom 4 Pro
DJI Inspire 1 v2.0
DJI Mavic Pro
Reflectance

From Images to Reflectance
Electromagnetic Spectrum

![Diagram of Electromagnetic Spectrum showing typical plant reflectance across different wavelengths (nm) for healthy and stressed plants. The spectrum is divided into Blue, Green, Red, Red Edge, and Near-Infrared regions. The diagram highlights the differences in reflectance between healthy and stressed plants within these regions.](image-url)
NDVI – Normalized Difference Vegetative Index

Heathy Vegetation Reflectance

50% NIR
8% Red

NDVI = 0.72

Stressed Vegetation Reflectance

40% NIR
30% Red

NDVI = 0.14

\[
\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}
\]
NDVI – Normalized Difference Vegetative Index

Sensor detects the amount of light reflected from the crop and calculates NDVI

\[ \text{NDVI} = \frac{(\text{NIR}-\text{red})}{(\text{NIR}+\text{red})} \]

- NIR 60% red 8%
- NIR 50% red 30%
- NDVI = 0.76
- NDVI = 0.25
Comparing sUAS with Modified NDVI cameras Values to GreenSeeker NDVI Values

Collecting color infrared imagery using Hexcopter and Canon T4i NDVI camera

Collecting NDVI data using the Trimble® GreenSeeker® crop sensing system

Yellow Arrows: GreenSeeker Row
Green Stars: N Reference Strips
Comparing sUAS with Modified NDVI cameras Values to GreenSeeker NDVI Values

Taking samples to calculate the NDVI values

NDVI map

T4i red-NDVI vs. GreenSeeker red-NDVI

\[
y = 0.0115x - 0.7787
\]

\[r^2 = 0.93\]

T4i green-NDVI (0-200)

T4i green-NDVI vs. GreenSeeker red-NDVI

\[
y = 0.0142x - 1.1332
\]

\[r^2 = 0.91\]

T4i green-NDVI (0-200)

s100 blue-NDVI vs. GreenSeeker red-NDVI

\[
y = 0.0182x - 1.733
\]

\[r^2 = 0.90\]

s100 blue-NDVI (0-200)
Using sUAS Imagery and AgPixel to Model Corn Yields

Color Infrared Mosaic of Corn Field

Yield Map

Sandy Soils

T4i green-NDVI vs. Corn grain yield

\[
y = 7.8986x - 823.77
\]

\[r^2 = 0.91\]

T4i red-NDVI vs. Corn grain yield

\[
y = 6.2546x - 607.85
\]

\[r^2 = 0.90\]
Drones / Sensor Technology

DJI Phantom 4 with Sentera Single NIR Sensor and Standard RGB Camera

Red and NIR Bands for NDVI

$5,499

$2,949 upgrade to a DJI P4Pro

DJI Phantom 4 with Sentera Single NIR Sensor and Standard RGB Camera
Drones / Sensor Technology

From DJI Phantom 3 with Sentera Single NIR Sensor and Standard RGB Camera
Parrot Sequoia

4 Band Sensor
Green, Red, Red-Edge, NIR

$3500.00
NDVI from Sequoia Sensor
NDVI and Novel Endophyte Fescue Varieties
NDRE from Sequoia Sensor
Corn Nitrogen Strip Trial

129 Images 7/20/17
Nitrogen Dates
4/18 60 lbs. & 0 lbs.
6/13 140 lbs. & 200 lbs.
NDVI – Normalized Difference Vegetative Index

\[
\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}
\]

- Healthy Vegetation Reflectance:
  - 50% NIR
  - 8% Red
  - NDVI = 0.72

- Stressed Vegetation Reflectance:
  - 40% NIR
  - 30% Red
  - NDVI = 0.14
Corn Nitrogen Strip Trial

NDVI on 7/20/17, derived from Parrot Sequoia
Nitrogen Dates
4/18 60 lbs. & 0 lbs.
6/13 140 lbs. & 200 lbs.
Visible Atmospheric Resistant Index (VARI), developed at the University of Nebraska uses the formula

\[
VARI = \frac{R_{GREEN} - R_{RED}}{R_{GREEN} + R_{RED} - R_{BLUE}}
\]

This is the index utilized by Drone Deploy for their Plant Health Image
Corn Nitrogen Strip Trial

Plant Health (VARI) on 7/20/17, derived from Drone Deploy
Nitrogen Dates
4/18 60 lbs. & 0 lbs.
6/13 140 lbs. & 200 lbs.
Comparing VARI vs NDVI

\[ y = 0.7789x - 0.6603 \]

\[ R^2 = 0.8382 \]
Soybeans – Sudden Death Syndrome
Detailed Photos to Verify
Flying to Waypoints for Detailed Photos
Soybeans – Sudden Death Syndrome
Soybeans – Sudden Death Syndrome
Comparing VARI vs NDVI

\[ y = 2.2405x - 1.8514 \]
\[ R^2 = 0.7751 \]
Comparing Imagery to Yield

Mean yield for all strips was 55.5 bu/A (58.8 bu/A with ILeVO; 51.7 bu/A without).

<table>
<thead>
<tr>
<th>Strip</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>ILeVO?</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Yield (bu/A)</td>
<td>54</td>
<td>45</td>
<td>55</td>
<td>49</td>
<td>59</td>
<td>60</td>
<td>67</td>
<td>53</td>
</tr>
</tbody>
</table>
Comparing Imagery to Yield

Yield in bu/ac

VARI

Yield in bu/ac

NDVI

y = 211.82x + 3.1173
$R^2 = 0.7222$

y = 591.21x - 498.46
$R^2 = 0.6584$
Update of Drone Technology

• Drone Technology
• Image Processing / Analysis