UAVs: What are drones and how are they used in agriculture?

Wednesday, September 4, 2019

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ANR Educator/Precision Ag Educator

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Basic Webinar Instructions

- Audio available through computer or phone.
- Check sound via Communicate menu at top left
- Closed captions: use arrow to expand or contact the Media Viewer window. You may have to enter some log-in information.
- Expand/contract any of the windows in the right-hand column with the arrows. May need to do this to see video of presenter.
- Expand/contract the size of the right-hand column.

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Basic Webinar Instructions

Questions and comments

- Go to the Chat option in the right-hand column. Please send to “All Panelists”. Enter message in box below TO and hit return. You may enter questions about the presentation at any time.
- In addition, during the Q & A period, if you have a web microphone, click the “Raise Hand” icon to indicate that you have a question. We will enable your microphone or phone connection.

Basic Webinar Instructions

- Please let me know if more than one person is viewing at your computer
- 4 quick survey questions + opportunity to share comments
- Session recorded and archived with PowerPoint files at www.agrability.org/Online-Training
- Problems: use chat window or email jonesp@purdue.edu

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AgrAbility: USDA-sponsored program that assists farmers, ranchers, and other agricultural workers with disabilities.

- Partners land-grant universities with disability services organizations. Currently 20 state projects
- National AgrAbility Project: Led by Purdue's Breaking New Ground Resource Center. Partners include:
  - Goodwill of the Finger Lakes
  - APRIL (Association of Programs for Rural Independent Living)
  - Colorado State University
  - Washington State University
- More information available at www.agrability.org

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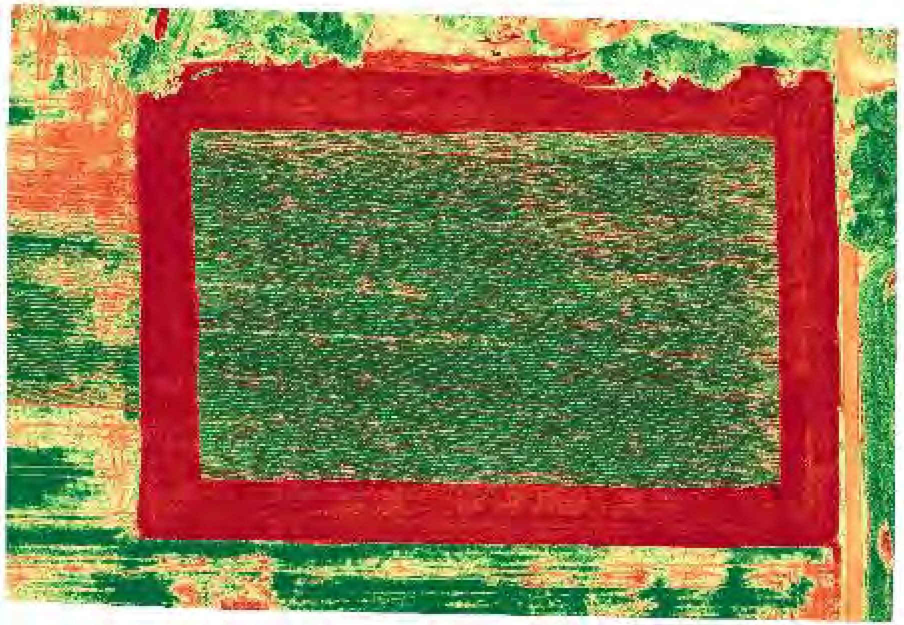
UAV Use in Agriculture

Mark Carter, MBA – Purdue Extension Delaware County ANR Educator/Precision Ag Educator



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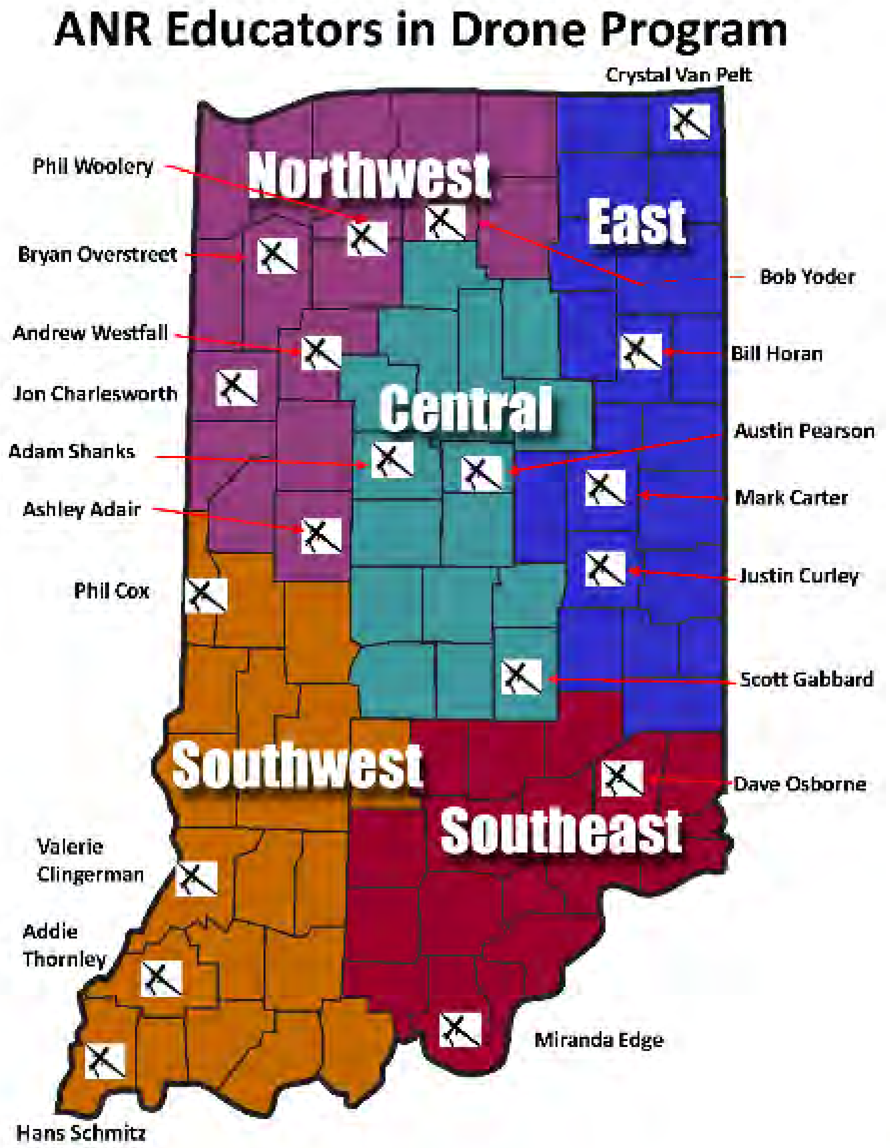
17 Extension Educators

Several Specialists

2 Coordinators

2 Purdue Ag Centers



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How is a UAV used in agriculture?

- Field scouting
- Aerial mapping
- Plant stand count, plant health, plant height
- Presence of weeds or disease
- Soil moisture and erosion
- Finding tile
- Livestock management
- Agribusiness marketing

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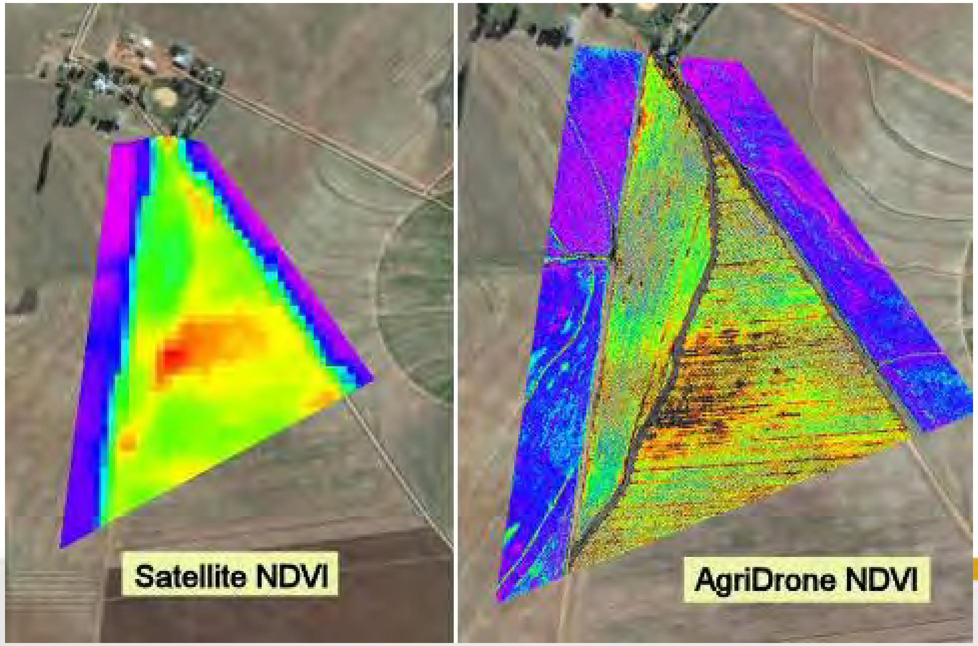
UAS pros:

- Image collection can be done more frequently
- Imagery is more precise
- Imagery is cheaper than satellite or plane
- The operator has more control of the data



Source: www.micasense.com

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UAS cons:

- UASs require more time and effort
  - Time to fly fields
  - Time to charge batteries
  - Time to process images and analyze data
  - Required to keep flight logs

- UASs require more maintenance

There is always the possibility of crashing your investment!

Source: www.google.com

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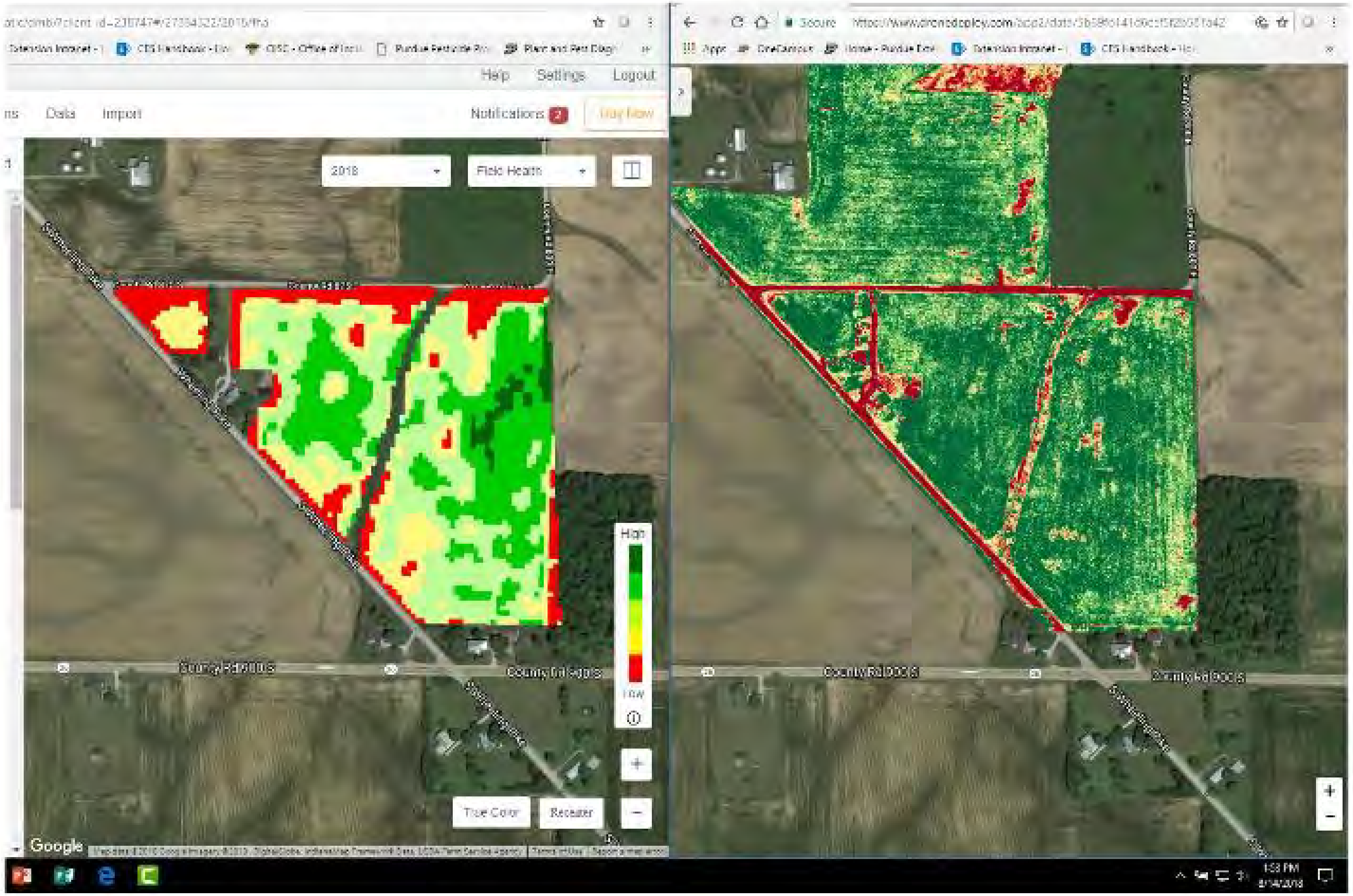
Climate Corporation Fieldview verses pictures taken by a Phantom 4 and processed by Drone Deploy.



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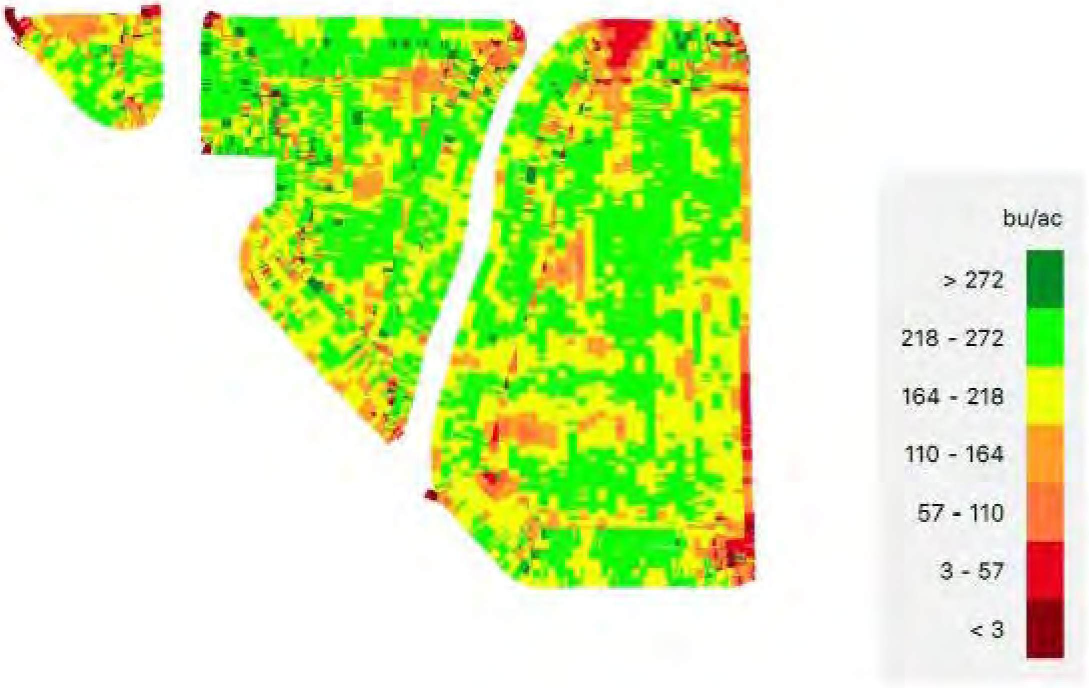
Harvest data matches consistently with the satellite and drone imagery.



Activity	Date	Avg Amount	Total	Product
Planted	May 8, 2018	34,482 seeds/ac	24.3 ac	7E253RIB
Harvested	Oct 12, 2018 - Oct 19, 2018	202 bu/ac 16.0% moisture	24.3 ac	

Notes
Seasonal Rainfall: 33.8" • 10 yr Rainfall: 24.0" • GDUs: 3,413

Part 107 Applicability

EA/EO

August 29, 2016

The rules : Title 14 of the Code of Federal Regulations (14 CFR) part 107, *Small Unmanned Aircraft Systems*.

Part 107 addresses:

a) small UAS classification,
b) certification, and
c) operational limitations

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FAA Part 107 to Title 14 Code of Federal Regulations.

Provides safety rules for the use of small Unmanned Aircraft Systems.

Gives information about airspace restrictions, visual observer requirements, and operational requirements.

UNMANNED AIRCRAFT SYSTEMS

FAA sUAS PART 107: THE SMALL UAS RULE

The Small UAS rule adds a new part 107 to Title 14 Code of Federal Regulations (14 CFR) to allow for routine civil operation of small Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) and provide safety rules for those operations. The rule defines small UAS as unmanned aircraft weighing less than 55 pounds. To mitigate risk, it will limit small UAS to daylight and civil twilight operations with appropriate collision lighting, confined areas of operation, and visual-line-of-sight operations.

The rule addresses airspace restrictions, remote pilot certification, visual observer requirements, and operational limits in order to maintain the safety of the NAS and ensure that small UAS do not pose a threat to national security. Because UAS constitute a quickly changing technology, a key provision of this rule is a waiver mechanism to allow individual operations to deviate from many of the operational restrictions of the rule if the Administrator finds that the proposed operation can safely be conducted under the terms of a certificate of waiver. This new rule will be effective 60 days after publication in the federal register.

Part 107 will not apply to model aircraft. Model aircraft operators must continue to satisfy all the criteria specified in Section 336 of Public Law 112-95 (which will now be codified in part 101), including the stipulation they be operated only for hobby or recreational purposes.

THE IMPACT TO AIR TRAFFIC CONTROL

After the effective date, those operators that have successfully passed the required knowledge test and received a remote pilot certificate may begin operations in Class G airspace at or below 400 AGL without contacting ATC or issuing a NOTAM.

For operations in controlled airspaces (Class B, C and D airspace, and E surface area) the Air Traffic Organization, in collaboration with NATCA, is establishing a process where the operator can make a request and receive approval through an automated system. The operators will not contact individual ATC facilities to make the request. ATC guidance, procedures, polices and processes are under development and will be available prior to the effective date of the rule. For more information on the new rule visit the FAA UAS website at www.FAA.gov/UAS.

MAJOR PROVISIONS

- Unmanned aircraft must weigh less than 55 lbs. (25 kg)
- Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS
- Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle
- Daylight-only operations or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting
- Must yield right-of-way to other aircraft
- May use visual observer (VO) but not required
- Maximum groundspeed of 100 mph (87 knots)
- Maximum altitude of 400 feet above ground level (AGL) or, within 400 feet of a structure, 400 feet above that structure
- Minimum weather visibility of 3 miles from control station and must remain 500 feet from clouds (no ceiling requirement)
- Operations in Class B, C, D and Class E surface areas are allowed with ATC approval
- Operations in Class G airspace are allowed without ATC permission
- sUAS cannot be operated from a moving aircraft
- sUAS cannot be operated from a moving vehicle unless the operation is over a sparsely populated area
- No careless or reckless operations
- No carriage of hazardous materials
- FAA airworthiness certification is not required

FAA.GOV/UAS

Federal Aviation Administration

EA/EO

Remote Pilot Certification Requirements

- Be at least 16 years old
- English proficiency
- Pass TSA background check
- Pass written (multiple choice) aeronautical knowledge exam at an FAA approved testing center
- Pass a recurrent aeronautical knowledge test every 24 months
- No aeronautical experience of flight proficiency required
- No airman medical certificate required

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Popular Multi-rotor UASs:

• Mavic Pro	$800
• Inspire 1 & 2	$2000/$3000
• Phantom 3	$500
• Phantom 4/4 Pro	$1200/$1500
• Matrice 100	$3300
• Matrice 200/210/210 RTK	$5200/$7000

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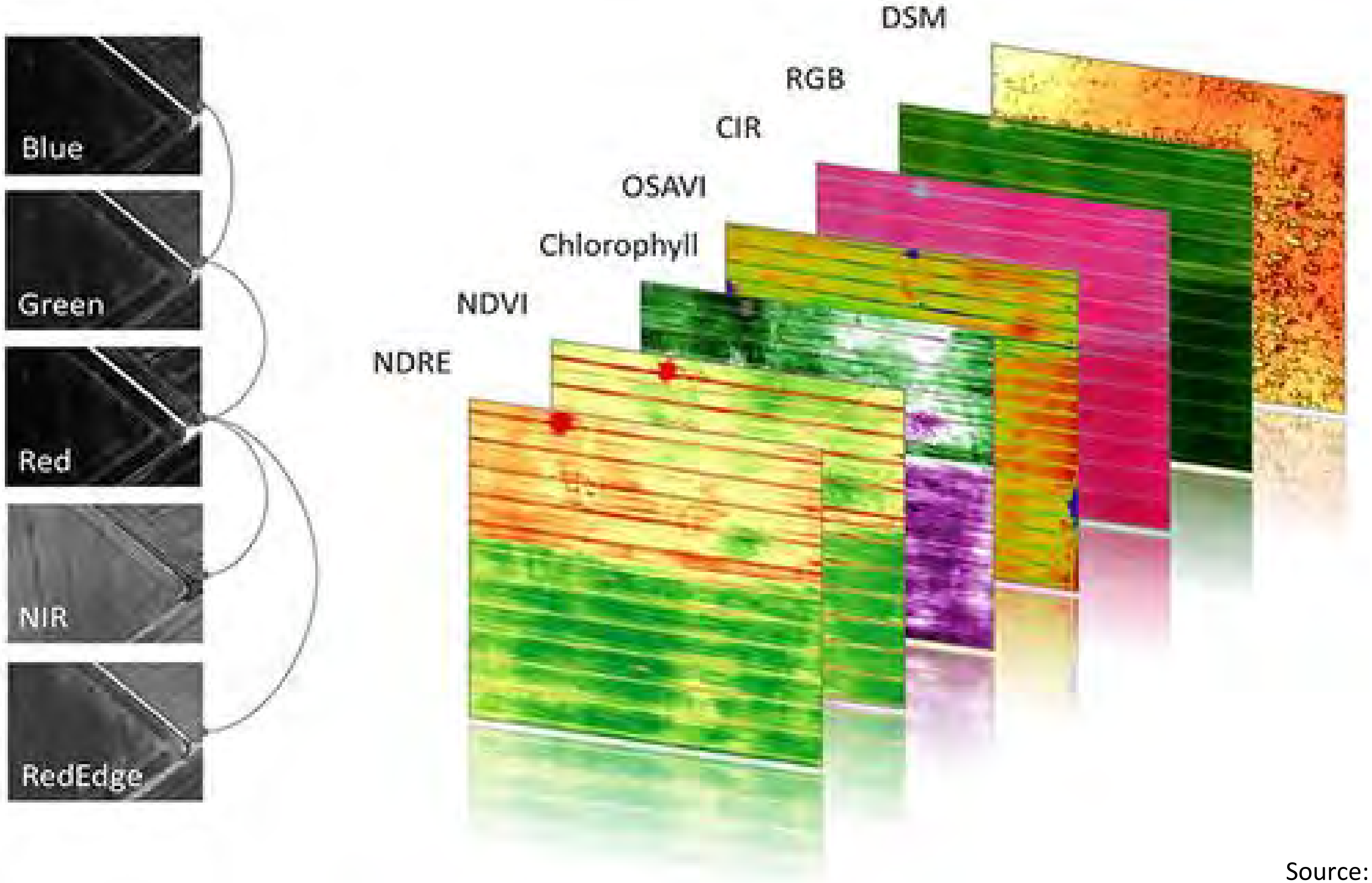
Source: drone-world.com

So what sensing options are available?



Source: www.micasense.com

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Orthomosaic – 2 dimensional imagery

- Requires standard RGB camera as the sensor
- Takes standard earth images (like Google Maps)
- Useful for finding trends from the “eye in the sky”
- Easily uploaded to most farm software

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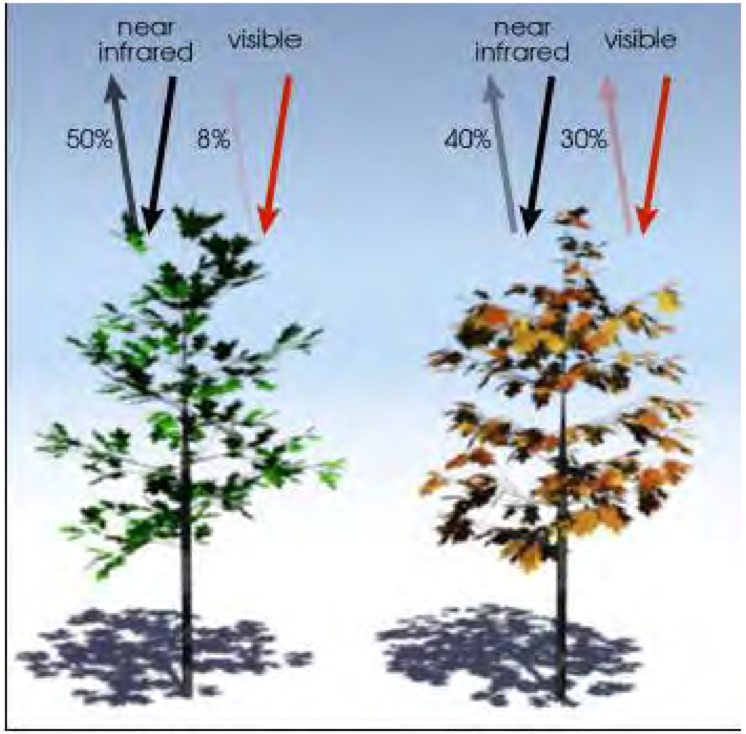
$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$

NDVI – Normalized Difference Vegetation Index

- Uses reflected light in the green, red, and near infrared light (NIR) spectrum to produce images
- The near-infrared (NIR) light spectrum can be defined as the region between 750 nm and 2,500 nm
- NDVI is beneficial for plant health
- NDVI can be calculated by finding the percentage difference between the near infrared and visible red light spectrums

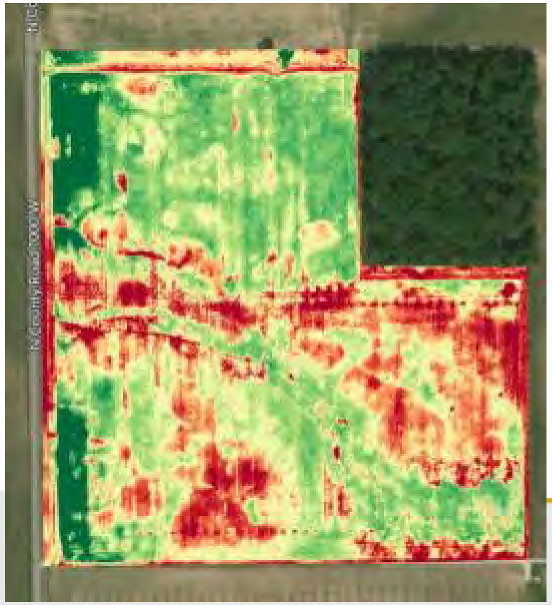


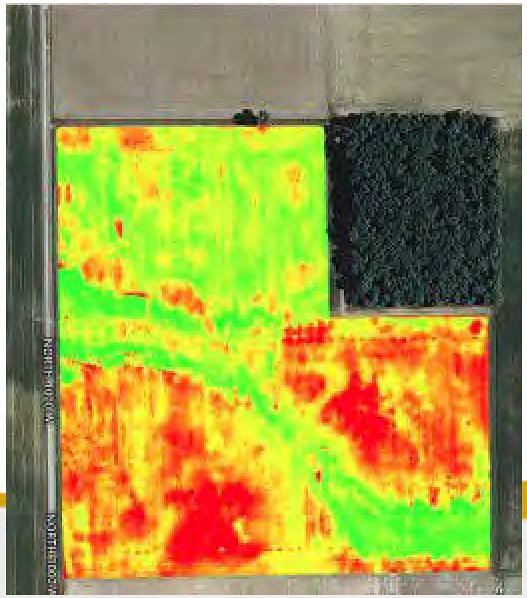
$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72 \qquad \frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

Image courtesy of NASA

EA/EO

The difference in each map is a result of the difference in light spectrum the original images were captured in. The bottom left was captured in standard red, green, and blue light spectrum which creates a good plant health map. The picture on the bottom right is a true ndvi which requires near infrared light spectrum to be captured (top right).





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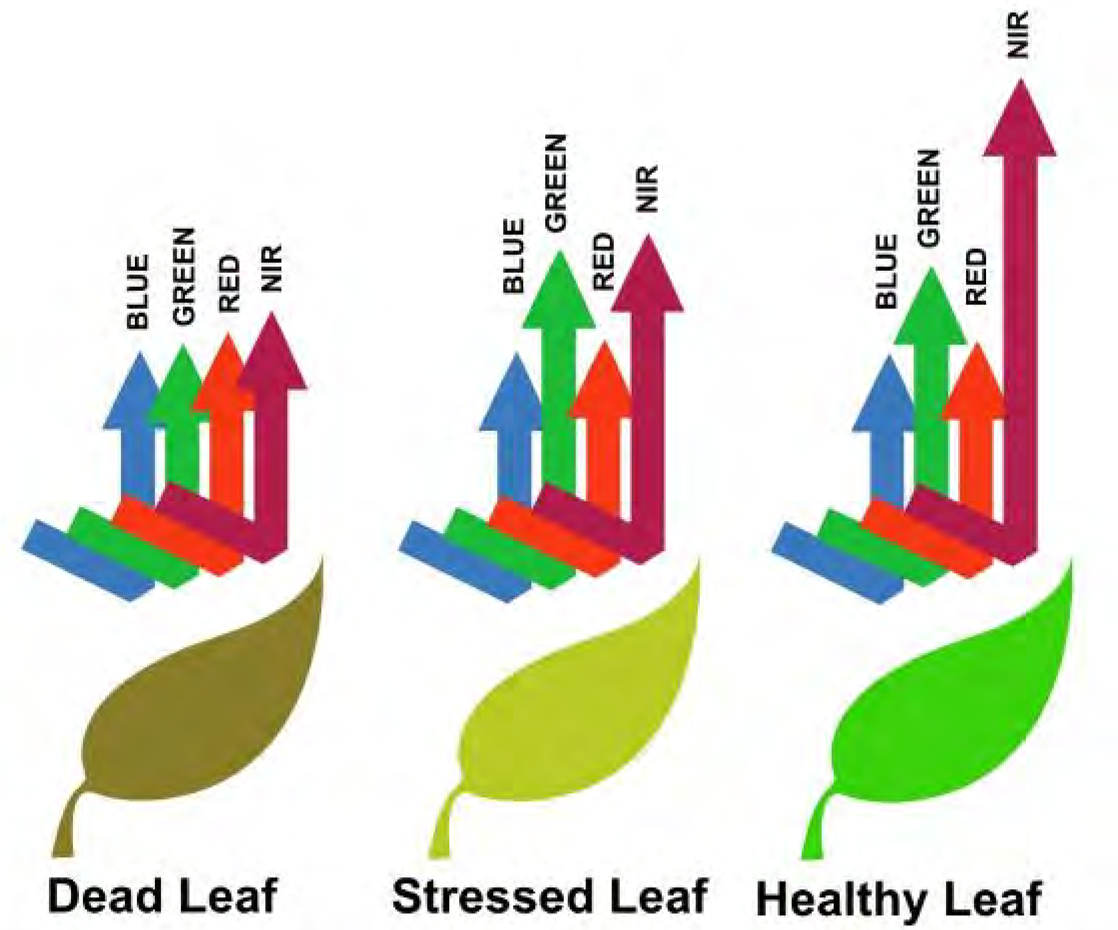
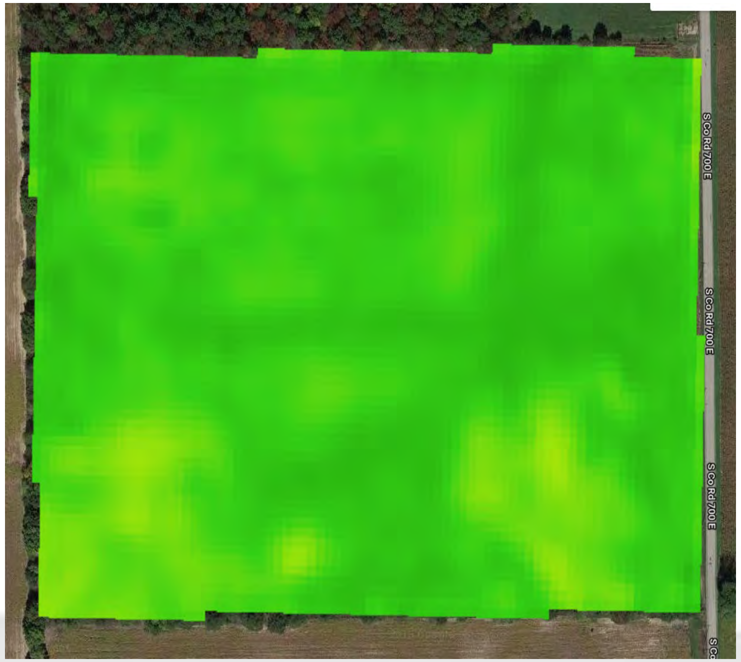


Source: www.Agribotix.com

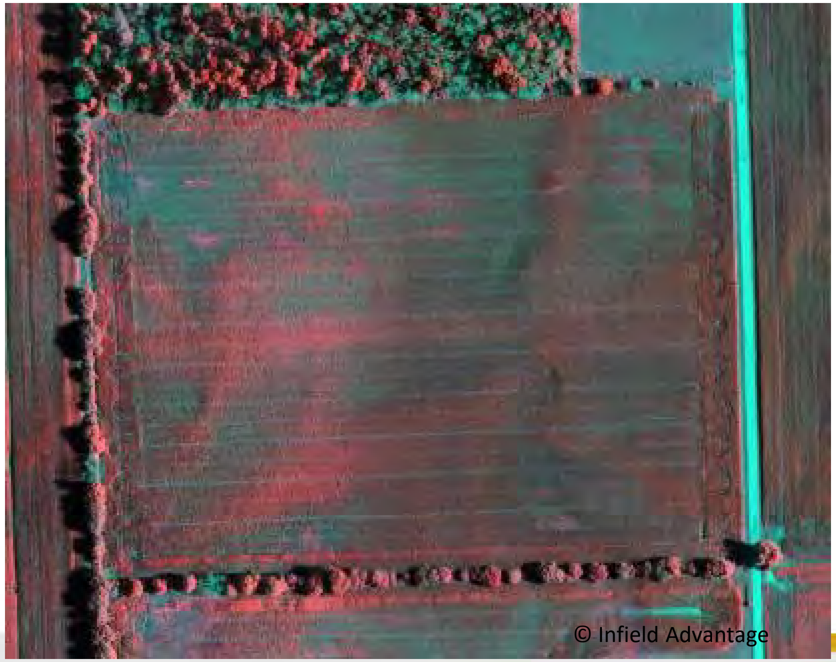
The NIR will reflect higher on a healthy leaf and green will reflect higher on a healthy or stressed leaf. However, none of the light spectrums will reflect higher on a dead leaf. NDVI has become a popular option for imagery solutions because it can be achieved consistently and is readily available through many imagery vendors.

Using Climate Corp (Monsanto) for satellite, Infield Advantage images for aerial, and Purdue Extension UAV's for drones, the following images were taken:

Satellite orthomosaic



Airplane orthomosaic (Near infrared)



UAV orthomosaic

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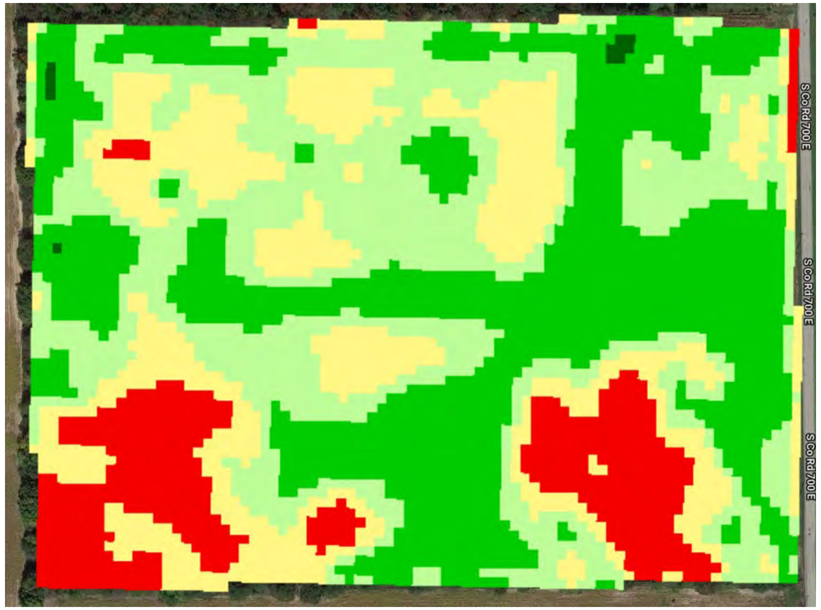
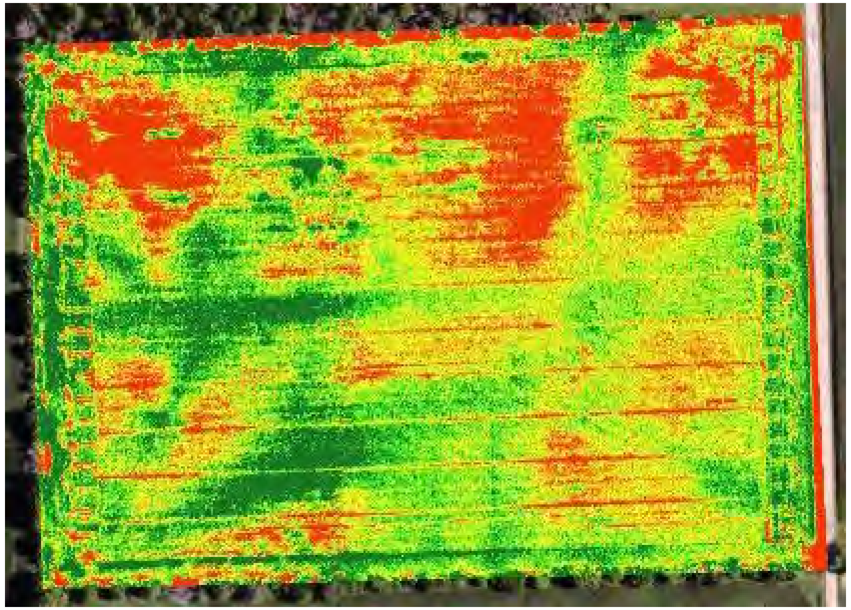
The same set was used for NDVI pictures

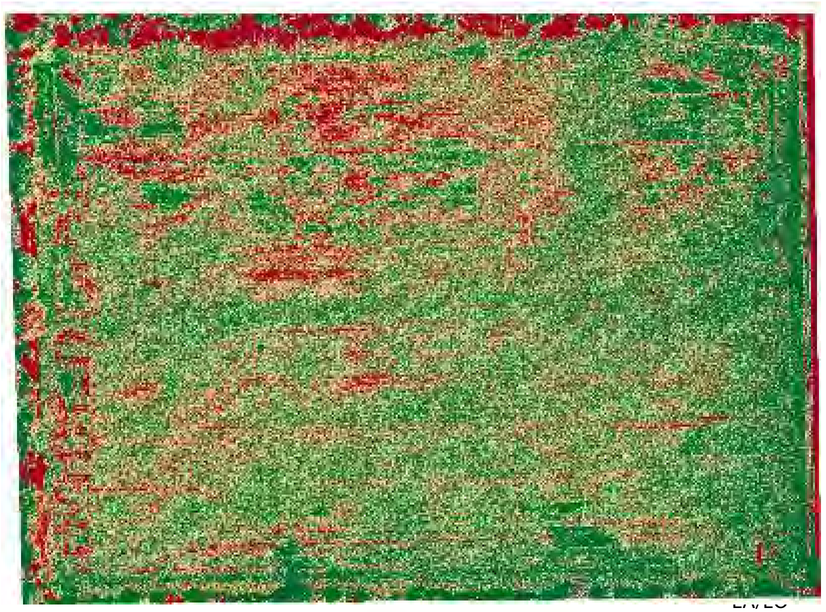
Satellite NDVI



Airplane NDVI



UAV NDVI



The NDVI or normalized difference vegetation index highlights plant health in terms of a green, yellow, red map. The satellite and airplane are both utilizing pictures from near infrared light spectrum. The lower producing and weedy areas can been seen easily. The lines from the plugged 28% applicator knife are very prevalent as well.

The UAV image is using VARI or visible atmospherically resistant index highlighting plant health in a green, yellow, and red map. The UAV software algorithm works off of the red, green, and blue light spectrums which happens to be the same as the camera in you cell phone or digital camera.

Sensors

- Sentera single sensor – ndvi or ndre - $2200
- Sentera Double 4k – ndvi, ndre - $3500
- AGX710 sensor - $4300
- Sentera Quad Sensor – multi-spectral (R, G, NIR, RGB) - $4600-6100 depending on options

Source: www.sentera.com

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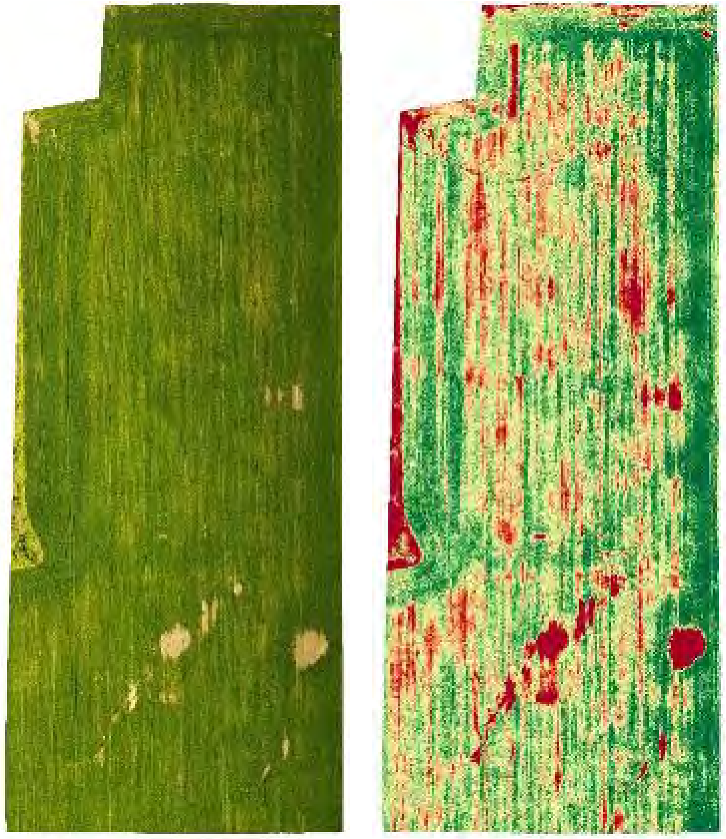
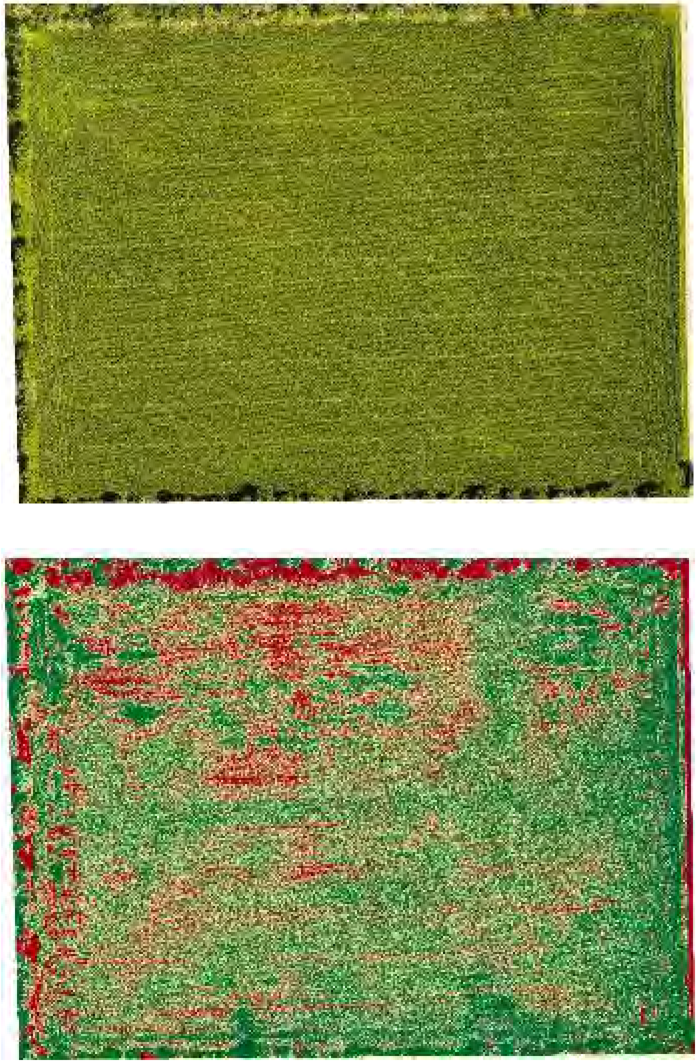
Practical application of the UAV in ag, you can see the streaking in the wheat field which was a nutrient deficiency. Also, you can see in the even streaks in the corn field which was a plugged 28% applicator knife during spring application of nitrogen. One problem was fixed this spring and the other will be fixed next spring.



Wheat



Corn

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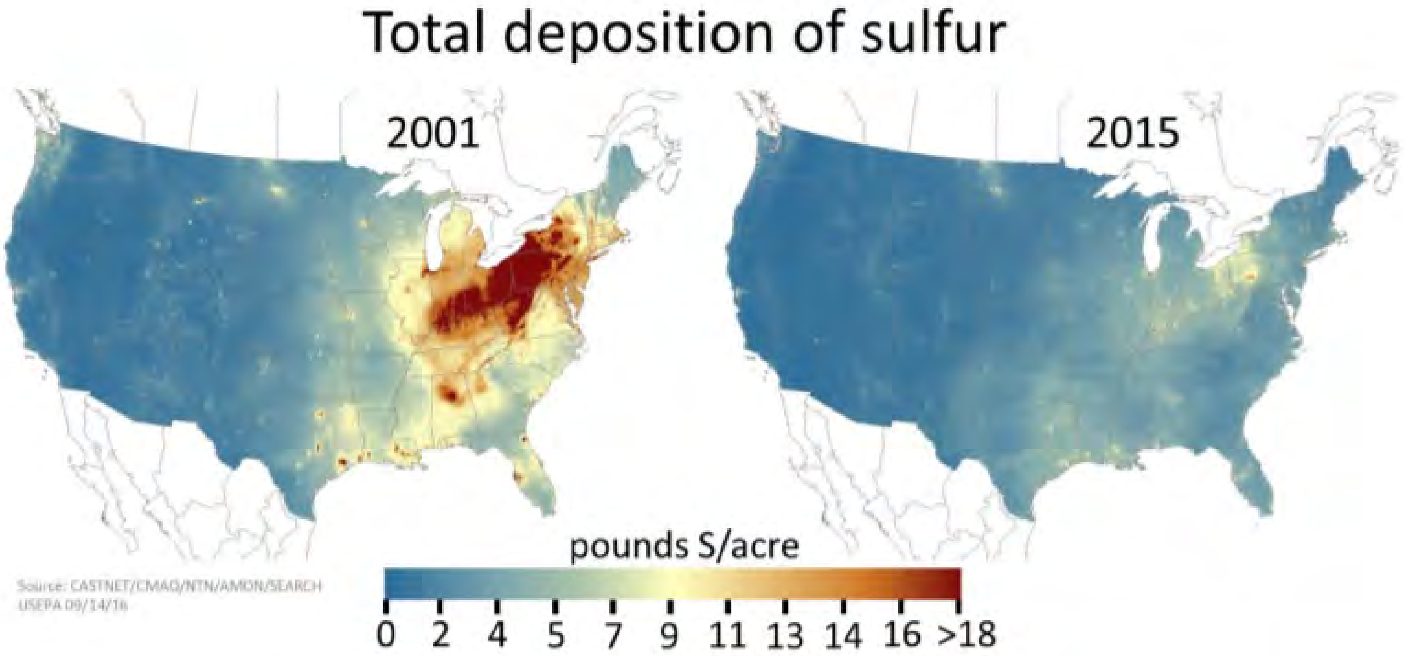
History

- "Soybean grain removes… about 10 pounds of S per acre at 60 bushels per acre."



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Source: https://www.agry.purdue.edu/ext/corn/news/timeless/sulfurdeficiency.pdf

AMS Trial

- Soybeans were planted on May 28, 40lbs S/acre were applied in two swaths across the field the following day
- Protocol calls for up to 20lbs S, but this grower has sandier soil and irrigates, which requires a higher rate
- Before and after irrigating, there was a striking difference in the appearance of the soybeans in the swaths, we are still awaiting yield data to do ROI analysis

Source: www.micasense.com

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Flown 7-13-18
Planted 5-28-18
197 lbs AMS 5-29-18
Loamy sand, irrigated
©Purdue University, Crystal Van Pelt

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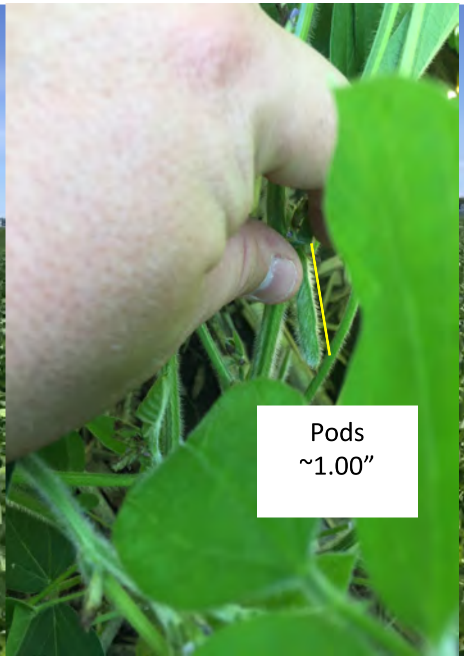
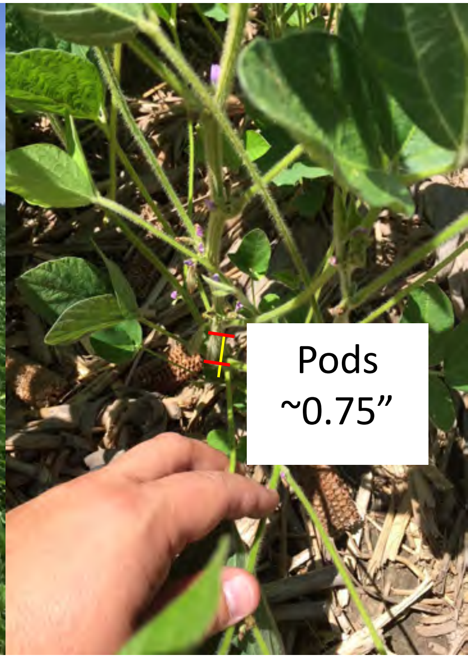
Boots to Ground 07/06/18 – Sulfur Field 1





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Tipton County Update – Austin Pearson

Yield Estimate 08/16/18 – Sulfur Field 1

- 10 plants sampled per 42" on 15 inch rows, late R5/early R6 for both treatments
- Counted pods, nodes, and branches.
- Results in table below:

	AMS	No AMS
Pods	66.36	43.6
Nodes	18.4	16.6
Branches	3	2.9
Yield Estimate bu/acre	100	60

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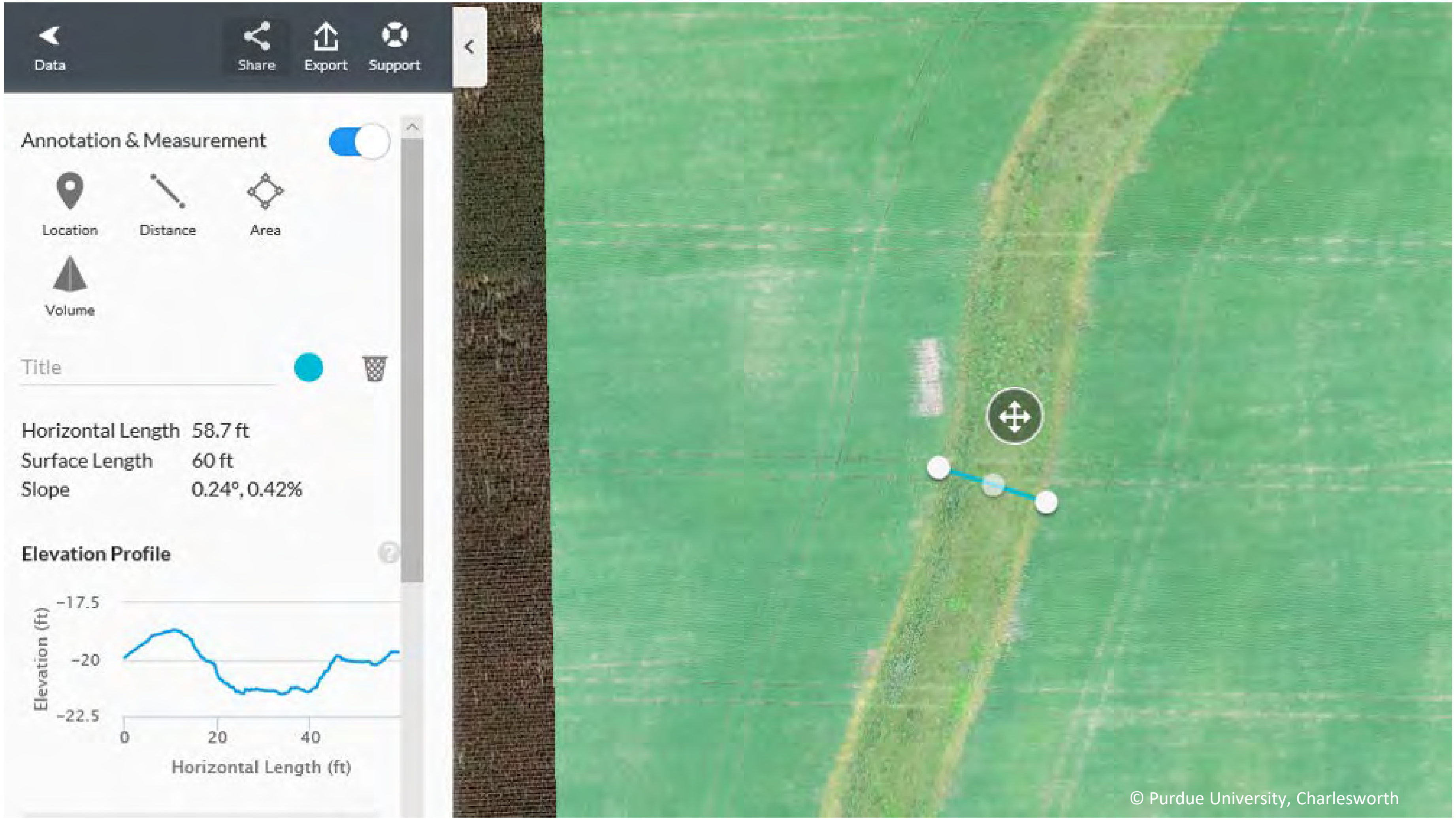
Conservation structures can be inspected in detail with a UAV by entities such as the Natural Resources Conservation Service (NRCS) for compliance with their standards. Structures must be inspected periodically to ensure that they are operating properly and meeting their program goals. Grass waterways are one of the most utilized structures around the state.

Drone Deploy was used for flight planning and grass waterway channel analysis. The channel is high on the left and uneven on the right due to weeds. Channel width is 58' and depth about 1.5'.



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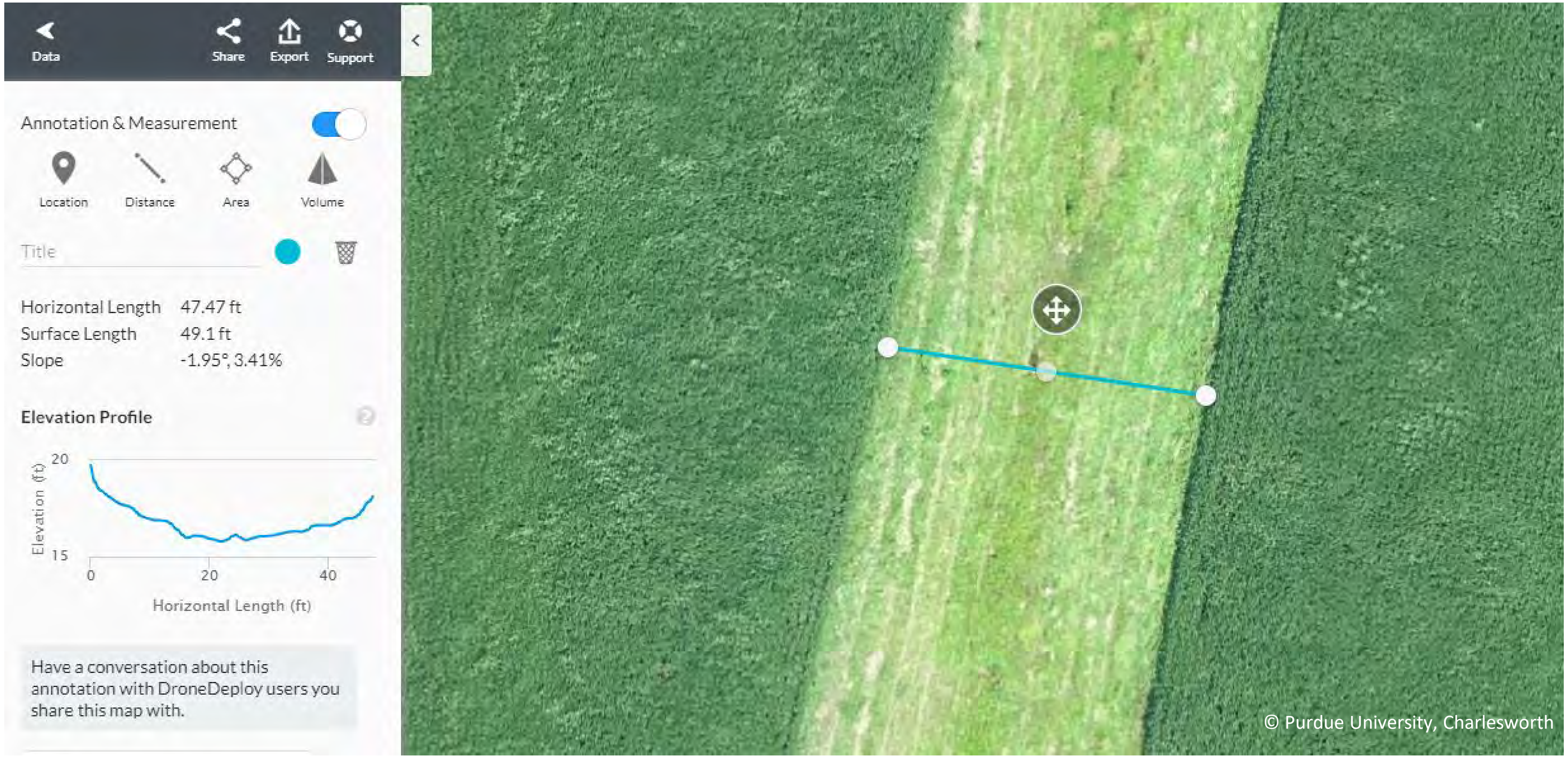
After mowing the channel and flying at a later date, the channel is more uniform and looks like it will meet NRCS expectations to carry water appropriately.



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By using the UAV, the channel of the waterway can be inspected without having to walk the entire distance saving time and effort. If something does not look right from the UAV imagery, the area can be walked to directly to discover any issues.

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Severe weather visited Shelby County this spring in the form of heavy thunderstorms contain high winds and hail.

The use of a UAV to determine the extent of damage to crops was used along with analytical software.

Extension

Early inspection to damaged fields can give the producer more options when deciding how to proceed with their crop. These beans were damaged early enough they could be replanted easily.

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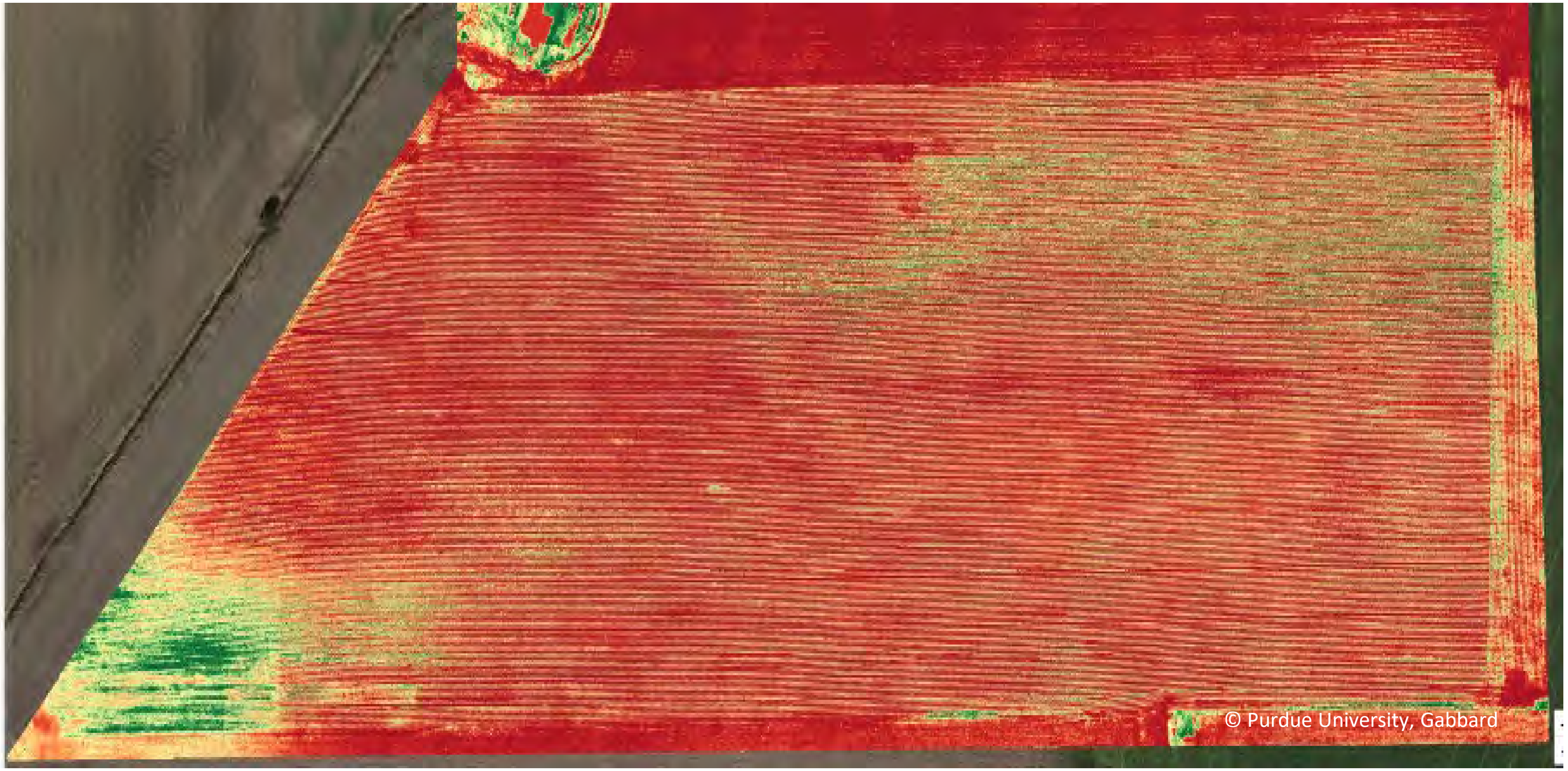
This map developed from aerial imagery shows a bean field that was hit hard with hail. Notice the green areas in the bottom left and top right that were not hit quite as hard. The center of the field was damaged extensively by the storm.



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By utilizing imagery software, producers, insurance, utilities, and many other business entities are able to make area and volume calculations.

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Tower Installation Damage & Compaction

Manually captured drone image of a newly installed power transmission tower showing that soil compaction and crop damage area is much greater than the immediate tower footprint.

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Tower Installation
Damage & Compaction

In this instance, tower installation resulted in a broken field drainage tile.

Due to the broken tile the field did not drain properly resulting in saturated soils and crop damage.

Using Drone Deploy, geospatial analysis was conducted to quantify the damaged area for the farmer.

- Orange area = 3.27 ac (too wet, not planted)
- Purple area = 1.52 ac (plant roots too wet)
- Total = 4.79 ac

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5 Ponds with Tilapia Released

We selected 5 ponds for tilapia releases in May of 2018 in Ripley County.

We then flew these ponds on a monthly bases to monitor the weed pressure in the ponds.

The release happened later than we had wished for due to slow water warm up in the spring.

Four flights were made at each pond beginning in July and ending in October.

The rates in the ponds varied but the target rate was 30 pounds to the acre.

Cope Pond Images

July

August

September

October

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So What's Next??

Source: Google.com

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Are we looking for more sensors, new projects, new UAV's? How do we stay relevant in the years to come?

- Thermal
- Lidar
- Multispectral
- Hyperspectral

$$ How much can we spend?? $$

Source: Google.com

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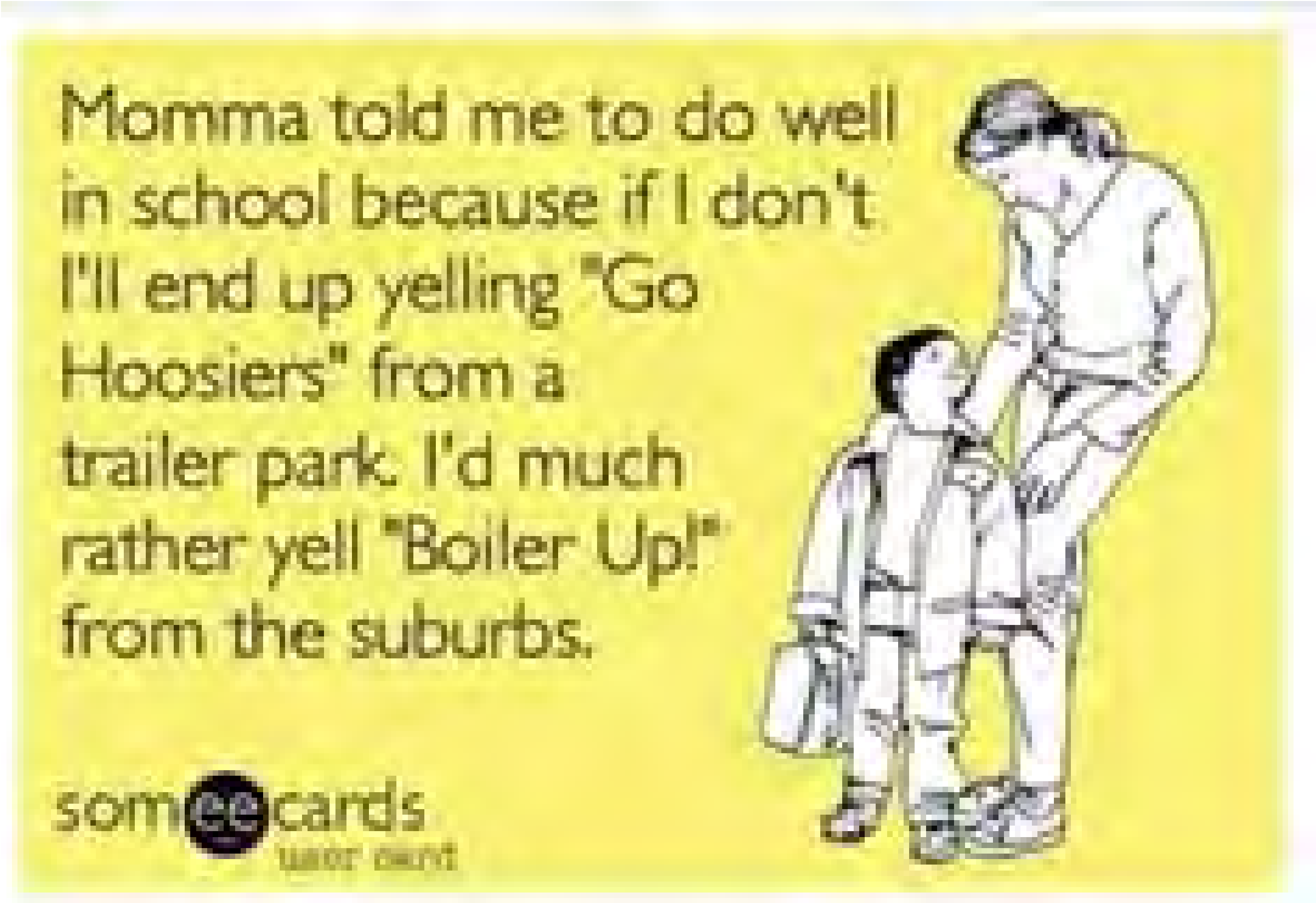
Purdue Extension is leading the way in the Midwest!



Source: Google.com

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Drone use for people with disabilities

- Allows people to see more things in their surrounding environment
- Improves crop scouting
- Makes checking on livestock, fence, forage, and water easier
- Gives a new avenue for business opportunities

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With UAV technology –

- Manual flights allow a person to see their crops from a “bird’s eye” view
- Find tile, erosion, or water standing issues without getting into the field during poor soil conditions
- Planned flights and stitching software can make crop scouting much more effective

Source: rcgroups.com

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Business Opportunities:

Crop scouting: $1-5/acre
Insurance inspection: $25+/hr
Photography: $25+/hr
Infrastructure inspection: $250+/hr
Video/cinema camera operator: $50-70k/yr
Contractor: make your own prices
Military: $110,000/yr

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Summing it up:

- Drones are used for many applications in ag
- Several drones are available for use
- Many sensing options are available
- The technology brings value faster to a producer
- Technology gives producers more options

Questions

Information provided by:
Mark Carter, MBA – Delaware County ANR
Austin Pearson – Tipton County ANR
Bryan Overstreet – Jasper County ANR
Crystal Van Pelt – Steuben County ANR

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