Integrating UAV's into your crop management system

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FAA Regulations

- The Federal Aviation Administration does not allow commercial use of UAV's within the National Airspace System (Section 636 of Public Law 112-95).
- To be able to fly UAV's commercially you must have a Section 333 exemption issued by the FAA.
- So currently we can not <u>legally</u> implement UAV's!

Thanks for your time!

- Questions?

There is a loophole!

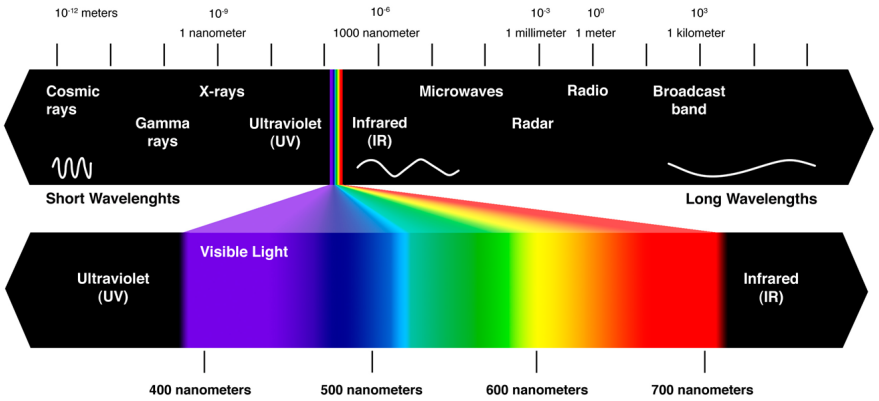
- Hobbyist Parameters
  - Altitude: Maximum of 400 ft.
  - Must maintain line of sight with aircraft
  - Must be outside of a 5 mile radius of any airport
  - No autonomous flight
  - No fee for hire operation of aircraft
- Very heavy fine for violation of these rules but usually stems from a complaint

What can be gained?

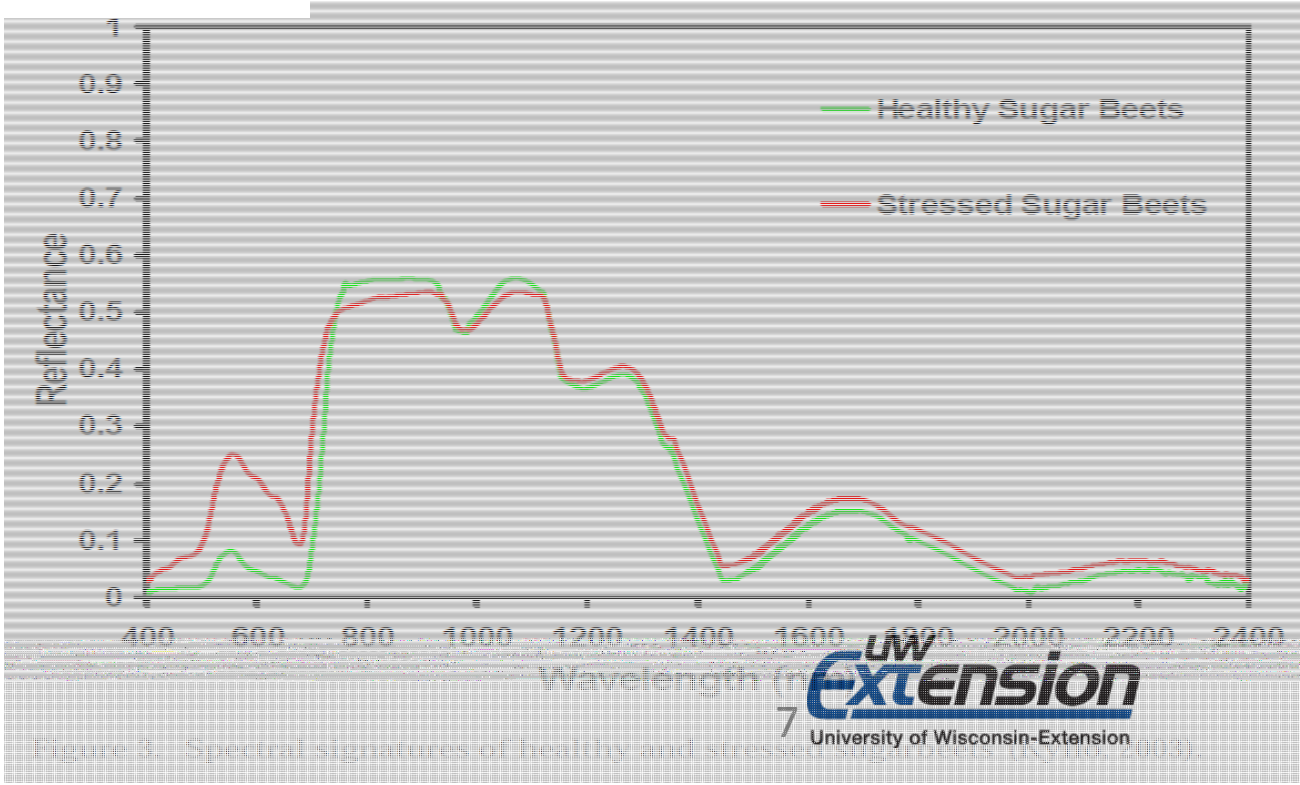
- Information at times during the growing season that we have not previously had access except on foot
- Information about plant stress over time within the growing season
- Opportunities to adjust inputs for profit optimization over the entire growing season!

What is remote sensing?

- Measurement or analysis of a phenomena without being in direct contact with it
- Relies on measurement of electromagnetic energy reflected or emitted from objects
- Used to identify:
  - Nutrient deficiencies, disease, water deficiency or surplus, weed infestations, insect damage, hail and wind damage, herbicide damage, plant populations, yield prediction, etc.
  - i.e. Plant Stress

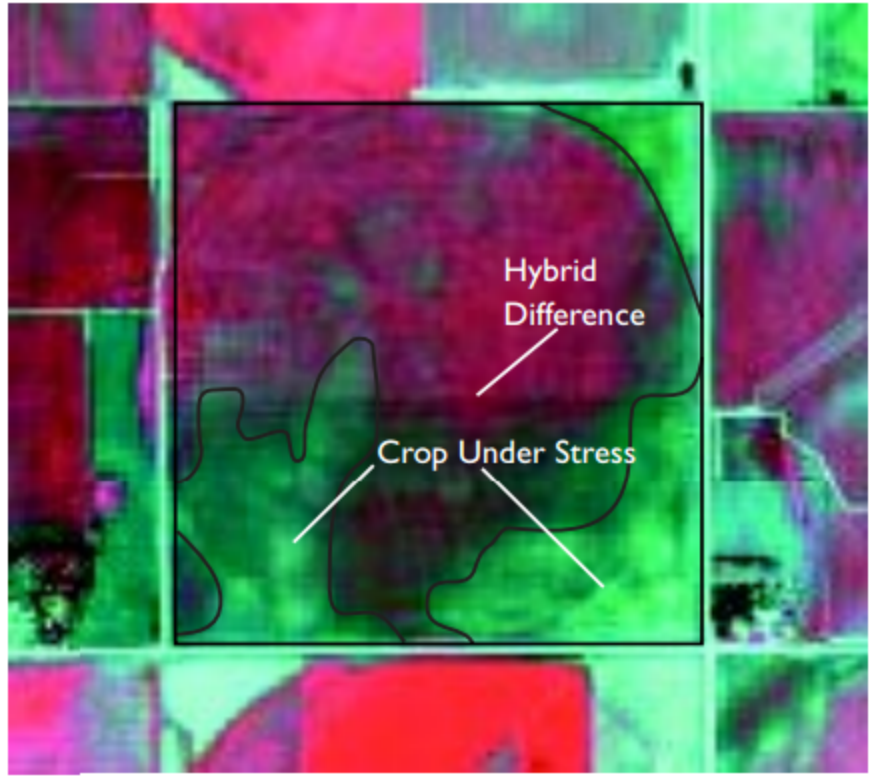


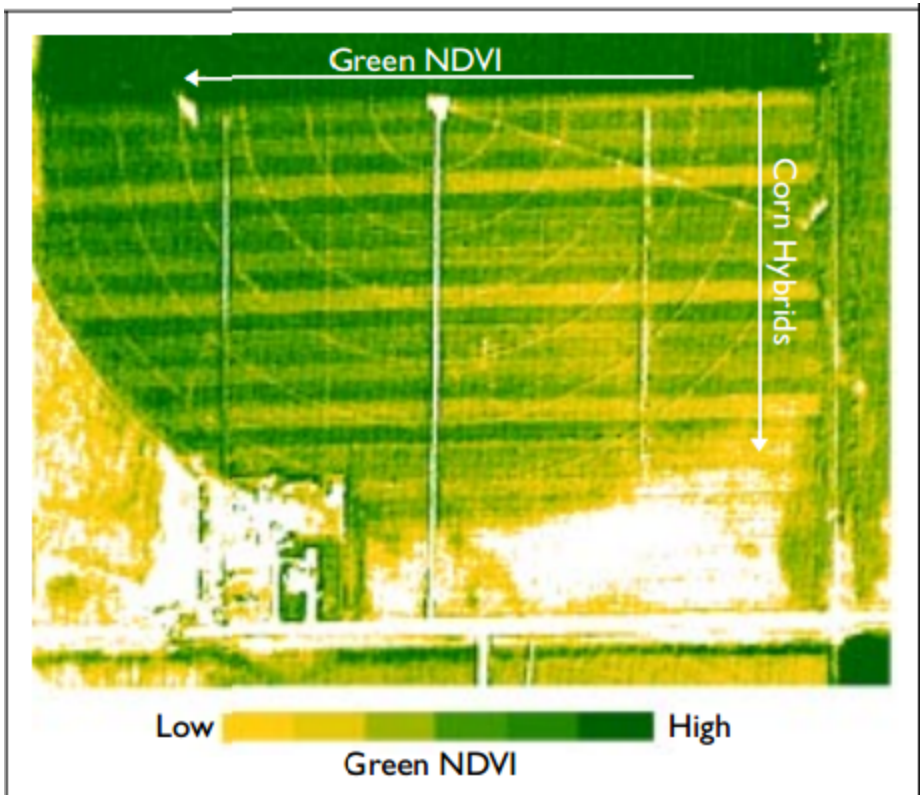
- Plants reflect light differently at differing wavelengths.



How is it done currently?

- Normalized Difference Vegetation Index (NDVI)
- $NDVI = L\downarrow NIR - L\downarrow V \,/ L\downarrow NIR + L\downarrow V$
  - L_{NIR} = Near Infrared (0.725 – 1.10 µm)
  - L_V = Visible (0.58 – 0.68 µm)
- Values range from -1.0 – 1.0
  - Rock, sand, snow = < 0.1
  - Dense vegetation = 0.6 – 0.9

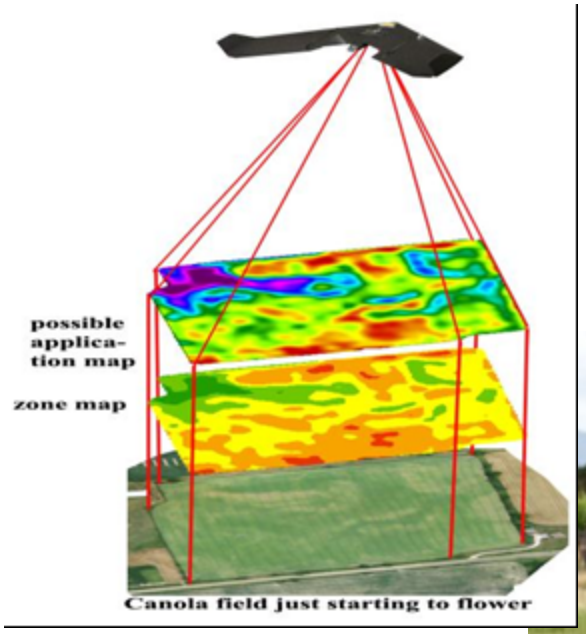




Types of sensors

- Passive Sensors
  - Sun provides energy source
  - Sensor measures energy reflected
- Active Sensors
  - Provide their own light source
  - Must be in somewhat close proximity to subject
  - Less affected by ambient conditions
- Most sensors account for incident solar radiation present

Unmanned aerial vehicle



Types of UAV's

- Fixed wing vs. rotor
- Battery powered vs. combustion powered
- Sensor considerations
- Data analysis considerations

Fixed Wing UAV's

- Flight speed: 27 - 56 mph
- Field Eff.: 450 – 2,470 ac./charge
  - @ 3,195 ft alt.
- Autopilot: On Most
- Mechanical Launch: Sometimes required

- Covers large area from high altitude to give a "macro" view of the field

Photo: agriviewsystems.com

Photo: sensefly.com

Rotor Type UAV's

- Flight speed: 0 - ~30 mph
- Field Eff.: 0 - 25 ac./ charge
- Autopilot: On Most
- Mechanical Launch: No

Photo: precisiondrone.com

- Hover capabilities allow for close measurement of the crop for more precise diagnosis.

Photo: gizmag.com

Autonomous UAV Operation

- Pre-determined flight path
- Repeated photo locations to maintain data consistency
- Provide a lot of information with minimal effort and cost
- Could be producer owned or a service provided by a third party
- Data transferred wirelessly to a server for processing/ utilization (Telematics)

Current UAV Limitations

- FAA regulations
- Cost
  - Drone
  - Camera
  - Data transfer/processing
  - Other
- Battery life/fuel capacity
- Ruggedness

FAA Regulations Rumor and Speculation

- UAV pilot licensure
- Flight plans submitted for high altitude
- Multiple operators
  - Pilot to operate the aircraft
  - Spotter to operate the camera
- Maintain line of sight with aircraft constantly
- UAV flights only during daylight hours
- Roll-out goal of September, 2015
  - Could be as late as 2017

Data and Data Analysis

- Types of data
  - Point Data (i.e. Lat, Long, Value)
  - Image Data
- Calibration
  - Sensors require calibration
  - Cameras require reference measurements for calibration as well
- Data transfer
  - Manual?
  - Automated?
  - Wireless?

Data and Data Analysis

- Software
  - Most UAV's come fitted with software to analyze the data that they collect
  - Question where the data is stored
    - On UAV
    - PC
    - Cloud
- Can the results of this analysis be imported into my current GIS package?
- Are there any conversions that need to take place before the data will match up and make sense?

Final Thoughts

- UAV data collection will provide us more information about our crops than we have ever had before
- Implementation
  - Two different types of UAV's for efficiency
  - Data transfer and analysis – streamline
  - Follow-up spot check to confirm analysis
  - Identify minimum effective delay between flights

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