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UAV for Precision Agriculture

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UAV FOR PRECISION AG

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WORKSHOP: DRONE FOR EDUCATORS

MAY 26, 2020

South Dakota State University

JACKRABBITS
SOUTH DAKOTA STATE UNIVERSITY

OVERVIEW OF PRESENTATION

1. What is Precision Ag Practice?
2. Why Remote Sensing in Agriculture?
3. What and Why is NDVI?
4. UAV for Precision Agriculture
5. How to use UAV for Precision Agriculture
6. Procedure of Drone Work (Planned Flying)

1) WHAT IS PRECISION AG PRACTICE?

- Site-specific management
- To do site-specific management, gathering data from fields is very important:
  a) Grain yields using yield monitoring system
  b) Grid-based soil/plant sampling
  c) Remote sensing data
- Based on the data, site-specific applications can be done.

2) WHY REMOTE SENSING?

1. Estimating Yields
2. Monitoring Crop Health (Scouting):
   - Water Stress
   - Nutrient Stress
   - Insect/Disease Detection
   - Weed Management

REMOTE SENSING DATA IS USEFUL FOR:

- Detection and Prediction

- Ag consulting business
- Insurance company
- Seed company
- Fertilizer/herbicide company

LIMITATIONS?

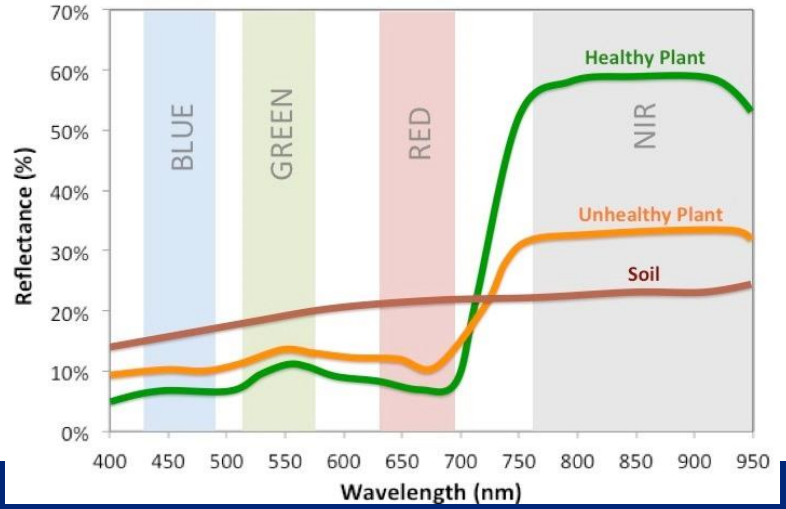
- Satellite images have been used in agriculture.
- There are limitations:
  a) Affected by weather
  b) Spatial resolution is low
  c) Commercial images are very expensive
  d) Not easy to use
- Drone overcomes these limitations.

3) SPECTRAL INDEX

- Spectral indices are combinations of spectral reflectance from two or more wavelengths (bands) that indicate the relative abundance of features of interest.
- Vegetation indices are useful for agriculture.
- There are so many VIs, but NDVI is the most common in agriculture.

NDVI (NORMALIZED DIFFERENCE VEGETATION INDEX)

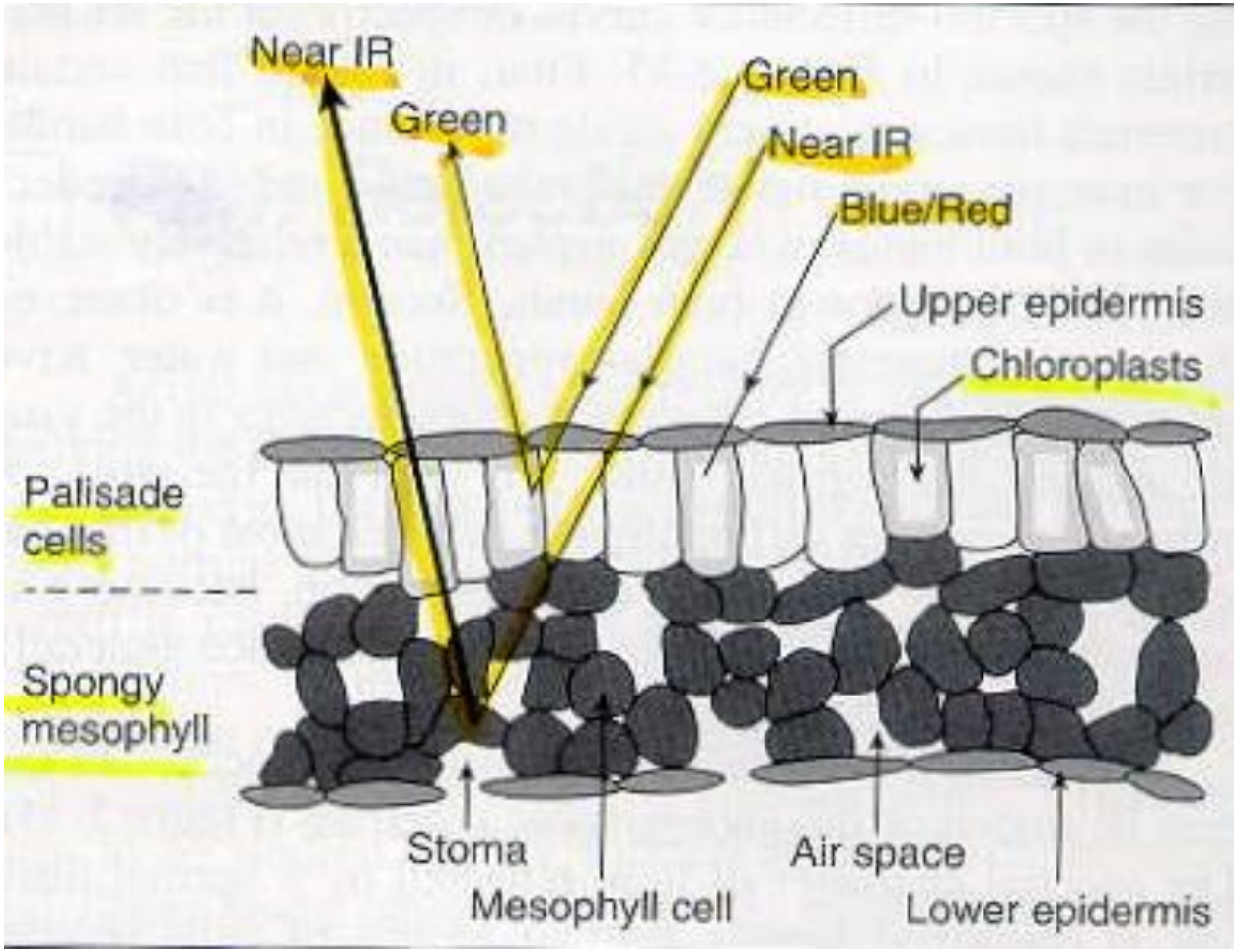
- NDVI is the most common vegetation index captured with satellites and drones and used in precision agriculture.
- NDVI = (NIR-Red) / (NIR+Red)
- NIR band is the most useful band in agriculture.



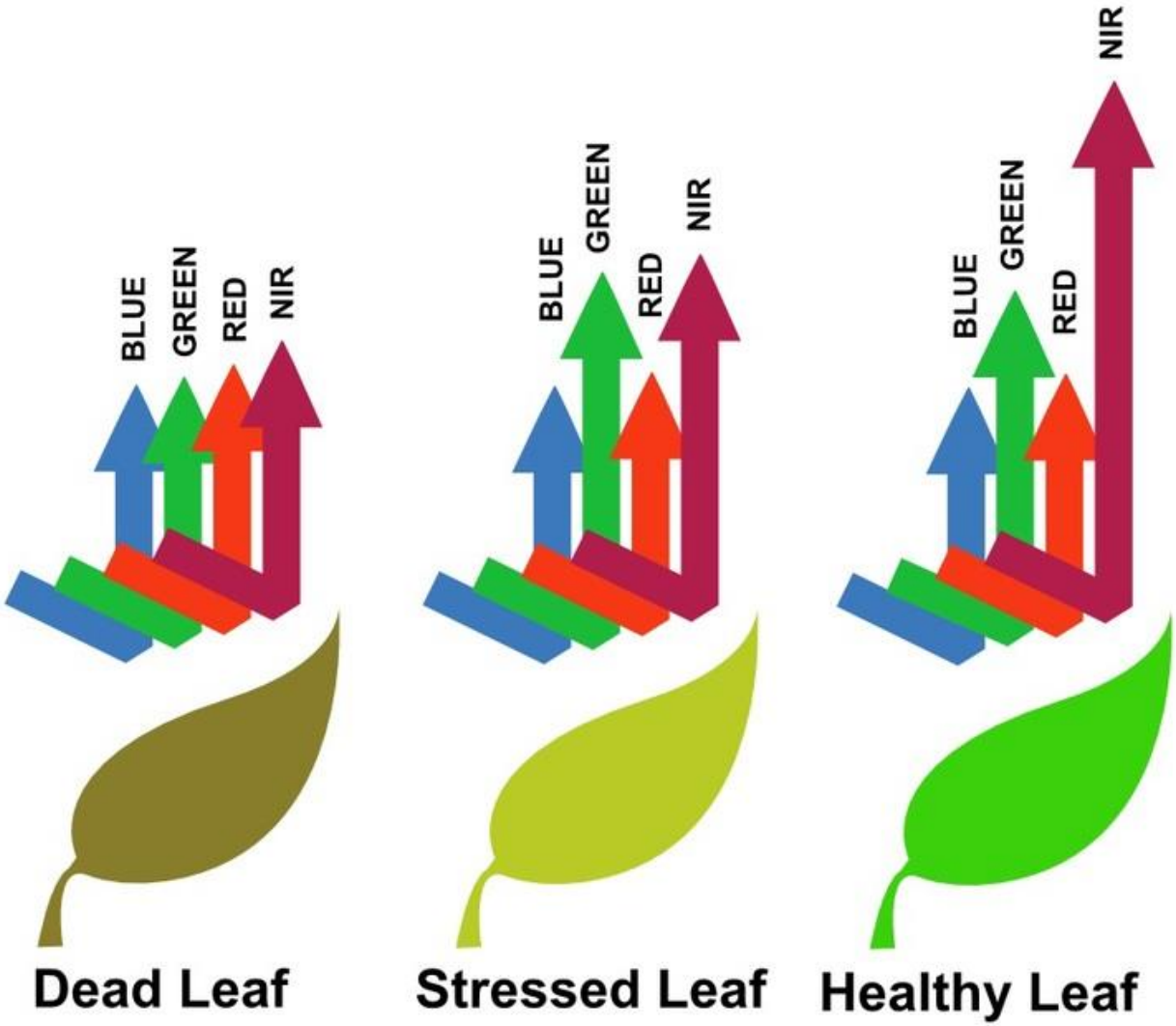
http://www.micasense.com/

- A normal, healthy plant will absorb blue and red light and reflect green light, which is why they appear green to our eyes.
- Plants also reflect Near-Infrared (NIR) light which is invisible to the human eye.
- The healthier the plant, the more NIR light is reflected.

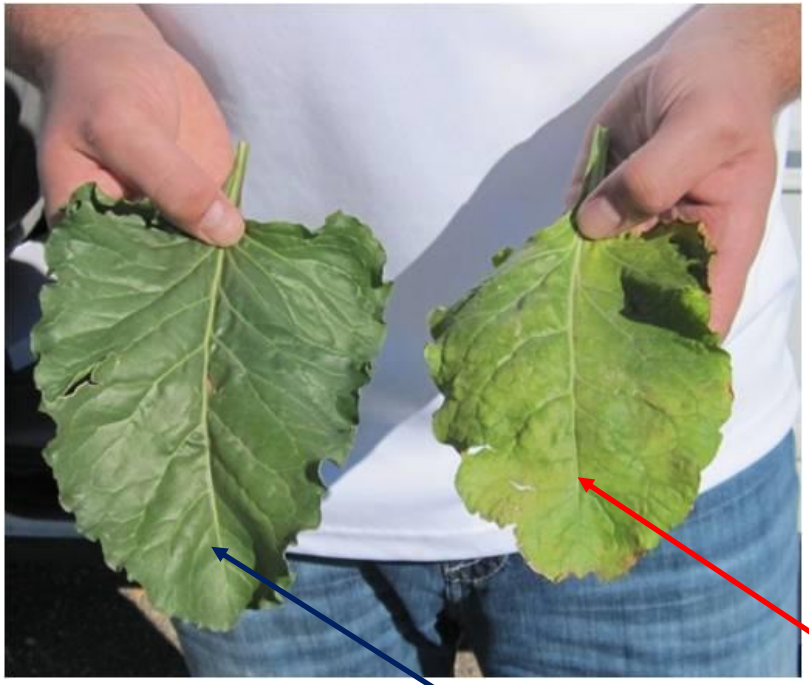
Diagram of plant leaf's structure and reflectance characteristics.



- When a plant becomes dehydrated or stressed:
  - the spongy layer of the plant collapses and its leaves reflect less NIR light,
  - yet they still reflect the same amount of light in the visible range.



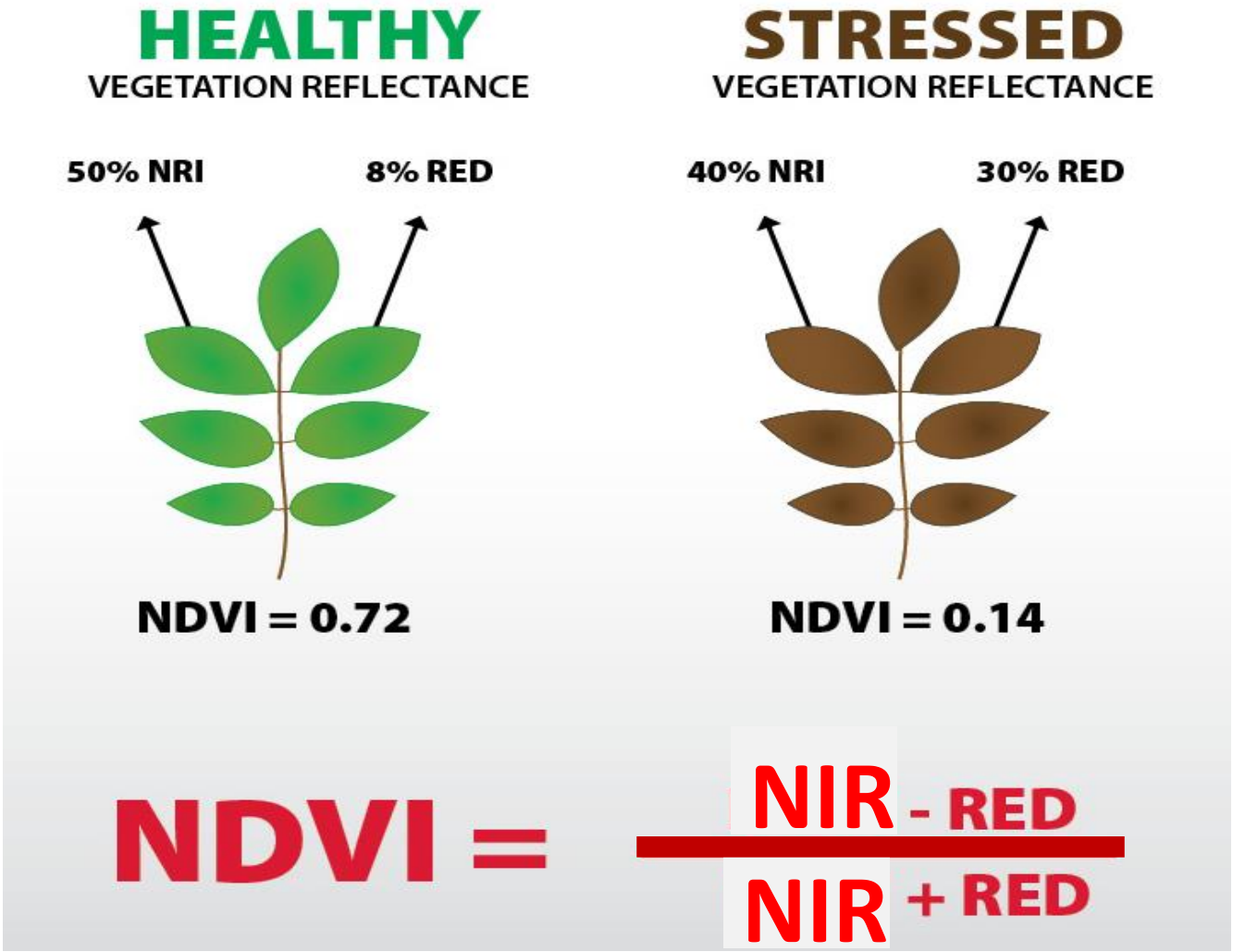
https://flurosat.com/blog/how-to-track-crop-growth-using-msavi-ndvi-and-ndre



(natural image)

(NDVI image)

NDVI image of healthy and stressed sugar beet leaves. (http://diydrones.com/group/agricultural-uavs?commentId=705844%3AComment%3A1175520&xg_source=activity)



http://www.ece.montana.edu/seniordesign/archive/SP15/OpticalWeedMapping/ndvi.html

A) IDENTIFY PROBLEMS SOONER

- NDVI enables agronomists and farmers to see stressed crops in a field up to two weeks before the human eye would be able to detect.
- So growers can identify diseases, pests, fungus, or arid conditions sooner, and then respond and make quicker decisions before the issues become an even bigger problem.

B) SCOUT FIELDS FASTER

- You can find problems with NDVI mapping and go straight to the problem area to do your ground-truthing and fix the problem.

C) CREATE VR PRESCRIPTION MAPS

- Once NDVI maps are created, issues are found, and ground-truthing is done, you make a site-specific prescription map.
- Spray fertilizer or pesticide where needed with variable rate applications that save you money and resources, and improve crop yields.

D) TRACK CROP HEALTH

- NDVI values can be averaged to establish the normal growing conditions for the crops in a given area for a given time of the year.

E) ESTIMATE CROP PRODUCTION

- NDVI map taken in appropriate time is highly related with crop production map.

4) DRONES FOR PRECISION AGRICULTURE

- Types of Drones:
  1) Fixed wing – for scanning large areas
  2) Multi-rotor – for scouting and spraying small areas

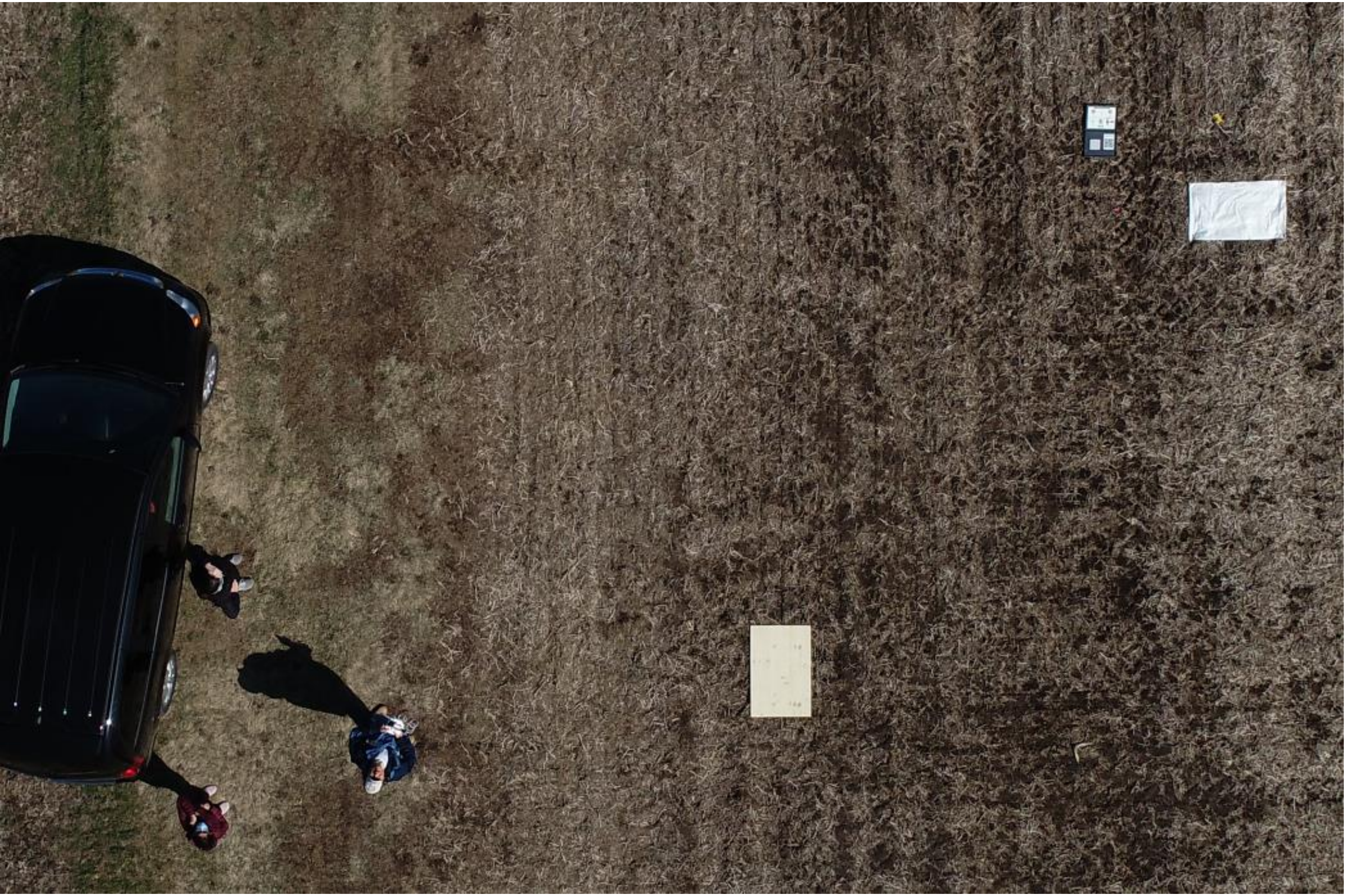
Fixed-wing:
AgEagle

Quad-copter:
Phantom 4

SENSORS FOR PRECISION AGRICULTURE

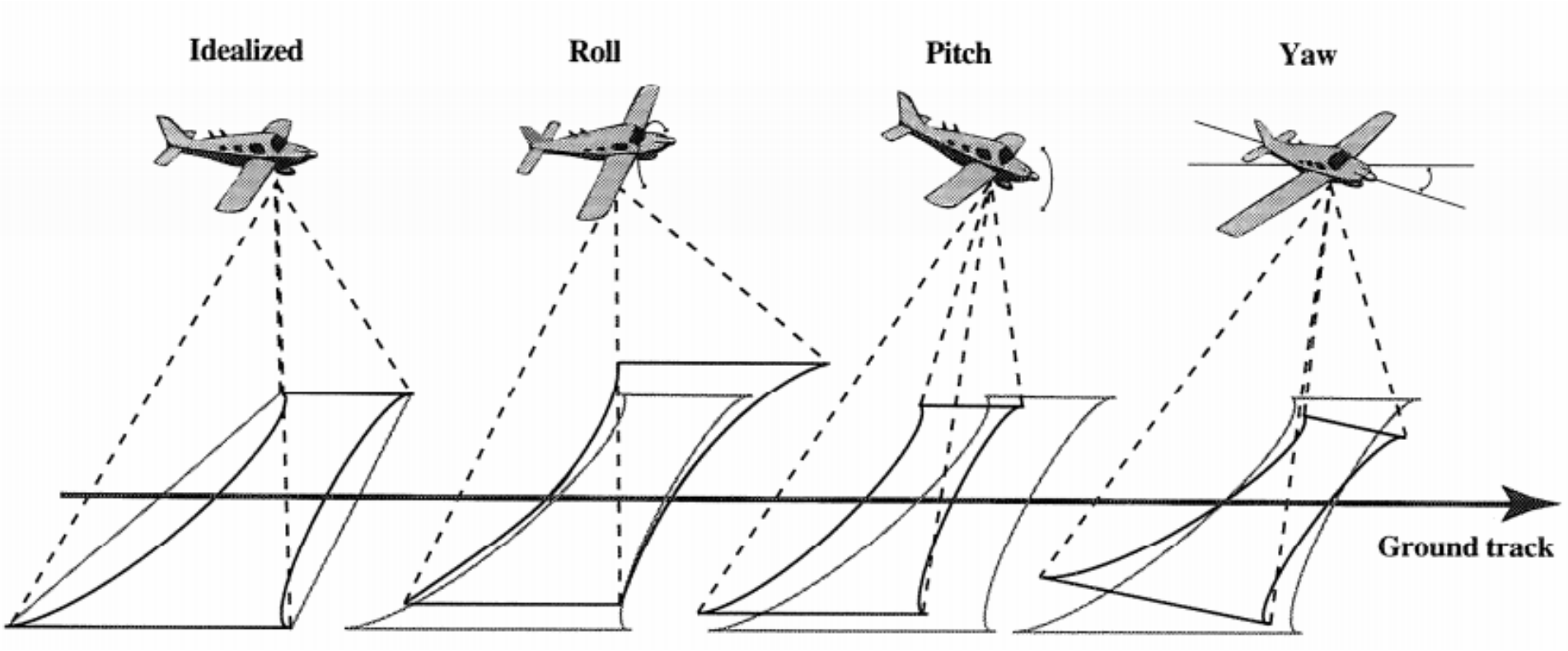
1. RGB camera
2. Red-Edge sensor (about 720 nm)
3. NIR sensor (700 – 900 nm)

- Benefits of drones:
  1) Flexible availability
  2) Relatively low cost
  3) Very high spatial resolution: 0.5 – 5 cm (0.03 – 2 in)
  4) Relatively easy to use



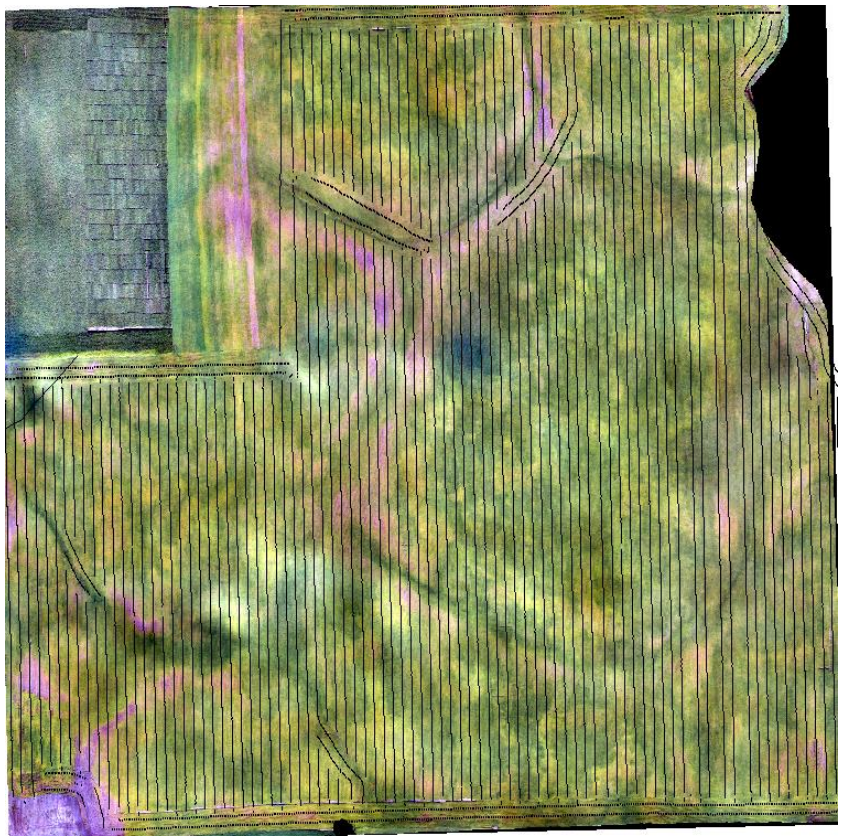
- Limitations:
  1) Unstable platform: may make fuzzy images
  2) Georectifying issue: may not correct location in images
  3) Many regulations for flying drone

Reasons of Image Distortions.



http://scomp5063.wur.nl/courses/grs10306/Clevers/RS%20CH4%20Preprocessing/IGI_preprocessing%20RS%20ppt.pdf

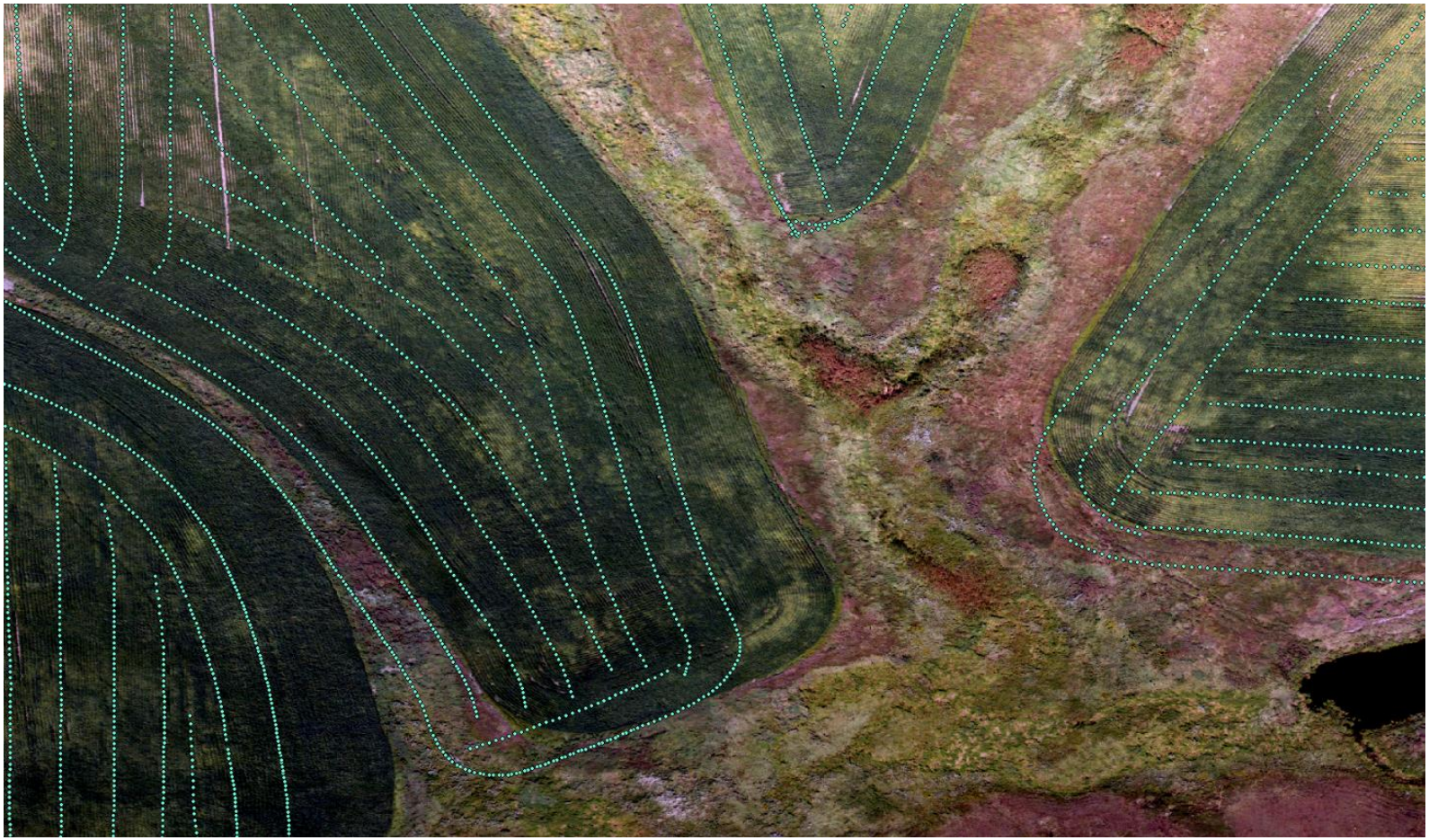
Yield maps and UAV images may not be aliened.



Georeferenced Unmanned Aerial Image with Yield Points
Image Date: Sept 15 2014: (Image courtesy of Farm Intelligence^{2} TM)

Georeferenced 2014 NAIP Image with Yield Points
Image Date: Aug 13 2014

Need to check with other data layers



Georeferenced Unmanned Aerial Image with Yield Points
Sept 02 2014

(Image courtesy of Farm Intelligence^{2} TM)

5) WHERE CAN WE APPLY DRONE FOR PRECISION AGRICULTURE?

1. Data Collecting
   a) Scanning
   b) Scouting
2. Site-Specific Spraying
   a) Fertilizer
   b) Herbicide
   c) Seeds

TYPES OF DRONE FLYING

1. Planned flying
   a) Fixed wing
   b) Multi-rotor
2. Manual flying
   a) Multi-rotor

PLANNED FLYING

1. Using fixed wing drone: to scan large fields
   a) Monitoring Plant Healthiness:
      i. Finding stressed areas
      ii. Mapping damaged areas by stresses or diseases
   b) Monitoring Crop Productions:
      i. Checking crop plant densities
      ii. Estimating grain yields
   c) Making Variable Rate Application Maps

2. Using multi-rotor drone: for small fields
   a) Site-Specific Spraying:
      I. Pesticides
      II. Fertilizers
   b) Scanning small study plots

MANUAL FLYING

- Using multi-rotor drone
  a) Monitoring (scouting) Plant Conditions:
     I. Water stress
     II. Nutrient stress
     III. Insect/Disease damages
     IV. Weed management

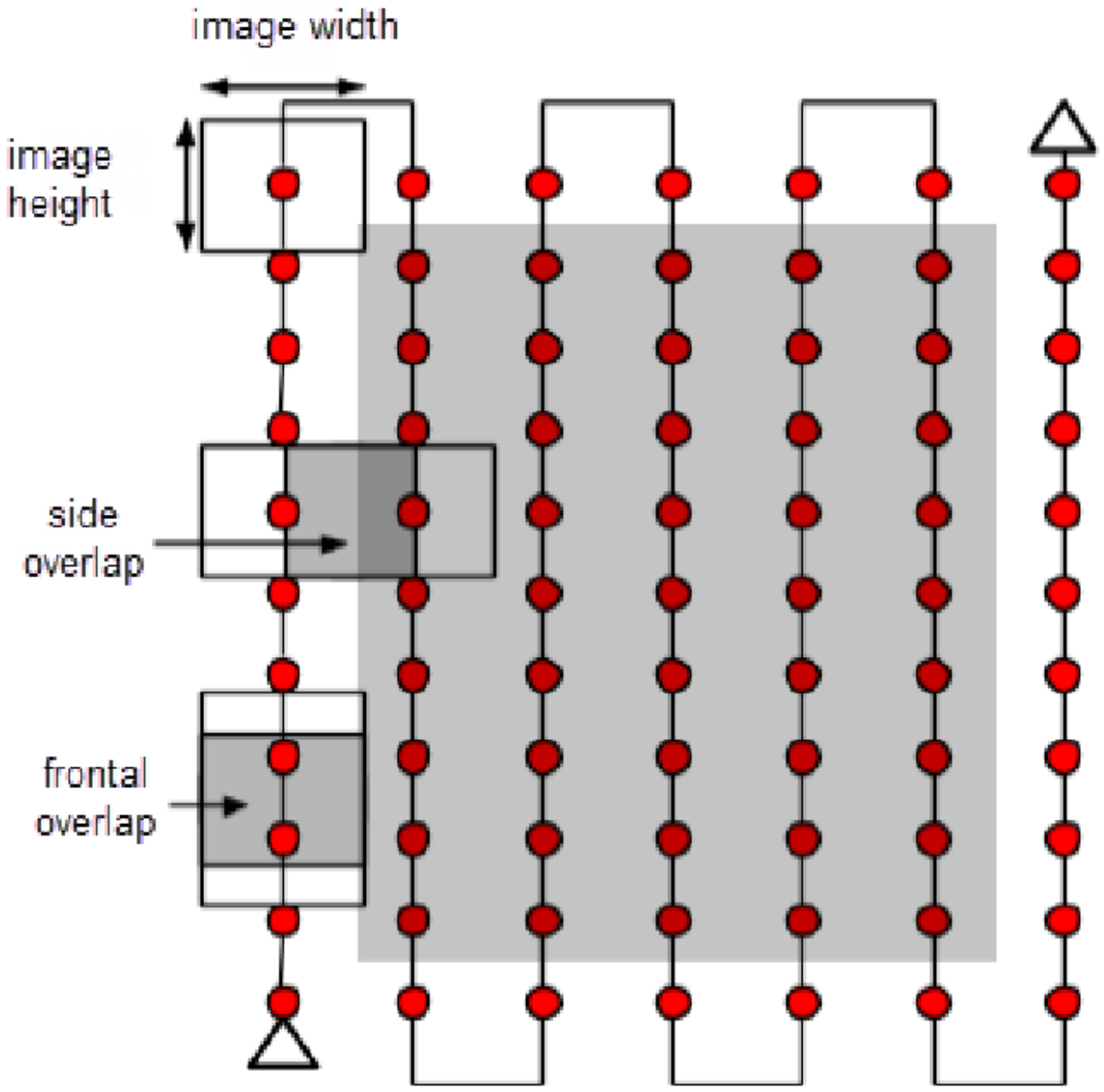
6) PROCEDURE OF DRONE WORK (PLANNED FLYING)

1. Making flight plan
2. Collecting images (flying drone)
3. Stitching images
4. Image analysis (Making NDVI map)

1) MAKE A FLIGHT PLAN FOR PLANNED-FLYING USING APP

- DroneDeploy
- And more…

https://www.dronedeploy.com/solutions/agriculture/



Settings

1. Flight altitude
   a) Fixed wing: 400 ft
   b) Multi-rotor: 100 ft
2. Side overlap
   a) 70 – 80 %
3. Forward overlap
   a) 70 – 80 %

2) COLLECTING IMAGES OF FIELD

3) STITCHING IMAGES USING IMAGE PROCESSING SOFTWARE

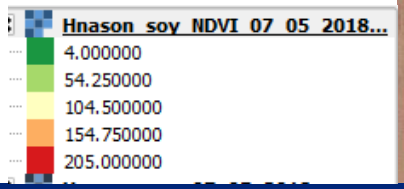
- Pix4D
- MapShots
- And more….

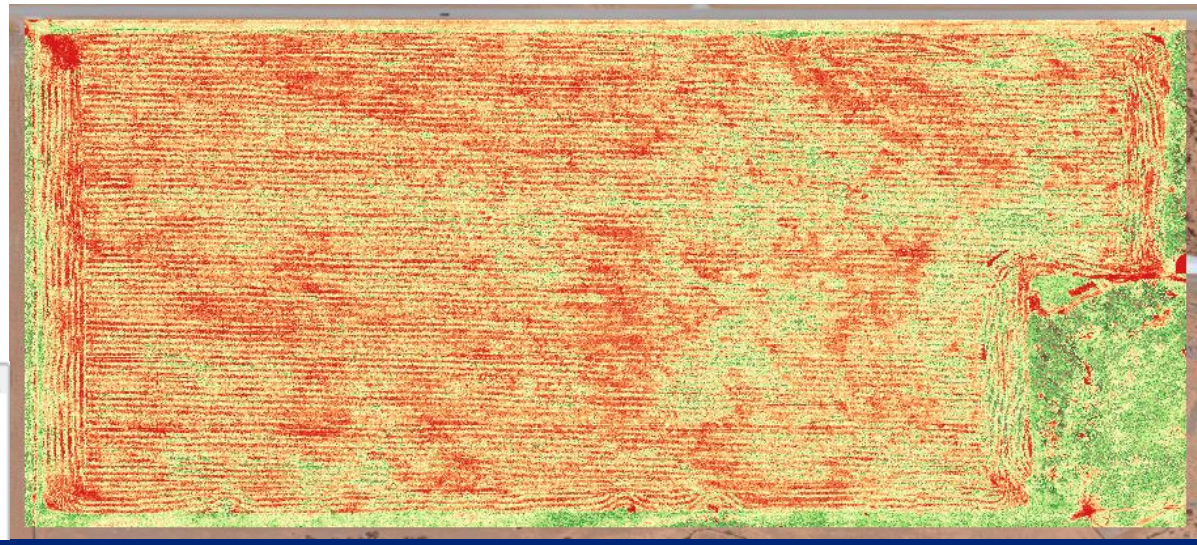
Stitched drone image, July 5, 2018

4) IMAGE ANALYSIS

- QGIS
- ArcMap
- ENVI
- And more…

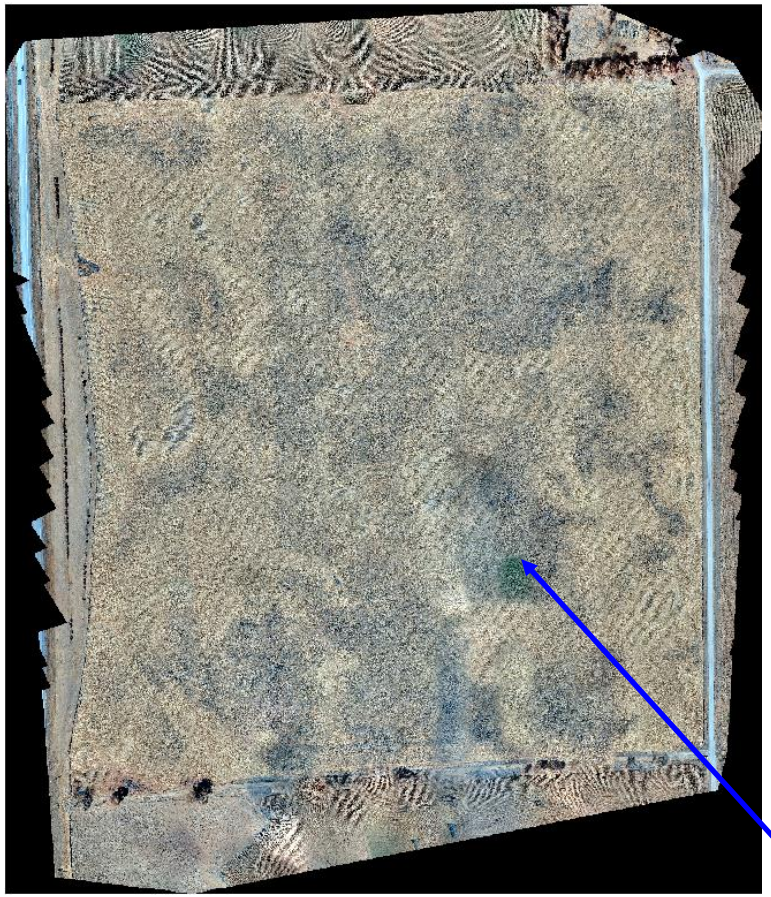
GNDVI map of soybean field, July 5, 2018



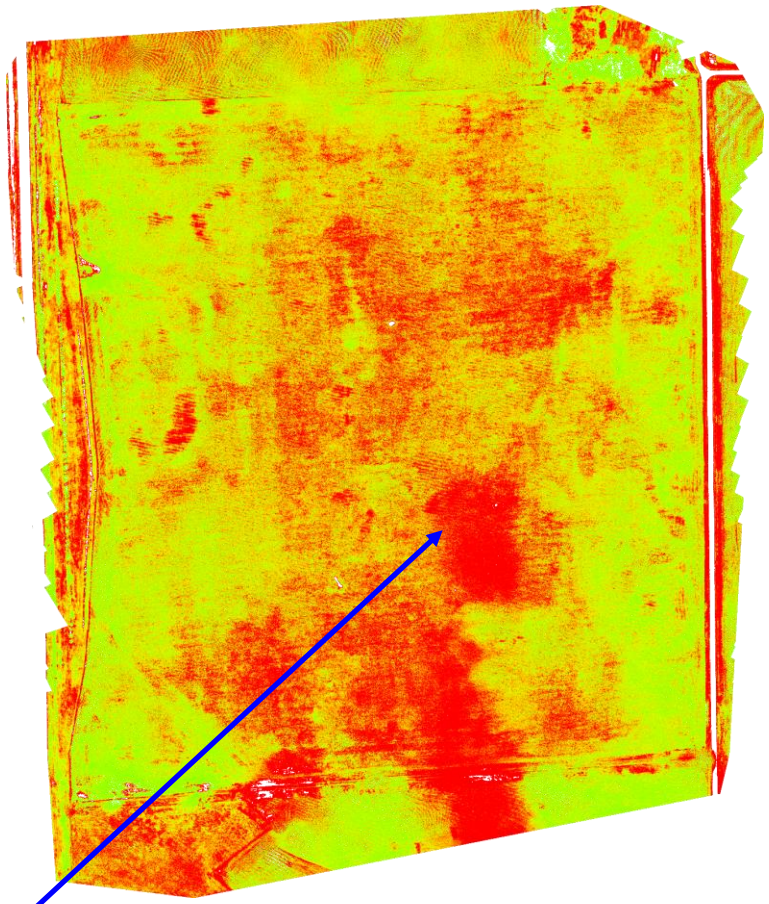


Soybean field: White mold disease

Color image



NIR image



White mold disease

Thank You!