DRONES IN MODERN AGRICULTURE
Drones vs Satellite

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WHAT CAN YOU SEE IN THE IMAGES?
What level of detail do you need?
Or do you need this level of detail?
Weeds Everywhere
Nutrient issues, double planting, soil erosion, poor emergence
Willcox, SK Canola Seeding
Drone, Manned, or Satellite

WHAT WILL WORK BEST FOR YOUR FARM?
Advantages

**UAS**
- On demand service
- High Resolution (1 cm)
- Really Fun
- Ability to fly with cloud
- Ideal for 160-1500 ac per day
- Can be inexpensive to get started ($1600-$16,000)

**Manned Aircraft**
- On Demand Service
- High Resolution (2.5 cm-25 cm)
- Large areas covered
- Ability to fly with cloud
- Ideal for 1500-60,000 ac per day

**Satellite**
- Large areas covered
- Constantly aloft
- Cost
- Little to no stitching
Disadvantages

**UAS**
- TC Regulations
- Efficiency
- Reliability (In some cases)
- 2 people to operate
- wind

**Manned Aircraft**
- Limited by number of planes
- Stitching needed
- TC regulations
- Expensive initial investment ($100,000)

**Satellite**
- Lower Resolution (>2.5m)
- Cloud and Haze
- Not on demand
- Expensive to develop and launch
Winter Wheat (UAS vs Cessna vs Satellite)

1.0 inch pixels
Color infrared
NDVI
Low NDVI
High NDVI

10.0 inch pixels
Color infrared
NDVI

5.0 m pixels
Color infrared
NDVI

AgPixel
Classification of Winter Wheat Emergence

Where are the corn plants and weeds?
Patterns (spatial arrangement) or context is critical for accurate image interpretation. Below are two weed types with different spatial arrangements that are key to proper identification.

Random Pattern:
- Annual life form, seeds are scattered by the wind

Clustered Pattern:
- Creeping perennial that reproduces from vegetative (rhizomes or stolens)
WHAT CAN WE SEE AND HOW CAN WE USE THE IMAGERY?

SELECTED APPLICATIONS
WEED MANAGEMENT

Canada Thistle (*Cirsium arvense*)

We are partnering with Agronomists to develop methods for delineating weed patches in crop fields.
Canada Thistle Mapping
1.0 inch pixel sizes

CORN FIELD

Canada Thistle

Canada Thistle
Canadian Thistle Study:
Herbicide Application

Only 0.6 acres affected of 120 acre pivot

Cost for single rate treatment: $700
(1.5L Glyphosate)
Estimated cost for data collection, processing, and spot treatment: $500

Total herbicide savings: $200
**Canadian Thistle Study:**
**Herbicide Application**

*Only 0.6 acres affected of 120 acre pivot*

- **Cost for single rate treatment:** $2400
  - ($20/ac Lontrel)
- **Estimated cost for data collection, processing, and spot treatment:** $500
- **Total herbicide savings:** $1900
Where is Canadian Thistle?

1.5 inch pixels

1.0 m pixels

5.0 m pixels

Weeds

Weeds?

Weeds?
NDVI of Corn Field with Thistle

1.5 inch pixels

1.0 m pixels

5.0 m pixels

Weeds

Weeds?

Weeds?
Crop Fertility
Crop Damage Assessment
SUGAR BEETS SPRINGTAIL DAMAGE

Wet areas
Red and yellow areas of the NDVI image are associated with the springtail damage.
Hail damage event took place June 21, 2014 in a soybean field near Hillsboro, North Dakota. Field was flown on July 16, 2014.
Crop scout or insurance adjuster’s view from outside the corn field.

Crop scout or insurance adjuster’s view from within the corn field.
Root-Lodged Corn With Range of Severity for Root Damage

Corn Genetics susceptible to root lodging

Color Infrared (Cessna 2.5 inch pixel resolution)

Natural Color Oblique

NDVI

Corn Root Lodging in University Genetic Breeding Plots

Severe

Less Severe

Severe

Less Severe

Severe

Less Severe

Severe
Corn Root Lodging comparison between 2.5 inch and 5.0 m resolution

If one is missing something as obvious as the root lodging above, what else is being missed using satellite imagery?

Same image resampled to 5.0 meter. Where is the root lodging?
WORK WITH HERBICIDE DRIFT
Soybeans

Color Infrared Mosaic
Images acquired using a KSU small Unmanned Aerial System

Healthier Soybeans

Drought Stressed

Herbicide Drift

Computer Enhanced Image
Herbicide Drift Semans, SK
Crop Yield Potential
BRINGING THE ORTHOMOSAICS INTO THE FARM MANAGEMENT PROGRAMS YOU ARE USING TO PRODUCE MANAGEMENT ZONES

The Normalized Difference Vegetation Index (NDVI) is useful for identifying problem areas in fields. NDVI is then used to create management zones into which different treatments will be applied. This NDVI Shapefile (SHP) product is compatible with most farm management software packages.

CORN PIVOT STUDY:
August 2014

COLORIZED NDVI MAP
COLOR INFRARED ORTHOMOSAICA

YIELD MAP (Previous Year)
Very Low Low High Very High

SOIL MAP (Previous Year)

NITROGEN REQUIREMENTS:

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Assessing crop yield potential 2.5 months ahead of harvest
1. Keith silt loam, 3 to 6 % slopes, eroded
2. Keith silt loam, 1 to 3 % slopes
3. Sulco-Ulysses silt loams, 9 to 30 percent slopes, eroded
4. Keith silt loam, 1 to 3 % slopes
5. Keith silt loam, 1 to 3 % slopes, eroded
Hybrid A
Inner row ripping

Hybrid B
No Inner row ripping

Down Hill
Low Water Pressure
Down Hill
Down Hill
Nutrient management zones
For variable rate nitrogen applications
COMPARISON BETWEEN NDVI AND CROP YIELD MONITOR MAPS FOR CORN

NDVI Map
Flown August 1, 2014

Crop Yield Monitor Map
Harvested October 16, 2014

2.5 months
difference

220 lbs/acre
nitrogen

Lower Yields  Higher Yields

Bushels

Low NDVI

High NDVI

0  50  100  150  200  250
CONSIDERATIONS FOR POTENTIAL UAS OWNERS

• Rapidly-developing technology and constant improvements
• Declining cost as technology becomes widely available
• Potential for inaccurate results without proper aircraft and training
• Research is ongoing and now is the time to ask questions
ABOUT ROBOFLIGHT SYSTEMS

“RoboFlight Systems assists our clients in acquiring, processing, analyzing, and managing remotely sensed data in order to make intelligent precision agriculture management decisions.”
<table>
<thead>
<tr>
<th>GEORECTIFIED ORTHOMOSAIC OF SURVEY ZONE</th>
<th>GEORECTIFIED NDVI MAP OF SURVEY ZONE</th>
<th>NDVI MANAGEMENT ZONES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map quality image products that allow agronomists and farmers to identify problem areas in their fields, such as diseases, insect infestations, nutrient deficiencies, and water stress. These images can also be used to identify areas where replanting is necessary early in the growing season.</td>
<td>The Normalized Difference Vegetation Index (NDVI) is useful for identifying problem areas in fields, often with better contrast than a color infrared image.</td>
<td>NDVI is used to create management zones into which different treatments will be applied. The Shapefile format is compatible with most farm management software packages.</td>
</tr>
</tbody>
</table>

**Spatial Resolution (Pixel Size):**
- 10 inches

**File Format:**
- GeoJPEG/GeoTIFF

**Output Products:**
- Natural Color (Red, Green, Blue) or Color Infrared (Near-Infrared, Green, Blue) Image

**Spatial Resolution (Pixel Size):**
- 10 inches

**File Format:**
- GeoJPEG/GeoTIFF

**Output Products:**
- NDVI Image (Single Band)

**Spatial Resolution (Pixel Size):**
- 10 inches

**File Format:**
- Shapefile

**Output Products:**
- NDVI Management Zones in Shapefile Format
We have our own state of the art computing facilities in Des Moines, Iowa. This also houses our research and development lab.
Multirotor systems are appropriate for small scale and research operations under 50 acres. The Fixed Wing can cover over 1000 acres at 1.0 inch resolution a day.
An Advantage is you can have gimbals and carry heavier payload.

Disadvantage is one cannot cover larger areas (10 to 50 acres).
RF70 Fixed Wing Unmanned Aircraft
Designed as a mapping aircraft that is significant step above the hobbyist aircraft, but under military aircraft level.
Can fly for 45 to 120 minutes on single battery charge.
Manned Aircraft

Our company is committed to collecting and processing quality remotely-sensed data, whether it be from unmanned aircraft, manned aircraft, or satellites. We are platform agnostic.
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