



GreenSeeker® Handheld Crop Sensor

Features

- Active light source optical sensor
- Used to measure plant biomass/plant health
- Displays NDVI (Normalized Difference Vegetation Index) reading.
- Pull the trigger and NDVI measurement appears on LCD display immediately.

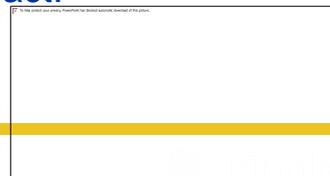


What Does GreenSeeker Handheld Do?

- Measures plant NDVI readings where $NDVI = (NIR - Red) / (NIR + Red)$.
 - NDVI can range from 0.00 to 0.99.
 - The principle behind NDVI is that red-light is absorbed by chlorophyll in the plant and near-infrared light is reflected by the plant's leaf
 - Vigorously growing healthy vegetation has low red-light reflectance and high near-infrared reflectance, and hence, high NDVI values.
 - Upon pulling the trigger, the sensor turns on and emits brief bursts of red and infrared light, and then measures the amount of each that is reflected back.
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Application of the Sensor

- Key use of sensor is to estimate fertilizer application rates.
- GreenSeeker technology can be applied in many ways to indicate plant health variability before it can be seen with the naked eye. It is a tool.
- Typical applications include sensing and agronomic research, biomass measurements and plant canopy variations, nutrient response, yield potential, pest and disease impact.



Fertilizer Algorithms

- Fertilizer algorithms for:
 - Spring wheat
 - Winter wheat
 - Dryland corn
 - Irrigated corn
 - Barley
 - Triticale
 - Sorghum
 - Canola



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Sensor Tour

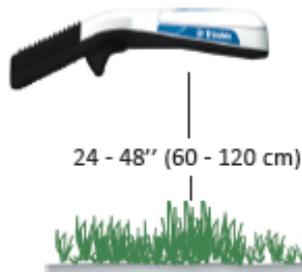


- A LCD display
- B Battery access panel
- C Wrist strap attachment loop
- D Trigger
- E microUSB port for charging
- F Remote switch connection
- G String attachment loop

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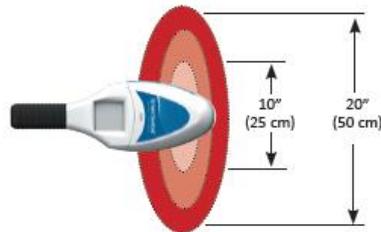
Using the Sensor

- Hold the sensor over the crop canopy and then pull the trigger.
- The sensor should be held 24-48" (60-120 cm) above the crop.
- Observe the reading on the display.



Sensor Field of View

- The sensor's field of view is an oval.
- Size increases with height of the sensor (approximately 10" (25cm) wide at 24" (60cm) above the ground, 20" (50cm) wide at 48" (120cm) above the ground).



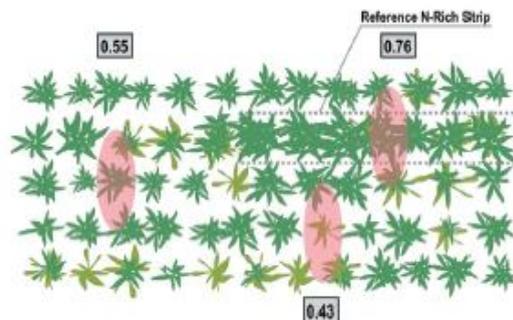
Sensor Field of View

- To obtain a reading representing a larger area, walk with the sensor while keeping the trigger engaged and maintain a consistent height above the target.
- The display updates continuously, but accumulates multiple readings and provides an average when the trigger is released.
- Maximum measurement interval is 60 seconds.



Using Sensor to Estimate Fertilizer Rate

- Use the peak value within the N-rich strip and a value typical of other areas of the field as two inputs to the *Fertilizer Estimation Chart* to determine an application rate.

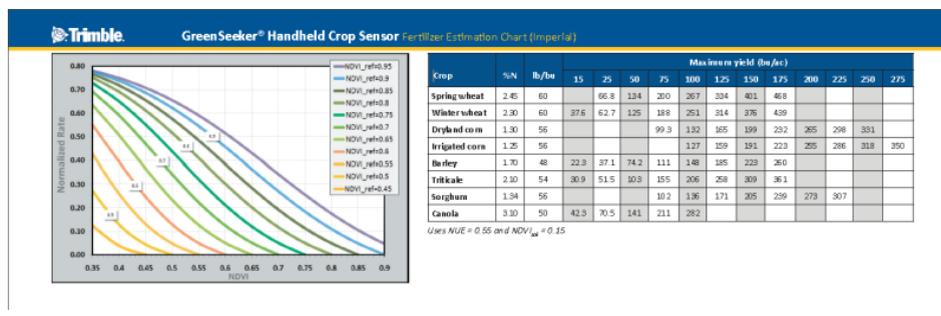


What Is An N-Rich Strip?

- An N-Rich strip is a small area within the field to which more than enough fertilizer has been applied at or before planting.
- This area will be a gauge of the crop not limited in vigor due to insufficient fertilizer.
- Including a reference area or “N-rich strip” provides an accurate method to determine how much additional fertilizer is necessary to maximize the crop yield in a particular field.

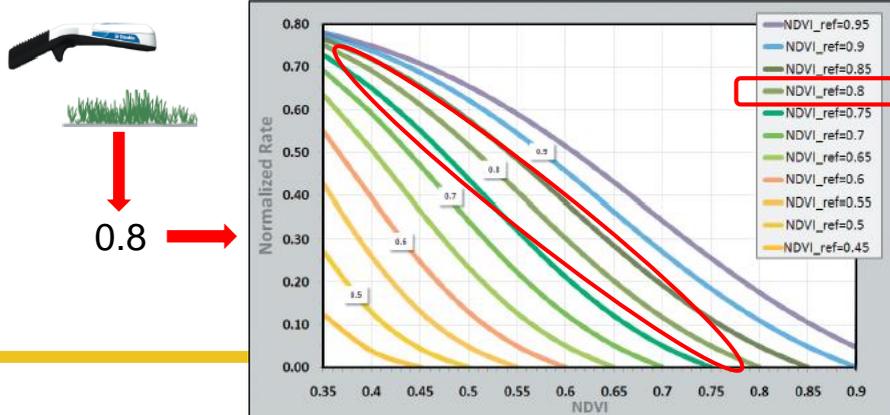
Fertilizer Estimation Chart

- Manual calculation process.
- Does not map where a reading is taken.
- Confusing process for users- difficult to calculate quickly in the field.



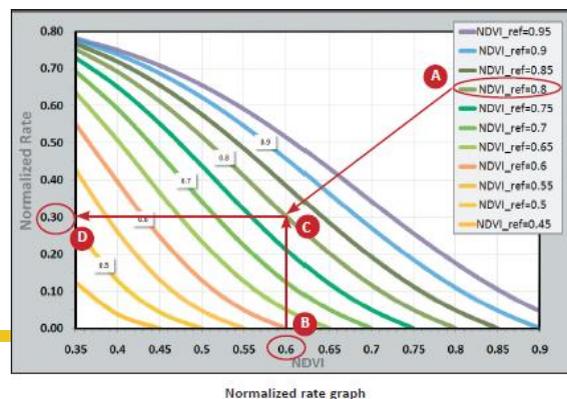
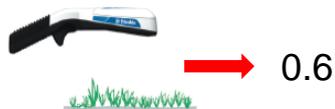
Step 1: Identify Reference Curve

- Scan the N-rich strip using that value to identify your reference curve to use.
- If NDVI in reference = 0.8, use sage green line



Step 2: Identify Normalized Rate

- Scan the non N-rich area of the field
- Use NDVI value to intersect the specified reference curve and determine Normalized Rate
- If non-ref NDVI = 0.6, then Normalized Rate = 0.3



Step 3: Identify Crop Factor

- Identify row corresponding to your crop in *Crop Table*.
- Find column that corresponds to maximum yield of your crop and region at the top of the table.
- Value where row and column intersect is crop factor.

Crop	%N	lb/bu	Maximum yield (bu/ac)											
			15	25	50	75	100	125	150	175	200	225	250	275
Spring wheat	2.45	60		66.8	134	200	267	334	401	468				
Winter wheat	2.30	60	37.6	62.7	125	188	251	314	376	439				
Dryland corn	1.30	56				99.3	132	165	199	232	265	298	331	
Irrigated corn	1.25	56					127	159	191	223	255	286	318	350
Barley	1.70	48	22.3	37.1	74.2	111	148	185	223	260				
Triticale	2.10	54	30.9	51.5	103	155	206	258	309	361				
Sorghum	1.34	56				102	136	171	205	239	273	307		
Canola	3.10	50	42.3	70.5	141	211	282							

Uses $NUE = 0.55$ and $NDVI_{201} = 0.15$

Step 4: Calculate Fertilizer Rate

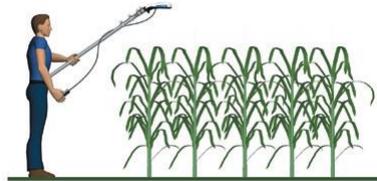
- Multiply normalized rate by the crop factor to obtain the estimated fertilizer rate
 - $0.30 * 439 = 131.7$
 - Round up to nearest 5-10 lbs ~ 135 lbs N/ac
- Note:** The calculated fertilizer rate is only an estimate. For more information, go to www.trimble.com/agriculture/greenseeker. Refer to your local agronomist if you would like further validation of your application rate.

Operating Tips

- You must pull the trigger to start a new measurement.
 - Unit automatically turns off after completing the measurement.
 - Pull the trigger to clear the screen and begin a new measurement at any time.
 - Sensor automatically turns off after 10 seconds for normal handheld operation, and after 15 seconds if using the remote trigger.
 - Try to keep the sensor level to the ground while measuring.
-

Remote Switch Kit (P/N 91520-00)

- Allows you to position the crop sensor at a sufficient height over taller crop canopies.
- The kit (sold separately) includes a mounting bracket, hose clamps, and a remote switch.
- Use parts from this kit to attach crop sensor to a user-supplied pole of the necessary length.



Remote Switch Use

- Connect remote switch to sensor's 2.5 mm input connection
- Push the button on remote switch to obtain a reading
- Lower the pole to read the display.



Mapping Solution for GreenSeeker Handheld

Diagram illustrating the mapping solution for GreenSeeker handheld:

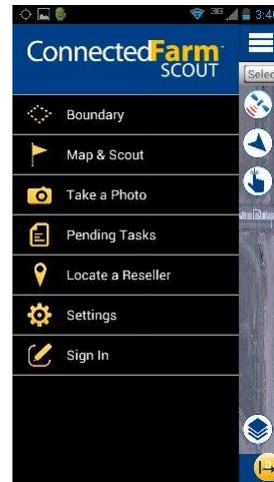
A blank white box (representing a field) + A smartphone displaying the Connected Farm app interface = A detailed screenshot of the Connected Farm web application interface.

The screenshot shows the Connected Farm web application interface, including a map view, a sidebar with layers (Scouting Layer, Boundary Layer, Equipment Layer), and a data table listing field information.

Name	Machine Type	Position
Case 1660	Combine	40.6523284912109, -104.999359130899
Mulch	Generic	40.6526441840703, -104.998609144453
Spider	Sprayer	40.6531677246094, -104.99787902832
CSU 3D 7820	Tractor	40.6595153806594, -104.992431640625
Kaiba 3M 78000	Tractor	40.663170664018, -104.984745330748

Connected Farm Scout App

- **New App for in-field mapping utilizing your device's GPS.**
- **Map boundaries, paths, points and perform scouting activities.**
- **Upload data to your Connected Farm account or Farm Works.**
 - **Data can be viewed both places**
- **Installs on Android or Apple phones.**
 - Selected models of Android phones with GPS, running Android 2.2 or later
 - Apple iPhone 3G, 3GS, 4, 4S, running iOS 6.0 or later

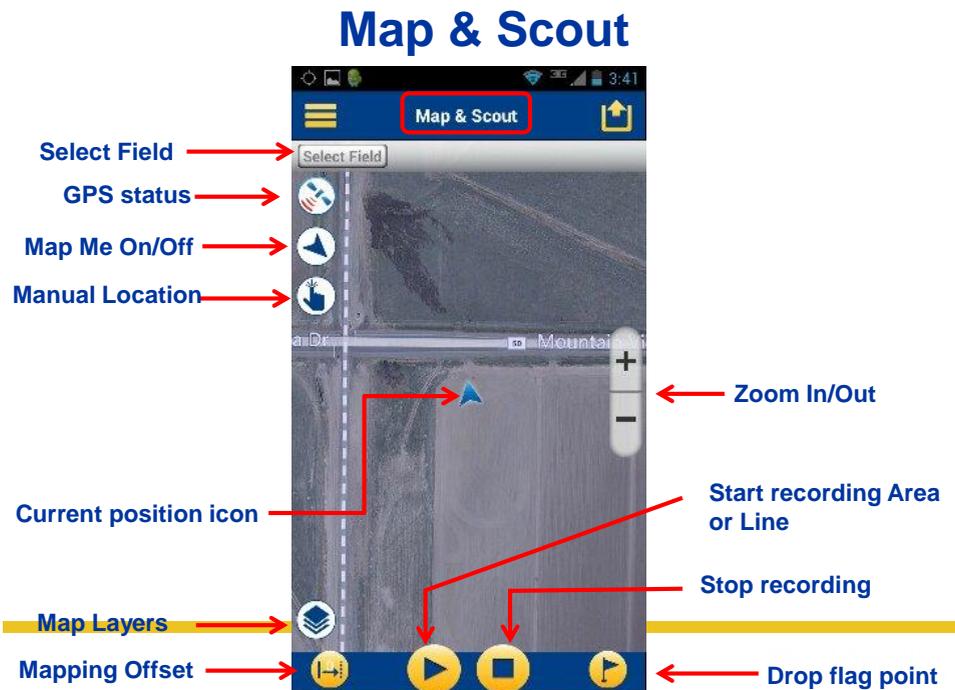


Scout App Details

- **Map field boundaries and calculate area**
 - **Switch between logging paths, points, and polygon areas**
 - **Enter scouting attributes**
 - **pests, weeds, diseases, crop condition**
 - **log severity of problems**
 - **capture NDVI**
 - **Capture and geo-reference digital images**
 - **Document and identify pests, field problems or field features**
 - **Manage data by client, farm, and field names**
 - **Send data to Trimble's Connected Farm for free online access or transfer it into Farm Works™ Office software (version 2013 or newer)**
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Mapping NDVI Values

- To log a point, select the Flag button.
 - To log an area or path, Tap Play, select Area or Line to start logging.
 - To:
 - temporarily pause logging, tap Pause.
 - resume logging, tap Play. Program draws straight line from previously logged position to current position.
 - stop logging and auto-close area, tap Stop.
 - finish job or save data for later, tap Done.
 - Once you have tapped Done you are prompted to Send, Save for Later, or Delete
-

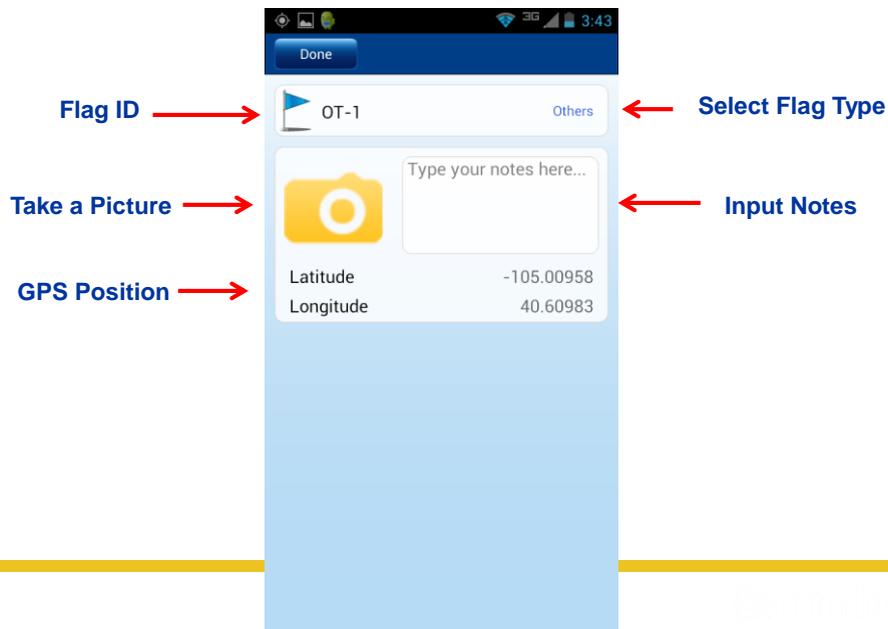


Scout a Point



Drop flag point

Identify a Flag



Flag ID

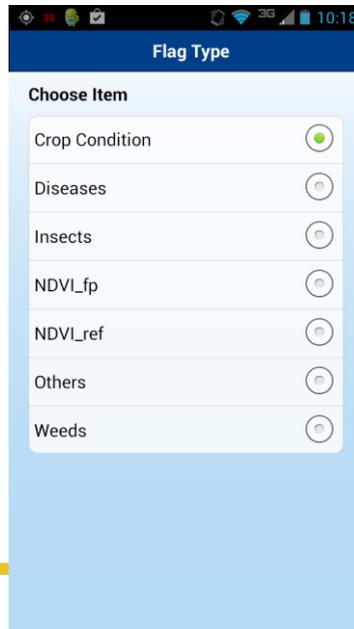
Take a Picture

GPS Position

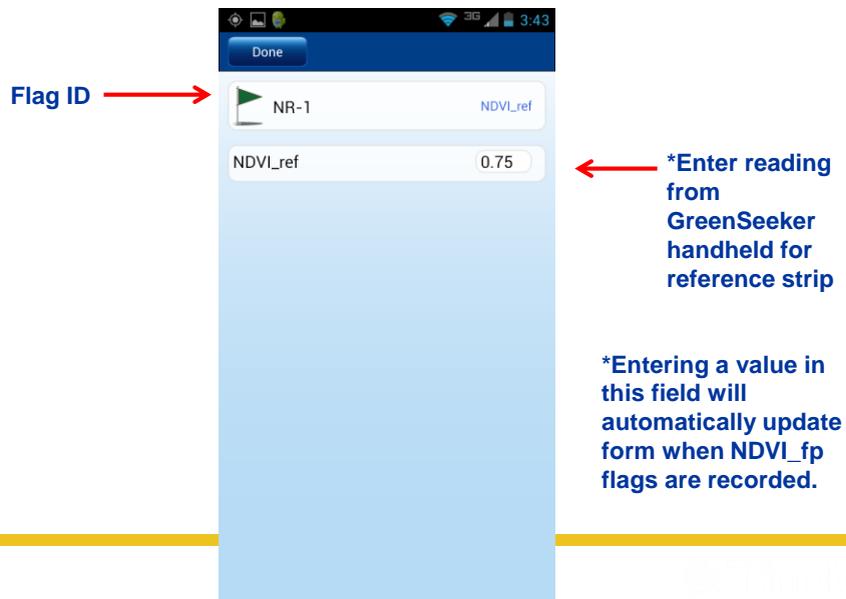
Select Flag Type

Input Notes

Select NDVI Flag Type



NDVI_ref (Reference Strip)



NDVI_fp (Field Practice)

Flag ID →

How do I use this calculator?

Crop	Winter Wheat	→ Select Crop Type
NDVI_ref	0.75	→ Enter reading from reference strip scan
NDVI_fp	.4	→ Enter reading from <u>NON</u> -reference strip scan
NDVI_soil	0.15	→ Enter bare soil scan
NUE	55	→ Enter N Use Efficiency
Max Yield (bu/ac)	75	→ Enter yield goal

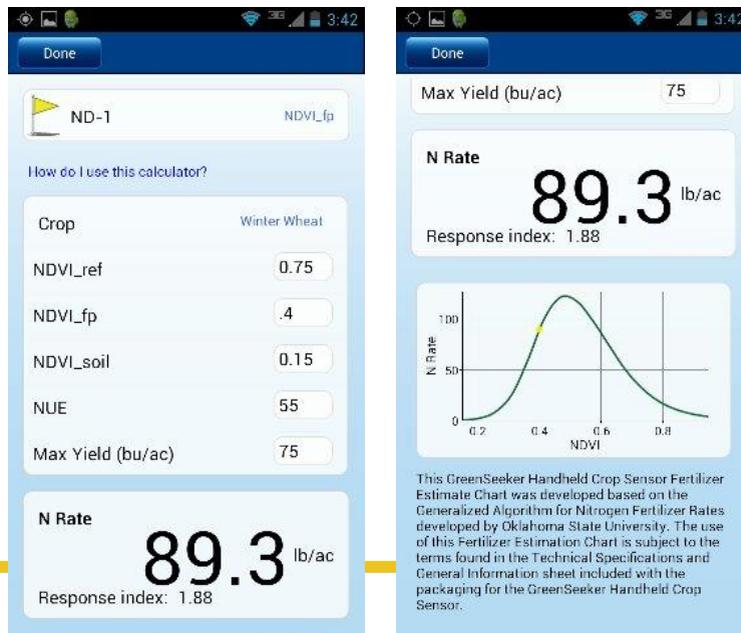
Crop Type Selection

Crop Type →

Barley	1.70	%N	<input type="radio"/>
Canola	3.10	%N	<input type="radio"/>
Dryland Corn	1.30	%N	<input type="radio"/>
Irrigated Corn	1.25	%N	<input type="radio"/>
Sorghum	1.34	%N	<input type="radio"/>
Spring Wheat	2.45	%N	<input type="radio"/>
Triticale	2.10	%N	<input type="radio"/>
Winter Wheat	2.30	%N	<input checked="" type="radio"/>

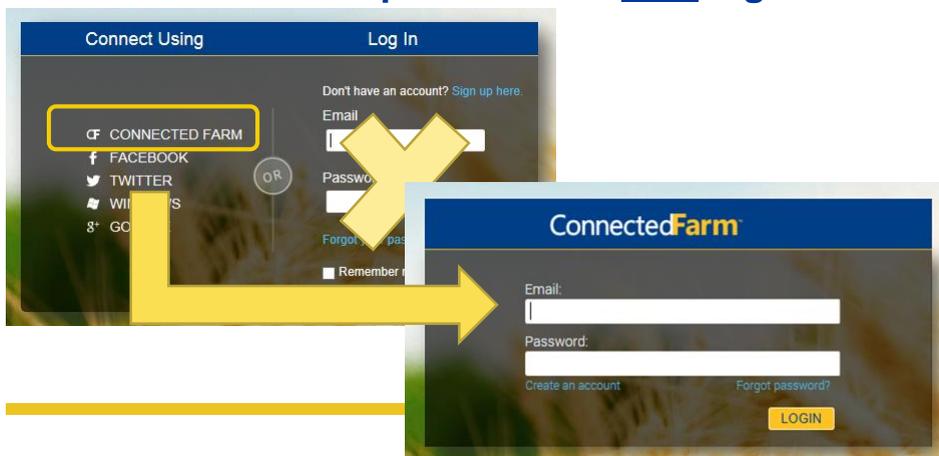
- %N is average amount of N for that crop.
- Does not represent a specific seed or variety.
- Enter actual %N if known.

Nitrogen Recommendation (lb/ac)

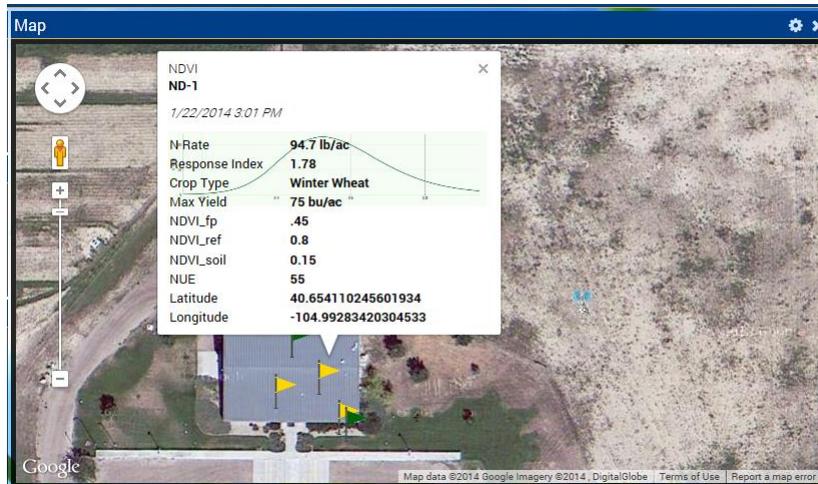


Step 3. Log In to Account to View Data

- Go to <http://www.connectedfarm.com>
- Select “Connected Farm” on the left
- Enter email and password on next login screen

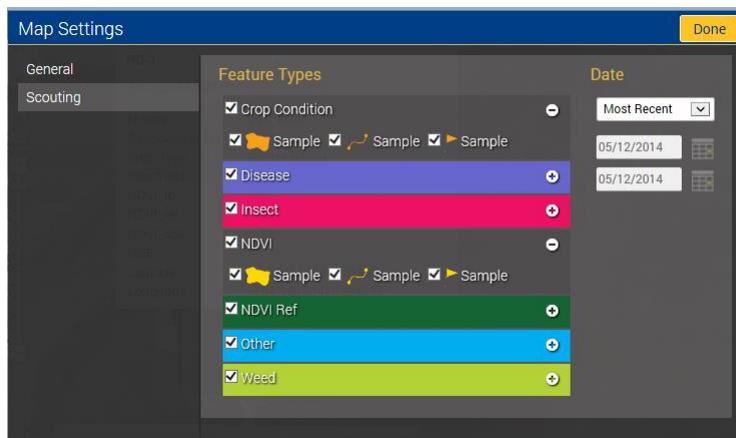


Data in Connected Farm



View in Connected Farm Dashboard or FarmWorks Office

Map Window Settings



<http://www.dashboard.connectedfarm.com>

Most Commonly Asked Questions...

- Does the GreenSeeker handheld unit store the NDVI readings?
 - No
- Can the GreenSeeker handheld unit communicate and send readings to a mapping device?
 - No
- The Connected Farm Phone App has the capability to allow the user to capture NDVI readings and calculate N recommendations.

Most Commonly Asked Questions...

- What if no algorithm is available for my crop?
 - Work with an agronomist or crop consultant to determine how NDVI readings are best applied to the crop using the sensor to collect data and validate a recommendation.
 - How much crop canopy is recommended to use the sensor?
 - 50% crop canopy is recommended.
 - Does the sensor differentiate between weeds and the crop?
 - No, the sensor does not differentiate between weed and crop species.
-

Most Commonly Asked Questions...

- Does soil affect the NDVI value?
 - Soil NDVI values are much less than a living plant.
 - This relative difference is what allows the sensor to determine biomass accurately.
 - Current wheat and corn algorithms require at least 50% of the field of view of the sensor be covered by vegetation.



Questions?