GreenSeeker Handheld Crop Sensor
Quick Reference Card

The GreenSeeker handheld crop sensor is an active light source optical sensor that is used to measure plant biomass and display as NDVI (Normalized Difference Vegetation Index). When you pull the trigger, the measured NDVI reading appears on the LCD display immediately.

How the sensor works

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. While the trigger remains engaged, the sensor continues to sample the scanned area by generating continuous bursts of light pulses and updating the display.

Green plants absorb most of the red light and reflect most of the infrared light. The relative strength of the detected light is a direct indicator of the density of the foliage in the sensor's view. The denser and more vigorous the plant, the greater the difference is between the reflected light signals.

The sensor displays the measured value on its LCD. NDVI can range from 0.00 to 0.99.

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

The *GreenSeeker Handheld Crop Sensor Fertilizer Estimate Chart* and the calculations discussed in this document were developed based on the *Generalized Algorithm for Nitrogen Fertilizer Rates* developed by Oklahoma State University.

The use of the *Fertilizer Estimation Chart* is subject to the terms found in the *Technical Specifications and General Information* sheet included with the packaging for the GreenSeeker Handheld Sensor. Trimble is providing the *GreenSeeker Handheld Crop Sensor Fertilizer Estimate Chart* **for informational purposes only.** ***You are responsible for making your own calculations and decisions regarding fertilizer application.*** Crop yields and crop health may be impacted by a number of factors including the manner of application of fertilizer, weather, and the combination of fertilizer with other products.

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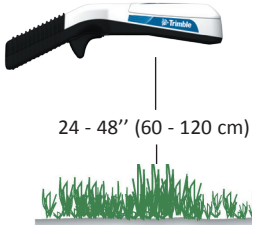
Using the sensor

Typical applications for using this tool include sensing and agronomic research, biomass measurements and plant canopy variations, nutrient response, yield potential, pest and disease impact. This allows you to get real-time readings for grain crops, vegetables, turf, sugar cane, and many others.

1



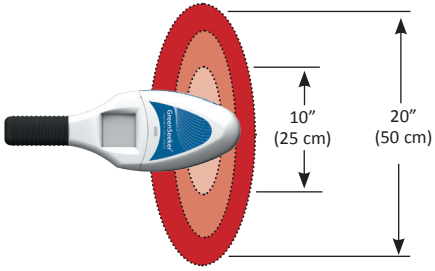
Hold the sensor over the crop canopy and then pull the trigger. The sensor should be held 24 - 48" above the crop.

2

Observe the reading on the display.

3

The sensor's field of view is an oval; its size increases with the height of the sensor (approximately 10" wide at 24" above the ground, 20" wide at 48" above the ground).



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. The maximum measurement interval is 60 seconds.

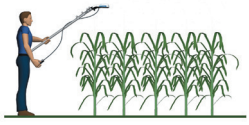
4

You must pull the trigger to start a new measurement. The unit automatically turns off after completing the measurement. You can pull the trigger to clear the screen and begin a new measurement at any time.

Using the extension

The 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.

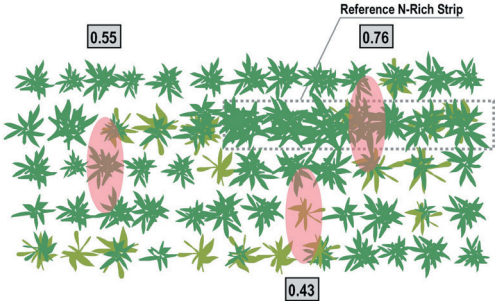
- Use the parts from this kit to attach the crop sensor to a user-supplied pole of the necessary length.
- Connect the remote switch to the sensor's 2.5 mm input connection, shown on page 1.
- Push the button on the remote switch to obtain a reading as described in *Using the Sensor* section and then lower the pole to read the display.



This sensor should not be mounted on a vehicle.

Using the sensor to estimate a fertilizer rate

A key use of this sensor is to estimate fertilizer application rates. Sensor measurements combined with agronomic information such as type of crop, may be used to estimate a fertilizer rate. The steps that follow show one procedure to get readings for a field that includes a reference area. These values are then referenced on the chart and table to determine a rate per the example. The current algorithm is available as a separate document (*Fertilizer Estimation Chart*).



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. 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. For more information on the N-rich strip practice, go to www.trimble.com/agriculture/greenseeker.aspx.

1

Nitrogen-rich area is usually more vigorous.

Measure the reference area and record each value of $NDVI_{ref}$.

2

Other non-reference areas in the field will be less vigorous if they need more fertilizer.

Measure the non-reference area* and record the value of $NDVI_{fp}$.

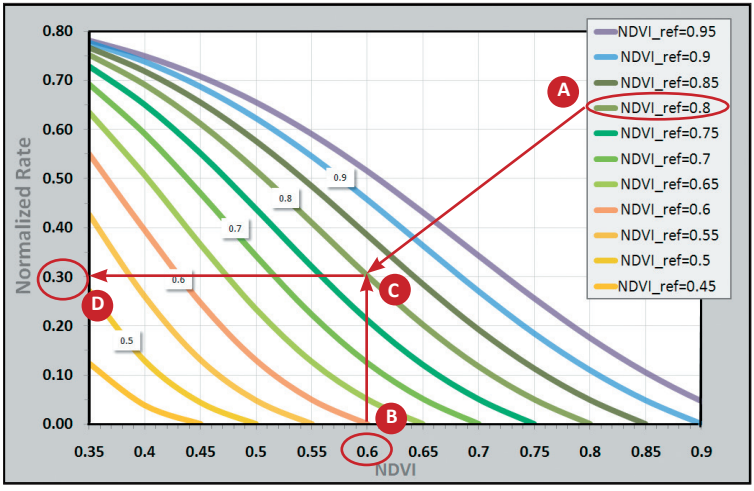
**The non-reference area is often referred to as "field practice." It may be indicated as $NDVI_{fp}$ or NDVI.*

Performance

- You can use the sensor for several days on a charge.
- The sensor automatically turns off after 10 seconds for normal handheld operation, and after 15 seconds if you are using the remote trigger.

Tips

- Tie a string and weight to the loop at the front of the sensor to help maintain a consistent height.
- Walk while measuring to scan a larger area for a better average.
- Try to keep the sensor level to the ground while measuring.



Normalized rate graph

3

Use the supplied *Fertilizer Estimation Chart.*

a. Use your previously recorded reference area $NDVI_{ref}$ value (taken in Step 1) and then locate the curve closest to your value using the legend in the graph, in this example
NDVI_ref = 0.8 A.

b. Use your previously recorded $NDVI_{fp}$ value (taken in Step 2) and find this along the bottom axis of the graph, in this example
NDVI = 0.6 B.

c. Go up from the *field practice* $NDVI_{fp}$ value at the bottom of the chart to where it intersects with the corresponding NDVI_ref curve C.

d. From the intersection point C, go directly to the left to the point where it intersects the vertical (left axis). This is the Normalized Rate, in this example 0.30 D.

e. Record this value - you will need it in Step 5.

Typical NDVI values

- Soils have small NDVI values. Light sandy soils read lower and dark soils with a lot of organic matter read higher; typical values range from 0.05 up to 0.2. The soil value has a small effect that decreases as the crop matures.
- As crops mature, plants tend to get thicker and greener, corresponding to greater biomass. On crops such as wheat and corn, mid-season readings can range from 0.60 - 0.90.

Care and Maintenance

- Keep the sensor in the supplied carrying pouch when it is not in use.
- For best performance, keep both lenses clean. Wipe with a soft cloth to avoid scratching.

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							

Crop table

4

Use the supplied *Fertilizer Estimation Chart.*

a. Identify the row corresponding to your crop in the *Crop Table*, in this example *Winter Wheat.*

b. Find the column that corresponds to the maximum yield of your crop and region at the top of the table, in this example, *175 bu/ac*.

c. The value where the row and column intersect is your crop factor, in this example, *439*.

5

Multiply the normalized rate (from the left axis of the graph) by the crop factor (from the intersection of crop and yield on the graph) to obtain the estimated fertilizer rate, in this example: ***0.30 x 439 = 131.7***

6

Round up to the nearest 5–10 lbs, in this example ***135 lbs/ac.***

Note: *The fertilizer rate that you have calculated using the Fertilizer Estimation Chart is only an estimate. For more information, including a link to a more accurate online calculator, go to* http://www.trimble.com/agriculture/gs-handheld.aspx. *Refer to your local agronomist if you would like further validation of your application rate.*

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Installing the battery

CAUTION: Risk of explosion if battery is replaced by an incorrect type.

CAUTION: Replace the battery only with the same or equivalent type recommended on the specification sheet.

CAUTION: Do not dispose of used batteries in trash. Recycle according to local regulations.

1. Press and slide the battery access panel to remove it.
2. Slide the battery into the slot as shown below.

3. Slide the battery access panel back into place.

Using the charger

CAUTION: To charge the battery, use only the approved AC or DC charger for the GreenSeeker handheld crop sensor.

- Charge the sensor at least four hours prior to initial use. The battery icon will flash slowly to indicate that the unit is charging.
- When the battery icon on the unit's display is flashing rapidly, you must recharge the unit. Charge the unit for at least five hours or until the battery icon disappears.
- Charge the sensor by connecting the appropriate charger to the unit's microUSB connection port (see pg 1). To charge the sensor:
  - Use the AC charger or optional DC charger (sold separately). If using the AC charger, select the appropriate wall outlet adapter and snap it onto the supplied AC charger.
  - Use the supplied microUSB cable. To do this, make a direct connection to another standard USB device.

Table of error codes

Display	Description	Action
E_C	Out of operating range, too close to plant	Move sensor further away from plant canopy (see pg. 2).
E_F	Out of operating range, too far from plant	Move sensor closer to plant canopy (see pg. 2).
Err	Other sensor error	Verify that your distance is within range and that the sensor is oriented towards the soil or plants. Repeat the measurement.

Support

This product includes two years of free user support (or three support cases). To contact the support team and for more information, go to trimbleagsupport.com. You must have the product serial number available for validation.

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