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Embracing Technology

Background image shows 'clear' MODIS pixels superimposed inside a pasture field

The key objective of the project is to construct and verify the accuracy of algorithm(s) that can change a satellite-generated vegetation index (VI) to estimates of forage production. These forage production estimates can be used for agri-insurance and other risk management initiatives. We focus primarily on native and tame pasture in this project.

A VI responds to chlorophyll in plants and green vegetation, but does not distinguish between grass and weeds—so it measures green biomass. Different satellites provide VI at different scales/resolution OR pixel sizes (e.g. 30 m x 30 m, 250 m x 250 m) and at different timing intervals (e.g. daily, weekly).

Satellite managers can distinguish between annual crops, trees, sloughs, etc., and provide pixels that are predominantly pasture (image above). Usually, the smaller the pixel size, the less frequent the timing and the more costly the satellite data. We used satellite data with a 250 m x 250 m resolution and at a daily frequency.

Any satellite that calculates an identical VI regardless of pixel size or timing could be used in an insurance design. An index is "an indicator of pasture production"—it is not a perfect measurement. Not even collecting actual samples in a field gives a perfect measurement as there is too much variation within a pasture. Index insurance does not require physical measurements taken in the pasture field.

Our research indicates two distinct algorithms depending on major soil zones and plant density—one for light and dark brown soils and another for grey and black soils.

> "This is a new approach—directly linking a satellite-generated vegetation index to pasture growth for agriculture insurance."

What we did

ON-THE-GROUND DATA GATHERING

1

Collected grass samples in pasture fields. Each sample has a corresponding “vegetation index value” acquired with a handheld spectrometer calibrated to the satellite.

2

Clipped the grass in the precise one-half metre location where the spectrometer reading was taken.

3

Stored the grass sample in a paper bag marked with the exact location where the sample was taken.

4

Dried each grass sample to prevent spoilage but retain colour.

5

Separated the green material in each sample from the brown material. Weighed and recorded the sorting results for each component (green and brown).

RESULT

This process gives one X (vegetation index) corresponding to a specific Y (amount of green biomass) for each sample.

Finding the link

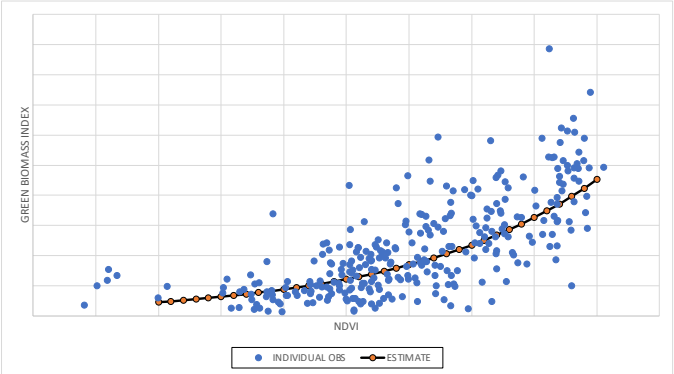
Over 5,000 grass samples were collected, dried, and sorted. This means we have over 5,000 “direct links” between a vegetation index and green biomass growth on the ground.

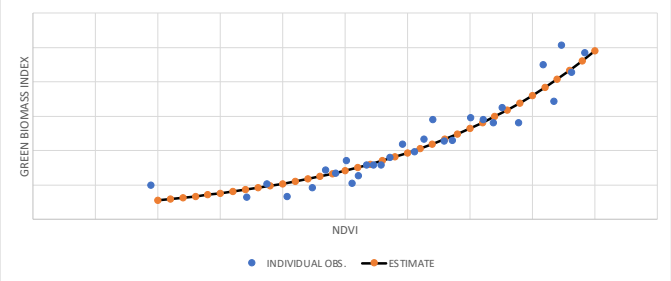
There is a lot of variation in biomass in a pasture field, especially if you look at differences between one-half metre spots. As you can see in the figure to the right (top), there is a lot of “scattering” or variability in the individual observations taken at a single ranch.

But if you rank the X vegetation index values from smallest to largest, keeping each corresponding Y value linked to its X, and then average all the data in groups of 10, you begin to see a clear and distinct pattern between the X and Y (figure at right, bottom).

A proper averaging technique reduces the variation between small grass samples and any “measuring error” in the data gathering process. More and more data averaging reduces the sampling variation but does not change the algorithm itself.

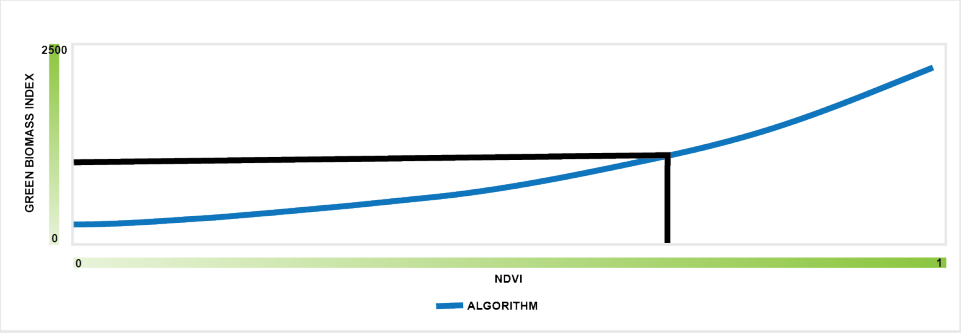
This pattern can be represented by a mathematical formula (algorithm) OR as a diagram that links any X value from the satellite to green biomass on the ground (figure below).





RESULT

Algorithm: a direct link between a satellite-generated vegetation index and green biomass.



Interesting FACTS

ACTIVE SATELLITES

According to the Index of Objects Launched into Outer Space, at the end of March 2020 there were 2,666 active satellites in orbit around the Earth.

OBSOLETE SATELLITES

Obsolete satellites closer to Earth are slowed down so they fall out of orbit and burn up in the atmosphere. Satellites in a very high orbit are blasted farther into space—into a “graveyard orbit” that is almost 200 miles farther away from Earth than the farthest active satellites: 22,400 miles above Earth!

NASA Interesting Fact of the Month July 2022. https://www.nasa.gov/ames/spacescience-and-astrobiology/interesting-fact-of-the-month.

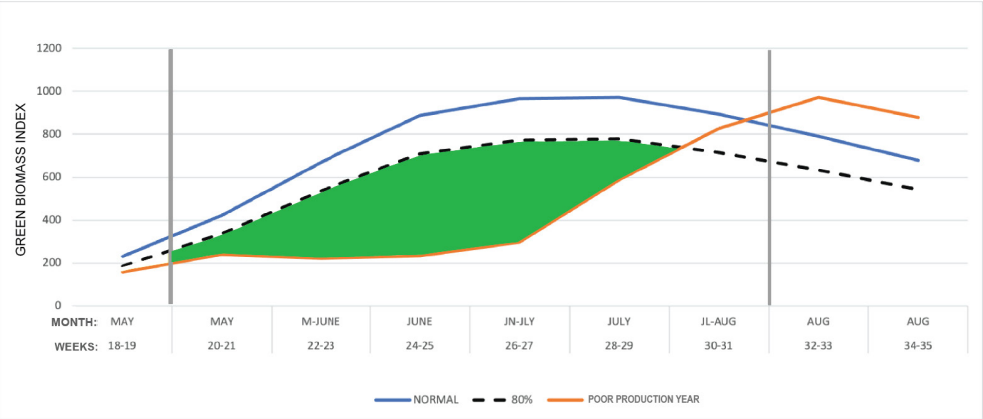
Using the link (algorithm)
IN AN INSURANCE DESIGN

An algorithm means nothing by itself. You have to see how it could work in an insurance design. So, we "invented" an insurance design.

Our design used the highest satellite value for each two-week period (bi-weekly) in the pasture growing season from 2000 to the present.

Each of these vegetation index (VI) values was changed to a green biomass index (GBI) to represent pasture production.

The insurance triggers at 80% of the historical production curve and pays fully at 60% of the same curve.



LEGEND:

Blue line – historical average of all bi-weekly VI values changed to GBI values representing green pasture

Grey vertical lines – bounds of the insurance period (mid-May to the end of August)

Orange line – GBI curve for one poor production year within the historical period

Dotted line – a "coverage level" (80% of historical) that triggers an insurance claim

Green shaded area – annual production shortfall below the dotted coverage line and within the grey vertical lines

RESULT

Pasture production on your ranch can be compared to the annual production "estimates" and theoretical insurance claims based on the project algorithm.

Curious??

Our website contains lots of great information about our current "Remote Sensing Applications to Insure Individual Farm Forage Production" project. It also covers the feasibility study on the same subject that we conducted between 2015 and 2018.

Visit us online at PastureTech.ca:

- learn about the project
- view photos
- get updates
- ask questions
- leave feedback
- connect with researchers

Project sponsor:

Canadian Cattle Association

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CANADIAN AGRICULTURAL PARTNERSHIP

IMPORTANT DESIGN FACTOR

Normally, green growth starts in late April/early May. Growth up to mid-June contributes most to total seasonal production. Incremental accumulations of green growth decline thereafter. Grass goes to seed and turns brown in the latter stages of the growing season. Grass may be plentiful in the field at this point but the amount of "visible green" is less. Insurance designs that cover "quantity losses" should consider this normal growth pattern and weight production shortfalls accordingly.