Research in Plain English: NDVI Sampling

A New, Satellite NDVI-Based Sampling Protocol for Grape Maturation Monitoring

Research in Plain English provides brief, non-technical summaries of journal articles by Cornell faculty, students, and staff.

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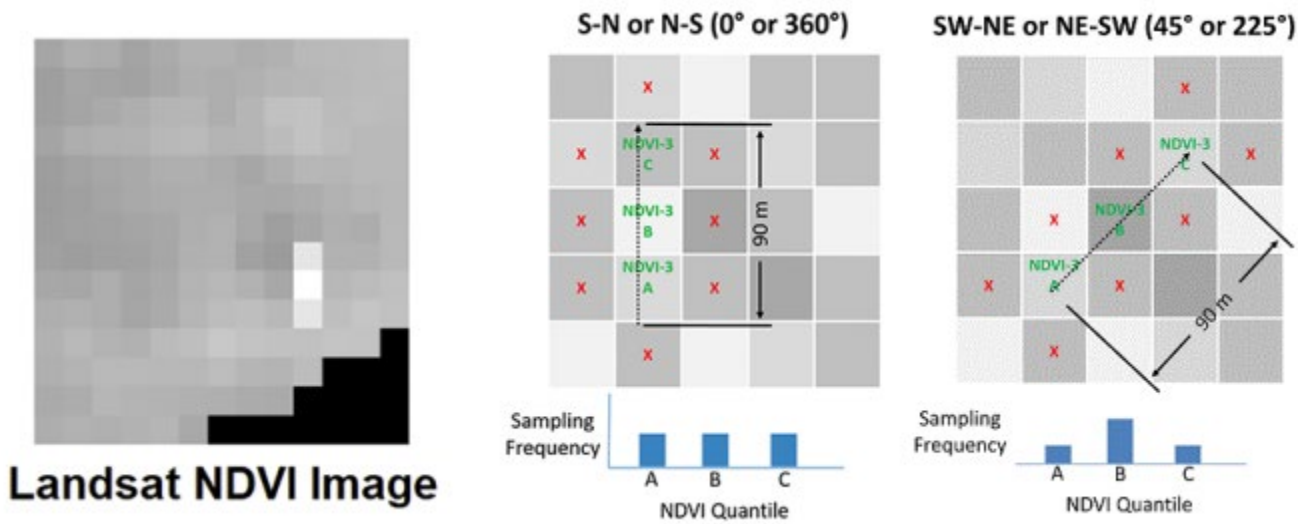
Summary by Rebecca Wiepz.



Three-pixel NDVI-directed sampling starts with Landsat NDVI images of a vineyard (left). Each pixel represents 30 square meters, and the program selects 3 adjacent pixels that best represent the block. Note that the path of travel is always limited to a single vineyard row, which is straightforward for N/S or E/W rows (center). With rows at different angles (right) sampling can overlap adjacent pixels.

The takeaway.

- Traditional sampling methods, both randomized and spatially stratified, often require visiting many different locations in a vineyard, making then very inefficient.
- NDVI is normalized differential vegetation index, an indirect measure of leaf area and photosynthetic activity. This information is now readily available to growers through satellite images collected by numerous satellite platforms.

- The NDVI3 protocol uses Landsat imagery to identify a three pixel (30m x 90m) area along one vineyard row that best represents the range of NDVI reflectance over an entire vineyard, enabling the sample technician tolimit sampling to a single location in the vineyard.
- This is particularly useful in environments with very uniform soil and climate, like the central valley of California, and where blocks are large.

Background.

Traditional sampling methods often require many locations in a vineyard be sampled, which requires excessive precision and time for those collecting the samples. While stratified sampling requires fewer locations, usually around four, it still results in technicians traversing a large portion of the vineyard. It's also difficult, using these techniques, to get a representative sample. Limiting sampling to a single row in the vineyard could significantly decrease sampling time, thus reducing costs.

Normalized differential vegetation index (NDVI) uses special sensors to quantify the spectrum of light reflected by plant surfaces. It is a good indicator of vegetation density and photosynthetic activity. The information needed to calculate this value is readily available for growers using available satellite technology.

This study compared two traditional sampling methods, a random one and a stratified one, with a new method that uses satellite images to select a single location which represents the entire vineyard, based on NDVI values for each pixel in a vineyard.

The experiment.

Three sampling protocols were used:

- *R20*: A randomized sample consisting of 1 cluster is taken from each of 20 random locations.
- *CM8*: Samples are stratified to represent each quadrant of a vineyard. To accomplish this, a technician walks 60m in each quadrant and collects 5 clusters. This is repeated for each of the four quadrants.
- *NDVI3*: A satellite image from the previous year is used to identify one location in each vineyard, in which a technician walks 90m down a row, collecting 20 clusters at a single sample location. Each pixel of the satellite image covers 900 square meters of land (30m x 30m). The sample location consists of three pixels selected to represent the lower, middle, and upper third of the range of NDVI values for the vineyard.

Quality comparison.

To compare these sampling strategies, fruit composition was measured in each of the two seasons with CM8 (stratified) and NDVI3 being compared to R20 (random) as a quality reference.

In both seasons NDVI3 produced samples of the same quality as the random sampling, while the stratified technique only produced an acceptable sample in one season. Thus the NDVI3 protocol resulted in more efficient and accurate sampling than the currently popular stratified sampling method.

Additionally, NDVI3 represented the entire vineyard better than stratified or random sampling in 12/13 blocks. This means that samples taken this way more accurately represented the entire vineyard than either of the traditional sampling techniques.

NDVI3 stability.

Running the algorithm to select a sampling location can be time consuming, so the temporal stability of the location was compared in 24 different vineyards over four years. A selected location produced reliable results for up to four years, decreasing the necessary frequency of running the NDVI3 algorithm.

Conclusions and practical considerations.

This novel approach to grape sampling based on remote sensing data is functionally the same as or better than random or stratified sampling to accurately estimate vineyard fruit quality.

Overall this technique could dramatically reduce labor requirements for vineyard sampling throughout the season without decreasing sample quality. However, this experiment occurred in relatively large and uniform vineyards. A location with greater soil or climate variability, such as the Mid-Atlantic region, may require a sampling area of more than three pixels.

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