



An introduction to N-Sight™: a rapid, on-site diagnostic platform for plant health measures

Cubed Labs has developed a novel automatic modeling algorithm that supports a diverse range of on-site tests... N-Sight™ will cut out lab assay turn times and allow for a more representative sample set of what is actually going on across the farm.

Cubed Lab’s N-Sight™ is a low cost, non-destructive and rapid on-site test platform for the agricultural industry. It combines world-leading validated hardware with proprietary data interpretation software to provide real-time actionable plant and crop data.

Increase Efficiency and Quality

N-Sight™ supplies timely data to make informed and precise adjustments with real-time feedback for consistent improvements. This allows agronomists and growers to consistently improve yields, nutrient content and quality by monitoring key plant health measures.

User Friendly

N-Sight™ is designed to scan samples directly with little to no preparation required. Tests are taken non-destructively and without shipping to a lab. They can be run with minimal calibration and user interface.

N-Sight™ provides the lowest cost and time per test, allowing for a more representative farm sample size and regular testing without worries.

Lab Level Accuracy

N-Sight™ results are within the range of lab-to-lab variability. It has demonstrated high accuracy and sensitivity within the statistically relevant confidence interval up to 95%. Performance is expected to improve with additional data and optimizations to its algorithm.

Near-Autonomous Modeling

N-Sight™ continuously refines its testing models to generate the best fit for the latest test data. Its machine learning algorithm automatically selects the best methods to create models from tens of thousands of possibilities and only requires a final manual review to ensure optimal performance.

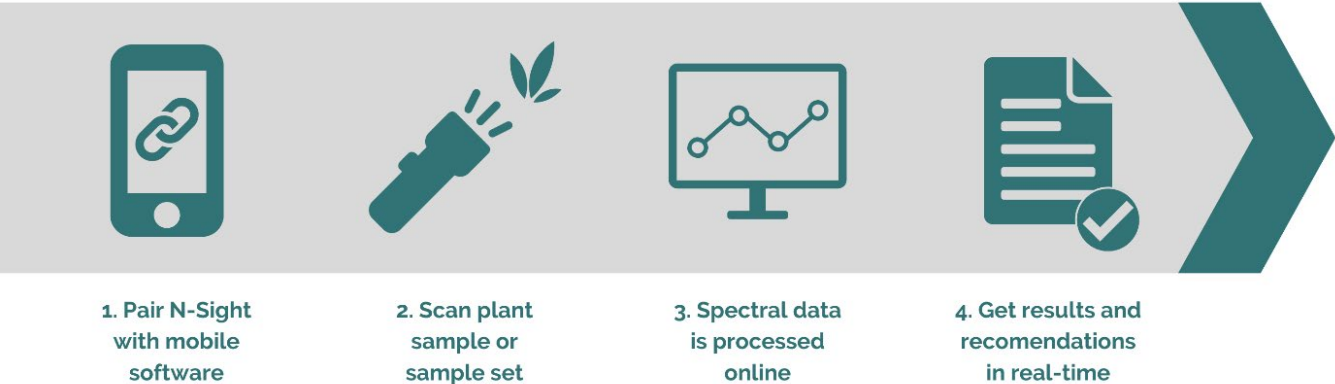


Figure 1. N-Sight™ Testing Process

N-Sight™ employs the best in market hardware

Portable & Easy-to-Use Design

N-Sight™'s novel model development approach was designed to be device agnostic, which simply means N-Sight™ can adapt to the best hardware options available.

Currently, N-Sight™ uses a validated industry leading handheld spectrometer, which has been tested and selected for its high performance, functionality/usability and field-readiness.

This wireless compact device offers single-button functionality for ease-of-use and has been validated to perform in varying environments (e.g. dusty or wet) and temperatures (20-40°C). See the table below for a summary of its technical specifications:

Lab-Quality Results On-Site

N-Sight™ scans a wide spectral range with a very high resolution of data. This spectral range was selected to completely cover the range of selected target analytes.

It uses a variable filter system to ensure consistent results without calibration even if dropped or hit between scans. This differs from other spectrometers that may require calibration with each use.



Figure 2. The N-Sight™ Device

N-Sight™ Technical Specifications

Parameter	Specification
Illumination Source	Two integrated vacuum tungsten lamps
Scan Time	<5 seconds
Battery Life & Charge Time	10 hours of continuous use & 3.5 hours
Maintenance	No maintenance required
Calibration	Calibration done automatically
Warranty	1 year included & option for 1 year extended
Device life	>40,000 hours
Sample working distance	3 mm from window optimal, 0-15mm
Dispersing element	Patented linear variable filter (LVF)
Detector	128-pixel InGaAs photodiode array
Wavelength Range	950 – 1650 nm (10,526 -6060 cm ⁻¹)
Pixel-to-pixel interval	6.2 nm for 950 – 1650 nm
Spectral bandwidth (FWHM)	<1.25% of center wavelength, 1% typical (e.g., @1000 nm, res. is <12.5 nm)

High Quality Results Demonstrated in Wheat, Milk & Mango

N-Sight™'s model development platform was evaluated using several large datasets to create and verify new models. A dataset of lab-calibrated samples for gluten (n=296), ash (n=571), moisture (n=504) and protein (n=567) content in stored wheat; fat and protein (n=147) content in milk; and sugar (n=300) content in mango was processed through the platform.

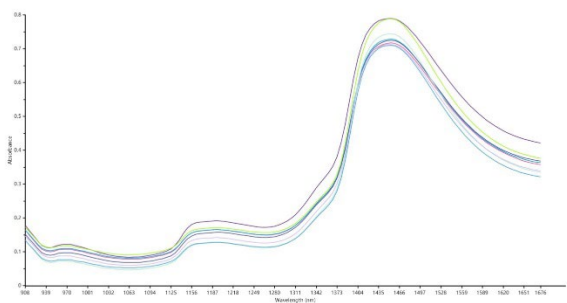


Figure 3. Example N-Sight Scan

N-Sight™ was able to generate optimized models for each analyte with many outperforming current commercial models. N-Sight™ evaluates model performance relative to commercial readiness using the Ratio of Prediction to Deviation (RPD) and for accuracy using Root-Mean-Square Error (RMSE). Below in **Figure 4** are the performance measures of each model:

Generated Model Performance Metrics			
Measure	RMSE	RPD	RPD Rating
Gluten (wheat)	0.73	2.40	Fair - Screening
Moisture (wheat)	0.20	8.40	Excellent – Any
Carbon (wheat)	0.08	3.60	Very Good - QC
Protein (wheat)	0.46	2.45	Fair - Screening
Sugar (mango)	1.33	2.69	Fair - Screening
Fat (milk)	0.20	4.00	Excellent - Any
Total solids (milk)	0.15	2.80	Fair - Screening
Protein (milk)	0.17	2.23	Fair - Screening

The RPD values of the models ranged from 2.23 to 8.40 and indicated a distinct signal and ability to measure the target analytes. A 3.0 RPD suggests a model is viable for quality control purposes. While some RPD values fall below this mark, statistical measures indicate these RPDs can be improved by increasing sample range and variability.

The RMSE indicates model accuracy at the 67% confidence interval, doubling it indicates accuracy at 95% confidence. The protein (wheat) RMSE of 0.46 demonstrates the model has a +/- 0.92% accuracy within 95% of the data range. Thus, if a reading was 11.0%, it is 95% likely that the real-world value is between 10.08% and 11.92%.

Graphs of model performance showing predicted vs measured results follow on the next page:

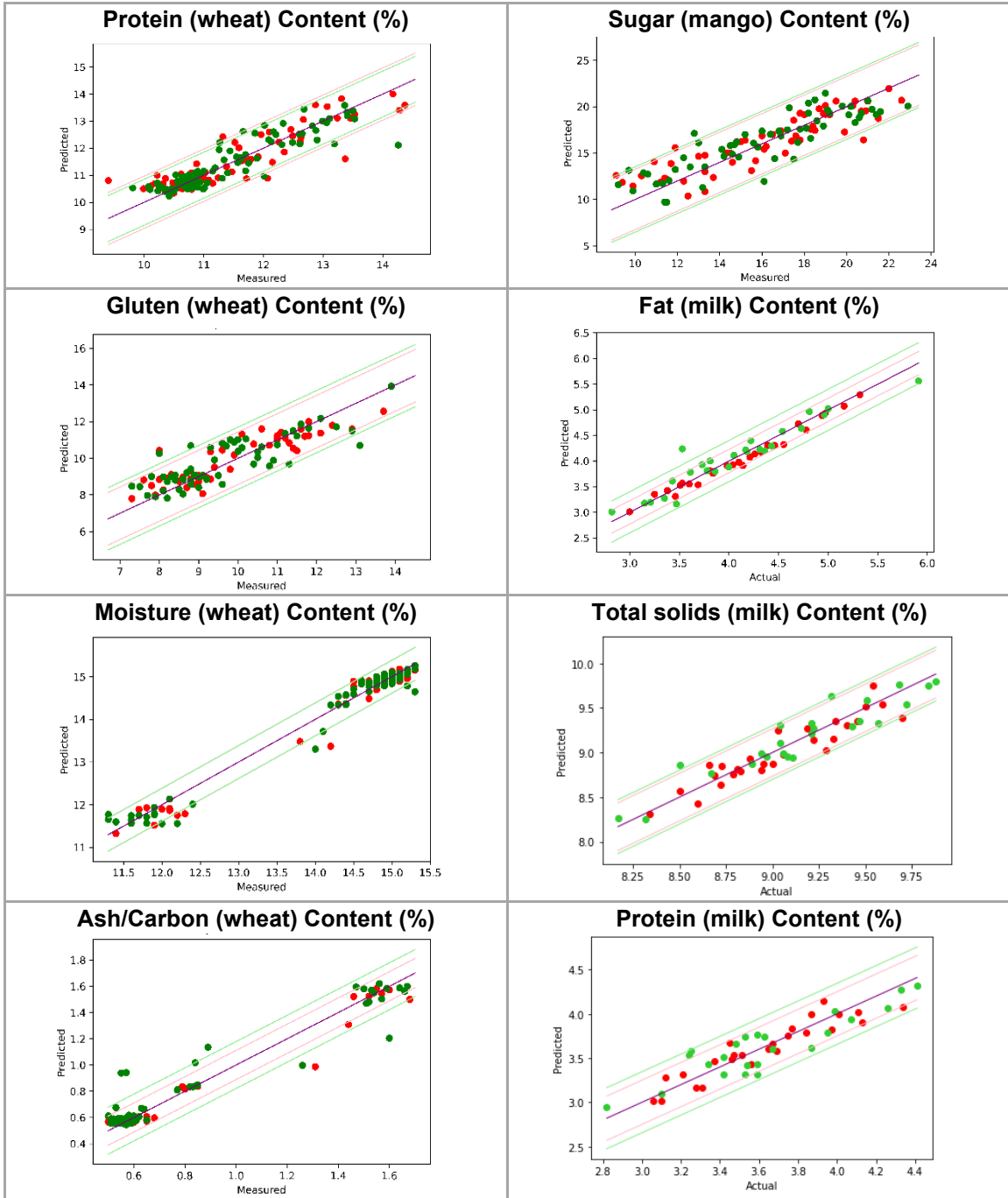


Figure 5. Model performance - predicted vs. measured values

N-Sight™ transforms our understanding of plant biology with data science and machine learning

Automated Model Development Platform – Methodology

A core component of N-Sight™ is its automated data interpretation and model development software for organic chemistry or chemometrics.

When the infrared light from N-Sight™ hits a certain chemical compound it creates a specific signal i.e., the reflectance and absorbance. Its software applies a series of transforms to this raw data to expose the hidden patterns that indicate the presence of any target analytes. N-Sight™ selects the optimal preprocessing combination to apply to the data and picks the best fit model from thousands of possibilities.

The model development software uses raw scan data in three ways:

- **Training Data:** Used to fit and develop individual models.
- **Cross-Validation Data:** Used to ascertain relative performance between models.
- **Test Data:** Used to test models to see if they generalize well to new data.

What sets N-Sight™ apart is that its model creation process is designed to be near-autonomous, removing the tedious manual work normally required in data science. This means N-Sight™ can rapidly generate and update its models for new sample data or market needs and only requires manual

review to ensure the best model performance. This automation makes it highly scalable and easy to integrate with other software platforms via an API.

Continued improvements to N-Sight™ will integrate the latest machine learning techniques from other industries and academia to increase model sensitivity, consistency and accuracy.

Real-time data is changing the possibilities of farming

You can't improve what you can't measure

The potentially unlimited assays enable a more representative sampling program from a farm thereby generating the real-time data needed to make informed decisions and optimize processes, increase yield, control inputs/costs and get consistent results.

N-Sight™ can check that your plant's nutrition is in the desired range regardless of environmental factors, meaning plants have what they need to grow and there is minimal under- or over-application of inputs.

Better tasting food that's better for us

Real-time data allows growers to measure and optimize nutrient density alongside sugar, protein and lipid levels. These plant components don't just improve taste and nutrition but also shelf life and disease resistance.

Part of a full crop management system

N-Sight™ can be used as a stand-alone application or integrated into most existing crop management platforms through an API.

When combined with our platform, N-Sight™ results can enhance photo, location, weather and nutrient input data to unlock new insights and help make more tailored crop management recommendations.

While Cubed Labs will be adding these features to the native application interface in the near term, N-Sight™ can be integrated with existing farm management software systems through an API for a more seamless adoption.

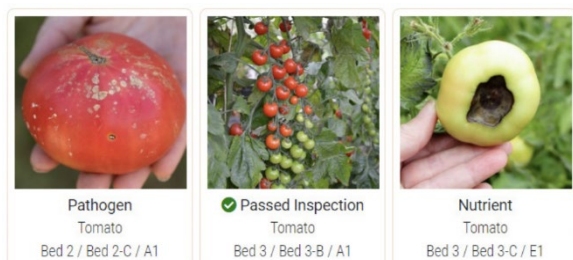


Figure 6. Example incident report system to pair with N-Sight™ scan data

What's Next...

While N-Sight™ is being developed for plant health measures first, its model development platform allows for the rapid creation of tests for a variety of other applications.

Furthering Plant Health

Cubed Labs is currently performing studies with N-Sight™ to develop predictive models for macro (N, P, K, Ca, Mg, S) and micro (Fe, Mn, B, Cu, Zn) nutrients in live plant tissue. N-Sight™ has thus far demonstrated

feasibility in detecting nutrient profiles in live butterhead lettuce samples. In the first round of the study, N-Sight™ was able to detect nitrogen content of between 3.5 to 6.0% to within 1.0% on an absolute basis with a confidence level up to 95%. Additional sample data is being collected to further optimize model development and improve test results.

Soil Health

The addition of soil nutrient testing allows us to serve customers while developing a better understanding of the interactions of nutrient uptake by plants. One key measure that has never been more critical is nitrogen management. Global pressure from regulators to reduce nitrogen and price increases have put nitrogen management at the top of the list of potential tests.

Soil Organic Carbon

Rapid on-site detection of soil carbon content gives a real-time method to monitor and quantify carbon sequestration. The \$2.0bn+ farm carbon credit market reimburses farmers for restoring carbon content in their fields using sustainable and regenerative practices. Tracking soil carbon at a low cost would allow farmers to measure accurately and to profit from these practices for the first time.

Grain & Silage Monitoring

Spectroscopy has already demonstrated functionality for both moisture and protein in grain & silage monitoring. N-Sight™'s models could represent an improvement on the current methodologies and a new data set to predict yield for commodities with

higher accuracy and set benchmark pricing in certain agricultural commodities.

Livestock, Dairy and Aquaculture

N-Sight™ has potential for monitoring livestock/meat, dairy and seafood for nutritional content, color, quality, safety and authenticity. This can be especially useful in reproductive programs. The system has demonstrated efficacy in milk content examination and can be used in numerous QAQC functions in the dairy industry.

Pharmaceuticals

N-Sight™ can be used in manufacturing and through verification at the pharmacy for most medicines.

Nutraceuticals

N-Sight™ can be used to target optimal production of specific compounds and nutrient profiles in desired crops.



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