SLANTRANGE

2021 Products & Services Guide

RESEARCH & BREEDING

“SlantRange has proven to be a best-in-class aerial phenotyping solution and trusted development and integration partner through multiple seasons as we scale up our program.

As a result, Syngenta is expanding its use of the SlantRange platform across multiple business units and application areas. Their focus on agriculture and long-term vision for technology in 21st century agriculture makes them a great asset in Syngenta’s quest to innovate sustainable agriculture solutions.”

Dr. Adrian Lund
Principal Research Scientist

syngenta

THE PHENOTYPING & ANALYTICS PLATFORM FOR RESEARCH & BREEDING

Faster, More Efficient Research & Breeding

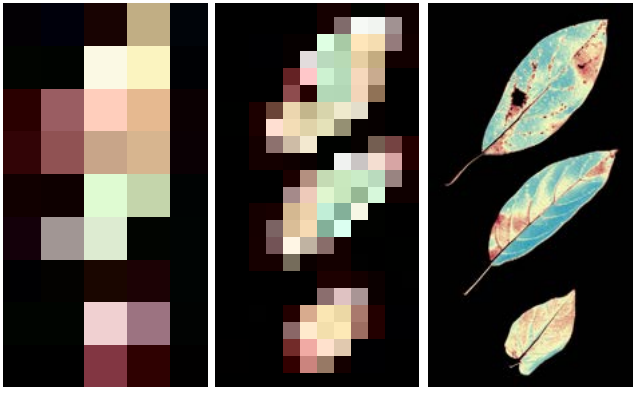
NEW TECHNOLOGIES IMPROVE CONFIDENCE IN INPUT PERFORMANCE

Input suppliers are reducing the cost, time, and risk to bring new products to market by improving their statistical confidence in how those products will perform in real grower environments.

SlantRange's new, low-altitude remote sensing and data science technologies automate phenotyping throughout the plant development cycle, and in response to changing inputs and environment, to provide researchers and breeders more accurate and comprehensive data to support their advancement decisions.

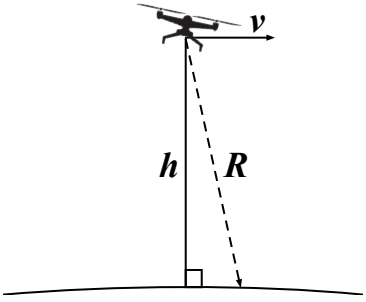
In addition, the SlantRange platform efficiently manages data collection, aggregation, analysis, and archiving for large-scale trials spanning hundreds of trial locations.

Through improved measurement and automation, suppliers are realizing **5-10% R&D cost reductions** while **accelerating time-to-market and revenue generation by 1-2 years**.



The high resolution of low altitude remote sensing enables new plant development information

Enabled by breakthroughs in remote sensing.



Low-altitude remote sensing systems (at or below about 100 m) have distinct advantages over satellites, higher-flying aircraft, and ground-based systems.

First, they can produce very high-resolution measurements at very low cost, and resolution is the great enabler for data science systems. Specifically, low-altitude sensors can surpass the critical "Johnson Criteria", or the ability to resolve individual leaves, without complex optical systems.

Second, the high-resolution image data enables plant signatures to be isolated ("segmented") from signatures of the surrounding soils, shadows, weeds, or other field residue for improved accuracy and sensitivity to changes.

Third, once segmented, individual plants, fruit, or other features can be classified, counted, and sized. Shape, morphological structure, and biomass can be analyzed to further improve the automated characterization of health and performance.

Lastly, low-altitude systems can be automated for highly repeatable, very low-cost measurement, enabling new time-based analyses of plant conditions.

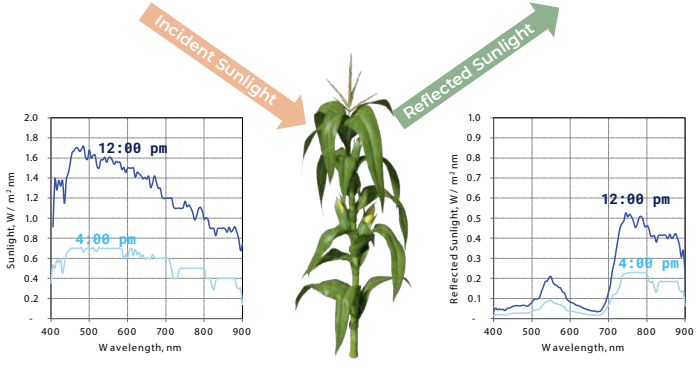
SlantRange's platform incorporates innovations in spectral and spatial measurement that exploit these advantages, so input suppliers can more accurately determine how traits and treatments will perform under real-world conditions.

Spectral Measurements

"Spectral" imaging can be a powerful tool for agricultural measurement and management, if performed accurately with adequate measurement and analysis systems.

The technique measures the amount of sunlight absorbed by a plant within specific spectral bands to infer properties of its chemical and physical composition. Those properties can then be analyzed against genetic traits, input protocols, and environment to characterize performance under a given set of conditions and to predict potential future performance.

Incident Sunlight = Absorbed Sunlight + Reflected Sunlight + Transmitted Sunlight



The spectral signature of incident sunlight must be known to accurately determine plant condition

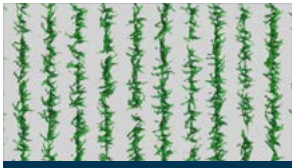
To conduct this measurement accurately, the spectral content of light reflected from the plant canopy is subtracted from the spectral content of the downwelling sunlight (along with other secondary corrections) using measurements made simultaneously of both light sources. Without this approach, even minor changes in sunlight conditions will impart errors in measurement that prevent the data's use in downstream analyses.

SlantRange introduced this new aerial sensing technique in 2014, thereby enabling the use of spectral imaging for a broad range of agricultural applications.

US Patents 9,470,579, 9,791,316. Canada Patents 2,960,375, 3,046,667. Australia Patent 2015315327.

Spatial Measurements

SlantRange incorporates new image processing and data science techniques to classify and segment key agronomic features within spectral imagery.



SLANTRANGE IMAGE 1 CM GSD

PLANT MORPHOLOGY CAN BE MEASURED

SATELLITE IMAGE 100 CM GSD

PLANT SIGNALS MIXED WITH SOIL

These enable accurate new measurements, including: plant/fruit counts, plant/fruit size, canopy density and structure, flowering, maturity, and many others. SlantRange introduced its first spatial feature-based data products in 2015 and continues to innovate valuable new trait measurements each season.

US Patents 10,318,810, 10,803,313.

Integrated Measurement Systems

THE STARTING POINT FOR ACCURATE PHENOTYPING & FORECASTING

The SlantRange / DJI Aerial Phenotyping System

Aircraft	DJI Matrice Series
Sensor	SlantRange 4P+ w/ Precision Navigation Module
Spectral Channels	6
Spectral Range	410 - 950 nm
Band Positions[1]	470, 520, 620, 670, 720, 850 nm
GSD @ 100 m AGL	2.2 cm
Detector Type	Si CMOS
Shutter Type	Global
Onboard Navigation	RTK GNSS/IMU with EKF
In-Flight Data	Setup, Status, Coverage
Onboard Storage	64 GB (2 hours)
Image Format	GeoTIFF

[1]Band positions are selectable at time or order. Some conditions apply, please call for details.

Patented Technologies for Measuring Plant Development

Fundamental to any data science system or forecasting model is a source of accurate raw information. To supply this, SlantRange developed and introduced the industry's first spectral imaging system with integrated sunlight sensors in 2014 for accurate, repeatable measurements under variable field conditions.

In 2018, SlantRange announced its SKYPORT integration with DJI Matrice series aircraft for improved automation and reliability.

In 2019, SlantRange integrated RTK GPS and a laser altimeter for even greater accuracy of plant morphological measurements.

With over 2x higher spatial resolution than its nearest competitor, SlantRange sensors, unlike alternatives, were designed specifically for aerial phenotyping.

US Patents 9,470,579, 9,791,316
Canada Patents 2,960,375, 3,046,667
Australia Patent 2015315327

New, Expanded Measurement Options for 2021

SlantRange's aerial phenotyping platform now includes support for 3rd party measurement systems. Standard color (RGB) images are supported for a limited set of data products, while the DJI P4 Multispectral system can be used for all applications.

Flight & Fleet Management

Plan and manage all of your data collections easily from a centralized flight and fleet management system offered in partnership with Measure UAS. Whether you're managing a single location or several hundred, Measure Ground Control automates and simplifies logistics.

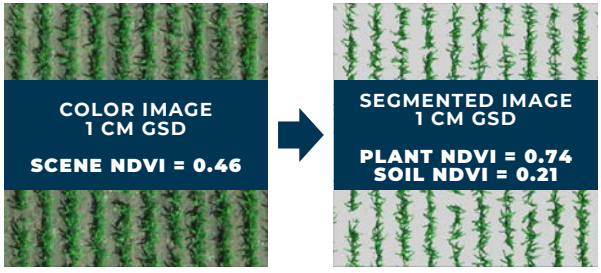
Data Science & Data Products

MORE ACCURATE ANALYSIS, MORE RELEVANT DATA

SlantRange has developed and patented new data science methods for more accurate and efficient phenotyping with a broader expanse of data products.

Segmenting for Accuracy

Intelligent computer vision techniques ensure that analysis and results are focused on the crop population, not the surrounding soils, weeds, or residue.

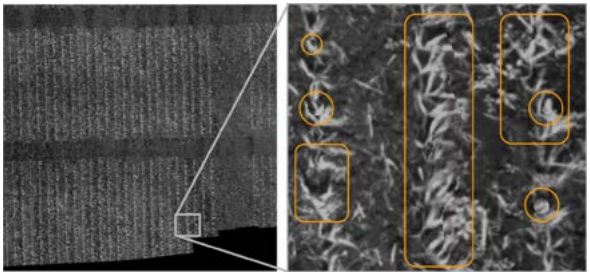


US Patents 10,318,810, 10,803,313

Eliminating Common Errors

Traditional image stitching is computationally intensive. It also introduces data artifacts that create errors in downstream analyses (example below). SlantRange employs a new method that eliminates image stitching to deliver more accurate results and a greater diversity of data products.

US Patent 10,217,188

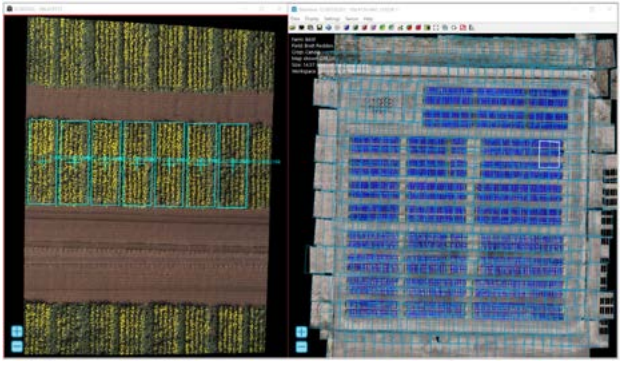


User-Defined Algorithms

The SlantRange platform hosts powerful data science tools and can be adapted to incorporate user-defined workflows. The analytics engine handles data calibration, preprocessing, and georeferencing to provide a workspace within which new algorithms can be developed, tested, and deployed.

Data Quality Assurance

Throughout the workflow, multiple test stages verify data completeness and accuracy, beginning at the point of data collection and ending with the delivered data products.



SlantRange includes multiple stages of data validity checks for quality assurance (in-field tool shown)

Traits and Data Products

Traits and data products are available for sunlight-calibrated multispectral and RGB sensor options. Data product availability is subject to crop type, maturity, and collection parameters as described below.

If there's a desired trait or crop application that is not listed, contact us for developmental options. SlantRange is continually developing solutions upon request.

DATA PRODUCT	CORN	SOYBEAN	WHEAT	COTTON	CANOLA	SORGHUM	CUCURBIT
Plant Population (Density, Count)[1]	●			●		●	
Plant Size[1]	●			●		●	
Emergence Fraction	●	●	●	●	●	●	●
Vegetation Fraction	○	○	○	○	○	○	○
Chlorophyll Index	●	●	●	●	●	●	●
Yield Potential[2]	●	●	●	●	●	●	●
Vegetation Stress	●	●	●	●	●	●	●
Maturity[2]	○	○	○	○	○	○	○
Flowering					●		
Plant Height	○	○	○	○	○	○	○
Weed Population (Density, Count)	●	●	●	●	●	●	●
Spectral Indices (e.g. NDVI)	●	●	●	●	●	●	●
Greenness Index	○	○	○	○	○	○	○
Absolute Reflectance	●	●	●	●	●	●	●
Plot Images	○	○	○	○	○	○	○
RGB (Color) Orthomosaics	○	○	○	○	○	○	○
Plant Lodging (Developmental)	●	●	●		●	●	

● Products available only with sunlight-calibrated, narrowband multispctral sensors.

○ Products available with RGB or narrowband multispectral sensors.

[1] Available within a maturity window shortly after emergence.

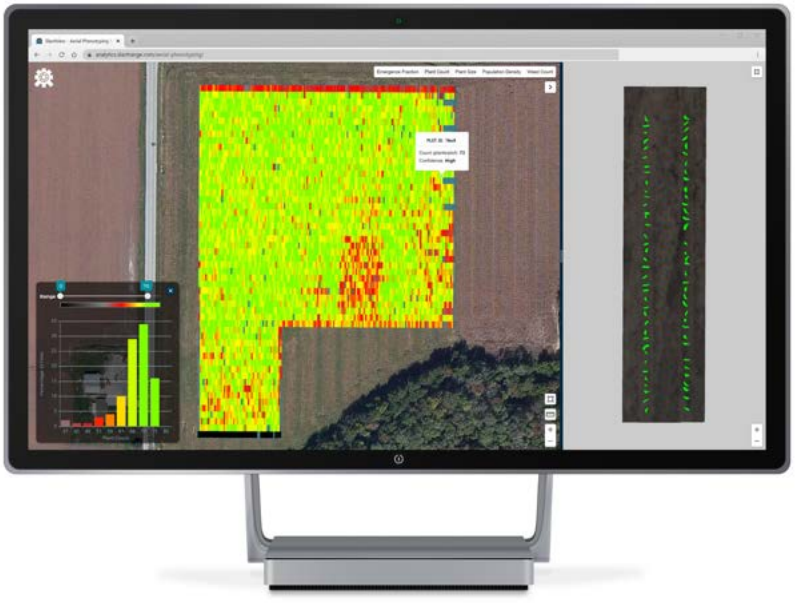
[2] Definition varies by crop type.

[3] Not all data products are available for all sensor types (e.g. RGB, multispectral).

SlantView - AP

THE FIRST PLATFORM FOR AERIAL PHENOTYPING

Easy-to-understand results across all of your trials, from emergence...



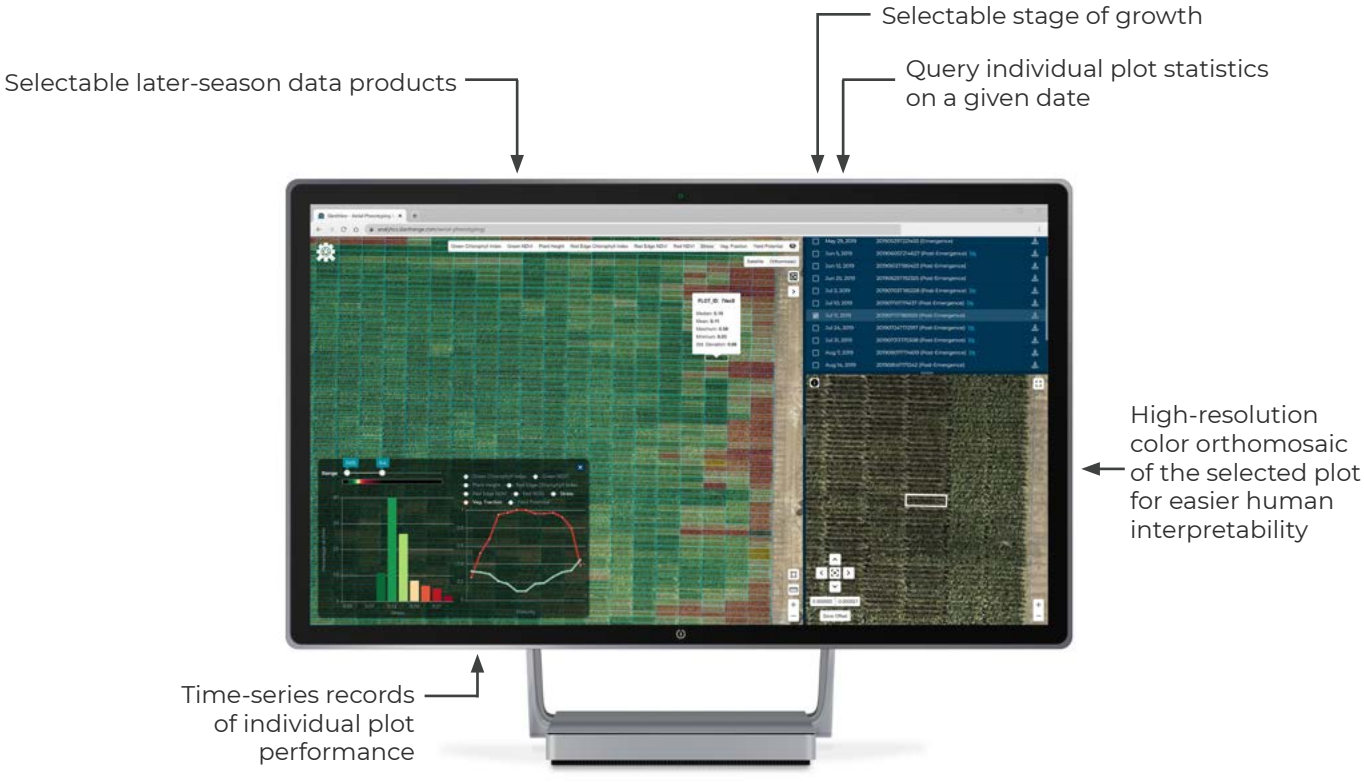
End-to-End Data Platform

SlantView - AP is the first platform designed for aerial phenotyping on an enterprise scale, from aggregating and managing data collections across multiple locations to analysis to data visualization and reporting.

Trial Configuration

Import the geographic and descriptive attributes of your trials directly from your planter or API, or described them manually to be managed and analyzed together with your aerial data.

...through full-season maturity



Management, Analysis, Visualization

Ensure the timing and quality of your measurements throughout the season with online data status, analysis, and visualization capabilities.

Data Interfaces

Transfer data into 3rd party or proprietary platforms for further analysis with easy exports and APIs.

Scalable for Efficient Use in a Single Trial or Hundreds

SlantRange's aerial phenotyping platform is designed to scale from the needs of a small Contract Research Organization (CRO) to global agri-business enterprises.

Analytics Engine Hosting Options

The SlantView - AP analytics engine can be hosted on our servers or deployed within your IT infrastructure for tighter integration with the other components of your business.

External APIs

APIs are available to exchange data with other platforms:

- Trial management software
- Planter or harvester data
- External databases

Algorithm Support

The SlantView - AP analytics engine includes the full suite of validated SlantRange algorithms but can also host 3rd party algorithms for supported sensors.

Custom Analytics

SlantRange commonly develops new algorithms to support the unique needs of its clients. Contact us if you have a new data requirement.

Drone Program Management

SlantRange's ecosystem partners offer integrated fleet management and scheduling for enterprise drone programs, including:

- Asset management
- User management, roles, and permissions
- Scheduling
- Regulatory compliance
- Customized procedures and checklists

Data Privacy & Security

The entire SlantRange Aerial Phenotyping workflow is executed with a commitment to maintain the security and privacy of your data. Data transfers and hosting include 128-bit encryption and firewalls protect your sensitive information. User roles and permissions can be implemented if desired.

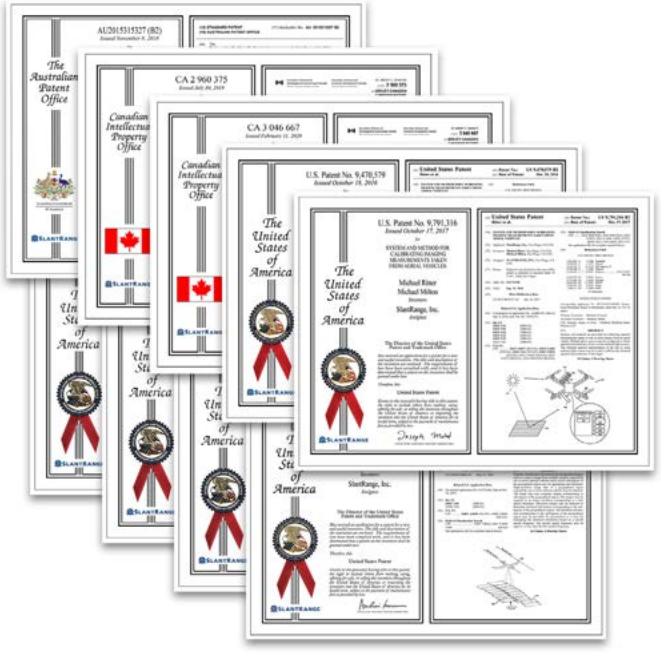
Rigorously Validated, Thoroughly Protected

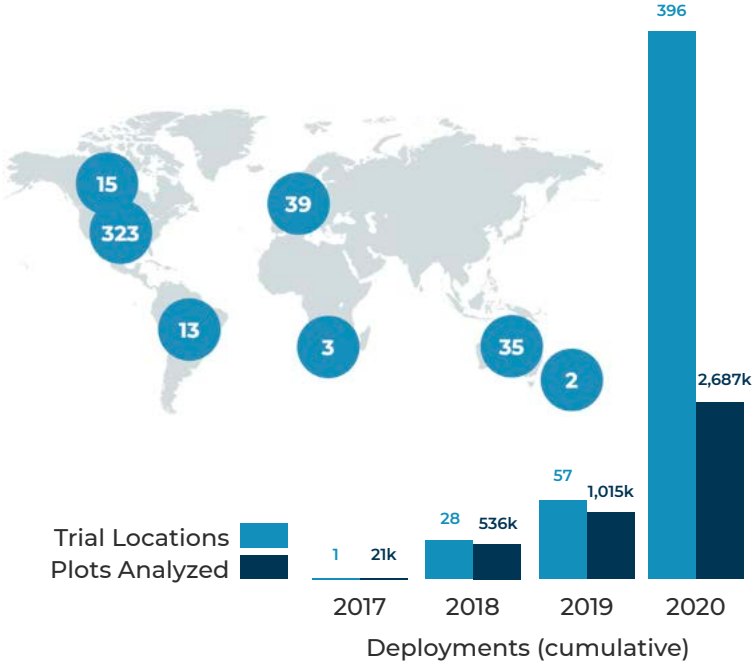
Validated for Accuracy & Reliability

SlantRange's aerial phenotyping technologies have been more thoroughly validated than any competitive alternative by the most advanced agricultural research & breeding organizations in the world.

Following years of pilot programs and field trials, leading agricultural suppliers trust SlantRange. To date, they've analyzed nearly 3 million plots across more than 400 trial locations on 5 continents with the SlantRange platform.

SlantRange is proving that aerial remote sensing and advanced data science can bring higher-performing inputs to market faster, and at lower cost.



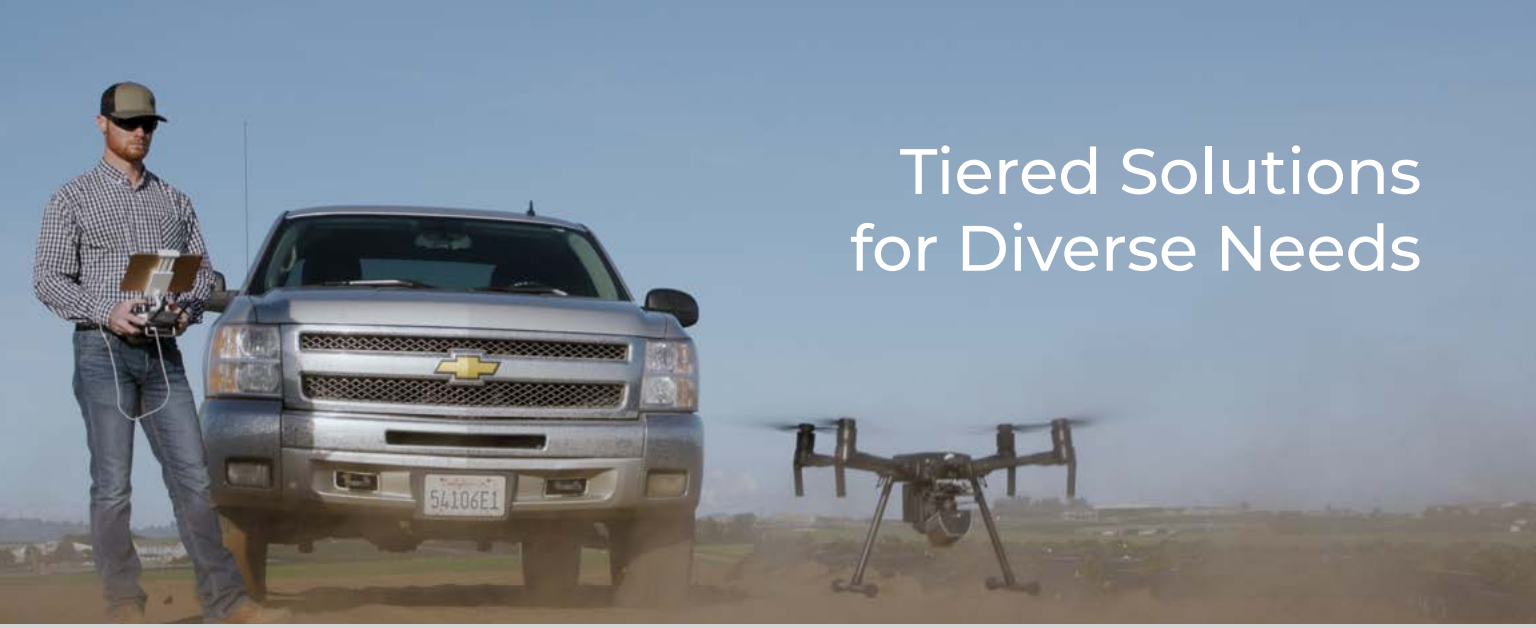


Secured Intellectual Property

SlantRange's solution is built upon an extensive portfolio of patented technologies spanning remote sensing to data science to computational methods:

- Spectral imaging techniques for accurate data under variable lighting conditions to enable time-based studies of plant response to inputs.
- Plant segmentation methods that enable plant population statistics and studies.
- AI-driven methods that improve collection and processing efficiency to reduce costs.

SlantRange has secured the IP footing for your digital ag investments.



Tiered Solutions for Diverse Needs

Basic
Self-Managed RGB Analytics

1. Prepare your own plot definitions
2. Collect your own data
3. Upload to SlantView Cloud
4. Adjust and verify plot alignment
5. View/export plot trait statistics

Enterprise
Full Service Aerial Phenotyping

1. Plan your program with SlantRange
2. SlantRange prepares plot definitions
3. Manage your own data collections or have collection service provided
4. View/export plot trait statistics

	Basic	Enterprise
SlantView - AP Cloud	✓	✓
Optimized Uploader	✓	✓
Plot-Level Exports	✓	✓
RGB Analytics	✓	✓
Multispectral Analytics		✓
Time Histories		✓
Advanced Analytics		✓
Custom Algorithms		✓
Plot Pattern Generation		✓
API Access		✓
In-Field Quality Check		✓
Priority Support		✓

“SlantRange’s broad suite of validated analytics coupled with their robust intellectual property portfolio for aerial measurement technologies made them an ideal partner as we continue to expand our research and development platform.”

Dr. Peter Lynch
VP of Research

AgReliant® GENETICS

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