DroneDeploy

Drones in Agriculture

The Ultimate Guide to Putting
Your Drone to Work on the Farm

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01 **Introduction:** Putting Your Drone to Work on the Farm

Four or five years ago, if you had asked most agriculture professionals about using drones on the farm, you probably would have gotten some strange looks. Fast forward to today, where most growers are thinking about getting a drone.

Here at DroneDeploy, we see thousands of growers, agronomists, and agriculture professionals use our platform to create data-rich maps and models of their farms and fields. And it's no wonder why. As fertilizer specialist Rob Eggert puts it, using a drone "is like being able to see your farm from a 10,000-foot altitude, but also being able to zoom in to two inches above the plants."

Agriculture is one of the fastest-growing markets in the commercial drone industry today. And UAVs are quickly becoming an indispensable tool to help you become more efficient in the field, and make more informed crop management decisions.

Over the past few years, a growing ecosystem of ag-specific drone solutions has emerged, making it possible to put aerial data to work in new and exciting ways, ranging from detecting crop damage to analyzing stand counts.

Crop Scout

Create Prescription Maps

Reduce Crop Loss

Today's drone solutions let farmers detect crop health issues in real time, accurately assess losses after a major weather event, and even generate variable rate prescriptions that can save some serious cash by limiting labor and resources.

Whether you already use drones on your farm, or you are just beginning to think about it, we've filled this e-book with everything you need to know to successfully put a UAV to work in the field this season. Read on to learn how to kick off a successful growing season with drones.

Let's get started,

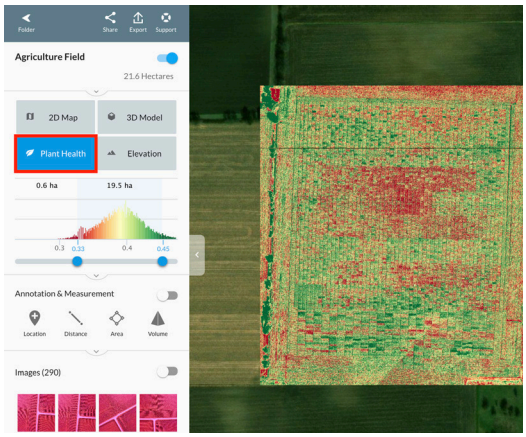
The DroneDeploy team

02 Early Detection and Timely Prevention: Measure Plant Health and Identify Crop Stress

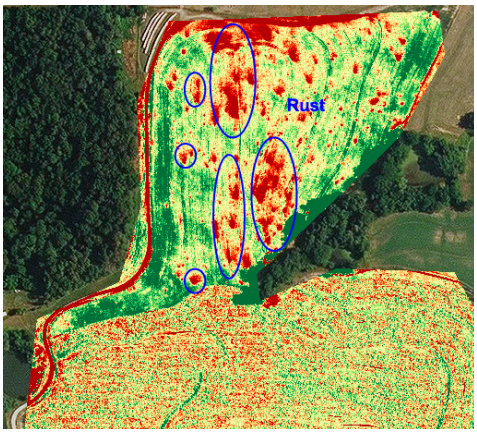
In the world of agriculture, timing is everything. Diseases and invasive species spread fast, but in the days—and in some cases, weeks— it takes to schedule and process imagery taken from a manned aircraft or satellite, what began as a small problem can spread to something much larger.

Drones, on the other hand, give you a high-resolution map of your field in a matter of minutes. Powerful plant health tools, built directly into the DroneDeploy dashboard, allow you to visualize issues and make decisions on the spot. No more guesswork or costly waiting periods. Just actionable data on plant health and crop stress in real time.

Growers like Brent Gerke use drone mapping to pinpoint issues like parasites and fungi. The very first time he used drone mapping software, Brent realized that by switching to the plant health map in his DroneDeploy dashboard, he could see areas of red coloration that turned out to be rust fungus in his wheat crop. The map enabled him to pinpoint the problem areas quickly and quantify the extent of the fungus in the field.



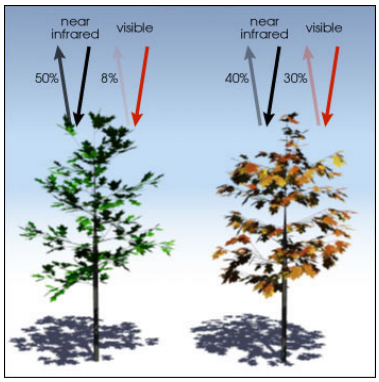
Farmer Brent Gerke identified areas of rust fungus in his wheat crop using DroneDeploy's plant health map.



DroneDeploy's built-in plant health toolbox helps you highlight crop variance across a field to measure plant health and identify crop stress before it becomes a major issue.

How Plant Health Algorithms Work

So how exactly can a drone map tell you anything about the health of your crops? In short: healthy plants reflect light differently than unhealthy plants. Plants that are healthier tend to reflect more green light than red light, which is why they look green. Plants also reflect near-infrared light that is invisible to the naked eye but can be detected with near-infrared sensors.

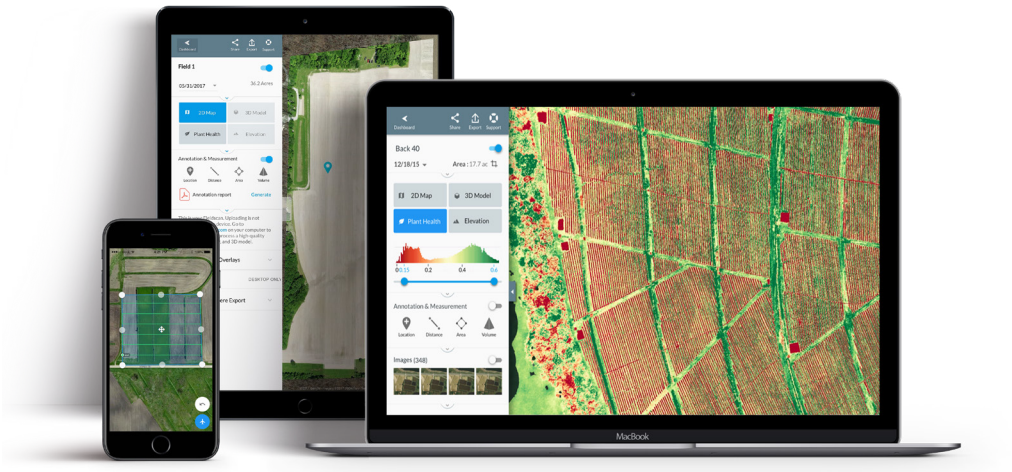


left (healthy) and right (unhealthy) with NDVI reflectance algorithm. Courtesy of NASA.

DroneDeploy's built-in plant health tools, along with a whole host of third-party apps available on the DroneDeploy App Marketplace, allow you to apply plant health algorithms** like NDVI and VARI to your drone map. These plant health algorithms compare the proportions of light captured across different bands (red, green, blue, and sometimes near-infrared) and assign numerical values for each pixel on your map.

These numerical values are then assigned colors on a spectrum. What you end up with is a map like the one pictured below. The color spectrum makes it easy to spot the variance between healthy and unhealthy areas of your field.

By applying these plant health algorithms to your drone map, you can quickly identify areas of crop stress and, with targeted ground scouting, diagnose pests, disease, irrigation, and fertilizer issues.

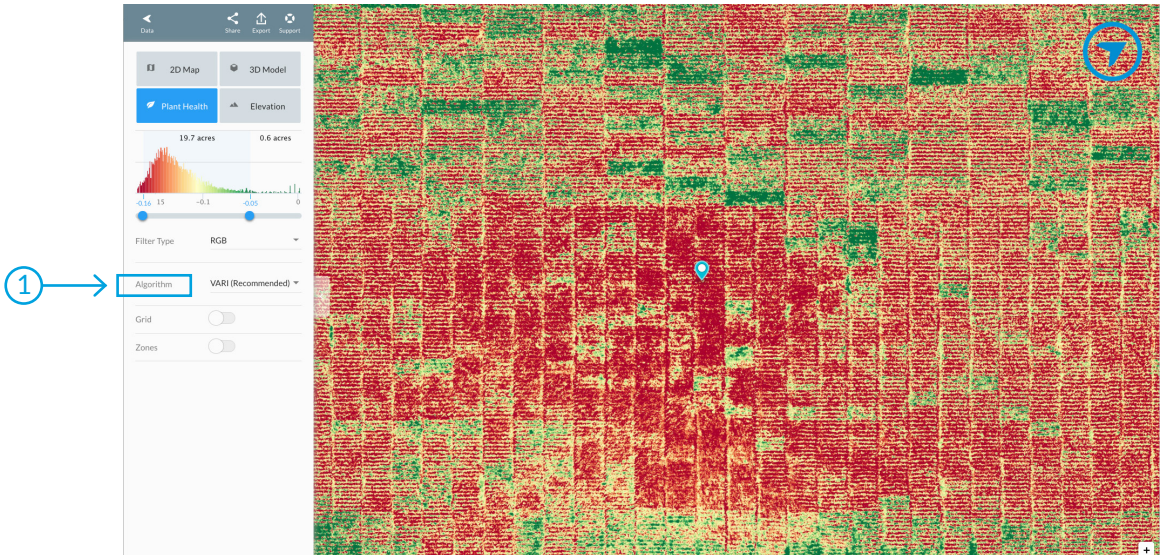


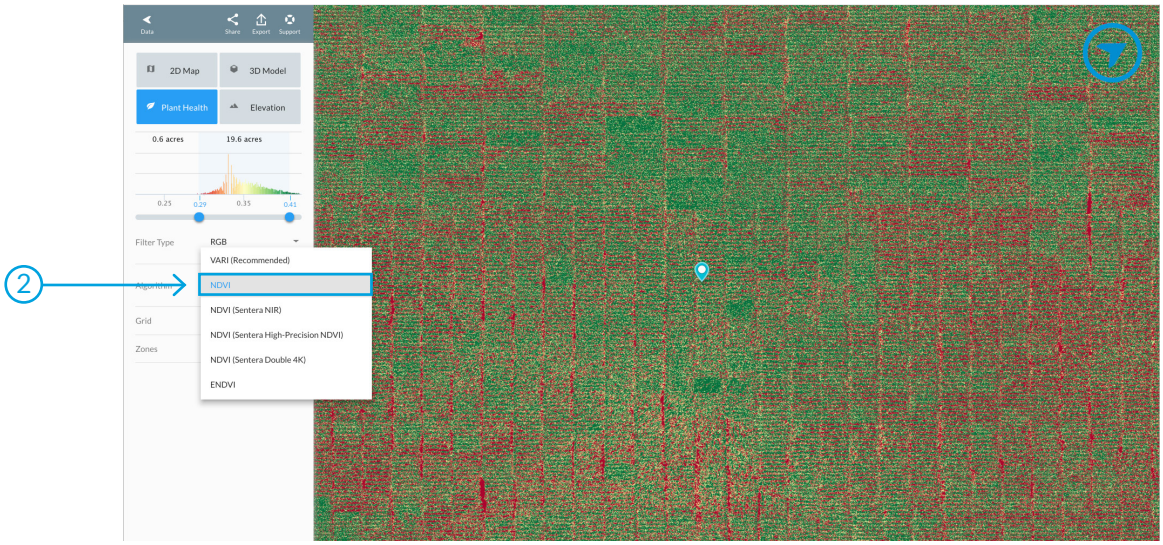
An example of the VARI algorithm applied to a drone map of a crop field captured using an RGB camera. DroneDeploy's built-in Plant Health Toolbox helps you visualize potential crop issues..

***Don't worry if you aren't familiar with NDVI and VARI. Later on, we'll point you to some great resources to help you figure out which algorithms and sensors to use.*

Tools to Help You Visualize Your Fields

DroneDeploy's built-in Plant Health Toolbox allows you to quickly adjust the contrast on your drone maps to highlight crop variability and visualize problem areas, turning a drone map into actionable data.





To get started, select Plant Health from the side panel on the map page. This will update the panel on the left to show a histogram of the data and the data itself. To adjust this, move the sliding scale bar below the histogram. Choose the appropriate color band order that is specific to the filter in the camera. You can also select a different algorithm (better suited to different crop varietals) by clicking the drop-down in the top left.

If you aren't sure where to start when choosing the right filter or algorithm, our support documentation walks you through the process. We suggest you start with our page on Understanding NDVI Data.

Plant Health Tools Help Coffee Grower Evaluate Crop Health 85% Faster Than Manned Aircraft

When a coffee grower discovered invasive guinea grass during a routine ground inspection, he needed a way to quickly assess the level of damage throughout his entire field. He could have hired a manned aircraft to capture NDVI imagery of his fields, but this would have taken as much as two weeks to turn around.

With drone mapping, he quickly assessed the scope of the problem and took action before it spread into something much more substantial.

READ THE CASE STUDY

Visualize Crop Health In Minutes With Live Map

When your crops are in jeopardy, every minute counts. Even the few hours it takes to upload and process a typical drone map can make a difference in your response time. That's why we recently introduced Live Map, a revolutionary tool that generates a drone map in real time on your screen. You don't even need a laptop or internet connection.

Just plan a flight, take off, and see maps render on your tablet or smartphone during flight. That's it. Once your drone completes its flight, you can immediately review your field's crop health and start ground-truthing your findings. Plus, all your data syncs to the cloud for sharing and collaboration.

DroneDeploy users with any paid plan can activate Live Map by toggling the option on the dashboard.

Learn more about real-time crop management by tuning in to our latest webinar: Smarter Crop Management with Real-Time Drone Data.

The Importance of Ground Truthing

Drone data is a powerful tool to help you visualize your fields. But it's always important to put boots on the ground to verify your findings and to incorporate other pieces of information, like field history, into the information you gather from your drone maps. Using your geotagged map, it is easy to pinpoint areas of a field that need further inspection up close.

"Drone imagery is just part of the equation. To make the right prescription you're have to ground-truth any findings and take local knowledge and field history into consideration as well."

Gary Naylor, Ag expert and drone mapping specialist

WATCH THE WEBINAR

03 An Aerial View of Your Fields: Make Informed Decisions with Plant Count and Stand Establishment Tools

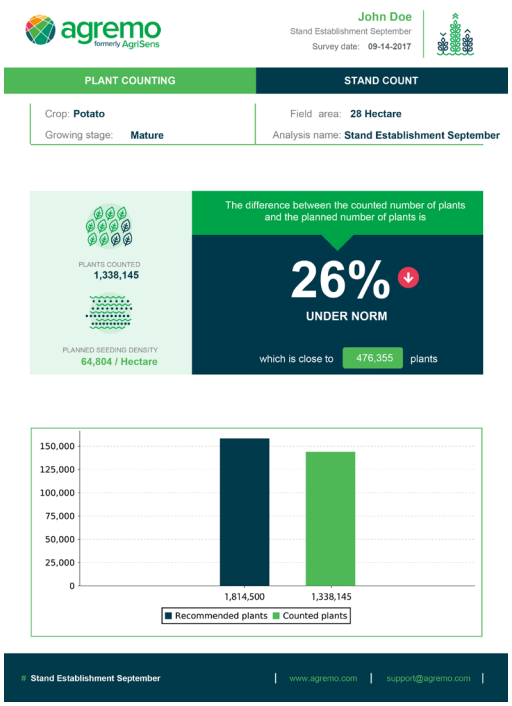
Stand Establishment Tools

That sick feeling in the pit of your stomach when one of your crops doesn't emerge as expected? For many growers, there's nothing worse. Except maybe the feeling you get from having to make, at best, an educated guess about the right course of corrective action. And let's face it, that's all ground scouting is: an educated guess. It's useful to a point, but it's an imperfect science with a high margin of error.

Drone maps, combined with powerful analysis tools, replace traditional scouting methods by delivering you a comprehensive set of aerial data on your entire field. No more guesswork or extrapolating. In a matter of hours, you can get an accurate classification of the problem and use it to make the most informed decision about a course of action.

DroneDeploy customers can take advantage of stand establishment tools by downloading drone apps like Agremo from the DroneDeploy App Market. Submit your drone map from directly within the DroneDeploy dashboard and receive outputs like a detailed stand gap map and a PDF report highlighting the economic impact of the loss.

Minnesota Corn Farmer Replaces Ground-Based Stand Count with Drone Data



DroneDeploy, combined with the Agremo Insights App, helped a corn grower gain an accurate picture of stand loss after an unseasonably cold spring affected germination across his field.

Armed with data-driven insights, he was able to make a confident decision about late-season course corrections.

agremo™

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DroneDeploy | agremo™

With the Agremo App—available on the DroneDeploy App Market—you can count plants, detect diseases, spot weeds and more with the click of a button.

STAND COUNT

Determine the number of plants in a specific area and compare this number to the results you have expected. Perfect for counting seasonal field crops and vegetables and determining sowing quality and potential yield loss.

PLANT POPULATION

Perform accurate plant counts for all types of rows, including different orientation angle rows. Perfect for counting perennial plantations.

PLANT STRESS ANALYSIS

Obtain general information on how healthy your plants are by determining the location of problem areas. Plant stress refers to any kind of distress: weed, drought, pest, disease etc.

WEED ANALYSIS

Identify the location and size of weed-infested areas to optimize pesticide usage.

PEST ANALYSIS

Spot and analyze pest-infested areas to proactively react to drawbacks.

PLANT DISEASE ANALYSIS

Scan your field for a particular disease and determine the location and size of disease-infested areas.

WATER STRESS ANALYSIS

Spot areas with potential water stress and standing water to optimize drainage and irrigation systems.

FLOWERING ESTIMATOR

Assess flowering levels to determine the exact growing stage of your plants and optimize pesticide usage and choose the perfect harvesting date.

EAGLE EYE REPORT

Create a complete list overview of field annotations to highlight specific points on your field, their GPS coordinates, area sizes and many more.

LEARN MORE

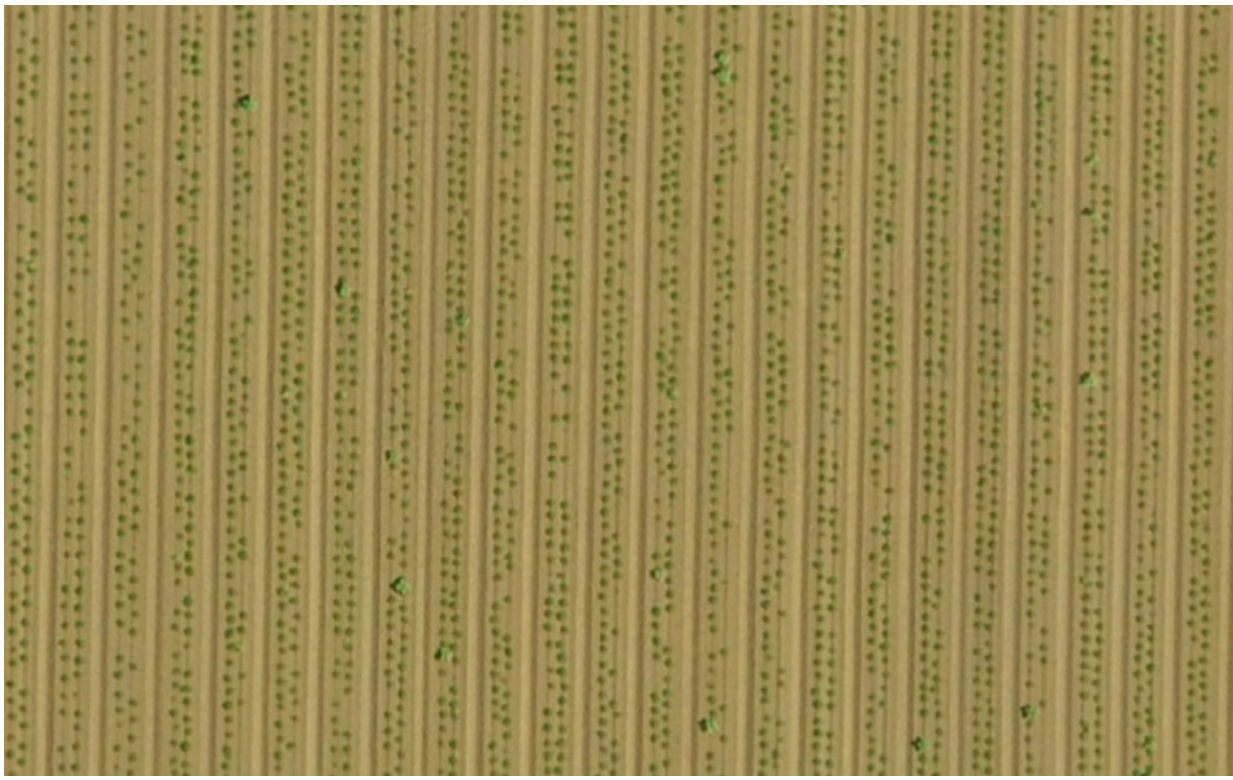
Plant Counts for Seasonal Row Crops

In addition to evaluating crop emergence, drone maps can be used to monitor the transplant of seasonal row crops like tomatoes. Not only are drone maps considerably faster and less labor intensive compared to ground scouting, but with machine learning to lean on, you know you will get consistent, trustworthy results. Agremo's user-friendly plant count reports make it easy to interpret your results and share them with stakeholders, like contracted transplanters.

Toshiro Aoki did just this as an agricultural consultant for a private farm in Northern California. During last year's growing season, hundreds of thousands of tomatoes plants were transplanted on a 74-acre field by an outside company. Toshiro wanted to make sure the company was billing them only for the established plants. He paired DroneDeploy with Agremo to quickly and easily get a plant count report that helped him hold the company accountable.

> **"The plant counting seals the deal. It saves us the trouble of having to go out and count the whole field.**
>
> Toshiro Aoki, agriculture consultant

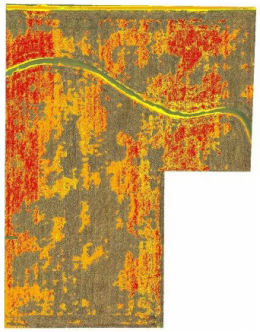
READ THE CASE STUDY



04 **Drones After a Major Weather Event:** Aerial Imagery to Assess Damage and Mitigate Loss

Lurking just beneath the surface of every growing season is this stark reality: at the end of the day, mother nature rules the field. One major weather event, or an unseasonably rainy year, can decimate a crop and leave you with considerable losses to bear. Aerial imagery helps farmers quantify the damage quickly so that action can be taken to mitigate the loss.

Assess Damage After a Storm



When heavy winds and exceptional rainfall downed corn on a 105-acre field in central Illinois, drone service provider Jeremy Jones helped the farmer assess the damage. A plant health map gave him a complete picture of the loss, instead of relying on ground scouting which could easily have missed catching large portions of downed crop.

READ THE CASE STUDY

Negotiate Fair Crop Loss Percentages

In situations of extreme crop loss, it's often time to call a crop insurance adjuster. But adjusters only have time to walk small sections of a damaged field, so gaining an accurate picture of the loss can be difficult.

When heavy rains destroyed nearly 100 acres of a Kentucky tobacco farm, drone service provider Gregg Heath produced an annotated crop health map of the entire field. This map convinced an insurance adjuster to re-inspect the field after an initial loss estimate fell short of expectations.

Thanks to the detailed information provided by Gregg's drone map, the adjuster took a second look at targeted areas and offered a far higher loss percentage. The tobacco farmer ultimately recouped an additional $110,0000 in crop losses.

> **"DroneDeploy is really tailor made for when you are surveying crops.**
>
> Gregg Health of Silicon Falcon Micro Aviation

READ THE CASE STUDY

05 **Advanced Crop Management:** Deploy Data-Driven Field Solutions

One of the best things about drones is that they allow you to analyze issues in real time, as they happen. But those same drone maps can also enable you to make long-term decisions and engage in advanced crop management.

Review Side-by-Side Maps for a Historical Perspective

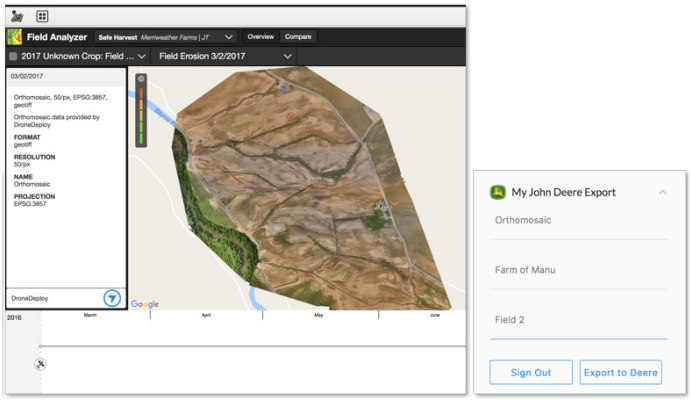
DroneDeploy automatically organizes and stores your maps by date and geographical location, so it's easy to track a crop's progress over time. This is a chance to dig a little deeper into problem areas, take a closer look at patterns, and visualize how crop emergence and plant health played out through the entire growing season.

Using Calendar View on your DroneDeploy dashboard, you can quickly see when you flew a mission over the same site—and compare changes over time.

Compare drone maps over time for greater perspective on crop management. This series appears in chronological order from left to right showing the same field from Late June through Late July

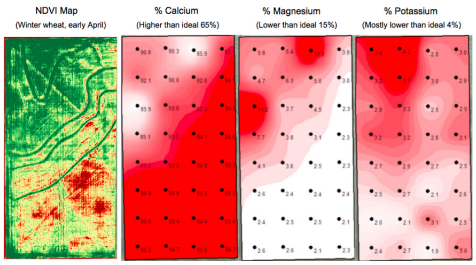
Integrate Drone Maps with Field Data

If you want to dial down even further, compare your drone maps with other information like harvest, yield, variety, and spraying maps. All of this is done seamlessly by exporting orthomosaic, plant health, and elevation maps into software like AgLeader, SMS, or John Deere Operations Center. You can also import field boundaries from your management software to make mission planning quick and painless.



Easily export orthomosaic, plant health, and elevation maps to your John Deere Operations Center account. The exported maps will appear in the Field Analyzer Section of your account.

Generate Variable Rate Prescriptions for Nitrogen and Pesticides



Using drone data to generate variable rate prescriptions can save thousands of dollars in manpower and supply costs.

DroneDeploy customers can easily export their drone maps as a zoned shapefile that can be integrated into precision agriculture software. We' seen growers use drone data to generate variable rate prescriptions for nitrogen and pesticides that save thousands of dollars in human resources and supply costs—and effectively maximize yields.

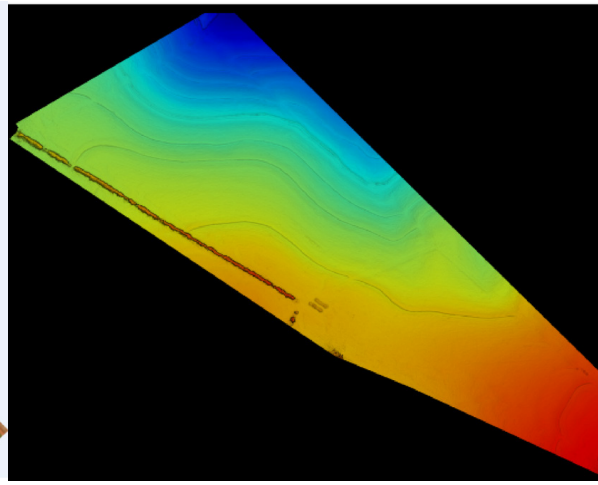
Landon Oldham owns Heartland Soil Services, a company that uses soil samples to estimate crop yields and make variable rate prescription maps. He pairs drone data with soil samples to generate highly accurate nutrient prescriptions. Instead of relying solely on data from soil samples—about one sample per two acres—Landon's new workflow combines this sampling with the many data points on a drone-generated NDVI map to gather information at a much more granular level.

> **"The ROI is tremendous because growers can further increase the site-specific application of any and all products rather than applying the entire field at the exact same rate.**
>
> Landon Oldham, Heartland Soil Services

Automate Planting with Drone Data

When it comes to mapping out planting lines on a sloping field, drone-based aerial surveys increase efficiency and cut planting costs. Leading sugarcane producer Ipiranga Agroindustrial used drone data to create an accurate contour map of a 300-acre field—tracing the field's planting lines 75% faster compared to ground methods. The company imported the information into John Deere Autopilot in preparation for plowing the field.

READ THE CASE STUDY

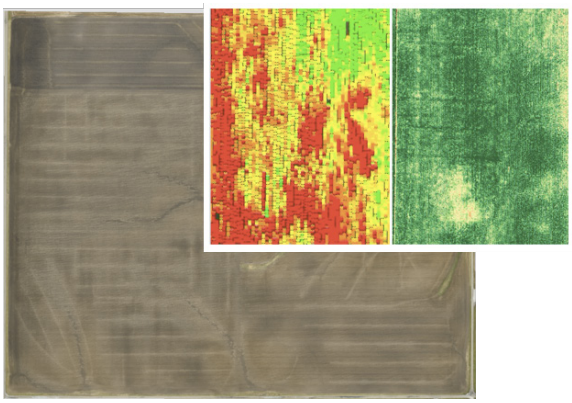


06 UAVs Before and After the Harvest: Harness the Power of Drones in the Off Season

If you only plan to use your UAV during the growing season, you might want to reconsider. From scouting for weeds to assessing drainage tiles, growers are increasingly using drones as an indispensable, year-round field management tool.

Assess Irrigation Systems and Drainage Tiles

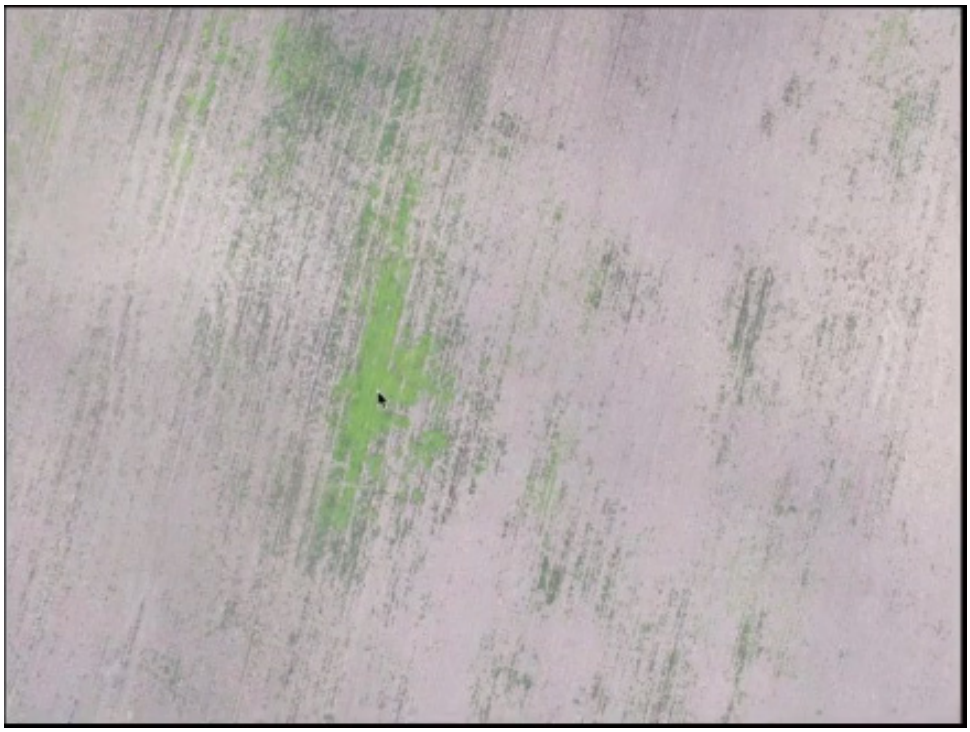
Before the ground freezes, chances are you'll spend time repairing drainage tiles and optimizing irrigation systems. Why not make your work more efficient, and more effective, by firing up the drone first? A bare earth map is a great way to catch drainage and irrigation issues early, before they turn into bigger problems next growing season



Subsurface Drainage Tiles
In the map pictured here, a farmer assessed his subsurface drainage tiles by mapping his field in the morning after a rainstorm, when the soil was still wet but beginning to dry out. The RGB imagery shows red areas that are driest and green areas which are still relatively wet, signifying they might not be draining as fast as the rest of the field.

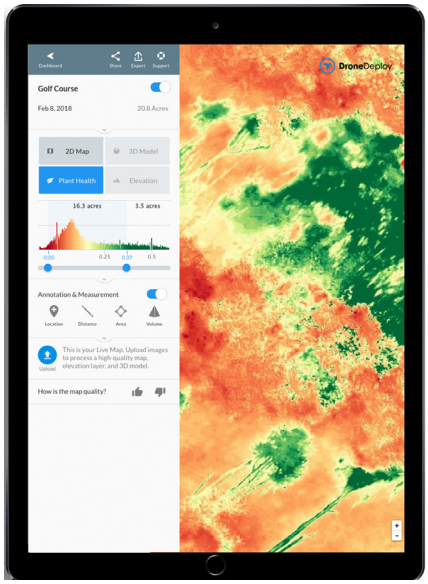
Pivot Irrigation Systems

To detect potential problem areas with an above-surface irrigation system, an RGB or crop health map is ideal. Because excess water builds below the surface before any issues are noticeable above ground, a lot of irrigation issues, like flat or sunken tires, or clogged nozzles, can be spotted early this way.



Mapping a bare field in early spring helps catch weeds or other issues that might affect planting.

Scan Soil to Detect Pre-Season Issues

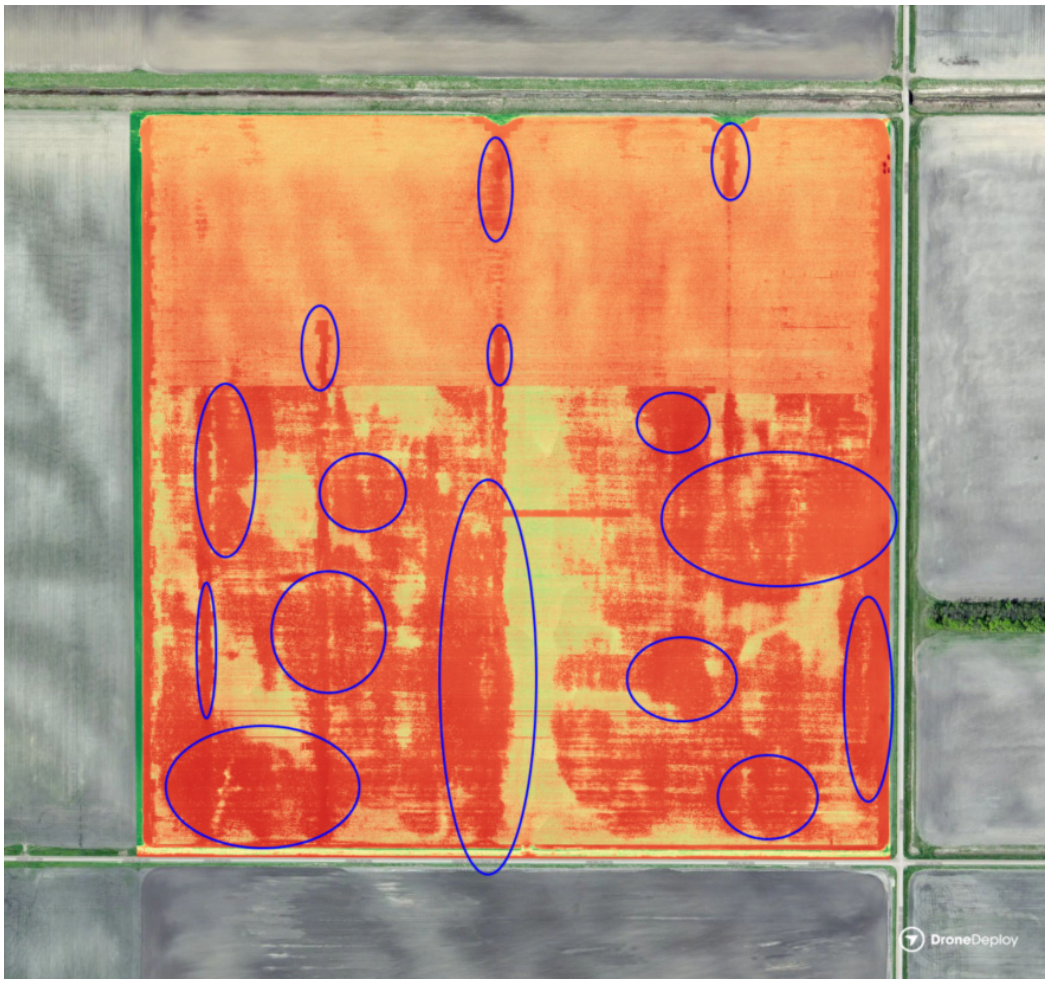


As spring arrives and planting approaches, it's a good idea to map your bare field one last time. A pre-season barren earth map, combined with targeted ground-truthing, can help you understand what pests and weeds have come up as a result of heavy rains or severe weather And, if any issues do exist, you can use DroneDeploy's plant health tools to assess how much treatment to order and where to apply it. When it comes time to plant, you'll go back to the field with a little more confidence in its overall health.

Use Maps to Plan for the Next Growing Season

Reviewing maps from past growing seasons is a valuable tool to help with planting plans for the year ahead. Spot trends by using your drone maps to visualize crop emergence and plant health over time, then compare this with historical information on things like soil conditions and yields.

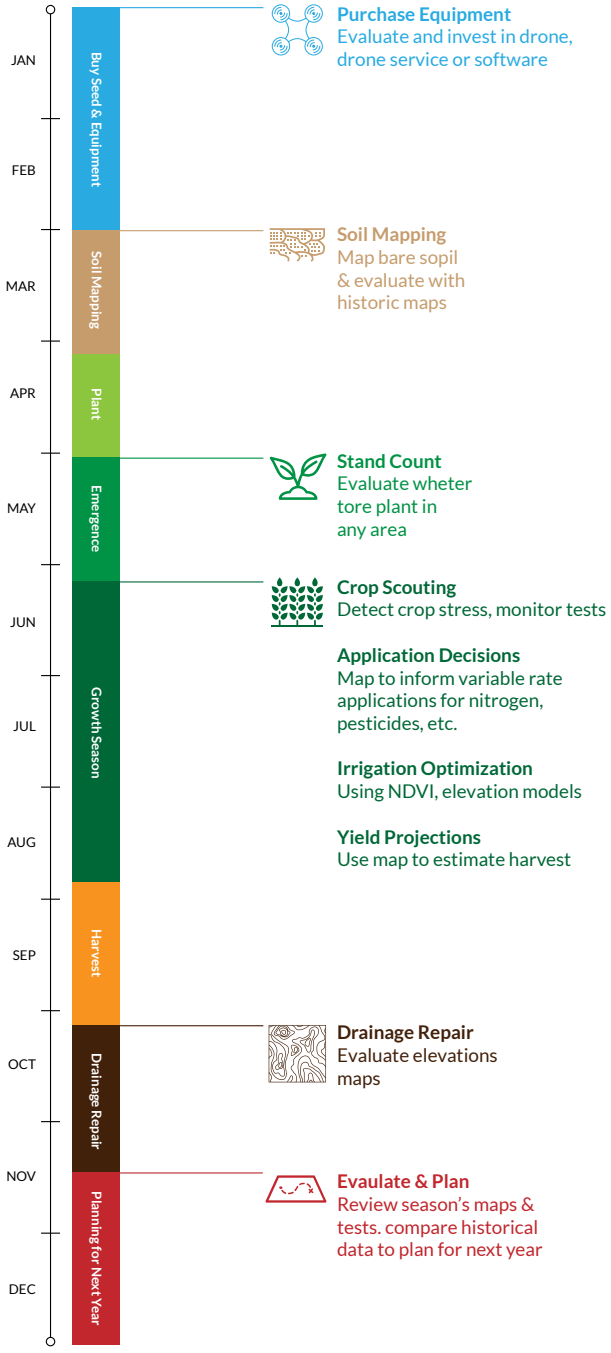
By comparing a mid-season map of his potato field with historical weather data and yield projects, one grower in North Dakota was able to determine which variety of potatoes resisted heavy rainfall most efficiently. Using this data, he made an informed decision about next year's planting and potentially saved his operation tens of thousands of dollars in future crop losses.



A potato farmer compared this drone map with weather and yield data to determine which variety of potatoes resisted heavy rainfall most efficiently.

Prepare for the Busy Season with a Flight Calendar

Flying at regular intervals creates a consistent record of what a field looks like over time and gives you more information to work with when it comes to making those big, mid-season decisions. How often you fly is going to depend on your crops, the size of your fields, their distance from your central location, and your specific data needs. But regardless of how often you plan to fly, if you head into the busiest months with a pre-established calendar, you'll be more likely to stay consistent even when things get busy. We've included a sample flight calendar below.



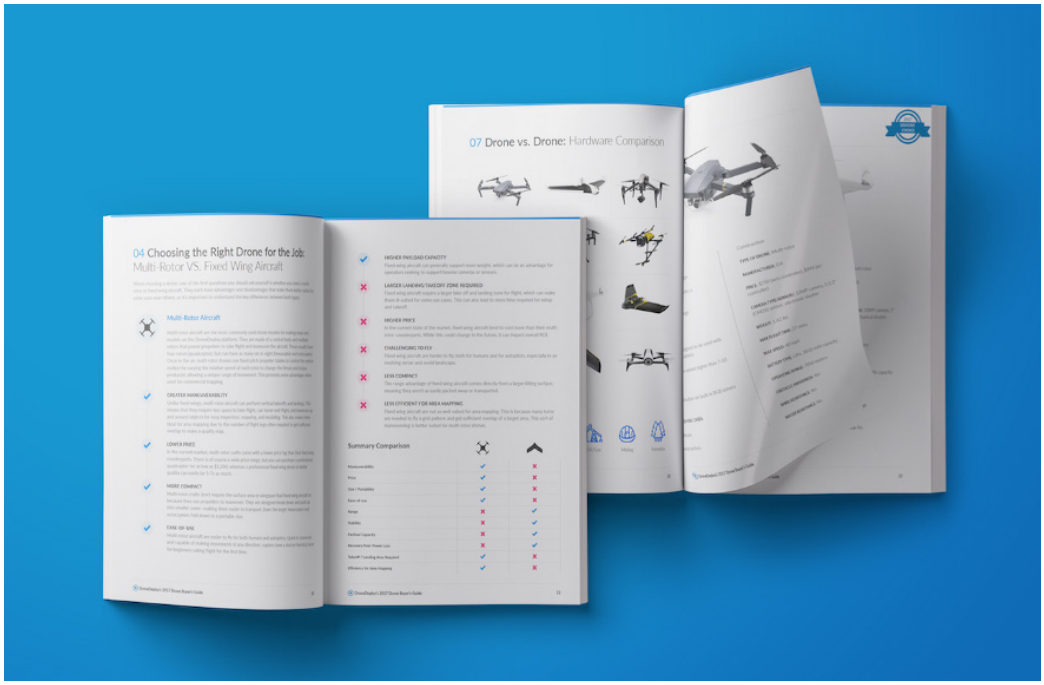
Prepare for year-round drone mapping with a pre-established seasonal flight calendar. That way, you'll be more likely to stay consistent even when things get busy

07 **Prepare for Takeoff:** Getting Ready to Deploy Your Drone

Choose the Right Hardware and Software

Drones and Sensors

Multi-rotor or fixed wing aircraft? Mavic or Phantom 4 Pro? Modified RGB or multispectral camera? Deciding which drone hardware to invest in can be daunting, so we've created a drone buyer's guide to help make sense of it all. Get a side-by-side breakdown of all the latest drone platforms along with industry insights to help you choose the best drone for your needs.



DOWNLOAD THE DRONE BUYER'S GUIDE

DroneDeploy App Market

The DroneDeploy App Market enables your business to unleash the full power of aerial data with enterprise software integrations and specialized tools built right into the DroneDeploy user interface.

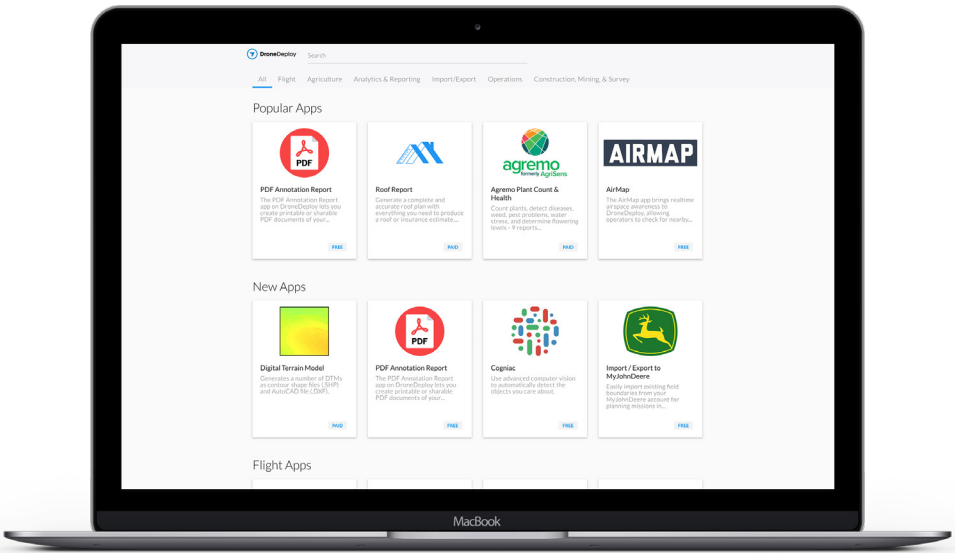
There are over 50 great apps available on the market. We've already mentioned a few. But here is a rundown of the top apps for the agriculture industry:

Agremo Plant Count and Health:
Count plants and determine flowering levels. Detect diseases, weed and pest problems, and water stress. Nine different reports are available.

Skymatics Crop Damage Analysis:
A PDF report is generated showing the map with crop damage classification and a table describing the area affected in acres and percent of field area for each class.

My John Deere Export:
Easily import existing field boundaries from your MyJohnDeere account for planning missions in DroneDeploy. Easily export orthomosaic, plant health or even elevation maps to your My John Deere account.

Farm Solutions:
Improve crop health and yield with FarmSolutions. Identify analysis areas to measure plant health and track over time. Share summary reports with growers and farm management.



EXPLORE THE APP MARKET

Get Part 107 Certified

If you are a farmer just flying your drone on your own fields, you might not think of yourself as a commercial drone pilot. But according to the FAA, you are. Anyone who operates a drone for business purposes, including growers and farmers, must obtain commercial certification—known as Part 107 Certification— through the FAA

It's a Straightforward Process:

1. Take the knowledge test at an approved center.
2. Register as a commercial UAV pilot through the FAA IACRA system

Drone Registration
All commercial drones must be registered through the FAA. Registration is done at the company level, not by individual employees.

Educate Yourself about Regulations and Compliance
Spend some time reviewing all of the FAA's regulations on flying commercial drones. Learn more here. Also, make sure to research any local and state regulations that apply to your area.

Read an overview of Part 107

Read the Part 107 fact sheet

Download the entire 624-page ruling

08 **Conclusion:** Next Steps and Where to Go From Here

Now that you've tackled the fundamentals of using drones on the farm, we hope you feel more prepared to integrate UAV data into your everyday workflows. Of course, there is so much more to learn about drones in agriculture. We suggest you start with these resources:

Crop Scouting eBook

For an in-depth look at crop scouting with drones, including a detailed discussion about cameras and sensors, don't miss our ebook: Crop Scouting with Drones: Identifying Crop Variability

Drones in Agriculture Webinar Series

- Drones in Agriculture: Putting Your Drone to Work in the Field
- Mapping and Analyzing Crops: Tips and Tricks from the Ag Pros
- Drones in Agriculture: Getting the Most out of Your UAV This Growing Season
- Smarter Crop Management with Real-time Drone Data

Agriculture Clinic Series

Our agriculture clinic series gives drone users of all levels valuable tips and techniques for making the most of UAVs in the field.

- Beginner Agriculture Drone Clinic
- Intermediate Agriculture Drone Clinics
- Advanced Agriculture Drone Clinic

Get Started with DroneDeploy

Ready to give DroneDeploy a try? Sign up to start a 30-day free trial of our software and begin putting drone maps to work in your company.

Talk with a Drone Mapping Expert

Still have questions? We are happy to hear from you. Please don't hesitate in reaching out to us with any questions. We'll connect you with one of our drone mapping experts to get you the information you need to get started with drones.

Precision Ag Package:
Drone Software For Ag Professionals

A best-in-class solution for growers, agronomists, and ag professionals. Take your drone program to the next level with the leading image processing engine, crop reports, and agriculture-specific export options.

Precision Ag Package customers have access to measurement tools, exporting capabilities, and support available to “Pro” customers, plus:

- **Real-Time Live Map** - Offline crop health analysis to view plant health without having to leave the field.
- **Crop Reports** - up to 1,000Ac of Agremo stand count and plant population analyses (a $1,500 value!)
- **Advanced Crop Health** - toggle between algorithms like NDVI or VARI, create management zones and change sensors
- **Plant Health Shapefile Export** - export data to your preferred farm managament software

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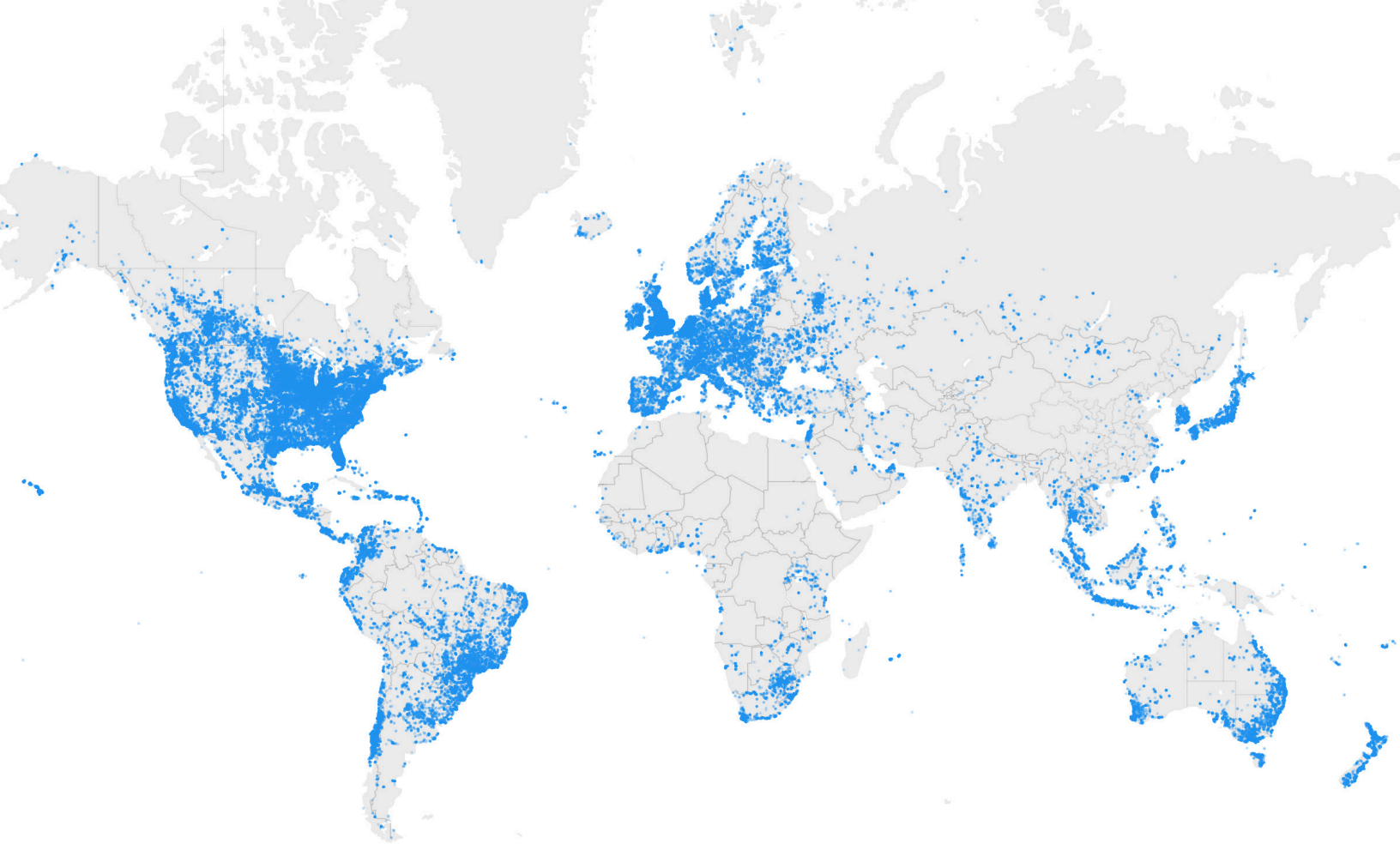

Areas Mapped with DroneDeploy

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About DroneDeploy

DroneDeploy is the leading cloud software platform for commercial drones, and is making the power of aerial data accessible and productive for everyone.

Trusted by leading brands globally, DroneDeploy is transforming the way businesses leverage drones and aerial data across industries, including agriculture, construction, mining, inspection and surveying. Simple by design, DroneDeploy enables professional-grade imagery and analysis, 3D modeling and more from any drone on any device.

DroneDeploy is located in the heart of San Francisco.
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