Using Drones to Ensure ROI in Precision Agriculture

What growers and precision agriculture practitioners need to know to choose the most effective end-to-end UAV solution

By Colin Snow, CEO and Founder of Skylogic Research
INTRODUCTION

When the United States Department of Agriculture (USDA) first began experimenting with photographs from radio-controlled model aircraft back in 2000, they quickly realized the potential of the technology. When compared with photographs and hyperspectral data from satellites and manned aircraft, it was clear the very high-pixel resolution from unmanned aerial vehicles (UAV) was more effective at identifying problem areas in the field, especially at early growth stages. But at the same time, the USDA recognized that applications for agriculture required far better technology, and so, what started as an experiment quickly evolved into a dedicated research project.

Fast forward to today, and you’ll find it’s hard not to find a precision ag news site that doesn’t have a monthly story on UAV research advancements or sensor technology. Each article in its own way unveils UAV’s value as part of a remote sensing practice. Each one touts the benefits of UAVs for acquiring both spatial and temporal information and as a source of data for site-specific crop management. Small drones are flexible, and different sensors may be configured to help detect pest stress, plant diseases, invasive weeds, irrigation operation and effectiveness, and more.

But just how good are the drone-based solutions in the market now? Do they live up to the hype, or are they really just a hassle to integrate with the tools you’re already using and therefore provide little to no return on investment (ROI)? And how mature are the offerings? Do they provide integrated data management or is that separate? Should you consider using them now or wait a year or two to see what comes next? In this paper, I’ll answer those questions and at the same time clarify misconceptions about drone use. By the end, I trust you will know how to distinguish an end-to-end solution from an incomplete one so that you can choose the right one to improve your agricultural practices and efficiency.

SOLUTIONS WITH THE END-GOAL IN MIND

Author Steven Covey reminds us in the 7 Habits of Highly Effective People that while our goals should be visionary, they always need to begin with the end in mind. This means asking the question: What is it that you want to accomplish? For a precision agriculture service business, that translates to spelling out your goals in terms of the outcomes you want to realize. Perhaps the best way to accomplish this is to state them in the same terms as your customer’s. The grower’s goal—while not always articulated in the heat of a problem—can be summed up as “bring more acres under management and service more acres at a higher quality for a lower cost.”

Given your customer’s (and your) goal, it only makes sense that a good UAV solution should support that. So it’s reasonable to expect that an agriculture drone solution helps you expand your service capabilities, scale your outputs, and enhance your brand. But how? And how do you do that for a low investment and an ROI well inside a single growing season?
TIMELY INPUTS

Experienced practitioners know that a good treatment prescription depends on the quality of data measuring the problem. As the saying goes: Garbage in, garbage out. Whether it's the inputs to a nitrogen model that requires soil, rain, cultivar, and temperature data or the image resolution and number of spectrum bands needed to create a crop vigor map, the quality of the source data matters. So does timeliness. All the right data inputs can go into the analytics of a model, but (as you know), if the data was acquired a week or even as little as two days prior, the validity of the results are at risk.

This is where drone solutions excel. Drones equipped with the right sensor are really good at acquiring high-quality data wherever and whenever—unlike satellites or manned aircraft which are less resolute, depend on fixed plots and on fixed time schedules that may not match the grower’s immediate needs.

NEW ANALYTICS AND TOOLS

Nearly all agriculture drone solutions process RGB color, near infrared (NIR), and normalized difference vegetation index (NDVI) data. But not all solutions provide additional analytics and tools better matched to the needs of growers and agronomists. For example, only one solution we know of in the market allows users to view live NDVI data via streaming video while the drone is flying without an internet connection. This means you can more easily fly missions and see critical information at the field’s edge without requiring a trip back to the office. This eliminates a huge bottleneck. Most solutions require that you upload images from the UAV to a mobile device, a laptop or cloud service where they are stitched together to create a base map and the underlying spectrum data is processed into a usable NDVI layer. In most solutions, you have to wait to wait for that information—sometimes for hours. But with this solution you don’t have to do that, and the added benefit is you can use the time savings to gather additional inputs from the areas the real-time map shows as suspect.

Another innovative analytic tool we see in solutions that we didn’t see a year or two ago is real-time weed detection. Instead of just pouring over pictures afterwards to find weeds, you can use new solutions in which the UAV flies over the field and automatically identifies weeded areas. These areas are pushed back as shape files which can then go directly into variable rate herbicide application programs.

There are still other new innovations. Until very recently, you had to choose between viewing data tailored for NDVI progression over time, or tailored for NDVI contrast around a single flight—doing both was not an option. Now, solutions with NDVI toolboxes allow growers and agronomists to do it all—recolor, dynamically regenerate, and highlight areas of a NDVI crop health map using data gathered today, tomorrow, and historically. These features allow you to compare NDVI insights for a single flight while

THE COST OF DOING NOTHING

It seems there is no shortage of case studies and academic reports on the economic benefits of precision agriculture practices, but only a handful quantify the benefit of UAVs. Even so, our research finds the benefit of a combined UAV/precision agriculture practice with nitrogen, weed, and irrigation analytics on a 3,000-acre mixed corn and soybean operation to be about $40,000 annually to the grower. We have found numbers higher and lower, but the problem with doing nothing is that there is just no savings.

At Skylogic Research, we look at UAVs like any other productivity tool. The problem with not adopting them creates the same risk as would be with not adopting auto-steer or variable rate sprayers or any other GPS technology that’s been deployed into agriculture in the last 10 years. UAVs are a productivity tool, and the cost of doing nothing is generally very high because the returns can be high. So those who don’t adopt them are at risk of generating a lower level of profit than those who do and with whom they compete for land or resources.
building a library of NDVI data points over an entire growing season. This depth and breadth of synergized data helps you make better informed, more confident input decisions.

Another innovation is the use of real-time data from the field that can be coupled with data from a drone to provide updates to variable-rate nitrogen prescriptions. This makes for more effective applications. In the past, growers made a blanket nitrogen application at the beginning of a year (of which half washes away) and a second or third blanket application later to compensate for the loss. Now, new analytics with real-time data basically allow you to compensate for the losses, spray on demand two or three times a year in the growing season and reduce nitrogen inputs by 30 or 40 percent. While it’s not perfect, there are yield advantages and we think it’s a service you will want to use.

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**CHALLENGES WITH MOST UAV SOLUTIONS**

**Picture fascination** — What’s the problem with most UAV agriculture solutions? For one, most are stuck in the “picture fascination” stage. They give you thousands of great looking images, but then it’s up to you to invest time to figure out what’s important and determine what it means to get results. And while it’s great that drones can produce so many good images, there’s just limited value in that. The greater value comes—as we have pointed out above—in identifying what’s important (like weeds) and pushing out that information in a consumable way (like an application program).

**Lack of integration** — The second problem with most solutions is the lack of integration between desktop and mobile clients, sensors and aircraft, applications and drone types, drone-based and mobile-based surveys, and more. Lack of integration appears in agriculture drone solutions in many ways—and if you are not careful to note the subtle differences, you will end up doing the work yourself. Here’s a list of the most common points where integration is vital:

1. The desktop and mobile client need to automatically sync and allow you to sort data by location, time, and type.
2. The application needs to be built so you can use it across multiple UAV brands or multiple aircraft type (multicopter or fixed wing).
3. The same sensor should be able to be used across multiple aircraft brands or type.
4. The UAV, its autopilot program, and the sensor trigger must be integrated tightly enough to create seamless base maps. This is vital for proper downstream crop management system use.
5. The solution’s NDVI map should be available in near real-time and not just after a batch upload to a separate processor.
6. The software’s analytics should take into account the most important characteristics of the sensor, like incident light and specific bands of light so they can produce accurate measurements of crop vigor under various lighting conditions.
7. The analytic models should be able to incorporate historical data, or other analytics that measure nitrogen levels, weed growth, and irrigation status.
8. The software needs to keep all your drone-based and mobile-based surveys together.
Deficient sensors in prosumer drones — There seems to be a persistent myth that you can get outstanding results with a prosumer drone and a simple online drone data service, but that’s a half-truth. Here’s the half of that myth that’s true. Prosumer drones—especially those made by DJI—are reliable, incredibly easy to use, have many built-in safety features, and take great high-resolution RGB video. We have studied this for some time now and we’re convinced this class of drones is where manufacturers will place their innovations long into the future. We make this point and others in Why I Think the Prosumer Drone Will Never Die.

Not only will innovations continue in this class, but it’s also where agriculture-focused solutions will continue to put their efforts. That’s because the dominant manufacturers have opened up their hardware for third-party access. This allows drone-based agriculture solutions to innovate on top of base models via software development kits.

But here’s the part of the half-truth that’s false. Off-the-shelf sensors on prosumer drones fall way short of precision agriculture needs. They’re not resolute enough, they’re not purpose-built, they don’t have global shutters (that prevent distorted images), their field of view is too wide, and they don’t capture the right light spectrums. Even the prosumer “swappable” agriculture sensors make compromises. Be forewarned. Some are just RGB cameras with filters on them, and the images they produce may look like NDVI or NIR, but they’re not true spectrum capture and processing devices.

THE IMPORTANCE OF A PROPER AGRICULTURE SENSOR

Advanced UAV agriculture solutions come with dedicated sensors that have been built from the circuit board up with plant-spectral response analytics in mind. For example, advanced sensors have the capacity to recognize six or more specific bands of light, as well as measure full-spectrum RGB to generate true color imagery. They capture full-spectrum imagery and comprehensive red edge data in a single flight. They have global shutters. They have the optimal field of view for capturing data over a field. They have internal image processors. The sensor will be compatible with the solution’s data management software so the source data can be organized, stored, viewed, and shared with team members via integrated workflows.

IMPORTANCE OF A PROPER DATA PLATFORM

Not all data platforms are created equal. In 5 Tips for Evaluating Online Drone Data Services, we make the point that your service provider should be in sync with your business objectives. Before signing up with a service provider, make sure that provider is fully committed to understanding the use case and the industry vertical you serve. Not all do. Some providers have more experience in one industry vs. another. They may have started out as a mapping service provider and later offered an ag solution as an add-on. For agriculture professionals we strongly recommend that you look at the pedigree of the data platform provider—keeping in mind that choosing a provider is akin to choosing a business partner.

The features you should look for in an agriculture-dedicated data platform include:

- ability to capture, share, store, and mark-up images
- ability to analyze and assemble all imagery into a functional field map upon completion of a drone flight
- synchronization of data between desktop client and mobile app
- data sharing tools for team or organization
- ability to match photos to fields and locations and display them in a simplified map view with a pin for every field
- ability to link images to the same field for easy side-by-side comparison and assessment
• features to manage all data collections including RGB, NIR, and legacy data
• no limits to the number of NDVI and crop health maps you can create
• ability to integrate with nearly any drone and any sensor
• compatibility with existing agriculture data analytic software tools like APEX, SST, SMS, or Farm Works Software®.

We also think it’s important that you pay attention to security, not just cost. Unfortunately, comparing vendors’ costs and security prowess isn’t always easy. In many cases, it’s simply not an apples-to-apples comparison. What’s more, tracking down information related to a provider’s costs and security strategy can be tough, but here’s what you want to know:

• **Access privileges:** Service providers should be able to demonstrate they enforce adequate hiring, oversight, and access controls to enforce administrative delegation.
• **Data provenance:** When selecting a provider, ask where their data centers are located and if they can commit to specific privacy requirements—especially if you are serving agriculture. The farmer will want to know.
• **Data recovery:** You must make sure your service provider has the ability to do a complete restoration in the event of a disaster. Your large customers will ask.

**THE ROI CHALLENGE**

Through our research on drone use in precision agriculture for the last four years, we’ve determined there is no one-size-fits-all equation for determining the ROI of agriculture drone solutions. We believe it is a subjective exercise that’s dependent on your needs and the particular grower’s problem you are trying to solve. We say this because ROI is subject to the way you consume the service. We advise shoppers to look at the range of features and pricing plans in a vendor’s offering. ROI for you will be different from another based on how much of the service you want to consume.

We recommend solutions that offer both integrated prosumer drone/ag-sensor packages and dedicated data platform services with multiple subscription pricing plans to support them. Some vendors offer “freemium” pricing strategies by which the basic data service is provided free of charge, but a premium is charged for more advanced features and functionality. We think this is a good thing because it gives you the ability to “test drive” a solution without a large contract commitment upfront.

**BENEFITS OF AN END-TO-END-SOLUTION**

Hopefully by now you understand that there are three parts to the equation: the drone, the sensor, and the data platform. All three need to be tightly coupled as an end-to-end solution. It’s our view that very few agricultural UAV solutions actually do that, so it’s best to look at the details. If you have to piece any two parts together yourself, then you risk the full benefit. Our goal is that you choose the best possible solution—one that enhances your services for input application, field scouting, equipment audits, historical analysis, consultation, and diagnosis. We hope you choose a solution that helps you accomplish the end goal of helping the grower bring more acres under management and service more acres at a higher quality for a lower cost.

**ABOUT SKYLOGIC RESEARCH**

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