Cornell University
Cooperative Extension
Northwest New York Dairy, Livestock & Field Crops Team

FAQs about Farm Drones

By Bill Verbeten, Regional Agronomist, Cornell Cooperative Extension

There's a lot of excitement and uncertainty about farm 'drones'. These unmanned aerial systems (UAS) have a lot of potential to improve crop management and we are getting a lot of questions about their use in western NY.

Drone, UAV, UAS? What does it all mean?

Many people think of the large military craft when they hear the word "drone" and know that it's an aircraft without an on-board pilot. However, many smaller unmanned aerial vehicles (UAVs) have become common. An unmanned aerial system (UAS) includes the UAV, the ground control station (what is used to fly the UAV), the pilot, a visual observer and any other needed equipment. Our UAS, purchased from PrecisionHawk, is pictured in *Figure 1.*

Can I legally fly a UAS over my farm?

It depends how you use it. As long as you fly your UAS under 400 ft, are more than 5 miles away from the nearest airport, fly only during daylight hours, obey visual flight rules, and do not use the UAS imagery to make a management decision on your crops or livestock then as a hobbyist you would be in compliance. However if you use the UAS imagery to, for example, write a prescription for variable rate nitrogen on corn, even if it's fed to animals, you would be in violation of the law. A change in management = commercial UAS use. We have obtained FAA approval to conduct research on a small number of farms in western NY to evaluate management changes based on UAS imagery beginning in 2015.

Figure 1. CCE's UAS platform

Source: NUAIR Alliance

How can I get a usable picture of my field from UAS imagery?

Software that stiches images together is needed to make a usable mosaic from UAS imagery. Many farmers in other parts of the US and Canada have spent a lot of time trying to figure this out with varying degrees of success. Paying for a service that does this automatically can save a lot of time if you don't have the expertise. We using PrecisionHawk's Datamapper service to get us and our collaborators useable geo-referenced imagery that can be taken back to the field within 24 hours of scanning with our UAS. Open source tools like TileMill hosted by Mapbox are also available.

What would I have to do to legally fly a UAS for eventual commercial use?

The proposed commercial UAS rules will likely be released for public comment in early 2015. While a number of things are up in the air, two things are going to be part of the process to legally operate UAS: a second class aviation physical and passing the private pilot written exam for airplanes (fixed-wing UAS) or rotorcraft (quadcopter UAS). Pilot training will be similar to getting a CDL, pesticide applicators license, or CCA certification. The more we can self-educate and self-regulate the better off we will be as an industry. There are a lot of rules in the sky and a lot of knowledge about flying

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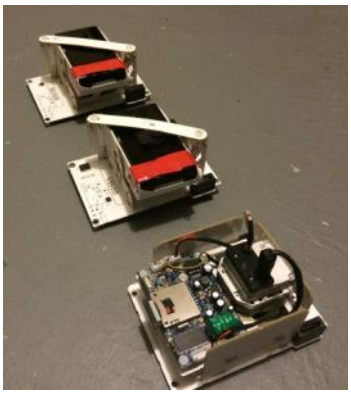
that is needed to operate UAS safely. Online courses, home study courses, and traditional aviation ground schools are available. The second class aviation physical is similar to an annual check-up plus an eye exam.

What kinds of cameras should a crop scouting UAS have?

Many types of cameras (also called sensors) are available. Most UAS have come with a visual sensor that takes pictures or video just like traditional cameras and cost anywhere from $500 to $2,000. Thermal sensors detect heat signatures and will set you back $5,000 to $6,000. Multispectral sensors take pictures of multiple colors at the same time (typical NIR or Red Edge, Red, Green, and/or Blue) in order to make NDVI (essentially a measurement of crop vigor) or other maps and have a $500-$4,000 price tag. Generally the higher priced cameras will have better image quality and resolution. All of these camera types (and others) can be useful for scouting crops. We will be testing the ability of visual, thermal, and multispectral sensors, *Figure 2,* to perform a variety of crop scouting tasks in 2015.

Figure 2: Multispectral, Visual, & Thermal Sensors



Source: Bill Verbeten

Which crop scouting tasks can a UAS do?

Prior to the growing season we will be taking bare soil scans with visual and thermal sensors to attempt to map variations in soil OM, drainage, and use a base layer for crop biomass estimates. Using the visual sensor we will attempt to count corn and soybean populations from the air in commercial fields and in population rate trials. NDVI measurements will be calculated from multispectral scans in corn as part of nitrogen rate trials evaluating GreenSeeker technology. Visual, thermal, & multispectral scans will be used to attempt to detect weed, insect, and disease outbreaks. We will also attempt to use the visual sensor to estimate yields near harvest. Calibration and ground-truthing are critical to figuring out how UAS imagery will be useful and we will be providing updates throughout 2015.

Why should I care about the rules? Who's going to catch me? The fines can't be that bad?

The first priority with any UAS, airplane, helicopter, etc. operation is safety. With proper training you will be able to have enjoyable and (hopefully useful) UAS operations without unnecessarily risking lives and property. The knowledge gained from studying for and passing the private pilot written exam will greatly increase the safety of your UAS operations. Working with a local Academy of Model Aeronautics club to get some experience on radio controlled aircraft will also improve your operational safety.

The FAA will fine individuals between $500 and $1100 for each UAS flight in violation at minimum. Additionally the financial liability can be much larger when something goes wrong. For our UAS research we are required to carry insurance that has: 1) NYS workers compensation insurance 2) $1,000,000 in combined single limit automobile liability 3) a commercial general liability policy with $1,000,000 per occurrence and $2,000,000 aggregate limit, 4) owned aircraft liability of $1,000,000 5) $1,000,000 umbrella policy. Standard liability coverage that most farms carry will probably not cover the costs of damages by illegal UAS operations.

Why not just use satellite or airplane imagery?

Bottom line: UAS can get higher resolution imagery more often than planes or satellites. Our UAS sensors have 0.5 cm or 2.5 cm per pixel resolution flying at 50 or 100 m (164 or 328 ft.). Satellites typically are not able to capture imagery more

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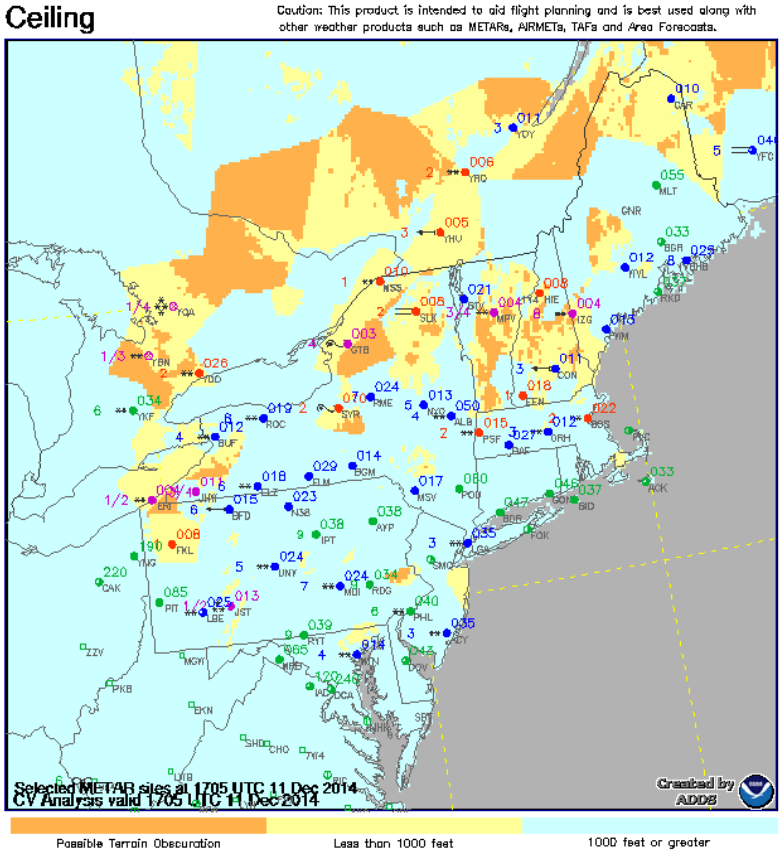
than a few times during the growing season with low resolution (>1 m per pixel), however companies like Skybox are increasing the frequency and quality of satellite imagery. That being said some satellites can't take a picture through a cloud, but UAS can fly underneath moderate cloud cover. Note 1000 ft. ceilings (clouds are 1000 ft. off of the ground) are required for safe UAS operations. See the latest METARs (meteorological aviation reports), *Figure 3,* for local ceiling levels. Imagery from airplanes will be better for large scale scanning of crop fields. At most a UAS can cover a few thousand acres a day, while a plane can cover tens of thousands of acres. Even though airplane imagery has lower resolution than UAS imagery, it is well suited for use in precision ag applications since variable rate management generally can not be done beyond every 10 inches. We are evaluating some airplane imagery in comparison with UAS imagery to see where each is most appropriate in 2015.

Figure 3 : Cloud Ceiling from METAR



Source: Aviation Weather Center

Will you be doing demonstrations?

We are tentatively planning to have two field days during the late summer of 2015 where will demonstrate our UAS, provide research updates, and have some of our collaborating farmers speak about their initial experiences with UAS imagery of their crops.

Why aren't you flying a quad-copter for your research?

The battery life is very short on rotorcraft UAS, under 30 minutes in most cases. Our UAS can cover about 250 acres in an hour, which is required for our large scale evaluations. Smaller UAS also tend to be more difficult to operate in high winds compared to fixed-wing UAS. Sensor quality and resolution tend to be lower for small rotorcraft UAS. As our research evolves we will likely consider UAS that can cover even larger acreage (600 to 700 acres) in an hour.

How can I be involved with UAS crop research?

We are advising many farmers about how to explore UAS use under the hobby rules and the COA (certificate of authorization) process and would be happy to discuss your ideas, questions, and concerns further. We can also receive industry sponsorship for evaluations as part of our FAA approved research efforts across western NY.

Also be sure to check out Busting Myths about the FAA and Unmanned Aircraft.