UAVs in Agriculture

Farm Advisory Service
National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

Emerging Technologies

Emerging technologies are continuously offering new ways in which drones can be used for smart farming and precision agriculture. The collection of real time data offers opportunities for farmers to significantly reduce their costs and increase yields. While there is already a considerable amount of drone services that can improve farming, there are many more either in the research or development phase. Some of the most likely services to become available soon include automatic detection of disease, field seeding, weed removal, spraying and automated drones that are housed on farm. As prices continue to drop and companies develop standardised workflows for more advanced applications, these technologies will become the frontline of precision agriculture and smart farming over the next decade.

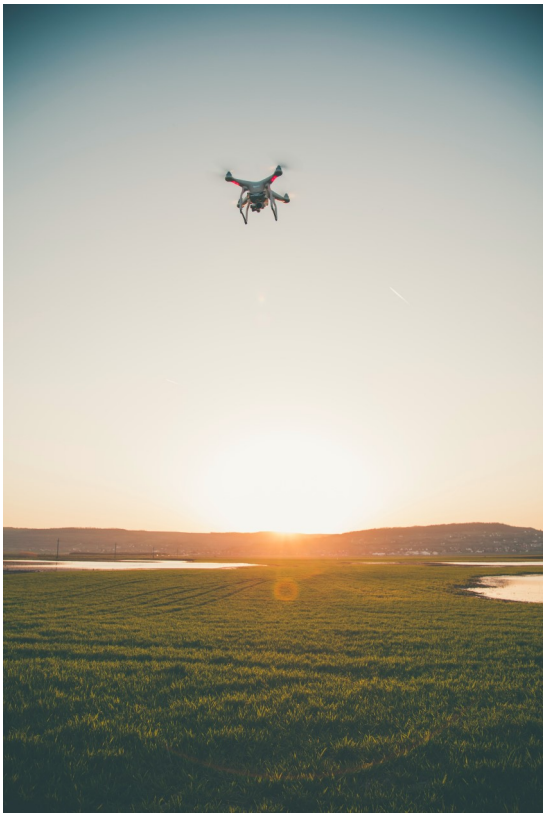
Automation

The automation of both drones and the services they offer will be a key factor in uptake of the technology, reducing the time farmers need to collect data. Research and development into automated drone-based technology has increased significantly over recent years, with companies seeking to take services already available in the market and automate them to become more user friendly. Supplying farmers with processed and analysed results that can be acted on in near-real time. The goal of these technologies is not to remove jobs or replace people on farm, but allow them to be more efficient and spend time on other more pressing jobs on farm.

Autonomous Farm Based Drones

For many the pinnacle of drone use in agriculture would be the ability to have fully autonomous drones that are housed on farm and require no input from the farmer. However, this could have implications on the traditional farming way of life, with farmers having a less hands on approach. Actions would then be completed by the drone with the farmer receiving daily reports on the processed results. The hope is that this would remove the need for farmers to learn how to use and process the technology and data, while still providing the benefits that drone technology can provide.

There are several companies developing protypes of automated drone systems. The goal is to develop weatherproof charging and computing housing that can sit on farm and detect when is suitable for a mission to commence. When suitable the housing will release the drone to complete a mission, following which the drone will return to the housing to recharge. The data collected will then be processed by the internal computer and the output sent to the farmer.



As is stands this technology falls outside of current UK regulations (Refer to FAS UAV Rules and Regulations Publication) as it is a requirement to have human observation of drone flights who can take control of the drone to react to real time issues during the flight. As a result, it will not be possible to trial and implement such technology on UK farms, until regulations that consider such systems are developed.

Autonomous Drone Swarms

Another technology that companies are developing is the use of drones in swarms, allowing them to work in unison to complete tasks. Such systems would have multiple drones that are able to communicate to each other; either completing the same task or multiple tasks that feed off each other, allowing the drones to work in unison to complete a complex range of tasks far quicker than conventional farming methods. For example, a drone monitoring a crop of winter wheat could detect the first onset of a patch of yellow rust and could then send the location of this patch to a sprayer drone which would target just the area effected by the fungal infection. Such systems will be designed to be fully autonomous with only minimal input required for planning flight plans and could make activities such as spraying far more efficient with regards to field inputs.

Automated Disease Detection

Automatic disease detection is an area that has had an increasing number of studies over the past decade. Currently most drone disease detection is done by interpreting plant health maps, however, when scaled up this can become time consuming and subject to human error. This technology would reduce the need for farmers to deal with data processing and interpretation, freeing up time and reducing the need for disease specialists on site. The difficulty here is that there is no standardised method for detecting all diseases and each crop type and disease type needs to be specified and tailored in the automation process. Furthermore, the large volume of data needed to be collected for automatic detection has seen researchers move to machine learning techniques.

What is Machine Learning?

Machine learning is a type of artificial intelligence (AI) that has the ability to automatically learn and improve based on experience, without any further external programming. Machine learning systems need large amounts of data that has already been classified, so that it can learn and improve its own classifications.

Automated Weed Removal

Automated weed detection is another area that is undergoing considerable research. Studies have already managed to detect and identify individual weed species, with the highest success in row crops such as maize and potatoes. This would give farmers clear information about weed pressure within the crop and could inform on what management actions to take. This can then be controlled and treated using conventional methods, or in the near future, using drones or unmanned ground vehicles that can automatically detect and manage affected land. However, these systems are still a long way from being commercialised as they deal with the same issues as automated disease detection, regarding data volume and use of machine learning in newer studies. Considerable levels of data and a standardised methodology will be required to move this into the phase where it can be considered for commercial use.

Automated Crop and Livestock Counting

Quick and efficient crop counting can be an invaluable tool when trying to calculate your inventory. There are already several products that can complete crop counting during the early stages of the crop cycle, however, where these tools struggle is when the density between individual plants increases later in the growth cycle. Attempts to solve this issue have been met with differing levels of accuracy, but recent uses of machine learning based deep learning has improved accuracy considerably. Currently these methods are only looking at specific scenarios such as counting potato plants or trees and are not translatable to other vegetation types, making it difficult to produce a product that can be used for a variety of crops.

Several companies are going further than this and developing systems for identifying and counting ripe fruit, such as tomatoes**.** Such systems have achieved varying levels of success, reaching detection accuracies of above 90% in some studies. However, converting this into a commercial product still faces a number of barriers.

Work on detecting and counting livestock is also being explored by companies and research groups around the world. These systems have often been more successful as there is less variability between animal types compared to crops, however other issues still need to be solved, such as detection under tree cover where normal cameras are unable to penetrate the canopy. Additionally, more work is being conducted around the effect of UAVs on livestock health, as flights closer to the ground are more accurate but have an increased chance of causing stress to animals.

While such systems are deep in the research and development phase there is basic object counting software already available. The accuracy of such software varies. More advanced products such as those explored here will begin to become a reality over the next decade. To begin with, consumers are most likely going to see the release of plant specific counting software before companies have enough data to produce products capable of accurately identifying multiple crop, vegetation or livestock types.

Planting

A range of companies are working on new ways to make planting more efficient using drones. Planting using drones offers several benefits over conventional methods, including reduced field intrusion and compaction, improved sowing success rate and reduced time spent out on the field. While most of the focus in this area is around tree planting, systems are being developed to distribute crop seeds and plant nutrients using drones. One such method is to shoot seeds encased in a nutrient pod into the soil, requiring little additional input during the sowing process. Such methods would reduce soil compaction from heavy machinery, while also reducing the time required by farmers to sow fields and increasing uptake rates. Recent start-ups have managed to reduce planting costs by 85% while achieving an uptake rate of 75%.

Spraying

Crop spraying using drones is one of the areas seeing the most developments in recent years with various drone manufactures having already developed commercial spraying drones. Drone spraying already has a long history dating back to the late 1980s, where they were first introduced in Japan for spraying paddy fields in mountainous regions that had limited access to machinery. Since then countries in Asia have begun to implement spraying drones in their agricultural sector and more recently the USA approved its first spraying drone. However, in the UK spraying using drones is prevented from being widely used, as the spraying products are not licensed to be applied from the air. This is expected to change in the upcoming years as the technology advances and regulations are updated to cater for industry needs.

Some researchers claim that when using drones, crop spraying can be completed up to five times faster than traditional machinery, while also reducing human risk from chemicals, improving precision through variable application throughout a field, and reducing chemical penetration into groundwater sources. One study found that they could spray up to 50 ha per day with an average of 10 minutes of work required per 0.5 ha area (Jeongeun, 2019).

There has also been research into the application of biopesticides using drones, by dropping beneficial insects across a field to enhance their population on site. Such systems are being trailed in greenhouses and still have a range of barriers and regulations to overcome before entering the market.

Other Research

Other research that is ongoing includes being able to automatically detect areas within a field that have more nutrients than others, such as picking out excreta patches in grass, and invasive species detection, identification and counting.

Further Information

The Food and Agriculture Organisation of the United Nations (FAO) produced a publication looking at drone technology and its applications in agriculture around the world:

http://www.fao.org/3/i8494en/i8494en.pdf

For a more visual conceptualisation of autonomous drones go to:

https://www.american-robotics.com/

The CAA website has the most up to date information on current UK drone operation regulations and requirements:

https://www.caa.co.uk/Consumers/Unmanned-aircraft-and-drones/

For further information regarding the rules and regulations surrounding the use of drones for your business refer to the UAV Rules and Regulation document on the FAS website.