Unmanned aerial vehicles (UAVs): the basics

Background
In the last decade, the use of UAVs in agriculture has become more widespread as advances in aerospace engineering and sensor technology have reduced in cost. UAVs use cameras to collect images and sensors to compile an array of data to help with monitoring and decision-making on-farm. UAVs are capable of collecting data at high spatial resolutions, this means being able to compare differences in crops by the centimetre rather than the metre. They can also provide immediate visual information about large areas of crop which helps with fast decision-making.

However, there are still limitations in using UAVs for precision farming; these include high initial costs, reliability, sensor capability and the lack of a standardised procedure to process large volumes of data.

If you are considering using a UAV, it is important to work out what useful additional information it provides and how this can improve operations on-farm or free up time for other tasks.

What exactly is a UAV?
Unmanned aerial vehicles are capable of operating without an internal pilot and are either flown by a remote pilot or follow a pre-set flight path. There are a number of other names for UAVs which you may come across:

- UAS (unmanned aerial system)
- RPV (remotely piloted vehicle)
- ROA (remotely operated vehicle)
- Drone

What can a UAV do?
UAVs have a range of potential applications depending on the type of sensors fitted to them, these include:

- Disease detection
- Weed detection
- Monitoring crop biomass green leaf area
- Monitoring responses to fertiliser
- Detecting water stress
- Crop Scouting
- Bare soil imagery
- Irrigation and drainage planning
- Yield estimation and monitoring
- Aerial pathogen spore sampling
- Research

**Limitations**
There are a number of potential limitations to UAVs which need to be considered:

**The vehicle itself**
- Low engine power, short flight duration, difficulties in maintaining flight altitude, aircraft stability and manoeuvrability in winds and turbulence.
- Inadequate building materials and engine breakdown.

**Sensors and cameras**
- A UAV has a limited payload, generally 20–30% of the total weight; this limits the type of camera or sensor system that can be attached.
- Low weight and low cost cameras do not usually have good optical quality, zoom lenses, fully automatic focusing and, most importantly, a near infrared band (NIR).
- Multi-spectral cameras with NIR band are currently quite expensive and infrequently used due to the high risk of damage if the UAV crashes.

**Image processing**
- The light weight of many UAVs means a less stable camera position resulting in different spatial resolution.
- Large numbers of spatial images by UAVs mean there is a very large volume data which needs more processing time.
- The low altitude flight path of UAVs results in a larger number of images for each field which requires a longer and more complex image mosaicking process.
- Blurred images due to forward motion of the camera.
- There are many other issues which may need to be addressed including multi-angle effects and impacts from clouds and/or shadows.

**Legislation**
- In Europe, UAVs less than 150kg come under the regulation of the National Aviation Authority. In the UK, that national aviation authority is the Civil Aviation Authority.
- The Civil Aviation Authority has stated that a number of requirements have to be satisfied before it will issue a Permission to Carry Out Aerial Work (commercial work). These requirements include:
  - An Airworthiness Certificate
  - A Design and Construction Certificate
  - Pilot Qualification
  - Appropriate Insurance
  - Organisational Approval
- UAS operators should note that there is a specific distinction between a Permit to Fly and Permission to Carry Out Aerial Work.
**Cost**

- The cost of UAVs varies greatly depending on if you are purchasing an entire system or purchasing a specific service from a company.
- The size of the vehicle, the type of sensors it has fitted and the software also affect the cost.
- At present, farm ready systems can cost in the region of £10,000 - £35,000 depending on the specification.
- Specific services are usually charged on a per hectare basis with prices ranging from a few pounds to around £30 depending on the service required.
- However, the industry is developing fast with new technology and new businesses setting up so costs and the type of services provided are likely to change.