



Digital Transformation Monitor

Drones in agriculture

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Drones in agriculture

Practical applications for UAVs (unmanned aerial vehicles), commonly referred to as “drones”, have progressed significantly in recent years as the technology has improved in tandem with a fall in its cost. Interest from both consumers and business in drones is growing, with new applications being developed rapidly for use across many industries including agriculture – one of the primary sectors expected to see sharp uptake of drone technology in the near future.

1

The fast-growing drone market

Despite a long history of humans experimenting with unmanned aircraft, the rapid development of both the consumer and professional drone markets has been made possible by recent progress in several fields, particularly miniaturization, batteries, imagery and remote communications. The value of global drone sales reached USD \$8.5bn in 2016 and is expected to surpass USD \$12bn by 2021 (a CAGR of about 8%)¹.

7 million
Estimated consumer drone shipments in **2016**
(BI Intelligence estimates, 2016)
29 million
Estimated consumer drone shipments in **2021**
(BI Intelligence estimates, 2016)



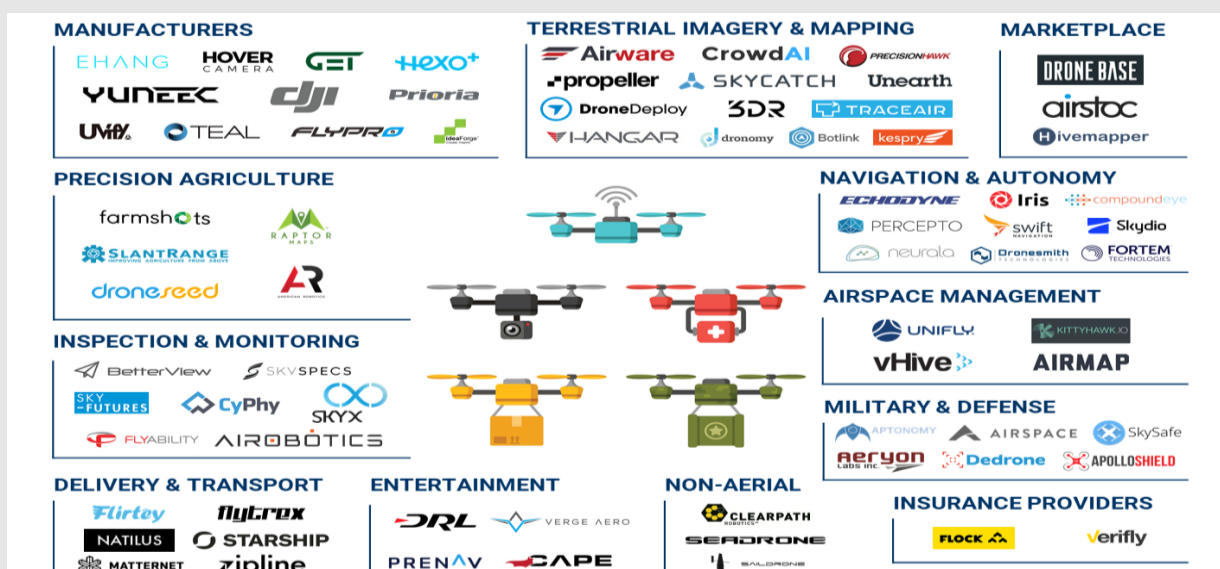
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Drones will help in many industries

Many industries are expected see growing reliance on drones, especially infrastructure, transport, security and agriculture. Proponents of drones argue that for many applications, their use will deliver faster, more precise results than traditional processes and methods, that generally rely heavily on a large human

workforce. In addition to the expected speed and time gains on many tasks, drones are expected to bring about significant cost reductions versus employing human workers – such savings will be particularly noticeable in industries where humans have typically undertaken difficult or dangerous work, as safety and compliance related costs will be reduced or avoided altogether.

Figure 1: Drone market map



Source: CBInsights

Many players involved in the drones market

The drone market is currently highly fragmented, with numerous software providers and vertical specialists competing in addition to manufacturers. Indeed, it is a common practice of many companies to build on drones made by manufacturers like DJI or Parrot by developing additional hardware, software or hybrid solutions tailored for use in a specific industry.

Different sizes and form factors available in the drone market

The drone market is very heterogeneous, with many different models used even within one specific industry. These drones can be categorized according to:

Size

- From very small drones (size of a large insect)...
- ... to large drones (able to carry heavy loads).

Type of aerial platform

- Multi-rotor configuration (with several motors) able to maintain a stable position – easy to pilot but with limited endurance.
- Single rotor, akin to an helicopter - generally has greater efficiency versus a multi-rotor², but is more complex to pilot and more expensive to purchase.
- Fixed wing configuration, akin to an airplane – cannot hover over one place and is hard to pilot, but able to cover large areas and distances.

2

Drones for agriculture

One of the keys to meeting growing food demand and improving current water usage levels lies in the introduction of new technologies to agriculture, including the Internet of Things (IoT), Big Data and Artificial Intelligence. These technologies are beginning to power or enhance new and existing methods and tools, and have already been deployed on farms – connected tractors are a well-known example of new technology already in use. Drones however are a more recent and less mature tool in terms of the new technologies driving the development of precision agriculture.

Figure 2: Single rotor drone for spraying (left) and fixed wing drone ready to take off (right)



Source: Australian UAV

Currently, most drones for agricultural use are medium-sized (usually for analysis applications) while larger drones are used when there is a need to carry a load (i.e. planting or spraying applications).

Like most industries currently using drones, multi-rotor configurations seem to be the favourite in agriculture, likely due to their lower cost and high level of simplicity.

Agricultural applications for drones

The versatility of drones provides many different avenues for improving upon existing agricultural processes including:

Soil and field analysis

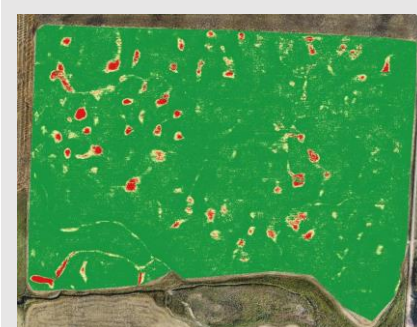
Drones are able to produce 3D maps, quickly and cheaply, which are then used for the design of seed-planting patterns and the generation of a wide range of data types with many applications. For example, nitrogen-level management.

Crop monitoring

Satellite imagery was previously the most advanced form of crop monitoring, but suffers from some major drawbacks:

- Satellite imagery is very costly.
- Images must be ordered in advance and can be imprecise.
- Poor weather impedes data quality.

Figure 3: Water control / drainage using drone imagery



Source: Agsky

Drones however can monitor crops much more accurately, frequently and affordably, delivering higher quality data that is updated regularly to provide insight into crop development and highlight inefficient or ineffective practices.

According to SenseFly (a drone manufacturer specializing in agriculture) the utilization of drones by the Ocealia group resulted in a 10% average increase in crop yields.

Health assessment

Drones can also be used to generate multispectral images of crops (based on the amounts of green and infrared light reflected), which are then analysed to track changes in health and maturity³.

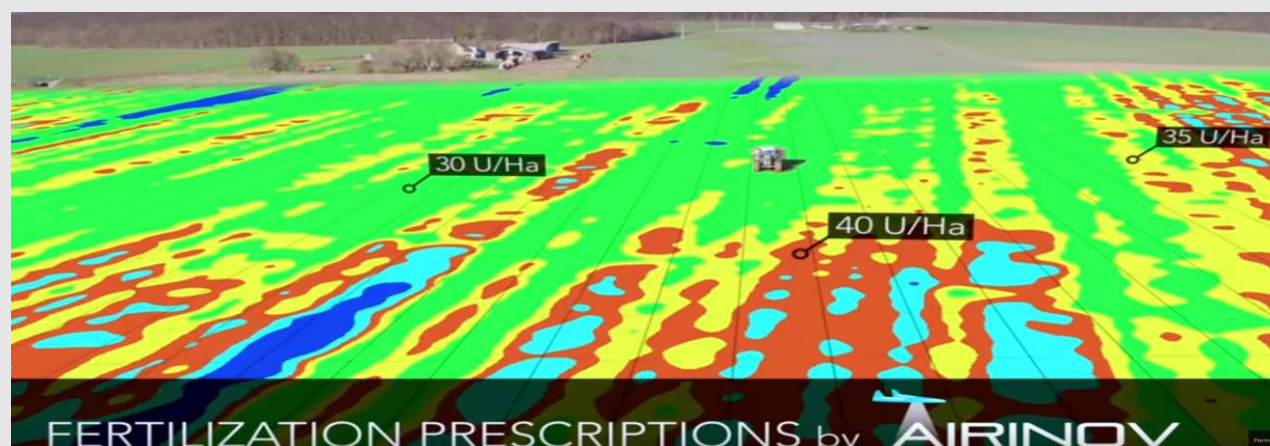
The ability to assess the health of a crop quickly and precisely can be invaluable for farmers. If for instance a bacterial or fungal infection is identified, early detection allows for quick action to be taken in order to remedy the issue.

Irrigation

Agriculture accounts for the vast majority (70%) of water used in the world – more than twice that of industry (23%)⁴. Aside from being wasteful, excessive water usage is increasingly unsustainable as competition for the planet's finite resources intensifies in the face of rapid population growth. Leaky irrigation systems and wasteful field application techniques are two of the factors contributing to inflated agricultural water use figures, and both can be addressed by UAVs.

Drones equipped with special monitoring equipment can be used to identify parts of a field experiencing "hydric stress" (inadequate of water of sufficient quality). They use infrared and thermal sensors to provide snapshots of entire fields, allowing targeted diagnosis of areas receiving too much or too little water.

Figure 4: Visualization of data based on drone imagery



Source: Parrot (French drone manufacturer)

These drones also allow for the vegetation index (density and health of the crop) to be calculated while the crop is growing, enabling and informing better crop management.

Crop spraying

The ability of drones to easily adjust their altitudes and flight paths according to the surrounding topography and geography comes from the use of increasingly sophisticated equipment (rader, LiDAR etc.). This makes them well-suited for crop spraying, as they can scan the ground and apply liquids quickly and with great precision. Some experts argue that crop spraying by drones may be up to five times faster than with regular machinery⁵.

Aerial planting

Drone-planting systems are under development with the goal of drastically reducing labor costs by using compressed air to fire seed pods directly into the ground. This avoids the significant labor costs traditionally associated with planting activities.

3

The challenges ahead

While the potential for drone-use in agriculture is significant, there are still several notable impediments to their progression beyond the niche market they occupy today.

Difficult financial situations of many farms likely to hamper adoption

Agriculture remains a difficult, low-margin business for many farmers, with governments frequently assisting when adverse weather or market conditions arise. Despite their savings-potential, drones still require substantial capital investment and technical expertise to be acquired and properly utilised, making them difficult to justify for many small-to-medium sized farms that are less likely to benefit from economies of scale.

5000 €

Price of *Bluegrass*, a multi rotor drone developed by Parrot for visual monitoring and health assessment

1850 grams

Weight of *Bluegrass*

According to the MSA (the farmers' social security in France), around 30% of farmers reported income below €350 per month in 2016⁶.

Currently, drones used in agriculture are generally either bought and used directly by a farmer or a cooperative of farmers (to share costs). Alternatively, they can be operated by a drone/technology company which is contracted by the farmer.

Regardless of the ownership model, it is clear that drones will need to prove they can substantially and reliably improve upon existing processes before they are widely adopted.

Figure 5: Drone usages based on season

	Spring	Summer	Fall	Winter
Tasks	• Prepare machinery • Apply fertiliser, manure • Apply herbicide • Till, prepare seedbed • Plant seed	• Apply herbicide • Apply fertiliser • Apply fungicide • Apply insecticide • Irrigation management	• Harvest crop • Manage & till residue • Apply fertiliser, manure • Land improvements	• Machinery purchases • Input purchases • Insurance purchase/claims
Drone usage	• Early analysis of soils, tillage, tile and drainage	• Stand count and gap analysis • Irrigation management • Observation of growth variability • Assess and observe nitrogen needs • Crop stage monitoring for timing of applications	• Pre-harvest: dry down and stand consistency observation • Post-harvest: analysis of soils, tillage and topography	• Assessment of input and machinery performance
	Year-round			
	• Post-rain: tile drainage system analysis		• Post-storm: determine wind/hail/flood damage	
			• Post-event: insurance claim documentation	

Source: Sensefly

Quality of data captured

Most applications of drone technology rely on its ability to generate and deliver precise and accurate information. This data is then either used to guide direct activities like spraying, or to inform complementary activities like crop analysis and monitoring.

Consequently, data quality is crucial and should be core priority of drone use decisions, with aspects like a drone's speed and flexibility only secondary considerations⁷.

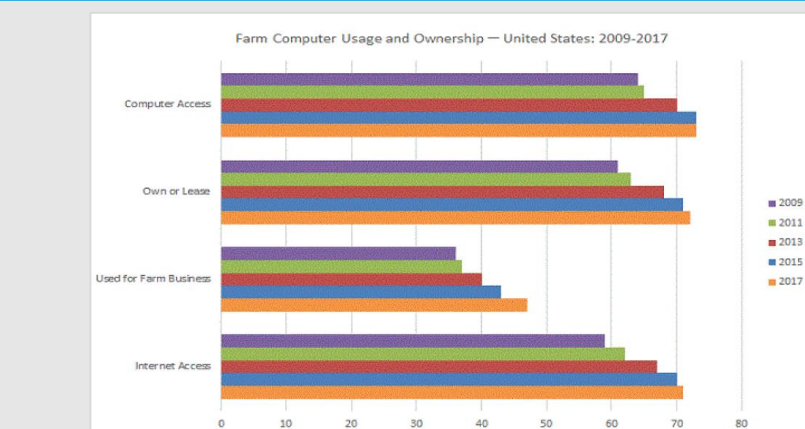
Given the relative infancy of agricultural drone technology, there is still much progress to be made. For example, Chateau Lagrange, a vineyard in the Bordeaux region, trialed drones and sensors and compared the measurements to reference figures they had compiled. Whilst valuable information was gleaned, the technology was considered to be commercially premature⁸ and not sufficiently reliable as a standalone solution. It will as such be used in tandem with traditional methods, as a complementary tool, until such time as the technology becomes more advanced.

Despite this, it is really only a matter of time until drone technology is mature enough to act as a replacement for existing methods, as the industry is rapidly integrating newer sensors, cameras and processing technologies, constantly improving the quality of the data captured.

Ability of farmers to modernize

Widespread uptake of new technology requires farmers to adapt and modernize production practices in order to obtain the best returns on these investments. With over 56% of the workforce aged over 55 in Europe⁹, digital skills are often lacking, meaning that additional investment in training is often required. According to a 2017 survey conducted by

Figure 6 : Farm Computer Usage and Ownership, August 2017



Source: United States Department of Agriculture

the United States Department of Agriculture, 73% of farms have computer access, but only 47% of farms are using computers for business purposes¹⁰. Furthermore, only 39% of farms use a smartphone or a tablet for farm business.

This raises questions not only of access to technology, but of the level of inclination farmers have to use it in their work. It's possible that possessing technology but choosing not to use it is a byproduct of the general lack of digital skills and confidence found in older segments of the population, where farmers and other rural dwellers are well represented.

This is an important issue to overcome, given that drones are usually controlled directly with digital tools (computers and tablets) in order to create the flight plan, and generate then analyse the gathered data.

As a result, drone manufacturers are increasingly adapting their products, and developing autonomous features which require less tech-savviness, flying skills/experience and infrastructure to operate effectively.

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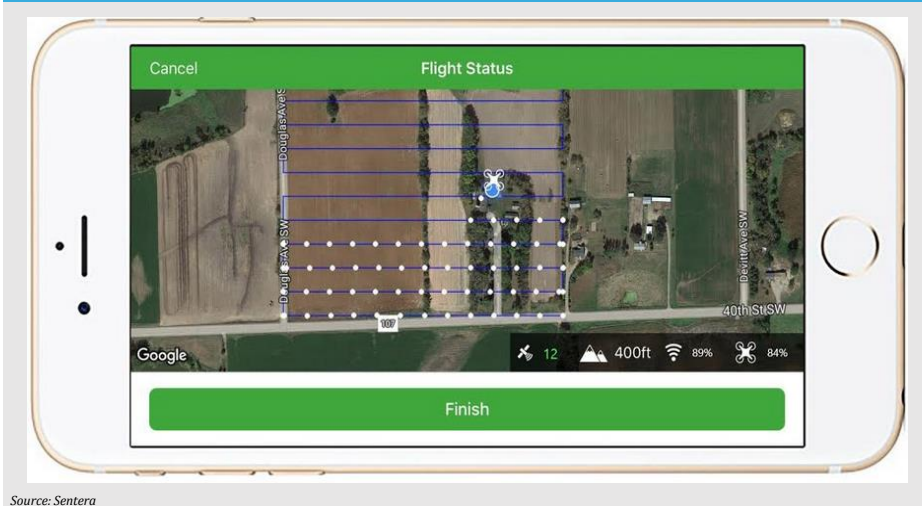
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⁸ Château Lagrange, Viticulture connectée, retour d'expérience, Available at <http://www.agence-fleurie.com/2016/09/viticultures-9-viticulture-connectee-retour-experience/>

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¹⁰ United States Department of Agriculture, Farm Computer Usage and Ownership, August 2017, Available at: http://usda.mannlib.cornell.edu/usda/current/FarmComp/FarmComp-08-18-2017_correction.pdf

Figure 7: Autonomous drone flight planning for agriculture(AgVault™ app)



Source: Sentera



About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.

Web page: <https://ec.europa.eu/growth/tools-databases/dem/>

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