FutureDirections international

INDEPENDENT STRATEGIC ANALYSIS OF AUSTRALIA'S GLOBAL INTERESTS

Associate Paper

18 April 2017

The Drone Revolution and Australian Agriculture Part Two: Case Studies and Practical Benefits

Mr Geoff Trowbridge
FDI Associate

Key Points

- Drones, **remotely piloted aircraft systems** or unmanned aerial systems, have evolved rapidly in recent years from military and hobbyist use into business applications across many industry sectors.
- Unmanned aerial systems can gather more detailed and complete information far more quickly and more cost effectively than satellites, manned aircraft or conventional ground survey methods.
- Of all Australian industries, overseas demand for clean, agricultural products has never been higher and drones can maintain our competitiveness despite our high costs.
- Normalised Difference Vegetation Index or NDVI images can differentiate between healthy plants and unhealthy plants which may indicate stress, nutrient deficiency, pests, weeds or other agricultural problems.
- Agricultural drones can provide farmers with immediate information about soils, plant health, growth rates, fertiliser requirements, weeds, pests and weather damage.

Summary and Introduction

The global professional services company, PricewaterhouseCoopers, has assessed that drones will allow farming to become a highly data-driven industry, which eventually will lead to an increase in productivity and yields. Due to their ease of use and low cost, drones can be used for producing time-series images showing the precise development of crops. Such analysis can reveal production inefficiencies and lead to better crop and pasture management. With those possibilities in mind, it can be assumed that this technology will transform agriculture into a high-tech industry for the first time, with decisions being based on the real-time gathering and processing of data. Thus, agriculture's prime concern is not the drone's speed or flexibility, but the type and quality of data it can obtain. It is assessed the industry will primarily push for more sophisticated sensors and cameras. The industry is beginning to benefit from drones that require a minimal level of training and are highly automated.

In Part Two of this FDI Associate Paper, Mr Geoff Trowbridge discusses in specific detail the benefits drones can provide to agriculture.

Analysis

Case Study - The Practical Benefits Drones Bring to Agriculture

Australian Agricultural Economics in Context. Business research provider, IBISWorld puts the value of all Australian Agribusiness in 2016-17 at $260Bn, employing 602,000 people in 174,000 businesses. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) puts the gross value of Australian farm production in 2016–17 at a record $63.8 billion, with livestock production accounting for $31Bn, and crop production $30Bn. Export earnings from farm commodities in 2016-17 are forecast to be around $47.7 billion. Over the past five years, there has been a flood of investment from overseas pension funds, sovereign wealth capital and foreign investors into Australian farming. National account figures show agriculture is now the strongest growing sector of the economy.

Immediacy and Efficiency of Drones. The LandSat program is the longest-running enterprise for acquisition of satellite imagery of the Earth's surface. Since 1972 remote satellite sensing of the environment by Landsat has provided spatial and spectral resolutions of broad utility especially since 2012 when its products have been available at no cost. LandSat, however, has a major issue of resolution (the level of detail that can be shown in an area). There are other issues of a spectral, temporal and radiometric nature but the key concern is that LandSat has a '30-metre' resolution, which means that two objects, thirty metres long or wide, sitting side by side, can be separated (resolved) on a LandSat image. By payment of a fee, a farmer may get a 10 metre resolution but then it may take 2-3 weeks to receive it. Manned aircraft can provide one metre resolution but the cheapest aircraft, a Robinson R22, costs $580,000 to buy and around $400 per hour to operate. By comparison, drones cost a fraction of this and only cents per hour to operate. Drones can be flown today and the data processed overnight.

A New Tool in both Precision and Broad Acre Agriculture. Of all Australian industries, overseas demand for clean, agricultural products has never been higher and we have the technology to maintain our competitiveness despite Australia's high costs. The emergence of low-cost, unmanned aerial systems (UAS) provide farmers with a new way to measure what is in their pastures and to improve their agricultural productivity. Drones equipped with very high resolution cameras can capture thousands of images in a single flight which produce 2D or 3D maps providing the farmer with detailed insights into every part of his paddock, crop or orchard. The information from optical, multispectral and infrared lenses, high definition video and moisture sensors is then available to the farmer in the comfort of his home office instead of out in the weather.

Agricultural Sensors. The process of photosynthesis involves changes to the absorption and reflectance of different wavelengths of light which specific sensors can 'read' and interpret according to the type of plants. There are optical, thermal, multispectral and hyperspectral cameras but the most common are those that calculate the difference between the near infrared reflectance and optical reflectance in an algorithm known as Normalised Difference Vegetation Index or NDVI. NDVI images can differentiate between healthy plants (growing well or ready for harvest) and unhealthy plants which may indicate stress, nutrient deficiency, pests, weeds or other problems for a farmer to deal with.

Data Processing. In a typical, 20-minute quadcopter flight, a drone will take around 10,000 photographs from a systematic grid pattern using predetermined track width, overlap and vertical or oblique look angles. The photographs are geotagged and recorded in a memory card in the camera. The memory card is

transferred to a computer or laptop with specialised software. The software 'stitches' all the photographs together to generate point clouds, digital surfaces and terrain models and ortho-mosaics from which volumes, angles and distances can be readily measured. Processing the data may take hours depending on the number of images and the processing power of the computer. Once processed, the farmer knows exactly where the problem areas are and can take whatever remedial action is warranted.

Zone Maps. Most farmers are happy to know that their crop is in good, neutral or poor condition. NDVI images will divide the paddock into corresponding zones of green, yellow and red that simply enables the farmer to combine this with truth of soil data to quickly create prescriptions for a variable rate application using the appropriate delivery method.

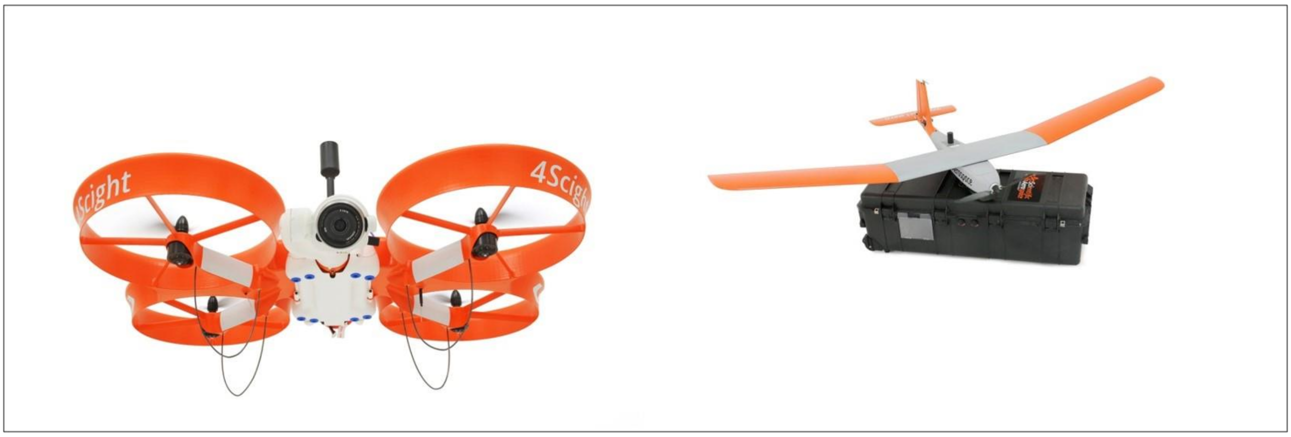

Figure 1. Examples of commercial rotary wing drone on the left and a fixed wing drone on the right.
Source: *Author*.

Quadcopter or Fixed Wing? Farmers have to manage complex, interacting issues of soil, water, nutrients, weeds, pests, weather forecasts, climate change, labour, machinery, feral animals, increasing input costs and variable farm gate prices. Intensive agriculture farmers may use a range of tools such as moisture sensors, plate meters and GPS or pay agronomists or service providers to conduct soil analysis and make recommendations about nutrients to be fed by sprayers and spreaders. Quadcopters are more appropriate for small, intensive plots. On larger paddocks, the farmer may only be able to spot check suspect areas or view from the boundary. The time and cost to do this increases with the size of the holding and often must be delegated or outsourced. Old fashioned boundary riders were replaced by helicopters, 4WDs, quad bikes and motor bikes long ago. Fixed wing drones offer a much more cost effective way to gather actionable, real time information about what is happening out there, right now, on much larger properties.

Measuring Biomass. The growth of forage varies over pasture areas because of the variability of nutritional availability, moisture content, organic carbon and other physical, chemical and microbial properties of the soil. Identifying this variability during plant development enables diagnosis of causes that could still be corrected in a timely manner to optimise productivity. Aerial surveillance enables dairy farmers to work out whether they have enough feed or biomass for their cattle and whether it is time to move them to another paddock or feedlot. They can then make decisions about the optimal use of nitrogen and a range of other nutrients to provide the best quality feed for their dairy cattle. With a clear and detailed picture of what is happening in their paddocks, farmers can be confident about their management decisions.

Measuring Pasture Dry Matter. One of the most important measures farmer have is the amount of dry matter on their land. Dry matter is an indicator of the amount of nutrients that are available to animals in a particular feed. Drones can gather the data before a grain harvest and measure the volume of silage and lucerne hay when baled in the field. By analysing narrow wavelength bands reflected from plant tissue,

farmers can tell a lot about plant health and composition, crop growth rates, make timely changes to farm management practices and forecast crop yield. The parameters are all readily discernible from aerial surveying. When combined with ground verified soil data, the farmer can then make far better decisions than without aerial surveying. These technologies are still being perfected but already they provide big information improvements for many farmers.

Assessing Mid-Season Crop Growth Rates. The ability to inspect in-progress crops from above with NDVI or near-infrared (NIR) sensors is, so far, the primary use for drones in farming. A time-consuming task, traditionally done on foot with notepad in hand, drones now allow for coverage of more acres, as well as capturing data that cannot be seen by the human eye (NDVI). Much of the human error in traditional, physical inspection is removed.

Mid-Field Weed Identification: Using NDVI sensor data and post-flight image processing to create a weed map, growers and their agronomists can easily differentiate areas of high-intensity weed proliferation from the healthy crops growing right alongside them. Drones can detect and map the presence and extent of weeds, invasive plants, crop diseases and damage by feral animals. Historically, many growers haven't realised how pronounced their weed problem was until harvest time. Drones are a lot faster and far more economical to operate than 4WDs, tractors or motorbikes.

Figure 2. Drone photography can provide up to the minute aerial photography at a resolution and cost not possible by other means. Source: *Author*.

Variable-Rate Fertility: Although many will argue ground-based or satellite imagery, along with a dedicated grid soil sampling program, is more practical for refining nitrogen, phosphorus and potassium applications in agriculture, drones can also make a valuable contribution. Drones provide the data that create NDVI maps to direct in-season fertilizer applications on various crops. By using drone-generated, variable-rate application (VRA) maps to determine the strength of nutrient uptake within a single field, the farmer can apply differing amounts of fertiliser to struggling, medium and healthy areas, thereby decreasing fertiliser costs and boosting yields.

Irrigation Equipment Inspection: Managing multiple irrigation pivots is difficult, especially for large growers that have many crops spread out across a region. Once crops reach certain heights, mid-season inspections of the nozzles and sprinklers on irrigation equipment that deliver much-needed water, becomes an onerous task. Aerial inspection of sprinkler testing can save a lot of time and effort.

Monitoring Cattle Movements: Many growers during the days of depressed commodity prices in the late-90s to early 2000s made the call to diversify their farms by adding cattle operations. Drones are a sound option for monitoring herds from overhead, tracking the quantity and activity level of animals on a property. They are especially helpful for night-time monitoring and to locate lost stock.

Evaluation of Rehabilitation Programs. Degraded properties suffering from erosion and salinity normally require significant planning before rehabilitation begins. Because these areas are often difficult if not impossible to access on foot due to claypan, sand dunes, erosion, holes, pits or saturation, conducting an aerial survey is a great way to start the process. This usually involves the setting of priorities and making trade-off decisions between natural systems (such as grasses, trees, paddock rest and rotation) and technical fixes (such as infill, creating drains and leaky dams) so that carbon can be returned to the soil to make it healthier and more productive. Regular aerial surveys then provide a rapid, comprehensive way of monitoring and measuring progress toward rehabilitation.

Bushfire Detection and Monitoring. Wildfires can be a very dangerous problem once they get started, but it can be hard to spot a grass or bush fire before it has grown into a size that is difficult to control. Farmers need to know what direction the fire is heading and who to call for help to put it out. Manned aircraft are expensive to fly and their velocity is too great for someone to be able to get a good image of an area. Provided helicopters are not already in the area, using UAVs equipped with an infrared camera or live video to monitor wildfires is much simpler and more efficient. They can look over a hill, find people, horses or other stock, detect smouldering hotspots and identify safe areas. In some emergencies, a drone allows fire rescuers to quickly identify dangerous chemicals without ever having to go near the fire site. The advantage of drones is that they can fly at lower altitudes and at much slower speeds, allowing them to get a clear image of fire-prone areas.

Managing Prescribed Burns. Drones can also be used to monitor prescribed burns and coordinate the location of fire lines with ground crews to ensure the burn is occurring as planned and no equipment or personnel are threatened. They can assist with post-burn monitoring and for flora regeneration because newer mapping technology allows data layering to look at changes of interest to landowners, agronomists, ecologists and other scientists.

The Purchasing Decision Intensive Agriculture. The business case for embracing this technology is relatively simple. Farmers growing high value, short lifecycle, intensive crops who capture data on a frequent basis can map the health and vigour of their crops, observing changes over time, whether growth and health benchmarks are being met and confident of what the yield will be. Increased yields of 10 per cent are commonly reported in table green vegetables, by orchardists, banana farmers, olive growers and others.

Broad acre farmers typically want to know if the cost per hectare of buying a drone is if it will assure at least a 5% increase in yield. For example, a wheat belt farmer with 20,000ha, with a yield of 2.5 tonnes per Ha at $180 per tonne would expect a cheque of $9m. A five per cent improvement in yield would be $450k, so his payback period on a $50k drone, with all the necessary technological capability, would be approximately six weeks.

Conclusion

The full extent of the influence commercial drones will have on agricultural production is difficult to predict as the capability is still perhaps in its technological infancy. Formal industry analysis, however, has identified agriculture as one of the most promising fields for UAS applications. The ability for farmers to make sound business decisions based upon real-time high quality data that is available at a reasonable cost is essential to a successful modern agricultural enterprise. UAS provide digital data that is difficult or impossible to obtain from the ground. Piloted aircraft with the precision of a UAS are very expensive. Satellite data can also be expensive and the collection intervals are often long and beyond the farmer's control.

*****

About the Author: Geoff Trowbridge is an internationally experienced program manager in the aviation, telecommunications, manufacturing and resources sectors. A former weapons system engineer in the RAAF, he subsequently held senior management roles and directorships with Optus, Siemens, Ernst & Young, Oracle and BHP Billiton. He has also worked in research and development facilities in London, Chicago and at Curtin University. He lives in Perth, WA and was appointed CEO of Scientific Aerospace in November 2016. Scientific Aerospace is the only designer and manufacturer of drones in Australia.

*****

Any opinions or views expressed in this paper are those of the individual author, unless stated to be those of Future Directions International.

Published by Future Directions International Pty Ltd.
80 Birdwood Parade, Dalkeith WA 6009, Australia.
Tel: +61 8 9389 9831 Fax: +61 8 9389 8803
Web: www.futuredirections.org.au