Digital agriculture: what's all the fuss about?

By Michael Robertson, Andrew Moore, Dave Henry and Simon Barry

Digital agriculture is causing excited chatter, especially about its potential benefits for farmers, industry, agribusiness, researchers and government. But why the fuss?

Let's look at how digital agriculture has transformed farming practice at an historic vineyard near Adelaide. Twenty years ago, they watered the vines on the basis of observation and gut feel. Today, they have automated watering, using a set of irrigation controllers that are turned on via a phone app. Water meters around the farm sense exactly how much water is being used and communicate back to a central station via a radio network.

The system is not state-of-the-art, but it does have sensing, automation and connectivity. The weakest link in their system is the internet connection from the base station to the service provider that delivers the app.

Today typical Australian broadacre farmers have access to hundreds of apps on their smart phones; up-to-date weather and seasonal climate forecasts; service providers that can use remote sensing imagery to monitor biomass and soils on their farms and forecast pasture production and crop yield.

Like other sectors, agriculture is benefiting from the huge leaps in digital technology, including big data analytics and predictive modelling; improvements in connectivity; cheaper and more powerful computing; storage in the cloud plus developments in automation and robotics. User-friendly and accurate sensors integrated into existing machinery, such as tractors or harvesters, can measure things like nitrogen requirements of crops, while drone sensors can assist with aspects such as detecting diseases.

These new technologies have opened the possibility of the agricultural sector using business models pioneered by tech companies. We have seen a lot of interest from the big multinational IT houses such as Microsoft, Cisco, Intel and Bosch, along with a spike in investor interest in the venture capital community. They see big opportunities in moving into agriculture and bring strengths in automation, communication systems, mobile computing and visualisation. But in turn the IT companies require knowledge of the sector and an understanding of the decision-making context for digital agriculture.

Farmers need to be aware that, consistent with what has happened in other industries, new types of business will be created, new jobs will be required, existing jobs will change and some jobs may even disappear. For example, the increasing efficiencies from digital agriculture – especially robots – will increase the number of hectares and animals that one farmer can manage. This is the continuation of a century-long trend that has major social consequences in rural Australia.

We are at a vulnerable position on the 'hype curve' and there is fierce competition for market share among many new and established players in digital agriculture. The promises being made by the proponents of some technologies run the risk of sliding towards the trough of disillusionment.

For instance, there's much talk of the Internet of Things in agriculture. If the technology remains isolated from knowledge of agriculture and an understanding of the actual on-farm realities and business problems, then instead of contributing solutions it will remain on the shelf or be of interest only for niche hobbyists.

And what happens when predictive analytics start to match local knowledge? We are conducting social research to explore these trends and drivers. We need to be more mindful of how our research and development will influence the forces of disruption.

A key challenge is to find simplicity on the far side of complexity. Too much information can confuse and not clarify. Technologists need to appreciate that farmers do not need high frequency and precise data for every decision.

What's in it for producers?

At the heart of digital agriculture lies the opportunity for sensing systems and associated analytics to lower the cost of knowing what's going on and more accurately predict the future. This can come from improved knowledge about an individual enterprise, or via efficient sharing and learning from data from multiple enterprises.

We believe these developments offer three big opportunities:

1. increasing management precision, with producers able to use better information to make more timely decisions with more predictable outcomes
2. automating tasks using sensing technologies and machine learning could cut costs and increase reliability
3. better categorising, differentiating and tailoring agricultural products and services, which will open up new markets.

All these opportunities are around the point where development translates into practical use on the farm. As yet unexplored new value lies in grasping two or all three simultaneously. For example, crops could be selectively harvested from zones of the farm according to their quality characteristics and then put into different processing and marketing streams to maximise their value.

Crossing key technology frontiers

Just as exciting as creating new data and information, business models and technologies, is creating innovative ways of putting together existing ones.

Sensing systems

New remote sensing systems, such as the European Sentinel satellites, will overcome many of the shortcomings of the established Landsat satellites. They will provide data at improved frequency, resolution and cost, with better access and timeliness. For example, satellite imagery can identify what is growing in each paddock and then forecast a yield or feed availability. This information can have a wide range of end uses: farm management, farm advice, input supplies, risk assessment, planning for logistics and handling and assessment for drought relief.

However, digital agriculture in Australia has been constrained by limited access and useability of satellite imagery. We are working alongside Geoscience Australia to create an Earth Observation Data Hub that will

provide ‘data cubes’ of satellite information for applications in digital agriculture. The prototype has given, for the first time, imagery of the whole of Australia’s land area at a resolution of 25 square metres. It shows how land use, vegetation, water movements and urban expansion have changed over the past 30 years.

Remote sensing systems will be complemented by proximal systems, such as handheld devices or even cameras on smartphones. In precision irrigation, for example, there are exciting possibilities of linking satellite information, weather forecasts and crop models with ground-based, spot sensing of crop canopy temperature. This involves static infrared thermometers giving precise warnings of the need for irrigation over whole farms and the consequences of delay.

While sensors abound on the market, there are still some notable gaps. For instance, we still don’t have a sensing system that can non-invasively measure soil fertility nor diagnose animal health.

The fewer manual steps needed between data collection and decision-making, the more adoptable the digital technology will be. The experience with yield monitors in the grains industry, where only a minority collect, download and use yield maps, has taught us that simple, easy-to-use systems of data management will facilitate wider uptake by farmers.

Distributed sensing systems can form the basis for knowledge platforms for social learning. For example, our Chameleon soil moisture sensing system, used by smallholder irrigators in Africa, has a learning platform based on colour coding of soil moisture patterns. The data is shared among farmer groups to facilitate them testing and improving their own heuristics for irrigation management. Governments are interested in using the data at the level of the irrigation scheme to assess the performance of their infrastructure investments.

Knowledge discovery and management

The use of artificial intelligence, machine learning and natural language processing will streamline the discovery, access, usability, and confidence farmers place in data. We should grasp the big opportunities in synthesising disparate information that resides in often fragmented and difficult locations, such as government agencies, research and development funding bodies, product manufacturers and distributers, and on-farm data. Doing this could unlock information for farmers and advisers.

The research community has a long way to go in storing its data in safe, discoverable and interpretable forms, so that it is not needlessly duplicated and can be reused for new purposes. The Australia National Data Service is making progress on this front and our Data Access Portal houses a growing number of valuable agricultural data sets.

Predictive analytics

At the moment our ability to collect vast amounts of data easily outstrips our ability to convert it into usable information. Predictive analytics can play a critical role for decision makers who need to interpolate and forecast from a current situation to an alternative state.

For example, we have developed solar-powered eGrazor collars for cattle to monitor and collect real-time data on the behaviour of each animal in order to infer feed intake. This can aid livestock producers in fine-tuning feeding regimes and grazing management. It can also identify individual animals that efficiently convert feed into meat and milk. Coupled with a forecast of feed availability and the potential to control the movement of livestock with ethical ’virtual fencing’, it is easy to see how digital agriculture is well placed to transform traditional livestock farming.

Blockchain

Agriculture and food are ideal domains to exploit the potential of distributed ledgers or blockchain. This emerging technology is most commonly associated with Bitcoin and other cryptocurrencies. But it can be used equally well in agriculture for decentralised and transactional data-sharing across a large network of untested

participants. It enables new forms of distributed systems and agreements and captures transactions permanently, without relying on a trusted central authority.

Blockchain technology allows information to be carried along a supply chain; to match product to processing demands; to enable traceability, verify provenance and monitor quality and safety. In future, a Tokyo restaurant could use blockchain technology to verify that a cut of wagyu beef originated from a particular farm in Tasmania.

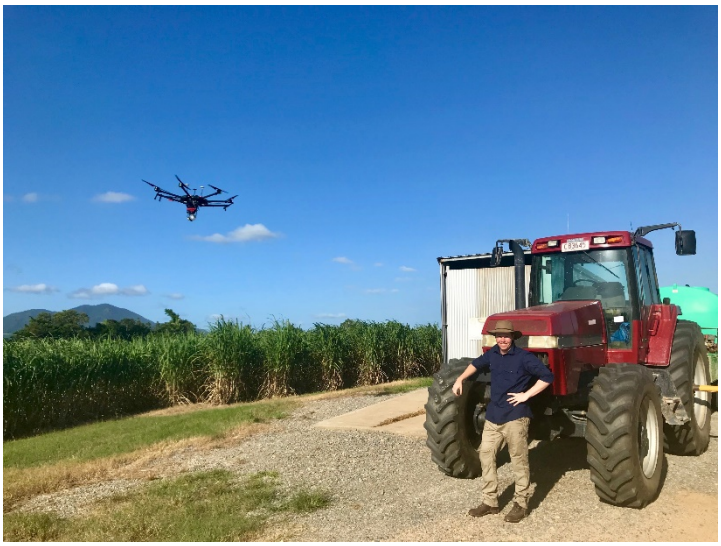
Through blockchain, producers will be able to escape the trap of commodity production, where products cannot attract premium prices. Blockchain will open up ways for farmers to put their products into differentiated markets by allowing verification of provenance and other attributes. It will meet the demand by consumers for better quality assurance of their food and fibre.

Novel communication systems

A range of new players and enterprising producers are developing solutions to the chronic lack of connectivity and poor mobile coverage across regional Australia. There are examples, such as long range wide-area network (LoRaWAN), successfully operating a low-powered Internet of Things on farms already. They show that not all digital agriculture activities require 4G mobile network coverage in the paddock. The benefits could extend beyond farm decision-making to rural or remote education, health and social wellbeing.

While improved communication will enable farmers to access greater amounts of information faster, it is not a solution in itself. Embedding analytics at the edge will shift the burden of processing large volumes of data from the communications network back to the point of collection. This will enable some applications without the need for high-end communications networks.

Value-adding to farm data



There is a huge opportunity in pooling data currently held in thousands of private hands to create products and services that farmers can use to improve their businesses. Working with farmer groups, we are actively exploring the viability of farm data-sharing arrangements. Once data is shared, individual farmers can benchmark their production against others. For example a farmer could develop more precise soil maps for his or her farm based on aggregated soil test results, or gain a more accurate picture of rainfall patterns in the locality.

Governments and research bodies already pool lots of ‘small data’ and use it to monitor performance trends in the industry. The innovation challenge in agriculture is finding the right business model for farmers to participate in. Farmers tell us that if they are going to contribute their own data and trust others with it, they want an obvious and transparent explanation of how it will be used to benefit them and others.

New partnerships to even-up information asymmetry

There is currently an imbalance of information between farmers and agribusiness or government. By improving transparency and access to information of common interest, we have the opportunity to increase trust and reduce costs among different players in the industry.

We are part of a new company, Digital Agriculture Services (DAS), which is creating digitised valuations, automated risk assessment, insight and productivity trends for rural land. Such intelligence is of interest to farmers and institutions alike including banks, governments, agribusiness and commodity handlers.

Inventing e-extension

How do we link farmers with the most relevant and knowledgeable agricultural advisor anytime, anywhere? This is particularly important in an era where one-on-one extension advisory services are in decline. Artificial intelligence systems can now be used to mine and interpret knowledge banks. For farmers it opens up fragmented and inaccessible extension and scientific material, and enables them to gain tailored answers to specific queries. Such tools could form an adjunct to advisory services, and support inexperienced staff working in unfamiliar situations.

Enabling digital agriculture to flourish

All of these developments show why there is such excitement about digital agriculture. We are working broadly across this field and actively filling vital information gaps that will enable digital agriculture to flourish.

We have identified a need for data assets, like the digital soil map of Australia, and ongoing improvements. Among projects CSIRO is involved in are:

- remote sensing imagery with Geoscience Australia
- climate forecasts at new time and spatial scales with the Bureau of Meteorology
- broad-scale monitoring products for ground cover, soil moisture, and feed availability.

We are building techniques to allow users to integrate a diverse set of tools with data assets for apps, information services and analytic services. The information technology infrastructure will allow developers to link a climate forecast, a soil data layer, remote sensing imagery and other sensor streams with models and other analytical tools more seamlessly than in the past.

We aim to test the infrastructure by developing a series of innovative digital agriculture products in domains as diverse as grains, aquaculture, sugarcane, irrigated crops, and carbon farming. Our high risk, fast results, frontier research is producing digital tools for farmers and agribusiness that should start being released in the next few months.

We realise it is our role to catalyse commercial activity in digital agriculture and not 'crowd out' private and other public sector players. The start-up community for digital agriculture in Australia is still young and needs vital core technologies that have underpinned the flourishing of agtech in parallel markets in the United States. Our role is to develop and deliver those technologies whether it is through licencing, research and development partnerships or free distribution.

We also need to improve some older decision-making tools to accommodate newer, data-driven approaches. The simulation-based approaches used in support tools like Yield Prophet® and GrassGro® were created in an era where data was sparse, poor in quality and infrequent. With the advent of more data streams, informing end users of variables like soil moisture and feed availability, we are helping redesign and upgrade these decision-making tools.

Warning – disruption ahead

Digital transformation is everywhere and, as we have seen, agriculture is no exception. Among the consequences is the trend for the big agri-bioscience companies to transform themselves into knowledge-based businesses, consistent with their earlier transition from manufacturers of agrichemicals and inventors of crop traits.

The relationship between the farmers and service providers will become more about information management, and greater access to information will alter the power balances between the different players in agriculture. Digital technologies reduce the advantage of being the local incumbent. Local knowledge and agility have been the traditional bulwarks of the family farm as an Australian institution.

Given the intersecting food, water, energy and climate change challenges that the world and Australia face, embracing digital technologies for agriculture gives us a significant opportunity. Australia is also a major trading nation and the highly competitive nature of international commodity markets means that we ignore these technologies at our peril.

We will continue to support innovation in Australian agriculture and assist governments and society to manage associated changes with trusted information and knowledge.

See our digital agtech on show in August 2018 at our AgCatalyst event in Melbourne.

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