

# Digitalisation of agricultural knowledge providers: the case of New Zealand

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**Abstract:** *Digitalisation is likely to transform the agricultural sector, through digital technologies, changing productive processes and the broader social and institutional context. This so called digital agriculture will create new knowledge boundaries among agricultural sector actors through, for example, new ways of generating and sharing data. This will require organisations to keep pace with digitalisation processes in agriculture, while integrating their current knowledge. Agricultural knowledge providers are thus likely to encounter both positive (new clients and services, more strategic decision making both on- and off-farm), as well as negative effects (job loss) of digitalisation. While digitalisation is a widespread phenomenon, it is largely unknown how agricultural knowledge providers adapt to digitalisation and how it affects their organisational identity. We explore this question in the context of New Zealand; identified as a digitally advanced country. 29 semi-structured interviews with knowledge providers show there are various perceptions of digitalisation, which is often perceived as an on-farm topic only. These views of digitalisation affects the way they prepare themselves for digitalisation in terms of adapting their capabilities, practices and services, or the expected changes in clients and partners. Changes in organisational identity appear slowly, and might be something that knowledge providers currently do not link to digitalisation. Agricultural knowledge providers can prepare for digitalisation by coordinating industry leadership; providing integrated solutions for decision support; and understanding the (social) implications of digitalisation in agriculture.*

**Keywords:** *Digitalisation, Digital agriculture, Knowledge providers, Organisational identity*

## Introduction

Digitalisation comprises technological innovations, such as big data, internet of things, augmented reality, artificial intelligence and robotics (Figure 1), that combine “knowledge, data, and processes of diverse physical machines, that were previously disconnected” (Yoo, Boland, Lyytinen, and Majchrzak, 2012, p. 1401), as well as “...the sociotechnical process of applying digitising techniques to broader social and institutional contexts that render digital technologies infrastructural” (Tilson et al., 2010, p.749 in Autio, 2017). Thus digitalisation can change the “market offerings, business processes, or models that result from the use of a digital technology” (Nambisan, Lyytinen, Majchrzak, and Song, 2017, p. 224).

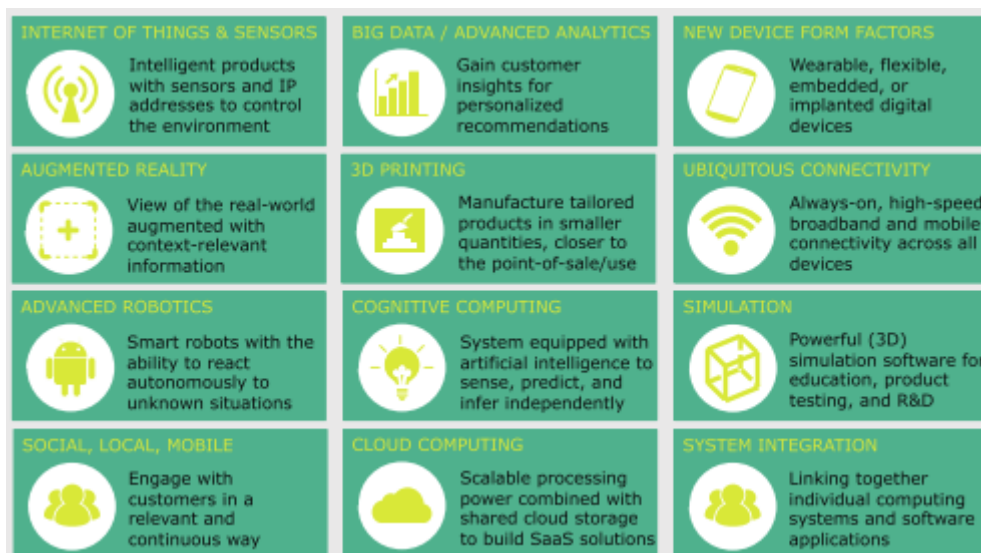


Figure 1. Digital technologies (Alm et al., 2016, p. 7)

Digitalisation in agriculture through so-called *smart farming* or *digital agriculture* implies that management tasks on- and off- farm focus on (location) data, enhanced by context- and situation awareness, triggered by real-time events (Wolfert, Goense, and Sørensen, 2014), influencing supply chain processes, logistics or consumer related information (Bronson and Knezevic, 2016; Hajkowicz and Eady, 2015; Wolfert, Ge, Verdouw, and Bogaardt, 2017). Kamilaris et al. (2017), for example, identified ten opportunities where big data analysis may solve agricultural problems, ranging from the development of platforms to enable access to high quality products and processes for supply chain actors; providing advice and guidance to farmers based on their crops' responsiveness to fertilizers, herbicides and pesticides; and developing tools for both yield and demand predictions.

These major changes could have consequences for agricultural knowledge providers (research and advisors) as it creates new knowledge boundaries. For example, as digitalisation enables an increasing involvement of consumers and other stakeholders in science and innovation through processes of data gathering and analysis (Buytaert et al., 2014; Karpouzoglou et al., 2016; Voinov et al., 2016). Farmers could thus be more enabled to take part in science through forms of citizen science and crowdsourcing (Minet et al., 2017), and become knowledge providers themselves. This challenges agricultural knowledge providers to keep pace with digitalisation while integrating current methods and knowledge (Dougherty and Dunne, 2012). Agricultural knowledge providers have to adapt their practices, skills, and capabilities (OECD, 2016; The Economist, 2016) in order to remain relevant and avoid potential redundancy of their professional expertise (Hirst and Humphreys, 2015).

Knowledge providers are also likely to encounter challenges in their digitalisation process, for example linked to data management, e.g. incompatibility or lack of standardisation of software and lack of data storage (European Innovation Partnership AGRI, 2015; Higgins, Bryant, Howell, and Battersby, 2017); uncertainty around the value of data (Pope, Wolfert, Verdouw, and Verwaart, 2013); suitability of existing large databases (Magee, Lee, Giuliano, and Munro, 2006; Philip Chen and Zhang, 2014); lack of trust in the quality of industry databases (Cooper and Green, 2015; Minet et al., 2017); data ownership issues (Bronson and Knezevic, 2016; European Innovation Partnership AGRI, 2015; Pope et al., 2013); and ethical implications (Tractenberg et al., 2015).

On the other hand digitalisation is likely to result in new services for knowledge providers, such as advising and situating new digital technologies for decision support (for example the use of drones and sensors) in practice on-farm (Lundström and Lindblom, 2018); the integration and coupling of several systems (Evans, Terhorst, and Kang, 2017); standardization of information and data models, such as animal classification (Allen and

Wolfert, 2011); or consumer-decision support (European Innovation Partnership AGRI, 2015; Poppe et al., 2013).

In summary, the pervasiveness of digitalisation and its implications for research and advisory professions, processes, products and services, may thus affect the *organisational identity* of agricultural knowledge providers, as it does of individuals and society which are developing 'digital identities' (Alm et al., 2016; Hirst and Humphreys, 2015). It is, however, largely unknown how agricultural knowledge providers perceive, and respond to digitalisation.

We address this gap using agricultural knowledge providers in New Zealand as a case. New Zealand provides an exemplar case as it is highly digitally advanced and exhibits high momentum (Chakravorti and Chaturvedi, 2017). The supply (e.g. infrastructure) and demand conditions (uptake) for digital technologies are promising, as well as the institutional context (a policy-led digital strategy) and there is space for innovation and change. Moreover, agricultural knowledge providers are considered to have an important place in the New Zealand innovation system (Turner, Stevens, and Rijswijk, 2014) and agriculture is a large contributor to the country's GDP (New Zealand Treasury, 2016).

In this paper, we will first elaborate on the concept of organisational identity, which we use as an analytical lens to unravel the agricultural knowledge providers' own perceptions of, and responses to, digitalisation. This is followed by an overview of the potential challenges and opportunities of digitalisation. We will then describe the methodology used to collect and analyse the data, followed by presentation of results. The discussion and conclusion give insight into how far New Zealand agricultural knowledge providers perceive a change in their organisational identity due to digitalisation, and provides recommendations for agricultural knowledge providers to adapt to digitalisation.

## Organisational identity

The concept of organisational identity is used to assess the perception of, and responses to, digitalisation by agricultural knowledge providers, e.g. how they deal with digitalisation. Albert and Whetten (1985) have described organisational identity as that which is central, enduring, and distinctive about an organisation's character. According to Gioia et al. (2013, p. 161) "organisational identity provides a guide for what an organisation's members should do and how other organisations should relate to it". An organisation's identity can (and needs to) be 'fluid' in order to remain relevant in a changing environment, but at the same time needs to keep a level of 'sameness' for internal coordination with insiders and external interaction with outsiders, i.e. to recognize the organisation and its activities (Gioia et al., 2013). Identity change includes multiple dimensions: "pace of change (shorter time horizons vs. longer periods), nature of change (continuous vs. discontinuous), source or impetus for change (internal vs. external) and context of change (technological changes, high-velocity environments, mergers, and so on)" (Gioia et al., 2013, p. 139).

Organisational identity includes intangible and tangible identity (Gioia et al., 2013). Margolis and Hansen (2002) describe the intangible identity as the purpose and philosophy of an organisation, addressing 'why and how things are done' (Gioia et al., 2013). Tangible identity refers to 'what things are done' and is semi-permanent as attributes (e.g. product and market strategies) are specific, tied to particular times and environmental conditions (Gioia et al., 2013).

In this research tangible identity has been operationalised as the capabilities of the members of the organisation, the practices they perform on a daily basis, i.e. knowledge providers need to give *input* to their own digitalisation process through upskilling or hiring new capabilities and adapting their daily practices. Tangible identity also has an *output* side, i.e. the services provided by an organisation, and the clients and partners they work with. With digitalisation client needs are becoming more heterogeneous, resulting in increasingly 'tailor-made' services, developed with strong involvement of the client (Leminen, Rajahonka, Westerlund, and Siuruainen, 2015). Clients and partners, i.e. collaborators, are thus crucial for the organisational identity of knowledge providers.

We operationalize intangible identity as the purpose and values of an organisation. These key aspects of tangible and intangible identity will be described in light of digitalisation using the four elements of identity change (pace, nature, source and context).

## Methods

To assess how digitalisation is influencing the organisational identity of agricultural knowledge providers' qualitative data was collected through 29 semi-structured interviews with key individuals from agricultural knowledge providers. The interviews focussed on: 1) the interviewee's interpretation of digitalisation; 2) what digitalisation means for NZ agriculture in general; and 3) for their organisation in particular. The questions were based on the theoretical framework, while allowing space for other themes and issues to emerge. The interviews continued until no new ideas were suggested by the interviewees and the emerging themes were fully explored, i.e. there was a saturation in the responses from the interviewees. All the interviews were transcribed and sent back to the interviewees to: 1) check if this was still in line with their current thinking; and 2) get approval for using the transcript in the analysis. For the analysis the emerging themes and key ideas of each interview were distilled according to the three foci of the interview and the related theoretical framework. The patterns and key differences that emerged are described in the result section.

The aim was to interview a broad variety of organisations across different agricultural sectors. These sectors were: dairy, red meat, forestry, horticulture and cropping. The organisations and interviewees were identified through a general scoping of the agricultural innovation system (i.e. who are the key knowledge providers in the New Zealand agricultural sector) and through snowball sampling. The interviewees were from applied research institutes (6), industry bodies (4), agricultural cooperatives (4), technology providers (4), universities (3), farm advisors (2), business consultants (3) and multi-stakeholder platforms (3), all of which provide knowledge either directly to farmers, or to other businesses in the agricultural sector whose clients are farmers. The interviewees were further categorised as: scientists; advisors (directly to farmers); technology providers; and consultants (to other agri-businesses). The interviewees were CEOs, managers, or a key person directly linked to smart farming and innovation. Although some interviews specifically looked at one particular sector (mainly the industry bodies and the advisors), most interviewees covered two or more sectors.

## Results

### Digitalisation

Before understanding if and how digitalisation influences the organisational identity of the different knowledge providers it is key to understand how the interviewees perceive digitalisation.

#### *Nature*

Definitions of digitalisation by the interviewees covered several aspects, from having improved software and technologies on-farm, undertaking precision agriculture activities, through to the 'farmer-less farm' (i.e. a hi-tech farm, which can be monitored and controlled from a distance, hence not requiring constant active presence of the farmer). These varied answers were also dependent on the level of digitalisation already occurring in the organisation. A manager from a supplier company said:

*"We can have a kind of adage that the farmers can stay in bed, have a cup of tea, watch the All Blacks play. As long as they got confidence in what we are doing, we will do all the complicated stuff behind the scenes. And they get a very simple, actionable item at the end, and that is what they are after. So that is kind of a big change that I think I would see in New Zealand. Some will do it better than others."*

The common thread was that responses were all farm/farmer centric and focussed mainly on 'digital agriculture' instead of a broader definition of digitalisation. The majority of the

interviewees understood digital agriculture as being more digitally connected, e.g. collecting more data on (and sometimes off-) farm and sharing this data for better decision making (mainly on-farm). Implicit in their answers was the link with the value chain: different service providers, farm suppliers, or processors need to enable the data collection, storage and analysis, and different data sources need to be connected together, this in turn will support for example tracking and tracing to ultimately meet consumer needs and market demands. A representative of advisors put it as:

*“At the moment it’s being put out as the end game that through good data we will be able to do a, b and c. And look that might well be the case. [...] I see it as very much an enabler a guiding tool for a line of thought or a product a new product going into the marketplace or assessing consumer behaviour that’s very much the end of value chain. But also if you look at how it might apply on-farm is it’s very much there as a guiding tool for a farmer or a farm manager or whoever it may be. To look at a benchmark and for them to actually push through productivity gains based on the information they actually have so it’s to try new things.”*

#### Source

The focus on digital agriculture only highlights *output* elements of digitalisation, namely services, clients and partners. The organisational changes as a result of digitalisation were mainly perceived as an external source of change, since the majority of the interviewed knowledge providers are organisations that do not develop digital technologies themselves, but they (could) make use of them to enhance their own business. Moreover the drivers for digitalisation are also external, often consumer driven, as pointed out by a processing organisation:

*“You know our consumers are looking for, and demanding, for more transparency and traceability. They want pasture-fed, they want natural, they want minimal processed, they want well cared for cows, they want environmental responsibility, as do our regulators.”*

Again implicit in the answers of those non-technology developing knowledge providers was that the external changes consequently had internal changes (i.e. changes in behaviour, skills and practices), in order to achieve their organisational output in the form of digital agriculture services. An advisor stated:

*“The challenge for farmers is: what does that information mean to their business? What decisions are they going to make? So yeah data and data management is going to be a key driver, the challenge is as I say how people are going to use it. Linked in with that there is going to be more data, simply by better systems for collecting and monitoring data.”*

#### Pace

The timeframe in which digitalisation, or mainly digital agriculture, could be achieved also varied among interviewees: from ‘within 5 years’ to ‘maybe in 20 years’ time’. Reasons for this were generally related to the perceived costs of digital technologies. Some people thought these costs were coming down fast, and therefore the technologies are going to be more affordable for a bigger audience. These people often thought of the shorter timeframes; up to 10 years. Other people, who thought it would take probably 10, if not 20 years, thought that not only the costs were a problem for increasing uptake on-farm, but they were often also sceptical about the quality (accuracy) and possibilities of the technologies:

*“I think some of this stuff is already happening. There are examples of people who have very good information systems and use a lot of these tools well at the moment. The issue at the moment is that a lot of them are disparate, they don’t talk to each other, and it really takes those really keen people with perseverance and good technical understanding to get it all together. But before it really reaches mainstream, I think a decade.”*

The sceptical interviewees emphasised uncertainty regarding the ability of digital technologies to link with other technologies and to deliver what was claimed. Regardless of the timeframes that people had in mind the majority of the interviewees often linked the timeframes of uptake and adoption to on-farm decision makers (i.e. the farm owner or manager), and less to uptake in the rest of the value chain, as indicated also by manager from a supplier company:

*“I think there will always be the early ones [farmers who adopt digital technologies], and those that watch and will follow fast. The rate at which they will do it depends on the value proposition. And in there is the*

*reward, and in there is the risk, and in there is any other constraints. How much capital you need, how much expertise, how much labour, whatever. So all of those things is really around the value proposition.”*

## Context

Most of the interviewees are positive towards the potential benefits of digitalisation. They say it could make it easier for farmers to comply (or prove compliance) with environmental regulations; improve and monitor health and safety on-farm; and adhere to animal welfare requirements. All of these benefits together also help to meet (overseas) market demands and consumer needs, for example through traceability and hence being able to provide a premium product, while leveraging NZ’s clean, green image.

At the same time most people are unsure about the value proposition on-farm, whether digitalisation is actually going to improve profitability and productivity on-farm, because this has not been ‘proven’ yet.

Some interviewees are also worried about what it might mean for the rural areas, whether people are going to lose their jobs on-farm if sensors and robots are going to take over most agricultural tasks, and what that means for the population living in these areas.

## Organisational identity

As with the variation of answers to what digitalisation might be, there was variation in the ways that the interviewed knowledge providers view organisational identity changes due to digitalisation. Table 1 shows an overview of the main perceptions of potential changes to organisational identity aspects for the four categories of knowledge providers (scientists, advisors, technology providers and consultants).

**Table 1.** Main perceptions of changes in organisational identity aspects

Organisational identity	Scientists	Advisors	Technology providers	Consultants
Tangible identity	<p>Capabilities</p> <p>Hiring external or upskilling internal new capabilities, such as data scientists.</p>	<p>In various stages, the farm suppliers seem to be more aware than the farm advisors.</p>	<p>Relatively well prepared but changes in technology fast, making it hard to keep up.</p>	<p>Not necessarily hiring new capabilities, but upskilling themselves on digitalisation topics.</p>
	<p>Practices</p> <p>New practices are slowly developing. The uptake and integration of new capabilities varies per discipline, department and organisation.</p>	<p>Most supplier/processor companies do have their own apps and ways of data collection.</p>	<p>A shift in focus from technology development towards decision support and data analysis.</p>	<p>No apparent change in practices. Consultants are aware of the necessity for changes regarding digitalisation for other organisations.</p>
	<p>Services</p> <p>First focus on internal customers of data science. Services towards clients (mainly agribusiness) appear to not change much yet.</p>	<p>Moving towards spending less time with the farmer for data collection, more strategic advice.</p>	<p>Adapting towards tailor-made services and focus on client needs than a one-size-fits all technology.</p>	<p>The focus of advice and strategy development changes towards digitalisation, the service however seem remain the same.</p>
	<p>Clients</p> <p>Generally the client has not changed thus far, nor does it appear their questions changed. However, frontrunners do ask different questions, hence demanding new things from science.</p>	<p>Remain focussed on the ‘followers’ and ‘laggards’, thus little changes in client base or questions.</p>	<p>Clients do not always know what they want, need and what is possible with digitalisation. Thus there is a need to raise awareness.</p>	<p>There is the potential for more and new clients as they all encounter digitalisation in the future for which they may need business support.</p>

Partners	First steps towards collaboration with tech companies and start-ups have been made.	Supplier/ Processor companies already have collaborations with tech companies and start-ups. Farm advisors and industry bodies to a lesser extent.	Opportunities for working with start-ups. Agriculture seem as the new sector to 'develop' technologies for, meaning more opportunities and competition, especially with global tech companies interested.	Potential opportunities to work with tech companies and start-ups. Unclear in how far this is already happening.
Intangible Purpose identity	No changes. Remain focussed on working for the greater good of the country.	No changes. Remain focussed on serving their clients' (farmers) needs.	No changes. Remain focussed on serving their clients' (agri-business) needs through technology.	No changes. Remain focussed on serving their clients' (agri-business) needs.
Values	Continue to deliver quality science in an integrated and transparent way to enhance New Zealand's production, profitability and sustainability.	Continue to deliver quality products, information and decision support to enhance production, profitability and sustainability of their clients.	Continue to develop quality products, but more emphasis on collaboration with client for increased efficiency and effectiveness of their clients.	Continue to deliver quality information, strategy development and company support for increased efficiency and profitability of their clients.

### *Tangible identity*

A large number of the interviewees had not considered the flow-on effects of on-farm changes for the rest of the value chain in general or for their own business in particular. Regarding the value chain changes the interviewees mainly thought that the advisors (e.g. farm advisors, as well as representatives of industry bodies, suppliers and processors) may find themselves without a job in the future if they were unable to adapt to the digital age. Scientists, technology providers or consultants were not identified as finding themselves without a job in the future, which could indicate that interviewees did not think that those roles are being threatened by digitalisation.

Regarding the flow-on effects of digital agriculture for their own business, approximately half of the interviewees had not considered the topic in great depth, whereas others had developed, or started to develop a strategy for dealing with and adapting to coming changes, and preferably how they leverage or create these changes themselves.

### *Capabilities*

Often the first step for organisations dealing with external changes, like digitalisation, is to think about the required capabilities. The interviewees with a digitalisation strategy thought that digitalisation requires different skills and capabilities within the organisation, which they either still need to develop or hire externally, a process they already started to implement, especially in science organisations. It appears that organisations with a strategy have been developing this strategy over the last a few years, which sometimes was a deliberate choice, but more often it seemed to just happen by hiring a person with a certain skill set because it was needed for a project or a client. Only later did the hire contribute to strategy development. A scientist described this as:

*"So that [data science] is an area where we are probably light, so we have a great base in biophysical skills, we have an active bio-engineering group. So we have aspects of that, but we probably deploy them in quite traditional ways. So we run an experiment with a statistician, but I guess data science can be a bit different. So new skills in the organisation. Getting out and having some conversations with our key stakeholders, to understand their vision in this area."*

Interviewees foresaw the biggest challenges regarding capabilities in the advisor category, and in particular independent farm advisors as opposed to the cooperatives and industry

bodies. Some suggestions for potential adaptations for advisors were made, such as change towards more technical support, or giving advice to farmers on which technologies will best suit their farm system. Only a few interviewees thought that the relevance of advisors would actually decrease a few years. Several interviewees thought digitalisation could help with the training of younger advisors and could make the profession more appealing to the next generation of advisors. Despite these potential opportunities the interviewees did say that most advisors are currently not ready for this change, and that some will never be, because of the older average age of (particularly farm) advisors and the lack of willingness or flexibility to change.

### Practices

When considering changing practices most interviewees, including those without a strategy, thought they would be able to adapt to digitalisation, and that the use of digital technologies could benefit them. For advisors this would be: less time spent traveling to farmers, less time involved in collecting basic information before actually discussing the options with farmers, hence creating the ability to serve more clients. Often the suppliers, processors and the sometimes the industry bodies, had already developed applications to collect data or to inform their farmer clients. For science organisations changing practices is sometimes challenging, as indicated by this quote from a scientist:

*“What happened in the past is that they’ve [scientists] put together a bid, had it approved and then they said that they were going to deliver a tool. But the terminology tool, means many things to different people. And then they come to us [data scientists] and say: hey we want to deliver a tool, what can you do for us? We find the requirements, and define those, provide a cost or a quote and then they are like: we’ve got no money for it. [...] They should be worked on alongside each other. [...] They know what they want, they just can’t make the technology do it. But our guys can make the technology do it. And if we can do that, we can crack that for them then they can crack the science question. And that is when you know you are enabling science through the technology.”*

### Services

The purpose of developing new capabilities and practices is to be able to better serve clients. Organisations with a digitalisation strategy thought that various aspects of their products and services will change due to new requests from clients and partners. However, it was often still unclear to the interviewees what these new services might be, and the changes in services were incremental. A technology provider said:

*“You know we are still taking gentle steps, we made a reasonable sized investment, but to the user at the front end that’s subtle: ‘I use my product slightly differently’. Some of the products are actually weeks away from launch, so not actually out there yet. So, I think that will change relatively quickly, I think that whole space generally. [...] But having stuff you sell and having a website and having sales reps that’s a model that will morph over time because of the digital effect. And this is true for every company. It’s true for us because [...] a good percentage of what we sell gathers data. So, [...] we’re accidentally in the digital space, but we will morph more into it because maybe it’s not services, but it’s how we interact with our customers will be different.”*

From the interviews it seemed that digitalisation would enable a more tailor-made service towards clients. One interviewee was concerned that the use of digital technologies in providing advice might become a ‘black-box’, meaning that all sorts of advisors can use the digital technologies to provide more strategic advice to farmers, but that farmers do not necessarily know or understand on what basis these advisors provide advice.

### Clients

Digitalisation thus presents a challenge for knowledge providers in the communication with their current and future clients, because for new services to establish it is necessary that the clients understand what is offered to them. There needs to be a demand for those services. The interviewees thought that they wouldn’t necessarily lose any of their current clients due to digitalisation, the expectation was that the majority of clients, and thus their needs and demands, would evolve along with the changes in services. The knowledge providers said that they are likely to raise awareness of the new possibilities amongst their (farmer) clients, and the clients themselves will also encounter digitalisation in other aspects of their businesses. Of course the interviewees realised that not all of their clients’ businesses would



successfully adapt to digitalisation. Interviewees actually saw digitalisation as an opportunity to attract new clients due to the possibility of developing new, more tailor-made services.

### Partners

The development and delivery of new services might also require new collaborations and partners, according to the interviewees. This would likely be with new technology oriented companies, including the bigger or even global tech companies as well as start-ups. However, as with their clients, the knowledge providers would try to maintain relationships with their current partners, which are often incumbent organisations as well. A scientist said:

*“That is always the risk [losing current collaborators or partners]. [...] You actually need to engage, communicate and align expectations with for example industry. So take them on the journey with us.”*

It was expected that the partners would equally develop their businesses in light of digitalisation, hence knowledge providers and partners alike could leverage off of the partnership and together be on the journey towards digitalisation. Another scientist indicated:

*“We’ve got our existing relationships and maybe to those we will bring some new players, or those groups will bring some new players to our discussion. Not to prejudge who is leading who. So I think we are necessarily saying that we will leave people behind, it is just to say who else needs to come for the journey.”*

### Intangible identity

The interviews showed that both the input and outputs of the tangible identity of an organisation would change under digitalisation. Even the interviewees who up to that point had not thought about digitalisation, and what it may mean for their own organisation, could see that changes would occur in various aspects of their business such as the organisational structure, i.e. the set-up of new teams. Some knowledge providers could foresee a new role for their organisation. For example, for applied research institutes perceived new roles included: (1) the development and commercialisation of digital technologies; (2) as a broker, bringing together various technologies and giving guidance on implementation; and (3) validating the technologies in the future. Moreover, even organisations that already have a distinct role in supporting digitalisation in the sector might not see themselves play just that role in the future, e.g. a technology provider considers itself to play a brokering role in the future, in which their technologies could support that brokering role.

### Purpose and values

In light of the changing tangible identity aspects and the development of new roles, the interviewees were also asked if that meant that the purpose of their organisation would change. Interestingly all but three interviewees answered ‘no’. The interviewees explained that, despite all the internal and external changes they foresee, they would still have the same purpose, based on the same values. An interviewee from an industry body expressed it as:

*“I think at the moment the purpose is adding value to the business of cropping. Which is actually really good, because we are saying that we are interested in cropping, and what do we do: we add value to it. So that actually gives us a really big scope.”*

A technology provider said:

*“If you look at us as a company, and it is not just obviously about shareholders getting some revenue, that is how a company survives, but the purpose of us as a company is to bring our know-how to help the agricultural sector to be more sustainable and more productive and profitable. All those things. And the exact mechanisms by which we do that might well vary overtime.”*

And a scientist put it as:

*“...the short answer is no. Because us being a [research institute], our core purpose is to enhance the value of New Zealand’s natural resources. And so this is consistent, even if technology changes that will always be our goal.”*

As shown by the quotes the purpose of knowledge providers, captured in a vision statement, is often along the lines of ‘supporting clients do better at x, y and z’ or ‘doing something for the greater good of the country’. These statements are often very broad and high level. Firstly they are using words that indicate the organisations values, such as sustainability,

transparency, quality, integrity etc. Secondly they would give quite a board description of their target group, e.g. the dairy farmers, or the wider agricultural sector of New Zealand. Thus the purpose would remain valid in ten or twenty years' time. Digitalisation would therefore only mean that the way they go about meeting that purpose is different.

The three interviewees that could foresee a different purpose, stated that the type of work and employees had changed, that their target group had broadened, or that due to the public nature of the organisation they might end up being amalgamated with other applied research institutes. However, when they thought about it a little longer they all concluded that the core values in all of those situations would remain the same, and as did their high level purpose.

## Discussion and conclusion

In this paper we aimed to understand how agricultural knowledge providers perceive and respond to digitalisation and how that influences their organisational identity. The results from the interviews indicate that regarding the concept of digitalisation the views vary widely, despite the general consensus on using a term as digital agriculture. The knowledge providers are uncertain about what digitalisation might entail for their organisation, meaning that they do not necessarily all have a concrete, let alone unified, idea of what that future might look like, and how or when it will happen, i.e. what the nature, pace and context of digitalisation is. The interviewees do think that the source of changes in their own organisation is external, due to external drivers such as food safety and sustainability, or due to digital technologies that they could, or have to, use in their business.

Regarding the *capabilities* an often heard comment is that digitalisation, or the lack of preparation and upskilling for digitalisation, may result in loss of jobs (Eastwood, Klerkx, Ayre, and Rue, 2017a; OECD, 2016; The Economist, 2016). While this is often related to unskilled labour, digitalisation also seems to create job instability for the educated workforce (Aubert-Tarby, Escobar, and Rayna, 2017). The knowledge providers, however, are not necessarily concerned for their own jobs, but more so for unskilled labour on-farm and the consequences it may have for rural communities. While this is a valid point, in line with many scholars (Bronson and Knezevic, 2016; Carolan, 2017; Poppe et al., 2013; Saleminck, Strijker, and Bosworth, 2017; Wolfert et al., 2017), it also shows the lack of focus of knowledge providers on the value chain and their own business regarding digitalisation.

When it comes to changing *practices* Lokers et al. (2016, p. 494) identify that scientists struggle with “capturing the huge heterogeneity of interdisciplinary data and around creating trust between data providers and data users”. The interviewees, despite being aware of the need for data scientists, (e.g. properly collecting, storing and analysing data) did not indicate that this is their biggest concern when changing their practices.

The development of new *services*, one of the potential challenges indicated in the introduction (Allen and Wolfert, 2011; European Innovation Partnership AGRI, 2015; Evans et al., 2017; Lundström and Lindblom, 2018; Poppe et al., 2013), were not attributed to digitalisation necessarily, but seen as a gradual process of change to better support their clients, supported by digital technologies. Moreover the changes taking place are linked to the ‘back office’ of the services, e.g. creating more efficiency, rather than at the customer end. Hirst and Humphreys (2015) indicate that in order for services to innovate in light of digitalisation, there is an increased need for organisational flexibility, the knowledge providers themselves therefore also need to be more flexible, as well as “unemotional and time-efficient” (p.1531), together resulting in a more modular way of organizing the capabilities, practices and services. This is not something that has come up in any of the interviews, which may show that digitalisation is not yet at the core of knowledge providers' organisations and they are taking a more ‘traditional’ or ‘conservative’ approach towards changing their organisation.

The other challenge identified in the introduction was around the changing *client* relationship, (Buytaert et al., 2014; Dougherty and Dunne, 2012; Karpouzoglou et al., 2016; Minet et al., 2017; Reichardt, Jürgens, Klöble, Hüter, and Moser, 2009; Voinov et al., 2016), which again

did not appear to be a major concern of the interviewees. Instead they saw that digitalisation could enable them to be more efficient and therefore to be more profitable. Except for technology providers, knowledge providers were not actively anticipating potential changes in clientele. For new collaborations and *partnerships* they were more aware, often linked to the changing capabilities, practices and services.

Overall most interviewees considered themselves to be prepared for digitalisation, based on their own view of digitalisation. It appears that knowledge providers in New Zealand are maintaining a balance toward *sameness* for internal coordination with insiders and external interaction with outsiders. They are achieving this by focusing on opportunities to use digitalisation to improve the efficiency of the services they already provide to clients, and by being able to continue to respond to client knowledge needs in the context of these clients adopting digital technologies. There were fewer examples of organisation's being *fluid* in order to remain relevant in a changing environment, perhaps as many organisations are still developing their understanding of what digitalisation means for their organisations.

This may be a result of the limited, albeit developing, (joint) understanding of the implications of digitalisation for the agricultural sector as a whole, and their organisation in particular. Several scholars (Kamilaris et al., 2017; Lokers et al., 2016) have also identified that digital agriculture is still developing, despite its 'predecessor', precision agriculture being around since the 1980s (Bos and Munnichs, 2016; Tey and Brindal, 2012). The tangible identity of knowledge providers will continue to face changes in the future. This undoubtedly will also affect the intangible identity, as knowledge providers are taking on new roles depending on the nature of their business and what sort of role they see themselves play in the future. Changing organisational identities appears to be a slow process and might be something that these organisations currently do not link to digitalisation. Change in organisational identities might thus be something that can only be attributed to digitalisation in hindsight.

It is widely recognized that capabilities, practices, services, as well as the relationships with clients and partners are subject to change due to digitalisation (Kiel, Arnold, and Voigt, 2017). Hence Agricultural knowledge providers, and the wider agricultural sector, are not the only ones to potentially be disrupted by digitalisation as this occurs in many different sectors, such as manufacturing, energy and creative industries (Kiel et al., 2017; Kolloch and Dellermann; Li, 2018). Different organisations across all of these sectors may however differ in the way they manage and adapt towards digitalisation depending on their situational context (Berghaus and Back, 2017). Agricultural knowledge providers can undertake a number of new roles to remain relevant under digitalisation. Knowledge providers with an interest in brokering can support coordinating industry leadership for the development of a sector wide digitalisation strategy (see also Eastwood, Klerkx, and Nettle, 2017b). The technology developing knowledge providers could focus on validating existing and new digital technologies and providing integrated solutions for decision support (see also Lundström and Lindblom, 2018). Furthermore, there is a need to develop the value proposition (Kiel et al., 2017) for commercial companies and farmers and understanding the (social) implications of digitalisation in agriculture.

There were several limitations to this study, such as the low number of interviewed consultants and technology providers, due to lack of interest to partake in interviews. Neither were the views of clients or partners of the knowledge providers included to provide a more balanced picture of perceptions of changing organisational identities of knowledge providers. This results in a knowledge providers' perspective which does not include the future needs of clients under digitalisation. Further research could therefore focus on the implementation of digitalisation within knowledge providing organisations through for example an in-depth study of one or more organisations. A broader analysis of involved stakeholders (i.e. clients and partners), as well as policymakers, could also enhance the understanding of the changing identities as a consequence of digitalisation. As well as comparing knowledge providers in New Zealand to those in other digitizing countries. Future research questions could furthermore include: how individuals cope with digitalisation, how digitalisation impacts on the compositions of innovation networks and whether the organisational structure influences both of the previous questions.

## References

- Albert, S. and Whetten, D.A. (1985) "Organizational identity." *Research in organizational behavior*.
- Allen, J., and Wolfert, S. (2011) Phase I: Australasian stocktake of farm management tools used by farmers and rural professionals *Farming for the Future: towards better information-based decision-making and communication*.
- Alm, E., Colliander, N., Lind, F., Stohne, V., Sundström, O., Wilms, M., and Smits, M. (2016) Digitizing the Netherlands: How the Netherlands can drive and benefit from an accelerated digitized economy in Europe: Boston Consulting Group.
- Aubert-Tarby, C., Escobar, O. R., and Rayna, T. (2017) The impact of technological change on employment: The case of press digitisation. *Technological Forecasting and Social Change*. doi: <https://doi.org/10.1016/j.techfore.2017.10.015>
- Autio, E. (2017) Digitalisation, ecosystems, entrepreneurship and policy *Policy Brief*: Ministry of Economic Affairs and Employment.
- Berghaus, S., and Back, A. (2017) *Disentangling the Fuzzy Front End of Digital Transformation: Activities and Approaches*. Paper presented at the Thirty Eighth International Conference on Information Systems, South Korea.
- Bos, J., and Munnichs, G. (2016) Digitalisering van dieren - Verkenning Precision Livestock Farming. Den Haag: Rathenau Instituut.
- Bronson, K., and Knezevic, I. (2016) Big Data in food and agriculture. *Big Data & Society*, 3(1), 2053951716648174.
- Buytaert, W., Zulkafli, Z., Grainger, S., Acosta, L., Alemie, T. C., Bastiaensen, J., . . . Zhumanova, M. (2014) Citizen science in hydrology and water resources: opportunities for knowledge generation, ecosystem service management, and sustainable development. [Review]. *Frontiers in Earth Science*, 2(26). doi: 10.3389/feart.2014.00026
- Carolan, M. (2017) Publicising Food: Big Data, Precision Agriculture, and Co-Experimental Techniques of Addition. *Sociologia Ruralis*, 57(2), 135-154. doi: 10.1111/soru.12120
- Chakravorti, B., and Chaturvedi, R. S. (2017) Digital planet 2017: How competitiveness and trust in digital economies vary across the world: The Fletcher School, Tufts University.
- Cooper, A., and Green, C. (2015) Embracing the Complexities of 'Big Data' in Archaeology: the Case of the English Landscape and Identities Project. *Journal of Archaeological Method and Theory*, 23(1), 271-304. doi: 10.1007/s10816-015-9240-4
- Dougherty, D., and Dunne, D. D. (2012) Digital science and knowledge boundaries in complex innovation. *Organization Science*, 23(5), 1467-1484. doi: 10.1287/orsc.1110.0700
- Eastwood, C., Klerkx, L., Ayre, M., and Rue, B. D. (2017) Managing Socio-Ethical Challenges in the Development of Smart Farming: From a Fragmented to a Comprehensive Approach for Responsible Research and Innovation. *Journal of Agricultural and Environmental Ethics*, 1-28.
- Eastwood, C., Klerkx, L., and Nettle, R. (2017) Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies*, 49, 1-12. doi: [10.1016/j.jrurstud.2016.11.008](https://doi.org/10.1016/j.jrurstud.2016.11.008)
- European Innovation Partnership AGRI. (2015) *EIP-AGRI Focus Group on Precision Farming: Final Report*.
- Evans, K. J., Terhorst, A., and Kang, B. H. (2017) From Data to Decisions: Helping Crop Producers Build Their Actionable Knowledge. *Critical Reviews in Plant Sciences*, 36(2), 71-88. doi: 10.1080/07352689.2017.1336047
- Gioia, D. A., Patvardhan, S. D., Hamilton, A. L., and Corley, K. G. (2013) Organizational Identity Formation and Change. *Academy of Management Annals*. doi: 10.1080/19416520.2013.762225
- Hajkowicz, S., and Eady, S. (2015) Rural Industry Futures: Megatrends impacting Australian agriculture over the coming twenty years.

- Higgins, V., Bryant, M., Howell, A., and Battersby, J. (2017) Ordering adoption: Materiality, knowledge and farmer engagement with precision agriculture technologies. *Journal of Rural Studies*, 55, 193-202. doi: <https://doi.org/10.1016/j.jrurstud.2017.08.011>
- Hirst, A., and Humphreys, M. (2015) Configurable Bureaucracy and the Making of Modular Man. *Organization Studies*, 36(11), 1531-1553. doi: 10.1177/0170840615593585
- Kamilaris, A., Kartakoullis, A., and Prenafeta-Boldú, F. X. (2017) A review on the practice of big data analysis in agriculture. *Computers and Electronics in Agriculture*, 143(Supplement C), 23-37. doi: <https://doi.org/10.1016/j.compag.2017.09.037>
- Karpouzoglou, T., Zulkafli, Z., Grainger, S., Dewulf, A., Buytaert, W., and Hannah, D. M. (2016) Environmental Virtual Observatories (EVOs): prospects for knowledge co-creation and resilience in the Information Age. *Current Opinion in Environmental Sustainability*, 18, 40-48. doi: 10.1016/j.cosust.2015.07.015
- Kiel, D., Arnold, C., and Voigt, K.-I. (2017) The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective. *Technovation*, 68, 4-19. doi: <https://doi.org/10.1016/j.technovation.2017.09.003>
- Kolloch, M., and Dellermann, D. Digital innovation in the energy industry: The impact of controversies on the evolution of innovation ecosystems. *Technological Forecasting and Social Change*. doi: <https://doi.org/10.1016/j.techfore.2017.03.033>
- Leminen, S., Rajahonka, M., Westerlund, M., and Siuruainen, R. (2015) Ecosystem business models for the Internet of things. *Internet of Things Finland*, 10-13.
- Li, F. (2018) The digital transformation of business models in the creative industries: A holistic framework and emerging trends. *Technovation*. doi: <https://doi.org/10.1016/j.technovation.2017.12.004>
- Lokers, R., Knapen, R., Janssen, S., van Randen, Y., and Jansen, J. (2016) Analysis of Big Data technologies for use in agro-environmental science. *Environmental Modelling & Software*, 84, 494-504. doi: <http://dx.doi.org/10.1016/j.envsoft.2016.07.017>
- Lundström, C., and Lindblom, J. (2018) Considering farmers' situated knowledge of using agricultural decision support systems (AgriDSS) to Foster farming practices: The case of CropSAT. *Agricultural Systems*, 159(Supplement C), 9-20. doi: <https://doi.org/10.1016/j.agsy.2017.10.004>
- Magee, T., Lee, S. M., Giuliano, K. K., and Munro, B. (2006) Generating New Knowledge From Existing Data: The Use of Large Data Sets for Nursing Research. *Nursing Research*, 55(2), S50-S56.
- Margolis, S. L., and Hansen, C. D. (2002) A model for organizational identity: Exploring the path to sustainability during change. *Human Resource Development Review*, 1(3), 277-303.
- Minet, J., Curnel, Y., Gobin, A., Goffart, J.-P., Mélard, F., Tychon, B., . . . Defourny, P. (2017) Crowdsourcing for agricultural applications: A review of uses and opportunities for a farmsourcing approach. *Computers and Electronics in Agriculture*, 142(Part A), 126-138. doi: <https://doi.org/10.1016/j.compag.2017.08.026>
- Nambisan, S., Lyytinen, K., Majchrzak, A., and Song, M. (2017) Digital innovation management: Reinventing innovation management research in a digital world. *Mis Quarterly*, 41(1)
- New Zealand Treasury. (2016) New Zealand Economic and Financial Overview 2016. Wellington: New Zealand Treasury.
- OECD. (2016) Automation and independent work in a digital economy *Policy brief on the future of work*. Paris: OECD.
- Philip Chen, C. L., and Zhang, C.-Y. (2014) Data-intensive applications, challenges, techniques and technologies: A survey on Big Data. *Information Sciences*, 275, 314-347. doi: <http://dx.doi.org/10.1016/j.ins.2014.01.015>
- Poppe, K. J., Wolfert, S., Verdouw, C., and Verwaart, T. (2013) Information and Communication Technology as a Driver for Change in Agri-food Chains. *EuroChoices*, 12(1), 60-65.
- Reichardt, M., Jürgens, C., Klöble, U., Hüter, J., and Moser, K. (2009) Dissemination of precision farming in Germany: acceptance, adoption, obstacles, knowledge transfer and training

- activities. [journal article]. *Precision Agriculture*, 10(6), 525-545. doi: 10.1007/s11119-009-9112-6
- Salemink, K., Strijker, D., and Bosworth, G. (2017) Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas. *Journal of Rural Studies*, 54, 360-371. doi: <https://doi.org/10.1016/j.jrurstud.2015.09.001>
- Tey, Y. S., and Brindal, M. (2012) Factors influencing the adoption of precision agricultural technologies: a review for policy implications. [journal article]. *Precision Agriculture*, 13(6), 713-730. doi: 10.1007/s11119-012-9273-6
- The Economist. (2016) The impact on jobs - Automation and anxiety. *The Economist*, 419.
- Tractenberg, R. E., Russell, A. J., Morgan, G. J., FitzGerald, K. T., Collmann, J., Vinsel, L., . . . Dolling, L. M. (2015) Using Ethical Reasoning to Amplify the Reach and Resonance of Professional Codes of Conduct in Training Big Data Scientists. *Sci Eng Ethics*, 21(6), 1485-1507. doi: 10.1007/s11948-014-9613-1
- Turner, J. A., Stevens, D., and Rijswijk, K. (2014) Revitalising the role of rural professionals in primary sector innovation. *Primary Industry Management*, 18(1), 21-24.
- Voinov, A., Kolagani, N., McCall, M. K., Glynn, P. D., Kragt, M. E., Ostermann, F. O., . . . Ramu, P. (2016) Modelling with stakeholders – Next generation. *Environmental Modelling & Software*, 77, 196-220. doi: 10.1016/j.envsoft.2015.11.016
- Wolfert, S., Ge, L., Verdouw, C., and Bogaardt, M.J. (2017) Big Data in Smart Farming – A review. *Agricultural Systems*, 153, 69-80. doi: 10.1016/j.agsy.2017.01.023
- Wolfert, S., Goense, D., and Sørensen, C. A. G. (2014) *A future internet collaboration platform for safe and healthy food from farm to fork*. Paper presented at the 2014 Annual SRII Global Conference.
- Yoo, Y., Boland, R. J. J., Lyytinen, K., and Majchrzak, A. (2012) Organizing for Innovation in the Digitized World. *Organization Science*, 23(5), 1398-1408. doi: doi:10.1287/orsc.1120.0771