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Australian AgTech: A Commentary on the Report of the Agri-Tech Expert Working Group June 2021

John Canning [1]

Laseire Pty Ltd, Sydney, and School of Electrical Engineering & Telecommunications, University of NSW

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Abstract

The government AgriTech Expert Working Group has provided a detailed overview of the practical challenges domestic Australian farmers have to deal with when digitising their farms through the implementation of connected sensor technologies, motivated by the predicted growth of the sector to AUD 100 billion by 2030. In addressing these issues, of which connectivity and access to wireless technologies along with unreliable sensor performances over time remain prominent, domestic regional specific solutions are sought. A key solution being relied upon are low earth orbital satellites, perhaps the only communication infrastructure that cycles over territorial boundaries and has both regulatory and technical challenges that are not widely considered. The resilience of these solutions is assessed in the context of the agricultural technology, or AgTech, market which is arguably invented and shaped by broader, global interests mostly centred where end-user populations are based. The argument is made that government policy must include the latter within a larger holistic framework, including education,

> when assessing the future of both agriculture and AgTech markets in Australia. At the core, the AgTech report does highlight some challenges in Australia's wider research approach.

Introduction

Agricultural technology (or AgTech) is a nascent industry that introduces connected technology, usually patented (Queensland Department of Agriculture and Fisheries, n.d.[5]) and often reaching across from other industries, in various formats to aid and transform agricultural sectors spanning land and sea farms (both private and industrial), vineyards, cattle stations and other food or organic resource generating. It includes innovation across the value chain from supply to demand and so, arguably, may involve traceability and transport innovations and restaurant contributions that increase the value of the sector. It also includes hardware and software, business models, new technologies (sensors, robotics, smart vehicles, cloud and edge computing, augmented reality, virtual reality, cable and wireless networks, GPS, satellites, electronic currencies, and more) and new applications, much of it underpinned by mainly digital data and finance transfer and manipulation. AgTech increasingly includes disruption of the product itself for reasons that may seem far removed from immediate business alone (e.g., climate change). For the traditional Australian farm, both digital and analog sensors constitute a critical part of data collection, whether passively sitting in the field or on autonomous vehicles and robots. Data transmission into the Internet is via edge-computing phone, tablet or computer apps to increasingly smarter sensing-based transmission and/or online cloud services.

There will be three areas where technology at the farm is being revolutionised – from (1) the type of hardware including point, distributed and mobile sensors; to (2) the transmission of the data via a range of connected devices and transmission media that are either cable (fibre comes into its own here) or wireless (acoustic, optical, mm, microwave, RF, infrared and more); to (3) the software and signal processing that controls, reads and analyses the data at various points determined by customer or provider. In increasing proactive AgTech, signal delivery back to the sensor or to additional control devices will occur. These points can be local or global, with many providers having cloud-based analysis somewhere else on the planet, reflecting how the Internet of Things (IoT) has changed the way business is being done. The industry remains nascent because much of the sensor technology is not care-free nor reliable, often requiring regular maintenance, calibration and replacement (providing a subscriber model for businesses). As well, transmission media have serious connectivity, latency and potentially compatibility issues, given the heterogeneity of the technology and recycling of the electromagnetic spectrum. Further, that technology is continually evolving at an increasingly exponential rate, creating a unique challenge for constant reinvention. Opportunities for business beyond increasing supplied market volumes of current items with new disruptive products are growing and their impact on traditional markets may undo much of the smarter but traditional farm, which makes up the present bulk of Australian AgTech.

Here, the recent Agri-Tech Expert Working Group report on the implementation of AgTech in agriculture is assessed against the context of a comprehensive definition of AgTech that is seeing substantial investment overseas. Given the ad hoc implementation of technology in the field, there are many solutions that, in principle, can be available to address the agricultural sector, often developing outside of agriculture. The report points to many impediments to local implementation reflecting that much of the technology is immature. To address this, this review looks at whether deeper research commitment from government investment, along with a strategic understanding of new technology and its global market beyond agricultural produce, is needed. This may equate with more efficient longer term, robust and sustainable outcomes from government investment.

Agricultural and AgTech markets

The Agri-Tech Expert Working Group was established by the Australian Broadband Advisory Council (ABAC) to review the current state of the sector in Australia. Its report (ABAC, 2021 [6]), henceforth referred to as the Report, was motivated by improving the competitiveness of existing agriculture. The expected agricultural market boost from going digital is identified in the Report. It is anticipated that the sector can grow by approximately AUD 40 billion by 2030, a figure provided by the Department of Agriculture, Water and the Environment (2022 [7]). This is an interesting market because agriculture is extremely sensitive to various factors including geopolitical and environmental – according to Elders CEO, Mark Allen, for example, Australian agricultural value appears to have dropped more than AUD 10 billion over the last two years, mainly attributed to bushfires, climate change and COVID impacts on demand, from over AUD 60 down to 47 billion (Woodward, 2021 [8]). This is almost half the amount it is predicted to grow to by 2030. Thus, climate and environmental factors will increasingly impact investor decisions in this space, and especially the AgTech market itself.

Despite the obvious synergy, the agricultural market and the AgTech technology market are not the same and misalignment of these markets may create confusion. The specific AgTech technology market is presently much less, arguably negligible in Australia, reflecting how infant the sector is, characterised by farmer-led innovation. On the other hand, the recent pandemic demonstrated that global and domestic supply chain concerns are not one way, boosting arguments for more self-sufficiency within smart cites so they produce some of their own food. This can directly compete with traditional rural farming models. AgTech will grow and the value proposition will change because an AgTech company must also address larger global markets (assuming continuing growth in premium food by the global market) with a stable longer term platform ecosystem that may need to be able to profitably integrate rapidly changing technologies and products, including new agricultural products displacing existing ones.

In the US, the AgTech market is estimated to be valued at approximately $6.2 billion, expected to grow over $14 billion by 2025, remaining lower than Australia's anticipated agricultural market boost over the same period (Agricultural technology (Agtech) market value worldwide from 2020 to 2025, 2021[9]). What is interesting is what is driving this market – alternative meat products will look to compete with traditional Australian beef markets, providing a solution to greenhouse-gas generation (Henshall, 2021 [10]; Carrington, 2020 [11]; Tangermann, 2021 [12]; George, 2019 [13]). These are rapidly growing products through accelerated investment in the United States, but which have little presence to date within Australia. If that were to reach into the Australian market, then the business model of a smart but traditional cattle station as described in the Report, for example, would be challenged. Substantive refocusing to a more niche, lower volume but higher valued meat product would be required. These may be from non-methane-producing cattle perhaps fed on seaweed, one competing solution that can extend traditional farming over longer timeframes (Lean *et al.*, 2021 [14]; Abbott *et al.*, 2020 [15]; Vijn *et al.*, 2020 [16]).

An important consideration will be the return per unit area of land if, for example, alternative, indistinguishable cost-competitive meat or other products are grown in a laboratory at scale, as predicted by those investing. There is already pressure across cities worldwide to have in-city farms including vertical farms, such as Scottish Intelligent Growth Solutions, which has raised over US 57 million in Series B joint UK/US/ European funding (Lea, 2021 [17]), to address both climate change and biosecurity. These sustainable city-based farms bypass transport and other supply chain costs, which have been a notable concern during the pandemic. Socially, the increased removal of larger transport vehicles from shared roads is viewed favourably in cities. In other words, from an investment perspective the future of traditional markets and their scalability is being challenged by new agricultural products. Hence, an inward-focused approach on lowering costs doing more of the same and boosting current supplies is important but may seem short-sighted. That is a principal reason why government investment requires more strategic and long-term considerations – there is an analogy with Climate Change in that, whilst older industries may continue for many years, the transition time to growing customer-driven (even demanded) new industries is long; and therefore advanced, long-term preparation and education is central to government policy. Addressing salt-and-pepper connectivity is as much about ensuring that new viable disruptive products, with greater output per square metre, can occur on the land, generating effective competition for farmers.

The technology side itself relies on global and wider markets and global investment, precisely because the local market alone is relatively small and potentially insular. This is nothing new and applies to all of Australia's high technology activities. It means much of it will happen in our cities and offshore, being closer to critical mass funding and population, technology expertise and current and new global markets. Addressing variability between national and international standards, across both products and technologies, and accessible bandwidth is another consideration that arises from such a complex environment. Access to technology from other sectoral advances, particularly in the IoT space, will shape the type of regional training and education alluded to in the Report that can be supported within a holistic ecosystem. For example, certain sector-agnostic challenges include reducing power consumption through the growing deployment of low power wide-area networks (LoRaWAN). Some of these have been demonstrated outside of agriculture, in "smart" cities where profit margins for a technology business are potentially higher. They include France's Sigfox's low power meter monitoring (SigFox, n.d. [18]) competing with Australia's Taggle (2019 [19]), which uses low power wide area network (LPWAN) radio technologies for smart IoT infrastructure. This type of technology has its limitations, but it can be deployed on farms where increasing numbers of sensors are necessary. Whilst the Report is extremely important within the entire AgTech ecosystem, it is focussed on the traditional end-user perspective and so may benefit from complementary analysis from other ecosystem viewpoints. Much of the technology that AgTech is predicting a future reliance on is being developed in other sectors with equally lofty market goals.

Connectivity and Reliability

The Report lays bare many of the significant challenges faced by AgTech applied within existing agriculture in Australia, and to some extent globally, from basic “salt and pepper” connectivity issues through to sensor technologies, which farmers are finding are also not working as promised, requiring constant maintenance and upkeeping. Global panacea solutions to connectivity, including low earth orbit microsatellites to reduce, but not eliminate, latency, appear attractive. This requires tens of thousands of satellites with seamless signal transfer between them to address drifting connectivity, superficially establishing a new modern technology marvel. Assuming the technology challenges associated with electromagnetic-field-resistant, reliable, directed beam-forming-based transfer handovers between satellites are resolved, they run the risk in time of facing political and environmental backlash by adding to growing “junkyards” in space (Garcia, 2021 [20]). Further, if not strategically planned for, these high density, large area moving communication hubs may threaten other markets, such as upper atmosphere flight and increased space tourism and travel. Because the upper atmosphere is not territorial and many of these satellites non-geostationary and planning to move over many nations, this requires global support and regulatory coordination — it is not something Australia can do on its own. Further, recent events have shown how vulnerable such a migratory hardware system can be, and there are other significant security aspects that need consideration. From an environmental perspective, astronomers are already lamenting the visual pollution of these clusters. More significantly, perhaps, the introduction of consumer-grade electronic satellites in their thousands is being undertaken with little understanding of the impact on the environment. For example, re-entry into the atmosphere of the recent Starlink mega cluster will introduce more aluminium into the upper atmosphere than that introduced by meteoroids (Boley & Byers, 2021 [21]). Given the increasing importance of climate change, this could end up being the most significant of the existential challenges such clusters bring — certainly, organic farmers may have reason to be concerned if such metals shower on their farms! Limited and flammable lithium battery and solar performances also need to be addressed to sustain practical longevity, requiring a push towards novel technologies and markets, such as Australian-led Silicon Valley start-up Orbit Fab’s refuelling in space (Orbitfab [22]). (Australia’s long consolidation of divesting manufacture to focus on immediately larger gains digging up much of the world’s lithium, rather than benefiting longer term from value-adding, is noted). Optimistically, there are potential opportunities if this approach proves sustainable, but it will require further fundamental research to create them. Of particular note are the international regulatory agreements that need to be in place — these will also both be determined by and influence combined technology network standards, a topic that goes beyond existing technology protocols but which will shape ultimate market-scale solutions. Putting aside these reservations, the Report recognises that, whilst this is seen to address many immediate issues for the agricultural sector with respect to salt-and-pepper connectivity, it does not address all, particularly broadband needs of sensors relying on image analysis.

The Farmer as Technology Engineer

If anything stands out in this Report, and in an impressive fashion, it is the overreliance on the farming communities, both small and large players, to conduct the Research and Development (R&D) in the AgTech space. Much of it is characterised by what seems a very early commercialisation stage. On the other hand, without their enthusiasm, engagement and financing (including founding many AgTech start-ups in Australia), it is questionable if Australian AgTech would exist in any sizeable way. Specific Australian AgTech companies, such as Agritech, have been able to pivot their business plan and technology multiple times to effectively move away from wireless sensor data back to manual USB-stick data collection by a well-trained customer (ABAC, 2021 [6]). This is also an indication of a tolerant, highly engaged customer base within an overall immature technology sector. By contrast, a young highly tech-savvy user in the city will hardly have the expertise, nor patience, to address connectivity issues should their TikTok transmission drop out or slow: this is not expected to ever happen. Many start-ups depend on seamless, near latency-free end-user engagement as a driving measure of their market access, regardless of whether it is narrowband or broadband. Interactive real-time gaming, for example, relies on latency times less than a few milliseconds at best, meaning that even within cities these businesses cannot operate beyond a few hundred kilometres. A reasonable rule of thumb from an investment perspective may be that it would be an unattractive proposition to invest in any technology service provider whose product requires the end-user to be a cooperative and trained expert with no clear end to a business co-dependency. On the Howe Farming Group case study described in the Report (ABAC, 2021 [6]), an investment of $400K on a LoRaWAN system, the farmers have reached their network capacity limits in terms of bandwidth. The increasingly sophisticated sensors, each with their own apps, will need to rely on improved mainstream wireless, which may or may not be compatible with the DIY solution developed by the group. This compares with the observation of a university-led DIY digital farm assessing similar technology with the time required to maintain a system at an operational level, requiring at least two days a week. Both are outcomes that may not instil confidence as working solutions for a profitable business, even before addressing market scalability issues. On the other hand, both clearly view AgTech as a necessary and worthwhile enterprise – engagement has led to a much stronger understanding of what appear to be formidable challenges, a key reason why the education focus of the Report has been on regional training and location.

Toward seamless, reliable and education-free connectivity

For comparison, in telecommunications and data transmission, the expected hardware reliability of fibre deployment is 20+ years, determined by the International Telecommunications Union (ITU) (2019 [23]). These are cables that are laid across oceans (where there is no population) and are expected to have fewer than two catastrophic events over that lifetime because of the extremely high costs involved with dredging and replacing them. The dense populations being served at either end are not enough to economically allow for more catastrophic events. Without such operational lifetimes, a cable business would not be expected to survive. No IoT and therefore no possibility of AgTech would exist if the telecom industry had not moved to unified standards and technologies and, rather, had remained operating with the same salt-and-pepper approach experienced by today's farmers. Reliable, stable, long-term and, importantly, education-free connectivity is an essential longer term goal that ideally drives government policy in this space – what this means is that an adopted policy on education and training in regional towns would be focussed on exploiting the infrastructure to generate new business, and new types of business, rather than regularly maintaining it. The Report concedes this point when it refers to optical fibre access in certain towns having been central to supporting seamless education and banking access; and it calls for greater access to passing cables along the way.

5G and 6G and Low Power Technologies

In the wireless domain, the move to 5G, and in time 6G, and shorter wavelengths is designed to help the IoT, of which AgTech is a part, more generally. It is a much more complex, and costly, technology than prior generations, because beam forming to assist dynamic signal directionality, to reduce power consumption and increase wireless bandwidth, is required. To increase directionality, manipulation and bandwidth, shorter wavelengths are required, meaning reduced antenna spacings and therefore many more antennas to maintain connectivity. Provided a degree of reliability is maintained, this complexity is expected to scale up the IoT and make up for increased cost through higher-volume returns, including for the transmission and network providers. For an IoT solution, it nonetheless relies on a high density of factors, including reliable self-powered sensors, dynamic antennas, signal amplifiers and, importantly, paying populations, all factors that do not favour lower density locations such as farms. The right conditions are usually in cities, where directional beam forming is critical to reducing interference, increasing device selectivity through tracking, and boosting signal power largely to compensate for increasing attenuation in the atmosphere.

In rural areas, the business case for high density distributed and possibly moving antennas, to make up for a potentially increased salt-and-pepper connectivity challenge, is unclear. Fourth Generation (4G) connectivity covers a much wider region, but it is not deployed widely itself, so the case that deployment might increase with 5G and 6G is unclear if sensor and communications power consumption is not reduced, if only to extend both sensor and power-source lifetimes. By contrast, growing popularity in low power networking alternatives such as LoRaWAN (Fewkes, 2021 [24]), arguably designed for regional areas, has recently led to its recognition as a formal ITU standard. Low power becomes important and power extraction from the environment (solar, thermal, motion) needs to be coupled with longevity. Otherwise, rising costs may make sensor-to-optical-fibre connections and to wireless towers attractive over the longer term – power over fibre is already a commercial product that supports distributed sensors without batteries over long distances. In contrast to optical fibre cables, consideration of any potential impact of short wavelength absorption within soils, crops and animals may require special consideration in network design – RF heating of soil can even be used to assist soil remediation (Price *et al.*, 1999 [25]). Similarly, whilst there is an overriding view of the need to have multiple formats for connectivity to address the AgTech sector's peculiar heterogeneity, the market justification means this technology mix cannot be too discontinuous, because cost, complexity, maintenance and upkeep also become heterogenous with high specialisation. Scaling is critical to bringing costs down generally. All these factors mean it is reasonable to conclude that the sector has not yet identified a robust, profitable technology for a stable and dominant service solution to evolve.

More Basic Research and Funding Continuity

From an external observer perspective, in addition to these incredibly valuable field trials, there needs to be more basic research exploring alternative technologies, because the limits of current technologies suggest they appear unlikely to work longer term. The Report recognises optical fibre networks really provide the overall bandwidth, latency and physical reliability that make AgTech possible, but the reach and interest is less than ideal. The National Broadband Network (NBN) only provides limited access into centres of reasonable regional population density and there is a dearth of optical-fibre-based activity in AgTech. One outstanding area that is presently costly but useful for AgTech is the deployment of distributed acoustic sensing (DAS) (Bao, Zhou & Wang, 2021 [26]). It uses transmission fibres for both transmission and sensing of temperature, strain and acoustics on or near a farm or related infrastructure, including within towns. This technology is being deployed in cities using existing active and dark fibre, where statistical analytics interpret and identify incoming signals remotely, generating maps and tracking, for example, moving vehicles (FiberSense [27]). The challenge for agriculture is the up-front costs of installing additional optical fibre in appropriate locations, and certainly an alignment with Internet delivery for other purposes is necessary. Nonetheless, the capabilities offered by such technology, including regional security, would provide additional leverage to justify national and private investment. Interestingly, one of the key US commercial narrow linewidth laser systems (RIO, 2021 [28]) used across a range of industries, such as energy infrastructure monitoring, and suitable for DAS applications, was founded in Australia as Redfern Integrated Optics more than two decades ago. Focussed on telecommunications at the time, the sale of that company supported a dozen other Redfern start-ups demonstrating what is possible within the Australian CRC model. However, the loss of continuity after the CRC demise in its second-phase funding demonstrates Australia's failure to have a continuing R&D approach that builds upon its successes. Instead, it often appears to prefer a string of inefficient stop-and-start, new-theme centres.

Unfortunately, there is an accessibility and upfront cost issue with optical fibre technology that appears to not be present for wireless technologies – a farmer can literally go into a local electronics store and equip a ready-made wireless sensor capability demonstration but cannot readily access any similar capability with optical fibre. Regardless of the other peripheral edge technologies, novel optical fibre solutions can potentially address many of the problems facing towers and satellites. For example, a workable direction is identified in technology proposed by an independent small Sydney start-up: successful electrical-to-optical sensor transduction into an optical fibre, originally intended for underseas communications (Brodzeli, 2021 [29]), can enable a novel connectivity solution on the farm. This retains the current use of sensors and avoids the reliance on wireless reach, another example of a left-field solution developed for other sectors that is critical for AgTech to continue. Importantly, it is a specific example of where government funding may be directed to ensure those kinds of technologies can be accessed and assessed. The challenge of accessibility to solutions such as optical fibre also raises questions about the Report's suggestion that regional-based education and training is a solo solution to addressing existing technology challenges. This ignores the location of other environments that enable vital cross-fertilisation between fields in high population density centres, not only in Australia but globally. Nearly all major universities around the world teach optical fibre communications and many sensing technologies but, unlike electronics, the technology is not easily accessible or affordable to the wider community. Conversely, many short-range IoT solutions that work best in dense cities may not translate profitably in many regional settings, so embracing a stronger symbiosis and understanding between city and regional towns is critical in ensuring access to future leading-edge technologies and solutions that simply will not come from too focussed programs and many businesses alone.

The Role of Research Centres

The Report itself does not mention organisations such as the Food Agility Cooperative Research Centre (Food Agility CRC [30]), who's Chief Scientist is uniquely both an academic and farmer, which in many respects works on the same technologies. An example aimed at extending Zetifi's existing technology being developed by the Food Agility Cooperative Research Centre (CRC), similar to many other active groups world-wide, is turning tractors and other vehicle infrastructure into mobile antennas to help address salt-and-pepper connectivity on the land (Tudehope, 2021 [31]; Powertec, 2022 [32]; Marek, 2021 [33]; Klaina *et al.*, 2022 [34]; Jackson, 2014 [35]). Making smaller and more compact antennas to take on developments in 5G is reliant on metamaterial designs to control transmission, reception, beam shaping and steering, the latter requiring some further progress in tracking in the field. This is an outcome made possible with Charles Sturt University's digital farm. Whilst this may not solve many of the issues that require reliable connectivity to be on all the time, it can help at least permit intermittent collection of data, addressing low signal connectivity spots as they arise, and help Zetifi address strategic connectivity issues. The Food Agility CRC, with its high-level experience and expertise, might therefore be expected to be engaged directly in this policy debate, so its absence raises the perception that greater collaboration is required.

Like many contemporary CRCs, the Food Agility CRC is heavily focussed on addressing targeted problems for specific industry partners, a flavour that appeals to current political mindsets aligned with specific industries' immediate needs. However, escalating rapid disruptive change in technology is raising questions over the longer term effectiveness of this approach. The larger absence of more basic research that is not being led by industry, nor in Australia attracting the investment it does overseas, is a significant issue government must address. Optical technologies, for example, are perhaps the least recognised technology, presumably because of higher upfront costs, accessibility challenges and implementation. This includes not only optical fibres but the increasing presence of optical wireless solutions, such as Li-Fi that, within other sectors, are disrupting traditional longer wavelength Wi-Fi, whether it be between satellites (Ciaramella *et al.*, 2020 [36]; Granath, 2015 [37]), within autonomous vehicles (Ferraz & Santos, 2015 [38]) or indeed within buildings (Li-Fi [39]). Further, the convergence of Wi-Fi and Li-Fi in the spectrum more generally, known as photonics, has been described elsewhere (Canning, 2020a [40]). (This convergence contrasts with optical fibre's unique dominance over any cable technology, so much so that the use of Wi-Fi or Li-Fi might be considered more generally as Fi-Fi: i.e., fibreless fidelity). The bigger picture challenge for research in Australia is why some of our leading space companies pursuing really novel stuff, such as orbital gas stations, continue to have a presence or base overseas, including Silicon Valley (Orbitfab [22]) – scaled money, vision, culture and "action", both technology and business wise, remains very much concentrated overseas. This is an important reason why any government strategic plan to address AgTech needs to be mindful of not losing "intellectual connectivity" to this expertise elsewhere, given its growing value in training and providing opportunities for Australians. This includes overseas capital investment. Along with the fact that most Australian tech. companies will need access to international markets, Australia's overseas landing pads are an extremely valuable resource for those seeking to learn more (Australian Landing Pads [41]). For space tech., this involves very sophisticated collaborative programs and equally important those smaller relationships on the ground – it needs to be the same for AgTech to ensure Australian innovation, adoption and future implementation in next generation technologies is both seamless, world leading, desirable and competitive.

Summary

All this investment and effort in AgTech is broadly viewed as important in being able to address the fundamental salt-and-pepper connectivity issue that is at the core of the challenges this Report articulates. There is also a fundamental longevity issue – maintenance-free connectivity and sensing are crucial. Alternatively, it must be so cheap to install and maintain that maintenance is effectively free. It may be argued that getting this right is more than solving current local problems — as indicated above, technological change is rapid, expanding exponentially for some time but now arguably reaching a critical and transitional uncertainty, unlike any other time in history (Nazaretyan, 2020 [42]).

So, whilst new technologies offer solutions, new solutions are expected to continually disrupt the former — microsatellites as a (partial) solution to addressing the latency issue of traditional geostationary satellites, described in the Report, are one disruptive example. Since they are not in geostationary (Clarke's) orbit, they suffer from intermittent transmission, because they are moving relative to an end user on the ground, a reason why so many are needed to create what will seem like seamless connectivity to a farmer. It is difficult to see, as they are currently presented, that they can be a solitary long-term solution as bandwidth demands increase, creating other challenges that in turn will also need to be addressed. Many existing and proposed AgTech sensor networks may not be fit for purpose. Part of this analysis has had to be discursive to highlight the substantial heterogeneity in the AgTech sector. For example, new developments overseas that may potentially disrupt the central reliance on traditional farming are not anticipated in the Report.

Presently, there is only one technology today that has addressed all these matters and we know it works, because it has given us the Internet and therefore the IoT-enabling AgTech – optical fibre cable. But direct integration of all these on-site technologies (robots, sensors and vehicles) through communications directly to deployed cable alone, if doable, is overwhelmingly costly up front. This cost may be mitigated over time when compared to running and maintenance costs. Cables themselves offer significant sensing capabilities as well as transmission, a valid leverage for further fibre deployment. Further, this sector can also benefit from disruption in the future – for example, the possibility of one day printing your own optical fibres at home on a desktop additive printer and tower exists (Canning, 2020b [43]) — another illustration why basic research to future proof all our sectors must also be part of government policy. In another example, a hybrid solution using a novel fibre-cable-based receiver offered by a new start-up for termite detection and for the defence sector (Oberst *et al.*, 2021–2025 [44]) may offer a more robust alternative for current farm connectivity. Otherwise, many of today's interim solutions potentially need to be either upgraded regularly or entirely replaced every few years, as in the case of Howe's farm mentioned in the Report. This is both a "followers' approach" and costly — for a supplier, the business model has to justify such costs and determine whether an extrapolated market makes it viable. Very quickly, a global market needs to be invoked. For this reason, a matching Report that addresses the technology supply side from overseas all the way to the small businesses hoping to make money in AgTech, as well as agriculture, in Australia may help build a more complete holistic picture of the AgTech sector. Scalability across IoT sectors will be attractive to investors.

The Report has described challenges facing the immediate uptake of smart technology and digitisation on the land, particularly farm-based agriculture. It does so through wide discussions with the customer base of such technology, reflecting an impressive and important awareness of the local technology problems that define heterogeneity in the wider agricultural landscape. It is an extremely valuable Report because, although these challenges may generally be known, the intimacy and impact at the local site lays bare to a wider audience just how inadequate much of the technology solutions are. Certainly, from this author's perspective as a distant observer of agricultural technology from a city, this insight is not often articulated well within many academic and centre presentations on similar topics, where the individuals presenting are not regionally based, nor necessarily representing the latest global trends in technology.

In conclusion, three aspects of policy concern arise from the current approach to AgTech in Australia reflected in the Report. Many technologies, often centred around connectivity issues for sensor networks, are already maxing out and not fit for purpose. There is a tendency to do more of the same, and the fact that many new IoT technologies centred on 5G are optimised for dense populations or dense sensor distributions presents ongoing challenges in this respect. From a market growth perspective, much of the sector relies heavily on farming communities carrying the load of the transformation, requiring a degree of consumer education and knowledge that has little parallel in the city. An underpinning challenge for Australia is to develop Australian policy beyond the economic value of growing the existing local Agricultural sector and addressing the commensurate value of growing the technology that underpins global growth of new, potentially disruptive agriculture. Access to and global participation in the creation of new ideas and new technologies, essential to build resilience to both product and technology disruption, including through multiple markets, remains Australia's key to overcoming the so-called tyranny of distance. This tyranny is not new but knows new forms — an Internet-based classical latency is already impacting security and remote economies based on market-insignificant populations and new tracing and transaction technologies (including electronic currencies) that are increasingly important to agricultural veracity. This means leading low latencies are needed, not compromised second-hand alternatives. Arguably, quantum teleportation (Cacciapuoti *et al.*, 2020 [45]) is the only visible solution on the horizon for a fair, globally connected world and for a fully standardised authentication protocol for future Australian AgTech and IoT products, services and businesses. Australian policy must target agricultural needs identified by the Agri-Tech Expert Working Group, but it must also, in the same breath, fit that into a broader plan that develops future technology continuity and cross-fertilisation and engagement, to ensure what is developed is long lasting and foundational, servicing a shared quality society.

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