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Global Expert Mission
Agri-Tech Innovation in Australia 2019

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Welcome

Innovate UK global missions programme is one of its most important tools to support the UK's Industrial Strategy's ambition for the UK to be the international partner of choice for science and innovation. Global collaborations are crucial in meeting the Industrial Strategy's Grand Challenges and will be further supported by the launch of a new International Research and Innovation Strategy.

Innovate UK's Global Expert Missions, led by Innovate UK's Knowledge Transfer Network, play an important role in building strategic partnerships, providing deep insight into the opportunities for UK innovation and shaping future programmes.

The Agri-Tech Expert Mission travelled to Melbourne, Canberra and Sydney in February 2019 and in this publication we share the information and insights gathered during the delegation's time in Australia.

A full list of the UK and Australian participating organisations is included in Annex 1.

Agri-tech collaboration discussions in the British High Commission, Sydney

The delegation at the British High Commission, Canberra

Executive Summary

There are clear opportunities for collaboration with Australia to address a common challenge in agri-tech.

Potential benefits to the UK include:

1) Access to collaborative, innovative and export-focussed talent and a strong research network.
2) Access to almost every global climate type in one geography (useful for testing, particularly out of season, due to seasonal inversion).
3) Opportunity to learn from Australian approaches such as the IGNITE programme, which focuses on youth engagement, young leader development and support for opinion leaders.
4) Engagement with the Asian market for both agri-food products and tech.
5) Collaboration in the development of satellite applications services and associated enabling technology innovation for domestic productivity gains and high service revenue rewards.
6) Insight into Australia's national data platform developments.

Potential benefits to Australia include:

1) Access to the UK's science and research sector.
2) Access to European markets.
3) Engagement with the Innovate UK business-led funding model for encouraging collaborative R&D through thematic and responsive calls.
4) Access to financial networks and venture capital through the City of London.
5) Access to existing government supported "soft landing" facilities for businesses looking to set up in the UK at various agri-tech and local enterprise partnership facilities, well-located for ongoing international activity with Ireland/the Netherlands/Canada/USA/Israel.
6) Collaboration in the development of the satellite applications sector and value-added services for domestic productivity gains and high service revenue rewards.
7) Insight and potential connections into the UK's Catapult network.

There are also common benefits including the opportunity to build on a shared aim to increase productivity within the agri-tech sector and eventually, although not a direct goal of this mission, increase high-value export sales to other regions of the world. The potential for both Australia and the UK to benefit from collaboration in agri-tech research is very significant, particularly in the areas of robotics and automation, diagnostics, water management and pest and disease resistance (both crop and animal). By connecting research teams and playing to respective strengths, duplication of effort can be reduced, and the potential for dual season testing programmes can be harnessed by both countries. This would speed up the innovation cycle and enhance the return on investment in innovation for both countries. Our shared cultural heritage and strong academic links make this a very realistic proposition, facilitated by modern connectivity.

Both the UK and Australia recognise the potential productivity gains from the application of satellite data and revenue rewards from associated services. Collaborative research and development (R&D) could help both countries to gain a global edge in this area. Potential benefits of Earth Observation (EO) applications include improved decision making about harvest times, future yields, grazing locations, irrigation and targeting of inputs such as fertiliser, fungicide and pesticide. The Global Navigation Satellite System (GNSS) has established use in precision farming and with improvements in positioning accuracy will be pivotal in the uptake of autonomous farm vehicles. Reductions in cost and latency are also bringing attractive communication solutions from space, and with 5G integration, there is anticipation of more hybrid connectivity offerings and satellite-enabled Internet of Things (IoT) systems.

1. Australia Agri-Tech Landscape

1.1 Overview

The cultural similarities between the UK and Australia are one of many reasons behind the long history of research collaboration between the two countries. Whilst the UK and Australia benefit from a strong agricultural research base, it is important to understand the fundamental differences between production systems on opposite sides of the world. These different approaches go some way to explaining our complementary strengths.

Although the land mass (and inherent transport logistics) are orders of magnitude greater in Australia, the gross value of Australian farm production in 2016-17 was AU$60 billion[1] (c £32 billion) - this is not much larger than the £24 billion produced by UK agriculture in a similar period[2]. However, Australian agriculture is very much outward-facing and innovative Australian farmers export about 77% of what they grow. This contrasts sharply with the position in the UK. Whilst we export in several key sectors, the UK is a net importer of food. Australia's farm exports contributed AU$44.8 billion (c £26 billion) in 2016-17, up from AU$32.5 billion in 2010-11. By comparison, the UK's agri-food exports amounted to c £10.5 billion in 2015, if you take out the skewing effect of UK beverage exports (mostly whiskey and tea) which add a further £7.5 billion to the total.

Much of the high quality Australian agricultural products are exported as raw materials. Australia is interested in increasing subsequent food processing, an area where the UK has particular strengths.

The Australian Government is actively highlighting the benefit that "unconstrained digital agriculture" could bring to the economy. A recent report[3] predicts a 25% increase in production (based on 2014-15 levels, worth AU$24.6 billion in national GDP). This opportunity is being seized by the sector which is coalescing behind the Australian Rural Development Councils (levy boards) who are trumpeting "a need for greater leadership in digital agriculture…for digital agriculture policy, governance, strategy and cross-industry collaboration". This aspiration is very much shared in the UK, where the Industrial Strategy aims to put the UK at the forefront of the global move to high-efficiency agriculture[4], but the statistics underline the differences between the two countries in rural R&D spending.

> Projected impact of unconstrained digital agriculture…a 25% increase in production… worth AU$24.6 billion based on 2014-15 production levels

The most obvious differences are the R&D spend as a percentage of farm production, and the huge influence Australian levy bodies have over the commissioning of agricultural research. The UK's levy board, the Agricultural and Horticultural Development Board (AHDB), has a research, development and extension budget of £25 million compared with a £185 million budget at the RDCs in Australia. From what our delegation saw, much more extensive involvement by levy boards in the commissioning of Australian agricultural research results in decisions more driven by the needs of the industry.

Australian and UK agricultural sectors

	Australia[5 6]	UK[7 8]
People employed in primary agriculture	304,200	466,000
Farm production	£32bn	£24bn
R&D Expenditure in agriculture (including public and private investment)	£1.8bn	£0.8bn
R&D Spend as a % of farm production	5.6%	3.3%

[1] National Farmers Federation (Australia) 2016-17; https://www.nff.org.au/farm-facts.html
[2] NFU Report: Contributions of UK Agriculture 2017 https://www.nfuonline.com/assets/93419
[3] Australian Government Dept of Agriculture & Water Resources (2017), Accelerating Precision Agriculture to Decision Agriculture https://www.crdc.com.au/sites/default/files/P2D%20Precision%20to%20Decision%20Agriculture%20Final%20Overview%20CRDC.pdf
[4] UK Government (2018) Industrial Strategy White Paper https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf
[5] National Farmers Federation (Australia) 2016-17; https://www.nff.org.au/farm-facts.html
[6] Council of RDCs, Australia (2018) http://www.ruralrdc.com.au/wp-content/uploads/2018/12/Vision-2050-Brochure-December-2018.pdf
[7] NFU Report: Contributions of UK Agriculture 2017 https://www.nfuonline.com/assets/93419
[8] Defra (2017) https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2016

Australian and UK agri-food sector research, development and extension funding

	Australia[9] (2014-15)	UK[10 11] (2012-13)*
Australian Government	£576m	
UK Government (Defra, DFID, IUK)		£99m
Australian state and territory governments	£152m	
UK Devolved government (Scottish Government, DARD)		£42m
Contribution from universities	£207m	
Research councils (BBSRC, ESRC, NERC)		£179m
Levies	£185m	£25m
Private funding of own R&D	£686m	£500m
Total	£1,806m	£845m
Total directly invested/facilitated by governments	£1,120m	£345m

* Note: This data pre-dates investment from the UK Agri-Tech Strategy, and so does not include investments in the Agri-Tech Catalyst or the Agri-Tech Centres.

Remaining internationally competitive is a huge focus for Australian farmers, achieved through efficiencies and productivity growth. The growth in the farm sector has increased steadily from 1974-75 to 2016-17, consistently out-performing other sectors.

Australia's focus in recent years has been to leverage the quality image of Australian food and wine to become Asia's Delicatessen. This was stressed to the mission by Austrade's CEO and can clearly be seen in Austrade's publications[12].

1.2 Australian Science and Innovation in Agri-Tech

We were briefed on Australian science and innovation in the agri-tech sector by the Science and Innovation Adviser at the Foreign & Commonwealth Office; one of 110 officers of the UK's Science Innovation Network, which is active in over 40 countries. They had previously worked with the Chief Scientist in the Australian government of Malcolm Turnbull, during the period christened his "Ideas Boom", so our delegation benefitted from real insight in this area.

During the briefing we learnt that in Australia, the UK Science & Innovation Network has the following Thematic Priorities:

- Health and life sciences
- Space
- Oceans
- Clean energy
- Food and agriculture.

Upmarket deli at Queen Victoria Market, Melbourne

"Australia's aim is to become Asia's Delicatessen"

[9] Council of RDCs, Australia (2018) http://www.ruralrdc.com.au/wp-content/uploads/2018/12/Vision-2050-Brochure-December-2018.pdf
[10] AHDB (2015) Annual Report https://ahdb.org.uk/reports-reviews
[11] UK Government, Private and public sector funding of agri-tech R&D 2012-13 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/536414/bis-16-17-private-and-public-sector-funding-of-agritech.pdf
[12] https://www.austrade.gov.au/ArticleDocuments/2814/Premium-Food-Capability-Report.pdf.aspx

The Science and Innovation Adviser highlighted the fact that at least half of all Australian University Vice Chancellors are British or British educated (which goes some way to explaining the high levels of informal collaboration between UK and Australian institutions).

There appears to be an opportunity for joint PhD programmes between the UK and Australia. The delegation favoured a more strategic approach of playing to each other's strengths.

We discussed the opportunities to leverage research funding: and we learned later that Australia doesn't generally do big programmes, and that there are only two bilateral arrangements in place (with India and China which date back to the late 90s).

During Turnbull's "Ideas Boom" there was an attempt to replicate, at least in part, something akin to the Innovate UK concept of support in Innovation and Science Australia. We were to learn later in the week that the Innovate UK funding model was not something that has been tried in Australia when we met with Australia's Department of Industry, Innovation and Science. In this round table meeting, our hosts were keen to hear more about our experiences with the Innovate UK model, as it appears there is an opportunity for Australia to develop something similar to support the funding gap between academic research and commercialisation.

Whilst there is an undeniable opportunity for Australia to create something akin to Innovate UK to drive collaboration, thereby helping to bridge the academic/industrial gap, from the Australian universities we met, there seems to be a culture of academic organisations wanting to hold intellectual property (IP) generated. This has the potential to discourage industrial/academic collaboration, for the simple reason that having key IP tied up by a university makes a start-up much less investable.

1.3 Levy Boards

Just as the UK has its producer-led levy boards under the umbrella of the Agricultural and Horticultural Development Board, Australia has Rural Research and Development Corporations (RDCs). There are 15 such corporations representing the main production sectors, the majority collecting a statutory levy from producers, which is in most instances matched by funding from federal government.

The RDCs are:

- AgriFutures
- Australian Eggs
- Australian Meat Processor Corporation

Yarra Valley Farms Food Service Truck, Melbourne

Australians often refer to "The Commonwealth" meaning the Federal Australian Government. This comes from the "Commonwealth of Australia" i.e. mainland continent plus the island of Tasmania and numerous smaller islands, rather than the British usage in which the term "Commonwealth" generally refers to the international association of the UK together with the states that were previously part of the British Empire and dependencies.

Cover of brochure launched at Austrade's Evoke AG networking breakfast

- Australian Pork Ltd
- Australian Wool Innovation
- Cotton Research and Development Corporation
- Dairy Australia
- Fisheries Research and Development Corporation
- Forest and Wood Products Australia
- Grains Research and Development Corporation
- Horticulture Innovation Australia
- Livecorp
- Meat and Livestock Australia
- Sugar Research Australia
- Wine Australia.

These bodies have a range of structures, some more or less producer-owned than others. The RDCs simply commission research, having no research infrastructure of their own, ensuring that the funding delivered remains mobile. When commissioning research at universities, these relationships are further complicated in that the universities themselves are state-owned but receive much of their funding from central government.

1.4 Global Trends

Most of the meetings with Australia's RDCs started by reviewing the following strategic "megatrends" that will impact on Australia's agri-food sector[13]:

- A hungrier world: rising world populations alongside shrinking global agricultural land area.
- A wealthier world: the move from poverty to middle classes (particularly in Asia).
- Choosy customers: high expectations, including certification, traceability and health claims.
- Transformative technologies: digital, genetics, data and sensing.
- A bumpier ride: changing risk profiles due to climate, globalised supply chains and herbicide resistance.

1.5 AgriFutures – Encouraging Thought Leaders in Agriculture

One of our first RDC meetings was with AgriFutures, the RDC which focusses on the future of Australian agriculture. Having a levy board whose specific function is to future-proof the industry was something of a revelation to our delegation.

AgriFutures aims to attract capable people into agriculture, support thought leaders and conduct research and innovation which complements activities at the other RDCs and carry out R&D in sectors which don't have their own RDC (specific examples here were the rice, chicken meat, honey bee and pollination, thoroughbred horse, pasture seeds, export fodder, ginger and tea tree oil industries).

AgriFutures moved to Wagga Wagga in New South Wales and have undergone significant change as part of a re-brand and re-focus. Their staffing now stands at twenty seven plus two new starters in the week we met with AgriFutures. They are co-located alongside Charles Sturt University and a government research farm which has been there since the first world war.

In all, AgriFutures operates in 12 different levy areas and they do have international activity, but this engagement is predominantly academic (particularly gene banks and animal health issues). In the areas (for example, ginger or tea tree) where there is no levy, statute governs what can be done, and much of the market development work undertaken is around helping producers to understand the regulatory landscape. Precision farming is clearly a priority, but issues around connectivity and cost were cited. A rather "mix and match" approach is being taken, but it is very clear that Australian farmers are internet-savvy and well-connected where possible. Satellite communications seem to be the best option for data communications in remote areas (although there appear to be issues with latency and cost). There is 4G availability, but this tends to be close to the arterial routes and drops off as you

AgriFutures discussion, British Consulate, Melbourne

[13] https://www.gov.uk/government/statistics/corporate-tax-research-and-development-tax-credit

get further from the highway.

A successful project to develop predictive models for rice was mentioned, and used as a great sustainability example, delivering impact through a significant reduction in water usage (about 50%). AgriFutures stated that the use of Earth Observation satellite data was in its early days, but they expect it to become important to the management of mass crop production, particularly rice, and the development of prediction models.

There was a short discussion about the commercial tension between the academic desire to publish and the need to preserve intellectual property; clearly these issues are the same the world over!

The development of people is a big part of AgriFutures' mission, with significant funding being funnelled into youth engagement programmes, such as the IGNITE programme, the impact of which became clearer later in the week at the Evoke[AG]. conference, where many sessions were led by future young leaders. Our delegation learned of a sizeable female intake into agri-tech subjects at university, and that STEM subjects were the subject of significant focus by schools. We heard a fascinating report of the rural school with just three teachers, and as part of the drive for capacity building and generational change, even in this tiny school in rural Australia, staff are teaching robotics and coding to under 12s. AgriFutures are also involved in the large undergraduate scholarship programme called "Horizon", as well as the National Rural Women's Award.

Collaboration between Australia and Israel was discussed. This emerged from an initiative called "Project Bridge Hub" and involved the Israeli Embassy. Israeli collaboration would be a theme throughout the mission. There seems to be a real synergy between the innovation cultures in the two countries, and there has been an AU$1 million call launched, which is likely to be very competitive.

There have been attempts to measure the impact of all this good work and set future direction. The latest report by Ernst & Young (March 2019) entitled "Agricultural Innovation — A National Approach to Grow Australia's Future" gives us significant insight into Australia's international approach to agri-tech policy[14]. This outstandingly detailed report was published just after our delegation returned to the UK and examines the approaches in Australia, Brazil, Israel, New Zealand, The Netherlands and the United States, and is very much worthy of study.

1.6 Levy Boards for the Australian Dairy and Beef Sectors

We met with Dairy Australia, another of Australia's Rural Development Corporations (RDCs). We met their Group Manager for Farm Profit and Capability whose career to date has included roles with Rabo Bank and even a two-year posting as an advisor to the Falkland Islands in the sheep and wool sector. This role with Dairy Australia involves responsibility for all pre-farm gate activity. Post-farm processing activity is handled by another team at Dairy Australia.

Dairy Australia is funded by a producer levy of 0.3 cents-per-litre which is matched from federal government.

The Farm Profit and Capability section of Dairy Australia accounts for around 75% of the organisation's activity and is responsible for the pre-farm gate investment that goes into the Australian dairy sector focussed on animal health, pasture management, producer margins etc.

Times are tough for the dairy sector in Australia, with production levels down 6-8% which impacts on the funds available for research commissioning.

Like most of the RDCs, Dairy Australia are not able to lobby government directly, but they do in practice have significant influence by analysis and insight available to active farm lobby groups such as Australian Dairy Farmers. Dairy Australia's levy has been set at the current level for some time, although it would be possible for the board to vote in a change at any point. Systematic annual reviews were scrapped a while ago when it was realised that an annual review process was very costly and, in practice, unnecessary.

We learned that the RDC responsible for beef, Meat & Livestock Australia, has a more challenging mixed portfolio, and the livestock experts in our delegation agreed. There are many areas of commonality between the UK and Australia in areas such as breeding, feeding and sensor technology. We also noted specific expertise in traceability, visual quality assessment and automation for meat processing.

Global Expert Mission meeting with Dairy Australia

[14] https://www.gov.uk/government/publications/innovate-uk-delivery-plan-2016-to-2017

In general, the RDCs set their research policy at a national level for simplicity. The focus is on capacity building: they are a project management organisation, commissioning research by others rather than undertaking research themselves.

International collaborative research is ongoing with three countries:

1) **New Zealand:** there is an MoU in place with Dairy NZ

2) **Ireland:** Teagasc and University College Dublin

3) **USA:** Michigan State University (milk fat depression) and Florida University (heat stress).

For Dairy Australia, their research priorities align with three strategic priorities: Profitable Dairy Farms, Capable People, and Trusted Dairy Industry. These then feed into strategic priorities, set out below:

Strategic priority 01

Profitable dairy farms

- Funding of projects and services (pre- and post-farmgate) that contribute towards improvements to farm profitability.
- Most expenditure and effort is focused on profitability improvement-oriented research, and subsequent extension program development.
- Post-farmgate programs are focused on improving the farmgate price through supply chain cost reductions or stronger demand from international markets.

Strategic priority 02

Capable people

- Activities that directly improve the capability and culture of industry participants, including extension services (the transfer of SP1 knowledge to farmers and advisors) and more general education and training activities.

Strategic priority 03

Trusted dairy industry

Activities that protect the sector's long term right to operate:

- Communication and promotion aimed at maintaining "Social Licence"
- Risk management activity that supports long-term sustainability
- Acting as the "trusted source of data" for the sector

On-farm		
Animal health and fertility Enhanced animal reproductive performance, improve profitability through enhanced milk quality, and promote best practices in on-farm animal husbandry.	2.14	3.8%
Genetics and herd improvement Provide farmers with the ability to utilise genetic gain to improve the productivity and profitability of their herd.	6.04	10.7%
Feedbase and animal nutrition Improve farm profitability and resilience via optimised feeding systems and more efficient feedbase management.	8.76	15.5%
Farm business management (FBM) Build farm business management capability for farmers and advisors through education and the use of business support tools, such as DairyBase.	1.57	2.8%
Farm systems and modelling Support integration and effective use of new technologies on-farm.	1.06	1.9%
Land, water, carbon Build industry capability to manage land, water and energy resources to minimise environmental impact whilst enhancing profit, and improve industry capacity to mitigate climate risk.	3.75	6.6%
Post-farmgate		
International market support To secure a more favourable export market trading environment through trade policy reforms and buyer preference for Australian dairy products.	3.49	6.2%
Manufacturing innovation and sustainability Support innovation in the supply chain that reduces costs and protects longer term sustainability.	0.48	0.8%
Regional extension services Facilitate on-farm adoption of best farming practices, new ideas and technology, particularly those which are the result of DA's investments in R&D.	10.75	19%
People & Capability Facilitating the provision of quality educational programs. Enhancing labour availability by improving the attractiveness of dairy as a career option. Improving on-farm human resource management and helping to facilitate a safety-first culture on-farm.	4.36	7.7%
Industry and community marketing Support the sector's licence to operate through communications and promotion that improves consumer trust in the sector and its products. Build farmer confidence to engage and participate in activities that improve sector profitability and sustainability.	6.86	12.1%
Industry risk and reputation management Protect industry reputation and support sustainability by managing the short- and long-term risks facing the industry.	4.45	7.9%
Knowledge and insights Central collection, analysis and distribution of information that assists stakeholders in their business decision-making and promotes general understanding of the sector.	2.89	5.1%
Total expenditure	**56.63**	**100%**

Dairy Australia's Programme Goals
Source: Dairy Oz 201706 Strategic Plan Summary.pdf

Stakeholder groups perform the vital work of maintaining grassroots engagement. Industrial match funding is sometimes used, for example in the Dairy Bio and the Dairy Feed Base projects which involve industrial partners from the seed sector (e.g. seed companies for ryegrass work or nutrition companies to provide supplements that combat the effect of hot weather).

The overriding priority for Dairy Australia is uptake by farmers, giving them an early-to-market advantage. Securing intellectual property can be challenging, and this can slow uptake. Typically, there would be no royalty streams involved, but they may impose a time-limited exclusivity deal for the technology developer.

Research and development commissioning is on an ad hoc basis, and certainly not on an "open call" basis (as is often the case in the UK). Capability is limited, and dairy R&D is mainly by local collaboration, in particular with Tasmania, New South Wales (with the Department of Primary Industries and Sydney University), Queensland University and Victoria (via Melbourne University). Some funding flows overseas if this represents best value.

The best opportunities for the UK appear to be in working together on an individual project basis e.g. looking at forage mixes or genetics work.

Typically, RDCs encourage collaborative work around a particular topic e.g. irrigation (across potentially diverse sectors like dairy/cotton/sugar). There are examples of match funding from government in areas like variable rate irrigation (there may be a potential opportunity – the UK has technology and modelling expertise in this area).

In genomics, there is a genetics research centre, with all cattle breed societies operating from one building with a central data repository containing all herd testing data, which facilitates sustainability work and reporting (benchmarking). Reporting and benchmarking are seen as the potential big wins for the red meat sector.

Alongside the levy board activity, there are also private providers of genetics in Australia including companies like Interbull. Regarding dairy semen, Australia is open to imports from the USA. However, there are significant inter-state bio-security measures, some of which impact on the livestock sector. As an example (obviously not a livestock one, but illustrative nonetheless) we were told that it would be impossible to drive a truck with GM produce from Victoria to Western Australia via South Australia, since South Australia is a GM-free state.

During 2017/18 the State of Victoria produced approximately 64% of milk in Australia[15] . The state itself is divided into three regions, each having several extension officers who lead discussion groups, organise vocational education and co-ordinate animal health training (with vets) in production disease issues like mastitis.

Whilst vets are employed by rural retailers (e.g. Landmark, Ellwood, CRT), in general, veterinary practices remain largely un-consolidated (in contrast to the UK where this has been driven by the need for economies of scale in drug buying) and are generally owner operated.

The two main supermarkets (Coles and Woolworths) have maintained artificially-low consumer prices on milk (under AU$1-per-litre). There is a drive for quality from manufacturers such as Unilever, demanding standards/ traceability for milk destined for specific ice cream products and there is a significant focus on export markets, mainly skimmed/dried milk powder (which again has traceability requirements). There is regional cheese manufacture, but the dominant product is milk powder exported to Asia. There is also advanced milk processing, with examples of companies (A2 Milk) extracting specific proteins.

The supply chain is generally direct from farm to processor, and there is one remaining dairy producer's co-op on the north coast of New South Wales; everything else is private following a recent scandal[16].

Farm gate milk price is now around AU$5.60/kg.
Milk producers are trading through tough conditions following two good seasons in 2016 and 2017 when spring weather was favourable and there was a good hay and grain harvest. In 2018, however, there was a poor autumn and both hay and grain prices rose from cAU$200 to AU$500/tonne. We learned that this led to around a 30% increase in the dairy feed budget.

The cost of irrigation water is also up, and whilst the dairying area of Gippsland is mostly rain-fed, the Murray River area is river irrigated. Typical irrigation water costs are about AU$7-800/megalitre, and whilst this is sustainable for higher margin activity such as almond production rather than dairying, many dairy farmers are selling out to those wishing to plant almonds.

[15] Rural Industry Futures: Megatrends Impacting Australian Agriculture Over the Coming 20 years. RRDC(2015) Publication No 15/065 Project No. PRJ-009712 www.agrifutures.com.au
[16] http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/innovation/full-report-agricultural-innovation.PDF

There are around 6,000 dairy farmers in Australia. The average dairy farm is 300ha and has 220 cows, mostly outdoor grass-fed.

So far there has been little uptake of robot milking systems and cows are typically out all-year-round. Issues of providing sufficient shade are more of a problem than winter housing, and there are issues of heat affecting foetus size. Feed is generally given at milking, rather than in separate feedlots.

Our delegation included expertise from the space sector, so we were keen to understand more about the extent to which satellite data is being used in the Australian dairy sector. There is uptake, and a specific example is the Dairy Feedbase project on smarter farming. It was explained that there was an interest for more projects in this area and that there is a need for pasture quality and growth monitoring, measurement and prediction to support decision-making for a 28-day management information cycle. For example, this type of information could help determine the likelihood of pasture growth and when to move cattle to a particular paddock. Currently there is a reliance on drones for real-time information and whilst there are timing and cloud issues with Earth Observation satellite data, it is hoped that with ongoing technology developments, these can be overcome.

Images from drones and vehicle/pedestrian cameras are being used to measure pasture density to determine feed wedges; our delegation was interested to hear about the challenge of calibration, and this seems to be a particular problem when the grass mix changes (i.e. not 100% ryegrass).
There has been a relatively low uptake of precision farming techniques by dairy farmers in Australia to date, although there is scope for more deployment of variable rate irrigation systems. Automated patch spraying systems for weeds in grassland is not used at all (and this may represent an opportunity to UK companies who are developing such systems).

It was explained to us that the key technological challenges in the Australian dairy sector are:
- microbial resistance
- lameness (Australian cows walk a long way).

This plays to a broader concern about welfare and a rising trend of animal activism, which mirrors the situation in the UK. Vegetarianism is reportedly at around 25% in Melbourne, with veganism becoming mainstream. The biggest perceived risk among larger producers is the public perception of the industry; the larger holdings are structured to deliver excellent welfare and pay close attention to issues like lameness for production efficiency. However, with squeezed margins, there is a risk that activists might film isolated cases of poor welfare on small farms, which could have a very negative impact on the public perception of dairying.

We learned that bull calves (bobby calves) are typically slaughtered on the farm, there being no veal market and a relatively undeveloped dairy beef sector. Discounts of around AU$200/beast are commonplace if they are not Angus (or just black). The market perceives black animals as producing better beef. Meat & Livestock Australia are promoting work which challenges this by assessing eating quality rather more rigorously. At the same time, there is work on optimising finishing of beef and some Australian farms have adopted a policy of “nothing leaves till it is 12 months old”.
An estimate was shared with us that the national herd could be reduced by 500,000 beasts if dairy beef were to be upgraded. This represents a significant opportunity for UK dairy beef expertise, and for Australia in terms of increased production efficiency and reduced GHG emissions.

Vegan slogans on the pavement in Melbourne

1.7 Levy Boards for the Australian Arable Sector

We met with the Deputy Chief Executive Officer at the Grains Research and Development Corporation (GRDC), which is broadly equivalent to the UK's Homegrown Cereals Authority. GRDC supports the sector by investing in research, development and extension in around 25 crops, but mainly wheat, barley, pulses and canola (oilseed rape).

Our delegation was given a very down-to-earth overview of the sector, and it was explained to us that the bulk of GRDC's funding comes from a production levy of 0.9% matched by a government contribution that is 0.5% gross value of production. GRDC delivers extension services (on farm knowledge transfer), external communications and commercialisation. Outside of this, like Dairy Australia, all research and development is carried out by collaborators. Much of GRDC's AU$198 million of R&D spend is allocated on an open tender basis via a web portal, and very little of this is international in nature (although there is clear engagement with global businesses like Bayer, Syngenta and Limagrain). GRDC's position was described to us as an "active seeker of tech…for the benefit of Australian producers". A good example of the kind of technology relationships that exist would be the relationship between GRDC and CSIRO on traits in various crops, with GRDC utilising the outputs from their genomic selection platform.

In all their commissioned innovation work, the main measures of success for the academics involved are the number of citations and the impact of the commercialisation pathway. This is where the input from the RDCs diverges from the VC funding model. The RDCs are predominantly concerned with uptake of innovation at the farmer level, and whilst they are concerned that farmers should be profitable, it is probably better to use their adaptability as a metric. Fundamentally, though, as our host quipped, "you can't be green if you're in the red!", as he bemoaned the fact that the RDCs don't have the budgets for extension work as they used to (some things truly seem to be the same the world over!)

That said, since we returned from Australia, our delegation has noticed that GRDC launched a new VC fund called GrainInnovate, with AU$25 million from GRDC and AU$25 million from investment management company Artesan.

> "GRDC are an active seeker of tech…for the benefit of Australian producers"

GRDC's Impact for Producers

2. The Australian University Sector

Our delegation visited the University of Melbourne where we met with the Director of Business Development, Veterinary, Agricultural and Food Sciences who explained what he perceived as some of the weaknesses of the RDC funding system citing an inability to fully deliver on cross-cutting technology opportunities. He claimed the university was focussed on entrepreneurs and support, but it is clear that the university wished to withhold access to critical IP, which most of our delegation felt makes projects at the university much less attractive to investors.

This handling of IP appears to be a notable difference in the Australian research and innovation ecosystem. IP is often held by government and/or universities and is licensed to industry for commercialisation. To illustrate the point, we learnt that CSIRO holds in excess of 1,000 patents.

The Director gave his view of the R&D funding landscape in Australia and became the first of many participants to explain to us that business funding for R&D is only really delivered via tax credits/tax relief. He explained that there was a reluctance to follow the crowdfunding model and was surprised when we explained the success of the UK-based Small Robot Company in gaining crowdfunding from farmers.

Our delegation asked about capacity in earth observations, climate and machine learning to deliver insight for agricultural production. CSIRO have significant capability in this area. There is a 90m x 90m soil grid with 25 descriptors available, alongside meteorological data for 40 years. This dataset has been used by the University of Melbourne in fascinating work modelling the anticipated aroma profiles in wine production.

Botanical Gardens at the University of Melbourne

3. Food Innovation

We had a very positive meeting with Food Innovation Australia. FIAL engages with 180,000 businesses of which two-thirds are sole traders (farming for tax purposes), and of the remaining 60,000, 90% are SMEs, so similar to the UK equivalent Food Innovation Network.

FIAL works across Australia at the federal level acting as a "voice of industry" and one of their main remits is to increase the percentage of value-added product being exported.

It was explained to our delegation that there was a need to develop a 10-year vision, identifying knowledge priority areas. It was felt that the Australian agri-tech sector is not working together very effectively to influence policy. To date, it was explained, Australia's main policy focus had been on growth centres, waste, and traceability.

There was criticism that these efforts were not truly focussed on industry problems and that funded work was not necessarily felt to be contributing greatly. However, it was explained to the delegation that the Crop Research Centre (CRC) has been very proactive and set up as a cooperative activity funded jointly by industry and government which is implementing an IoT-approach to agri-food. The twin challenges were cited of how to digitise information and how to put that information into the hands of the farmer.

It became clear that FIAL in no way focuses on investment, but they do react to Australian Foreign Policy to help get industry ready to seize international opportunities. This basic activity is fully-funded by government, whilst industry pays for events and services. Their total budget is AU$3.5 million and there is a team of ten for the country which engages with approximately 180,000 businesses.

Apparently, traceability is becoming more of a political priority, with government keen for the supply chain to implement technology that will cut fraud. Mention was made of a significant fraud in China where more of Australia's premium Penfolds brand of wine is in circulation than is actually produced in total.

Food waste through spoilage in-transit is another big issue. The government is contributing approx AU$150 million to address logistics and cool chain challenges over ten years.

Food Innovation Australia: "Holland's research facilities are outstanding"

Vertical farming was mentioned with interest (with particular reference to Singapore), and there is a sizeable call in this area coming out from the Future Food Systems Cooperative Research Centre in April 2019. This represents an opportunity for the UK.

The conversation turned to the general position on GM production, which it was felt was unlikely to change. It was interesting to note that Holland was referred to as an exemplar, although the ongoing FTA negotiation between Australia and the EU was mentioned a number of times.

Oriental fruit at Queen Victoria Market, Melbourne

4. Satellite Applications

Our delegation benefited from expert space and satellite applications input from Innovate UK's Innovation Lead for Space. They led on the discussions on satellite applications and provided much of the background for this section.

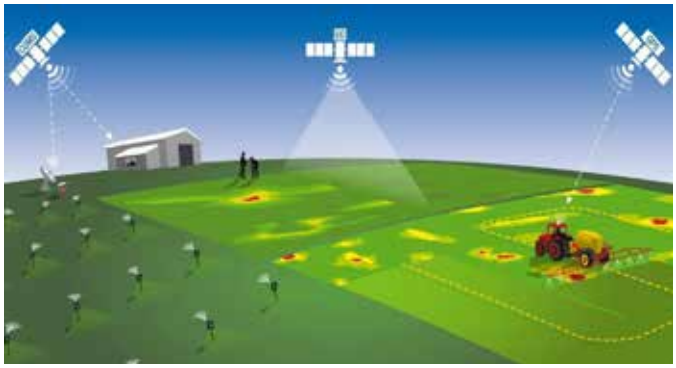
With ongoing advancements in satellite technology, data infrastructure, analytics and other enabling technologies, the agricultural sector can gain increasing value from the use of satellite applications. Earth Observation (EO) applications have the potential to provide significant insight and decision support in the management of crops, pasture and livestock. For example, EO data can provide insight into plant quality, growth, water and nutrient status, and enable pest and disease detection and yield prediction. This can help inform decision making about factors such as harvest times, grazing locations, irrigation and targeting of inputs such as fertiliser, fungicide and pesticide. The Global Navigation Satellite System (GNSS) has established use in precision farming and, with improvements in positioning accuracy, will be pivotal in the uptake of autonomous farm vehicles. Reductions in cost and latency are also bringing attractive communication solutions from space, and with 5G integration, there is anticipation of more hybrid connectivity offerings and satellite-enabled IoT systems.

4.1 Earth Observation

The Australian federal government is showing a strong commitment to stimulating the use of data, particularly within the agri-tech sector. This is illustrated by recent investment, through Geoscience Australia, in a platform to drive the exploitation of freely available EO satellite data within Australia, entitled Digital Earth Australia (DEA). (This is being followed by a similar platform for Africa).

Digital Earth Australia is derived from the Open Data Cube (ODC), an open data source, and embraces the concept of Analysis Ready Data (ARD). This has the potential to enable more industry players to develop value-adding services more efficiently although the level at which processed data is produced is recognised as sensitive, as it potentially risks displacing industry players in baseline data processing activities.

The initial goal at Geoscience Australia (GA) is to raise the baseline of useable data through DEA to improve ease-of-use and enable greater domestic end-user adoption for national productivity gains, particularly in the agri-tech and environmental sectors. By targeting the end-user over the value-adding service provider, there is a risk that SME service providers may not be engaged. Geoscience Australia has explained that they do recognise the value in downstream industry and wish to grow the ecosystem with industry.



Conceptual use of satellites in Precision Agriculture (UK Satellite Application Catapult)

As the platform is focused on freely available data with lower levels of resolution e.g. down to 10m spatial resolution, there will be limitations to capability compared to that of commercial data that can identify detail down to 25cm.

Members of our delegation met with Geoscience Australia and had a good discussion in which shared ambitions for development were identified. Interest was shown in the concept of the Satellite Applications Catapult with whom they are already in contact.

A further data platform developed by CSIRO is their Digiscape future science platform, which also reflects recognition for the value of integrating a range of data sources and for the availability of accessible, interoperable data sets.

There is a broad recognition across the RDCs that EO satellite data (together with other data sources) can help solve a number of the more intractable challenges across the agri-tech sector.

Dairy Australia, for example, explained that there is a need for pasture quality and growth monitoring, measurement and prediction to support decision-making for a 28-day management information cycle. This can help determine the likelihood of pasture growth and when to move cattle to a particular paddock. Reference was made to smarter feeding projects and an interest in more development projects in this area. Currently there is a reliance on drones for real-time information and whilst there are some timing and cloud issues with EO satellite data, it is hoped that with ongoing technology development, these can be overcome.

AgriFutures stated that the use of EO satellite data was in its early days, but it is anticipated to become important to the management of mass crop production, particularly rice, and the development of prediction models.

The development of EO falls into two parts: advancements in i) upstream technology and ii) downstream data analytics and application. With advances in the miniaturisation of electronics, better optics systems, power capture and storage and communications systems, the technical specifications and capabilities of EO satellites continue to improve. These advances translate into increasing resolution and frequency of data as well as lower costs. It is advances in data infrastructure, data integration, associated enabling technologies and their application that then enable greater data exploitation.

The UK is investing in EO satellite technology development as well as project-based application development and is creating a comprehensive downstream ecosystem. The UK is also stimulating commercialisation of EO services. The Satellite Applications Catapult has been established to help catalyse application use across a range of vertical sectors including agri-tech, and this is a model which is of interest to Australia. Both the UK and Australia are investing in artificial intelligence (AI) which will help unlock the potential of earth observation at scale.

Whilst the satellite applications sector receives public funding in both the UK and Australia, there are an increasing number of UK companies that are commercialising. This may in part be due to the UK's business-led model of R&D funding. Hummingbird Technologies Ltd is a good example of a UK precision farming company that has expanded operations to Australia and is successfully applying satellite and drone data together with AI techniques, to the benefit of both countries.

4.2 Positioning, Navigation and Timing

The Australian government is funding the development of an Australian Satellite Based Augmentation System (SBAS) and upgrading the ground infrastructure required to deliver this. Once operational it is expected that positioning accuracy will be within 10cm generally, and 3 to 4cm where there is mobile coverage. This is expected to provide greater precision for in-field guidance and will be pivotal in the uptake of autonomous farm vehicles.

4.3 Satellite Communications

Australia continues to experience challenges with rural communication coverage. There were mixed reports about the merits of current satellite communication offerings with some stating that they can still present issues with latency and capital cost. It is recognised that current and future developments in satellite capabilities and the associated reductions in cost will bring increasingly attractive connectivity solutions from space.

Thought leaders in the UK expect satellite-enabled IoT systems, that support lower data rates in real time, to become prevalent with the development of smaller, low-power, less expensive sensor devices and integration with 5G networks. It is also thought that the development of integrated hybrid receiver devices that are able to connect to satellite, cellular, Wi-Fi and eventually high-altitude platforms will increase the overall reliability of communication signals and strengthen the role of satellite communication.

4.4 Other Initiatives

SmartSat Cooperative Research Centre (CRC)

Since the UK mission in February, the new SmartSat CRC was announced in April. This is backed by AU$110 million – a 50:50 funding arrangement between participants (more than 80 organisations and companies), and the federal government together with an additional AU$130 million that is coming from in-kind investments of people, infrastructure and satellite time.

The centre will be focusing on three key areas: advanced communications, connectivity and IoT; advanced satellite systems, sensors and intelligence; and next-generation earth observation data services including onboard artificial intelligence. The aim of the CRC will be to "ensure Australia can execute a technological leap-frog to deliver smart satellite systems that are Australian-designed, owned and operated and that will deliver the nation real-time

[17] https://www.dairyaustralia.com.au/industry/production-and-sales/milk

connectivity, surveillance and sensing capability over land and sea". Professor Andy Koronios, centre CEO from UniSA, told InnovationAus.com. "This is the biggest space research collaboration in Australia's history. We see ourselves as the R&D engine for the (Australian) Space Agency's objectives."[17]

Protection of Space Assets

A few people conveyed Australia's interest in developments to protect space assets, but we received no further detail on this during the trip.

Group on Earth Observation Ministerial Summit

There will be a GEO Ministerial Summit in Canberra in November 2019, and this could represent an opportunity for UK businesses to showcase commercial success in this area.

Existing UK/Australia Space Relationships

- UK and Australian Space Agencies

The UK Space Agency (UKSA) signed an MoU with the Australian Space Agency in 2018.

- NovaSAR

The Australian Space Agency is accessing data from NovaSAR, a radar satellite manufactured by UK's SSTL (Surrey Satellite Technology Ltd) with funding from the UK.

CSIRO and the Satellite Applications Catapult also share capacity in NovaSAR, and are working collaboratively on ground segment and exploitation activities.

- UK's Satellite Applications Catapult

The Satellite Applications Catapult are currently:

  - Partners with CSIRO, Frontier Si and GA in the Open Data Cube. The Satellite Applications Catapult is the current chair of this group.
  - Working collaboratively with CSIRO and GA on African Regional Data Cube activity through the Global Partnership for Sustainable Development Data (GPSDD). This has led to the recent announcement around Digital Earth Africa.
  - Sharing capacity with CSIRO in NovaSAR, and are working collaboratively on ground segment and exploitation activities.
  - Collaborating with GA, CSIRO, Australia Bureau of Meteorology, Joint Remote Sensing Research programme, Australian Space Agency and others on developing the concept for an Asia-Oceania Data Hub through Asia Oceania Group on Earth Observation System of Systems (AOGEOSS).
  - In partnership with SmartSat CRC on development opportunities.
  - Involved with GA and CSIRO through the Committee on Earth Observation Satellites (CEOS) which is the international coordination of civil space-based Earth Observation.
  - Working with GA and CSIRO on a potential Digital Earth Pacific project linked to Common Sensing.
  - Pledging support into a CSIRO SAR science programme.

In 2016 the Satellite Applications Catapult signed a Heads of Terms with Australia's Cooperative Research Centre for Spatial Information for a five-year joint initiative/R&D programme relating to spatial information applications and big data technology issues. This involved a shared objective to encourage industry to capitalise on EO data, particularly SAR (Synthetic Aperture Radar). This was set up as part of a wider collaborative project "Collaborative SAR Solutions for Australia" which was funded by UKSA and the Satellite Applications Catapult and included three partners in Australia – Geoscience Australia (GA), Cooperative Research Centre for Spatial Information (CRCSI) and the Commonwealth and Scientific Industrial Research Organisation (CSIRO).

Following the above agreement, a project was carried out by the Satellite Applications Catapult, CSIRO and two other partners under the UKSA's International Partnership Space Programme (IPSP) in 2016 called the Australia Agriculture Showcase Project. This investigated the feasibility of EO derived services/products available through a geospatial data infrastructure (i.e. Data Cube) for the Australian agricultural market.

5. Evoke^{AG} Conference

Our delegation was privileged to be delegates at this outstanding event. Everything about Evoke^{AG} highlighted the ambition in the sector, from the crisp execution of the Evoke branding, to its global reach (delegates from around the world with particular representation from the US and Israel).

Global Expert Mission Team arrive at EvokeAG conference, Melbourne

The venue at Melbourne's Royal Exhibition Building, a UNESCO World Heritage Site, leant something of a "great exhibition" feel to proceedings and the contrast between the achingly-modern delivery by a very slick events crew and the air of Victorian splendour and optimism from the building itself made this a truly impressive event delivering clear thought leadership.

Pictures included in this section illustrate the activities, but the excellent Evoke^{AG} website www.evokeag.com is to be recommended and has an immersive video which gives an even better impression of what was achieved. The event included plenary sessions with investors, tech developers and outstandingly confident and articulate young farmers. The breadth of involvement made it a great introduction to Australian agriculture. The event included a "start-up alley"

of credible tech start-ups from a range of agricultural sectors seeking investment. The exhibition area included a range of funded tech accelerators, companies, universities and levy bodies. There were plenary sessions with thought leaders from around the world. AgriFutures had made an excellent job at encouraging youngsters from around Australia to participate in the debate about how we are going to manage resources in order to feed the world.

There were opportunities for entrepreneurs to pitch for seed funding. The range of technology on offer was similar to such events in the UK, including ear tags, mobile fencing, soil testing and farm liquidity offers. Most of the entrepreneurs had received some support from tech accelerators, even if they had not been direct recipients of funding.

The key areas on show were biotech, AI/robotics, vertical farming and alternative protein, all showing very rapid growth and mostly free from the ties to seasonal agriculture. Spraying from Yamaha's unmanned helicopter was an interesting addition (UK regulations do not permit this at present).

Satellite applications also featured in the exhibition area. Geoscience Australia and CSIRO were present and are in the early stages of promoting their respective platforms which make use of earth observation capabilities to help farmers increase productivity. There were a few companies also promoting applications of earth observation and satellite communication.

In short, Agriculture 4.0 was the predominate overarching offer and generally aligned well with the needs of the UK. Around 40% of the venture capitalists we met were from the US Bay area and very digital focussed. Potentially Australian agriculture is not taking the global view needed to attract strong VC funding, and (in common with the UK) the conservative farming culture may need to evolve further to address this. However, Evoke[AG] is attempting to challenge stereotypes.

Whilst at Evoke[AG], there was very little mention of business angels becoming involved in agri-tech, which is a growing trend in the UK. "Lots of nice start-ups but not VC potential" seemed to be the prevailing message, although since returning to the UK our delegation has since learnt of www.agthentic.com , which is in setup, and is intending to be Australia's first agri-tech VC.

General view of the Evoke[AG] conference, Melbourne

Precision farming and demonstration/research facilities on display at Evoke[AG]

On-farm innovation is the key theme on the GRDC stand

5.1 New South Wales and the GATE (Global Ag-Tech Ecosystem)

New South Wales' Department of Primary Industries has set up a collaborative research and technology facility specifically designed to develop agri-tech called the GATE (Global Ag-Tech Ecosystem). Our delegation met with key members of the GATE team. The GATE is based in a small town called Orange, NSW, and their model is one of specifically bringing together researchers and entrepreneurs in an environment which encourages tension between rigour and speed. The GATE is relentlessly focussed on return-on-investment, which was refreshing; they exist to incubate, accelerate, invest and commercialise. Very importantly, they do not take an IP position (in contrast to some of the universities our delegation spoke to).

Our delegation meeting the GATE, New South Wales agri-tech accelerator

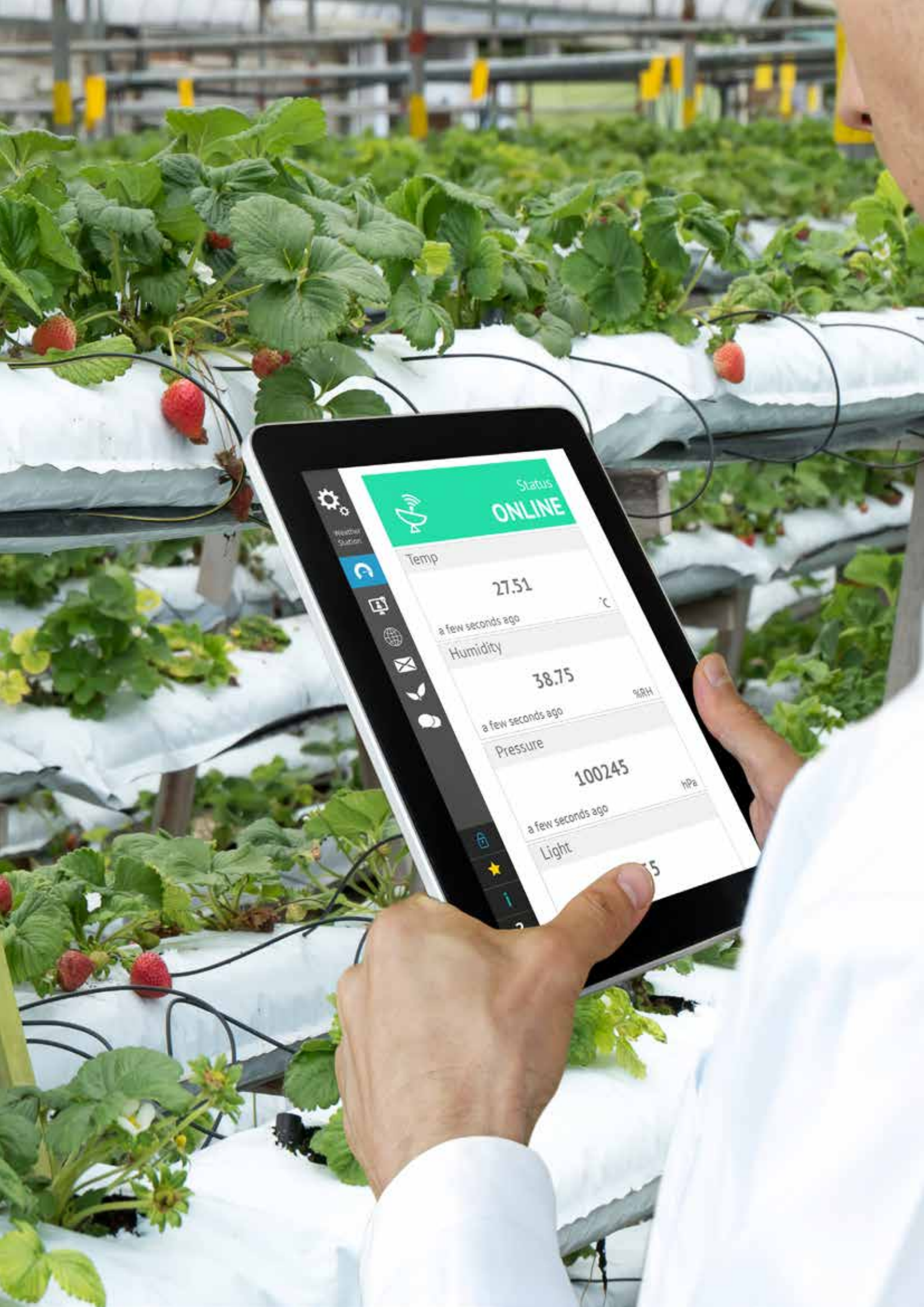
Annex 1

List of UK Participants

Agri-EPI Centre	www.agri-epicentre.com
Dunbia	www.dunbia.com
Elsoms Seeds	www.elsoms.com
Innovate UK	www.gov.uk/government/organisations/innovate-uk
Knowledge Transfer Network	www.ktn-uk.org
Precision Decisions	www.precisiondecisions.co.uk
Quantech Solutions	www.quantechsolutiosn.co.uk
Satellite Applications	www.gov.uk/government/organisations/innovate-uk
Science and Innovation Network Australia, British High Commission, Canberra	www.gov.uk/world/organisationa/british-high-commission-canberra

List of Australia Participants

The Council of Rural RDCs
CSIRO
Dairy Australia
Department of Industry Innovation & Science
Food Innovation Australia Ltd
The GATE project, NSW Department of Primary Industries
Geoscience Australia
Grains Research and Development Corporation
Horticulture Innovation Australia
Innovation and Science Australia
Meat and Livestock Australia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