



## Building Innovation Communities





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by Professor Dame Ottoline Leyser 3

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# Foreword

**This booklet describes a project aimed at building the community necessary for effective innovation in the potato supply chain. It arose from a policy round table hosted by the University of Cambridge Centre for Science and Policy (CSaP), which focused on the challenges to delivery of the UK Agri-tech Strategy. The complexity of agricultural supply chains and their associated value chains makes it difficult to identify the most important opportunities for improvement and to engage the relevant parts of the research base to tackle them. Multiple stakeholders from across the supply chain and the research base must work together in different combinations as an innovation community. This differs significantly from the more linear model for research translation that can be effective in industries with less complex value chains.**

Given the many demands on the time of the relevant players, finding time-efficient ways to build the necessary innovation communities is essential. One approach is to broker the initial interactions needed through a structured Roadmapping approach. Because of the local expertise available, the potato supply chain was selected to test this model. The results are presented in this booklet.

The project involved a structured series of work packages that mapped the potato value chain, engaged diverse industrial stakeholders to prioritise the opportunities to add value, aligned these with research expertise, and brought together industrial and research base participants to design specific projects of relevance to the prioritised opportunities. Funding to support pilot work was awarded to two of these projects.

Bringing the project to this stage has involved many people and organisations across Cambridge and East Anglia. I would particularly like to thank Belinda Clarke and Agri-Tech East; Mariana Fazenda and Maria Huete-Ortega and the CambPlants Hub; David Almond and the Cambridge University Potato Growers Research Association (CUPGRA); David Firman and Simon Smart and the National Institute for Agricultural Botany (NIAB); Jacqueline Garget and Howard Griffiths and the Cambridge Global Food Security Initiative; Carlos Lopez-Gomez, Michele Palladino, Imoh Ilevbare, and Nicky Athanassopoulou and Policy Links and the Centre for Science Technology and Innovation Policy at the Institute for Manufacturing; Kate Parsley and the School of the Biological Sciences Bioscience Impact Team; and James MacDonald for the workshop reports.

The second workshop was supported by the Isaac Newton Trust, and the final work packages and pilot projects were funded by the Biotechnology and Biological Sciences Research Council through their Agri-Food Technology Seeding Catalyst Award.

This is, of course, just the beginning. The ultimate goal is to establish sufficient connectivity in the system to support collaboration, knowledge exchange and innovation into the future. The growing momentum in Agri-tech in Cambridge and the wider Eastern Region provides optimism for success.



**Professor Dame Ottoline Leyser**  
**Director, Sainsbury Laboratory**  
**Cambridge University**

February 2018

# Introduction

In 2013, the UK government published its Agri-tech strategy with the aim that the UK “become a world leader in agricultural technology, innovation and sustainability; exploit opportunities to develop and adopt new and existing technologies, products and services to increase productivity; and contribute to global food security and international development.” Various mechanisms and funding streams were established to improve the translation of research into practice and the rapid adoption of new practices. The strategy starts in the translational “pipeline.”

However, the Agri-tech landscape is complex and includes many different disciplines as well as diverse stakeholders. This can lead to a situation where either communication between the relevant subset of actors is insufficient to support innovation, or the benefits of innovation are too thinly distributed to catalyse it. It seems then that what is needed is not a translation pipeline, but more of a translational “cat’s cradle”, in which flexible and dynamic consortia can be assembled and supported to address particular translational priorities.

Building on successful models from other sectors operating in the region, Agri-Tech East was put in place to develop the networks needed by the emerging Agri-tech sector. There are now a number of mechanisms to facilitate action.

The University of Cambridge is home to an exceptional diversity of high quality research relevant to agriculture, including plant science, engineering, information technology, systems modelling, and management and business practice. It is located in a region with superb research and translational centres highlighted in the Agri-tech strategy, such as NIAB, the John Innes Centre and Rothamsted Research. Moreover, the East of England region is rich in end users for Agri-tech innovation, with arable farming and horticulture as major industries. This creates an extraordinary opportunity to test out the translational “cat’s cradle.”

A Cambridge University Policy Workshop in 2016, chaired by David Willetts brought together senior researchers, policy makers, and agricultural sector representatives, to discuss ways to make that ambition a reality. The workshop was led by Professor Ottoline Leyser, Director of the Sainsbury Laboratory Cambridge University, and organised in partnership with Dr Tina Barsby, CEO of NIAB, and Dr Belinda Clarke, Director of Agri-Tech East.

The potato industry was chosen for a pilot project, given the leading capabilities in the industrial and research communities in the Cambridge region. The project was established as a cross-disciplinary initiative of the University of Cambridge, with the participation of the following project partners:

- Agri-Tech East
- CambPlants Hub
- Cambridge University Potato Growers Research Association (CUPGRA)
- Cambridge Global Food Security, a University Strategic Research Initiative (GFS SRI)
- Centre for Science, Technology & Innovation Policy (CSTI) / Policy Links
- School of the Biological Sciences Bioscience Impact Team

## Pilot Project Aims

Ensuring that academic research is translated into business outcomes remains an elusive target. Industrial and R&D communities host diverse actors, each with their particular technological focus, challenges and priorities. There is often a lack of clarity as to how these diverse communities might benefit from each other. As a result, opportunities to align industrial and R&D strengths and pursue higher value-added opportunities are often missed.

This pilot project aimed to identify and support increased value capture in the potato industry through innovation. In particular, it sought to:

- Reveal opportunities to pursue higher value capture across the potato value chain;
- Articulate the capabilities required to address such opportunities;
- Identify research opportunities to address such capability challenges, as well as potential partnership opportunities between UK businesses, university researchers, and other relevant stakeholders.

## Methodology

The project partners identified the need to develop a systematic process to align business opportunities and research capabilities relevant to the potato industry. It was agreed that a single workshop would not be enough to bring together both industrial and research perspectives, given the diversity not only in areas of specialisation but also in language and particular interests. The table below summarises the work packages that were defined for the project.

Work package	Activities
<b>WP1</b> <b>Mapping value distribution in the potato value chain</b>	<ul style="list-style-type: none"><li>▪ Review of economic data and studies on the UK potato industry</li><li>▪ Mapping value distribution across potato value chain</li><li>▪ Initial mapping of potato innovation ecosystem of interest</li><li>▪ Review of previous studies on value capture opportunities along the potato value chain (including inefficiencies)</li><li>▪ Selected interviews (e.g. to agronomists)</li></ul>
<b>WP2</b> <b>Industry Workshop (entrepreneurial discovery)</b>	<ul style="list-style-type: none"><li>▪ Validation of value capture opportunities</li><li>▪ Characterisation of industrial challenges – and prioritisation</li><li>▪ ‘Inventory’ of tools and techniques relevant to industrial challenges</li><li>▪ Initial list of relevant R&amp;D domains</li></ul>
<b>WP3</b> <b>R&amp;D Domain Mapping</b>	<ul style="list-style-type: none"><li>▪ What are the priorities? What are the challenges?</li><li>▪ Validation of relevant R&amp;D domains (efforts will be made to identify relevant competencies outside the Agri-tech sector)</li><li>▪ International benchmarking of research and innovation strategies</li><li>▪ Identification of areas of perceived Cambridge strengths</li><li>▪ Initial list of potential partnership/collaboration opportunities</li></ul>
<b>WP4</b> <b>R&amp;D Alignment Workshop Opportunities for Cambridge</b>	<ul style="list-style-type: none"><li>▪ Validation of partnership/collaboration opportunities – and prioritisation</li><li>▪ Making it happen – business and research cases</li></ul>
<b>WP5</b> <b>Synthesis</b>	<ul style="list-style-type: none"><li>▪ Synthesise the key features of a process to more systematically align business opportunities and research capabilities</li><li>▪ Define future steps</li></ul>

These work packages were carried out through the course of 2017; their outcomes are reported in this booklet.







## **A: Policy Workshop Report**

### **Innovation in agriculture:**

supporting and catalysing a translational cat's cradle

**13 May 2016**

**Sainsbury Laboratory Cambridge University (SLCU)**

**Building on our strong foundations, what are the big opportunities to deliver on the aims of the Agri-tech strategy? This workshop seeks to explore this question in the context of the rapidly developing plans for the new Cambridge Centre for Crop Science (3CS). 3CS is a collaboration between NIAB and the University of Cambridge that will enhance research in crop sciences, promote knowledge exchange and develop resilience in food security. Planned development of 3CS encompasses a new, state of the art, physical centre and laboratory, based at NIAB in Cambridge, which will serve as a hub for crop science research. A new Professor in Crop Science will direct the Centre and lead a programme of international exchange and collaboration.**

## Summary

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There is a great opportunity for the East of England to become the global go-to place for agricultural innovation given its excellent research centres, its inter-disciplinary strength in relevant areas of its universities and institutions, its publically funded Agri-tech centres, the scope for experimentation in startups combined with experienced vertically-integrated companies, and a strong agricultural sector.

Nevertheless, important challenges remain. These include residual frustration with the difficulties of realizing collaboration and remedying fragmentation, a lack of clarity over where agricultural innovation will add value in the supply chain, the weakening of UK applied crop research in previous decades as well as flagging agricultural productivity, and various gaps in expertise and leadership at different points of the 'translational cat's cradle'.

To ensure that these challenges can become opportunities for the new Cambridge Centre for Crop Science (3CS) there is a need to adapt the correct translational model and concentrate on a few key real world problems that emerge from agricultural practice but are also able to inspire the scientific community.

## Next Steps

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1. There was agreement on the need to organise a flagship interdisciplinary project, a "rallying call" that locates and centres on a concrete problem in agriculture and catalyses scientific intervention. Capturing the right level of granularity is important here and there is a strong argument for 'superlocal' partnerships.
2. There was a strong argument that mapping the supply chain for a specific crop would be an important first step

in identifying opportunities for concerted action. Potato emerged as a strong candidate crop for trial mapping as a commercial, physiologically and agronomically complex crop. Beetroot, beans and wheat were also discussed.

3. The chair suggested that it would be useful to invite George Freeman MP to attend any follow-up event that will discuss the progress made in the first two points.

## Discussion

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### The Relationship between Agriculture and Science

- Attendees from the farming sector pointed out that currently farmers are having lots of technology thrown at them, rather than being the initiators of technologies that have a narrow remit to address specific problems. This needs to be reversed.
- There is a need for greater leadership from the farming community in articulating their Agri-tech needs.
- The differences between the farming and scientific communities were highlighted. While one finds enthusiasm and funding opportunities in scientific research, the farming community is aging and under-resourced. A culture of innovation doesn't always fit neatly with the agricultural sector, whose basic unit is often the family farm.
- The need for effective intermediary bodies that can mediate between 'coal-face' agriculture and innovative science was emphasised. At the same time, there was a suggestion that rather than a simple two-way science base/user relationship, we need to account for a range of actors diffusing innovation in different ways.
- In the relationship between agriculture and science, the need for two-way communication and translation was emphasised. Science must be explicable and relevant to farmers, but real-world challenges and opportunities in the agricultural sector must also be translated into problems that scientists can grapple with and get excited about.
- The current models of funding, success and advancement for academics in science (e.g. the focus on publications) potentially work against changes in the direction of greater industrial collaboration and entrepreneurship.



## Mapping Value Creation

- Greater clarity is needed on locating where value will be added in the chain from research to sale in the agricultural sector.
- Conducting value chain analysis on a particular crop as embedded in a system could be a useful exercise as a way to explore what academic and scientific competencies are needed to address challenges. Nevertheless, systemic problems, such as the lack of crop rotation, might remain.
- Agriculture is only an emerging area of interest for top engineers, and this is partly due to difficulties in identifying where value can be added and contracts easily arranged.
- Aerospace was suggested as an example of an industrial sector where the supply chain between research and sale, as well as the points of value creation, were much clearer. Might Agri-tech learn from this example, and could national bodies and academies play a role in identifying points where scientists can usefully intervene?

## Funding

*There was discussion about the strengths and weaknesses of current funding arrangements for crop science and Agri-tech collaborations:*

- There are opportunities at Cambridge for combining blue-skies research with more applied science, supported, for example, by the Newton Trust.
- The agricultural board levies were considered as a potential source of funding but these are insufficient and small in comparison to other countries.
- There is a willingness of the government to invest in the sector, as evidenced by the £68 million invested in Agri-tech and the creation of various Agri-tech bodies. However, part of the argument for obtaining this funding was that it would generate a virtuous circle of private investment. Further funding will need proof that this is happening.
- The possibility of industry partnerships (such as with Pepsico or Unilever) was discussed, with the advantages (available funding, interest) being weighed against the drawbacks (potentially undesirable business model, substantial legal costs and time commitments for partners).
- Private investors are interested in investing in innovation in agriculture in the East of England but increasingly want a 'deal' with a clear exit embedded: software and app development are no longer as attractive.

## Successful Models of Integration

*A discussion of the best model for optimising relationships in a complex multi-stakeholder, multi-disciplinary environment took its cue from the workshop title suggesting not a translational 'pipeline' but rather a 'cat's cradle'. A range of different case studies and models at a variety of scales were considered, especially in the context of discussing how 3CS might function effectively:*

- There was recognition that rather than a model of high returns selling products to farmers, what we were dealing with here was potentially a more complex case of thinly distributed profits and the transformation of agricultural practice.
- The model of vertical integration for sector businesses was lauded, where great scientific endeavour is combined with the provision of something for everyone down the supply chain. Vertically-integrated companies can also be useful in stopping blockages by 'middle-men'.
- A model that can overcome the initial activation barrier is needed, such as a low-cost super-local project with a farmer (a parallel case was Engineering's bio-engineering collaboration with Addenbrooke's) or with someone from further afield but with more funding.
- The suggestion was made that perhaps the ideal model was not necessarily a business case at all; sometimes there is a public (or collective/group) good but no profitable way to internalise the benefit from a piece of research. In such cases a greater role for government is required.
- At a national level, it was argued that the countries that do well in integrating agriculture-centred research with commercialisation and practice have either retained government investment (eg. Australia) or have substantial industrial investment (eg. US, Holland). Is it possible to reassemble without these top-down dominant drivers?
- Within the UK, different case studies of effective collaboration were discussed. G's have been involved in successful collaborative research with Microsoft on lettuce and have projects in the pipeline with the Department of Engineering. Velcourt are engaged in a range of technical collaborations, such as remote soil sensors (University of Cambridge) and real time blight detection (Rothamsted).

## Participant Quotes

"We know a single silver bullet doesn't exist to help solve the numerous challenges facing the global agriculture and horticulture industries. However, by bringing together innovations and expertise from different disciplines, new insights, approaches and solutions to those challenges now become feasible. We collectively have an unprecedented opportunity to catalyse those new partnerships."

**Dr Belinda Clarke, Director, Agri-Tech East**

"It is necessary to turn it around so that the farming industry is contracting technology providers to address key problems that have a narrow remit. At the moment it is the other way round, with lots of people piling in with technologies and looking for applications. This is too slow, too fractured, too unstructured. There is a perception that all this stuff is irrelevant to practical agriculture...to the farmer in the field."

**Robert Allen, Research Manager, Greenvale AP**

"There is a need to identify what areas in agriculture are high value and focus upon them. What are the commercial opportunities, and what are the challenges with regard to being competitive in that space? What capabilities do we need, and what technical competencies do we need to put together to be able to have those capabilities? At that point you are able to ask what we can get out of the scientific base that can contribute to those competencies and find its way back to the opportunities and competitiveness challenge."

**Dr Eoin O'Sullivan, Director, Centre for Science, Technology & Innovation Policy, University of Cambridge**

"The event showed how big the challenge is, because the distance from one end to the other is long. And it needs real facilitation, real skill in integrating knowledge so that one person can talk to another with meaning."

**Roger Sylvester-Bradley, Head of Crop Performance, ADAS**

"The Department of Engineering has identified Agri-tech as a key area and we are on the brink of getting some really good projects off the ground. We need those breakthroughs and we need to celebrate them. We need pioneers; pioneering academics to put in a bit more time and effort to understand an area with which we are unfamiliar, to understand the language and the issues, and to work with colleagues in different disciplines to get key projects off the ground."

**Phillip Guildford, Director of Research & Finance, Department of Engineering, University of Cambridge**

"This event shows that the 3CS initiative has got real roots and that we are in business – both literally and metaphorically – in the sense of representing applied interests and pure research interests and being able to use that knowledge to engage with the agricultural industry. It has given us a clearer idea of the work that we need to do to facilitate the kind of engagement that is required. That's the key thing."

**Professor Howard Griffiths, Department of Plant Sciences and Co-Chair of the Cambridge Global Food Security initiative, University of Cambridge**

## Attendees

- **CHAIR: Rt Hon. Lord David Willetts**, Resolution Foundation
- **Robert Allen**, Research Manager, Greenvale AP
- **Dr Tina Barsby**, CEO, NIAB
- **Dr Belinda Clarke**, Director, Agri-Tech East
- **Professor Achim Dobermann**, Director & Chief Executive, Rothamsted Research
- **Dr Rob Doubleday**, Executive Director, Centre for Science and Policy
- **Dr Mariana Fazenda**, Innovation and Enterprise Officer, Department of Plant Sciences, University of Cambridge
- **David Flanders**, CEO, Agrimetrics
- **Tom Green**, CEO, Spearhead International
- **Professor Howard Griffiths**, Department of Plant Sciences, University of Cambridge
- **Phillip Guildford**, Director of Research & Finance, Department of Engineering, University of Cambridge
- **Professor Ian Hodge**, Department of Land Economy, University of Cambridge
- **Nick Joicey**, DG for Strategy, International, Food and Farming, Defra
- **Charlie Kisby**, Innovation Director, G's
- **Ben Lang**, Department of Land Economy, University of Cambridge
- **Professor Ottoline Leyser**, Director, Sainsbury Laboratory Cambridge University
- **Professor Graham Moore**, John Innes Centre
- **Keith Norman**, Technical Director, Velcourt
- **Patrick O'Hare**, Policy Intern, Centre for Science and Policy (note-taker)
- **Dr Eoin O'Sullivan**, Director, Centre for Science, Technology & Innovation Policy, University of Cambridge
- **Dr Kate Parsley**, Research Facilitator, School of Biological Sciences, University of Cambridge
- **Roger Sylvester-Bradley**, Head of Crop Performance, ADAS
- **Professor Leon Terry**, Director of Environment and Agrifood, Cranfield University
- **Mark Turner**, Infrastructure and Materials Directorate, Department for Business, Innovation and Skills (BIS)



# B: Preliminary Research Study

## (Work Package 1)

**This report provides a brief overview of the main economic and technology trends, drivers and opportunities for the UK potato value chain. It is the main deliverable of Work Package 1 and acts as background for the subsequent stages of the project, in particular the Industrial and Alignment Workshops. The research to prepare this report was coordinated and funded by Policy Links - the knowledge transfer unit of the Centre for Science, Technology & Innovation Policy (CSTI), and the Institute for Manufacturing, in collaboration with Cambridge University Potato Growers Research Association (CUPGRA).**

### Overview

The UK potato market has a farm gate price of c. £900m and a retail value of c. £2bn. This report discusses trends occurring in the potato market both in terms of production and consumption, analyses where value is added along the supply chain and suggests where further improvements may be made.

### 1. Trends and drivers

#### 1.1. Market trends

##### 1.1.1. Production

The planted area of UK potato crops has decreased from c. 140,000 ha in 2000 to c. 115,000 in 2016 (AHDB 2017a). Yields vary between years depending on weather, but from 2000 to 2015 have plateaued at c. 45 t/ha, resulting in total production decreasing from c. 6 million tonnes to c. 5 million tonnes per year (AHDB 2017a). Across the EU, larger decreases in production have occurred, falling by 36 % between 2000 and 2015 (De Cicco & Jeanty 2017). These trends are in contrast to those occurring in developing countries, where production is growing steadily, although per capita production is only one quarter of that in Europe (FAO 2008).

##### 1.1.2. Consumption

In the UK, consumption of fresh potatoes has decreased steadily from 1200 g/person/week in 1980 to 500 g/person/week in 2014 (AHDB 2017a). Despite this, the category remains significant with a total value of £1.1 billion per year (Hughes 2016). The consumption of processed potatoes increased from 1980 to 1995 but has remained stable since then (AHDB 2017a). Those aged over 65 consume the largest amount of fresh potatoes, with younger people preferring frozen products (AHDB 2017a). Convenience is a major driver of these trends in consumption, linked to the average time taken to prepare an evening meal having fallen from 60 minutes in 1980 to 30 minutes in 2016 (Hughes 2016). The chilled potato category is a relatively small part of the market, worth £250 million in 2015, but is growing rapidly in contrast with other categories (Hughes 2016). Campaigns have been held to encourage fresh potato consumption, particularly amongst younger people by highlighting their versatility and health benefits. Similar campaigns have been held in France, Spain and the Netherlands (HZPC 2015).

The processed sector is dominated by multinational brands with PepsiCo (Walkers) and McCain having market shares of c.40% and c.50% market share in the crisp and frozen categories respectively (Kynoch 2013). In the fresh category, brands have a limited presence in the marketplace. However, specific varieties are pseudo-brands and attract higher prices than generic varieties that are unknown to the consumer. King Edward and Maris Piper are old varieties (bred in the 1900s and 1960s respectively) that are recognised by consumers for their culinary characteristics. Rooster was introduced in the 1990s and in the last decade has been marketed aggressively by Albert Bartlett (Pate 2016) to become one of the most recognised grocery brands in the UK (Kynoch 2013).

##### 1.2. Technological trends

There is a continuous trend for machinery used in potato production such as planters, irrigation booms and harvesters to become wider in order to increase work rates and reduce labour costs. Precision farming aims to optimise the use of inputs by applying them at different rates within fields to minimise costs and maximise yields. Yield monitoring is a crucial part of precision farming in other crops but is not widely used in potato crops. Various smartphone apps have been released in recent years to facilitate efficient crop production. CanopyCheck captures and processes photographs of the crop canopy in order to predict crop yield at a later date (Allison 2015). PotatoSize (Allison 2017) and Solgrader (HZPC 2016) capture photographs of potatoes and report estimates of yield and tuber size. The aim of these apps is to provide information to the grower on when the optimum marketable yield or crop value will be achieved so that crops can be harvested accordingly. Unmanned aerial vehicles (UAVs) are beginning to be used in potato production to improve the efficiency of crop monitoring. Uses include establishing plant populations (Brown & Butler 2016), monitoring crop growth (Bayly 2016) and detecting virus infected plants (O'Connell 2017). However at present, UAVs are not used routinely by growers and their cost effectiveness is unclear.

Potato crops are managed intensively with average crops in 2014 receiving 12 fungicides, 3 herbicides, 3 molluscicides and 2 insecticides (Garthwaite *et al.* 2015). The loss of agrochemicals threatens to decrease crop productivity, increase the cost of production or increase wastage. The herbicide linuron a "cornerstone" of weed control in the UK for decades was withdrawn from sale in 2017 (Meredith 2017). Metaldehyde

(a molluscicide), nemathorin and vydate (nematicides) and chlorpropham (a sprout suppressant) are potentially under threat, with industry stewardship groups established to encourage responsible use and maintain their availability.

### 1.3. Business model trends

There has been a substantial decrease in the number of potato growers in the UK, falling from c. 4500 in 2000 to c. 2000 in 2015. Consistent with this change, the average area per grower has increased from 30 ha in 2000 to 50 ha in 2016, with 14 % of growers planting over 100 ha and accounting for 53 % of the planted area (AHDB 2017a). Similar trends are occurring across North-West Europe (AHDB 2017a). Consolidation has also occurred in the processing sector in recent years. Heinz shut a factory in Norfolk (BBC 2014) in 2015, Produce Investments shut a packhouse in Kent (Horne 2015) and Walkers shut a factory in County Durham in 2017 (BBC 2017).

Supply chains are increasingly vertically integrated with end users of the crop being involved with its production. For example, packers and processors provide seed tubers and agronomic advice to their growers (McCain 2017; Greenvale 2017), while larger growers provide storage, transport and washing facilities to other growers (AKP Group 2017; Cockerill 2017).

## 2. Value chain studies

Figure 1 shows the most recently available flowchart of how potatoes move through the UK supply chain. It should be noted that 2012 was an exceptionally poor year for potato production in the UK and, consequently, imports were approximately 50 % higher than in subsequent years (AHDB 2017a). Figure 2 shows a more detailed, but unquantified, diagram of the UK potato supply chain. For potatoes sold in supermarkets, the supply chain is relatively compact, with growers selling directly to processors or packers who then distribute to supermarkets.

The total farmgate value of potatoes grown in the UK is c. £900m per annum although this can vary by  $\pm$  £200m depending on yields, with lower yielding years tending to have higher prices and hence higher values (AHDB 2017a). Between 2011 and 2015, average farmgate prices per tonne have ranged from £128 to £245 (AHDB 2017a).

### 2.1. Cost of production

The cost of production of UK potato crops varies widely and is not always known accurately, although the Farmbench tool in development aims to change this (AHDB 2017a). The most recent estimates of the projected costs of production are for 2014 (Table 1). Data are not available regarding the proportion that individual inputs make to variable costs.

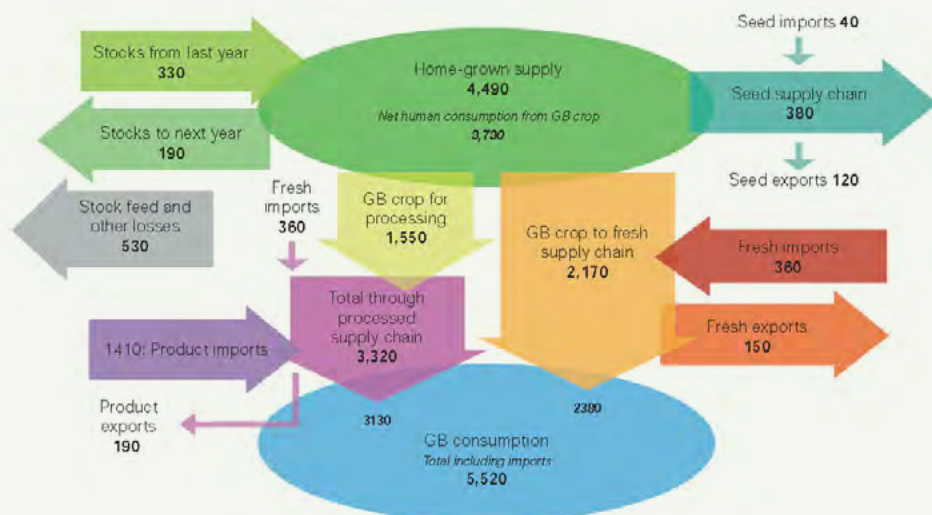
**Table 1.**  
Estimated costs (£/ha) of production for ware and processing potatoes in 2014 (Potato council 2013).

	Ware (fresh) potatoes	Processing potatoes
<b>Variable costs (seed, fertilisers, pesticides)</b>	2344	1876
<b>Total fixed costs</b>	3810	3227
<b>Labour</b>	1145	1046
<b>Machinery</b>	2119	1722
<b>Property</b>	255	207
<b>Administration</b>	291	253
<b>Total cost (excl. rent and finance)</b>	6154	5103
<b>Rent</b>	874	874
<b>Finance at 5 % for 7 months</b>	205	175
<b>Total cost (incl. rent and finance)</b>	7233	6152
<b>Average yield (t/ha)</b>	45	46
<b>Cost of production per tonne excl. (or incl.) rent and finance (£)</b>	137 (161)	111 (134)



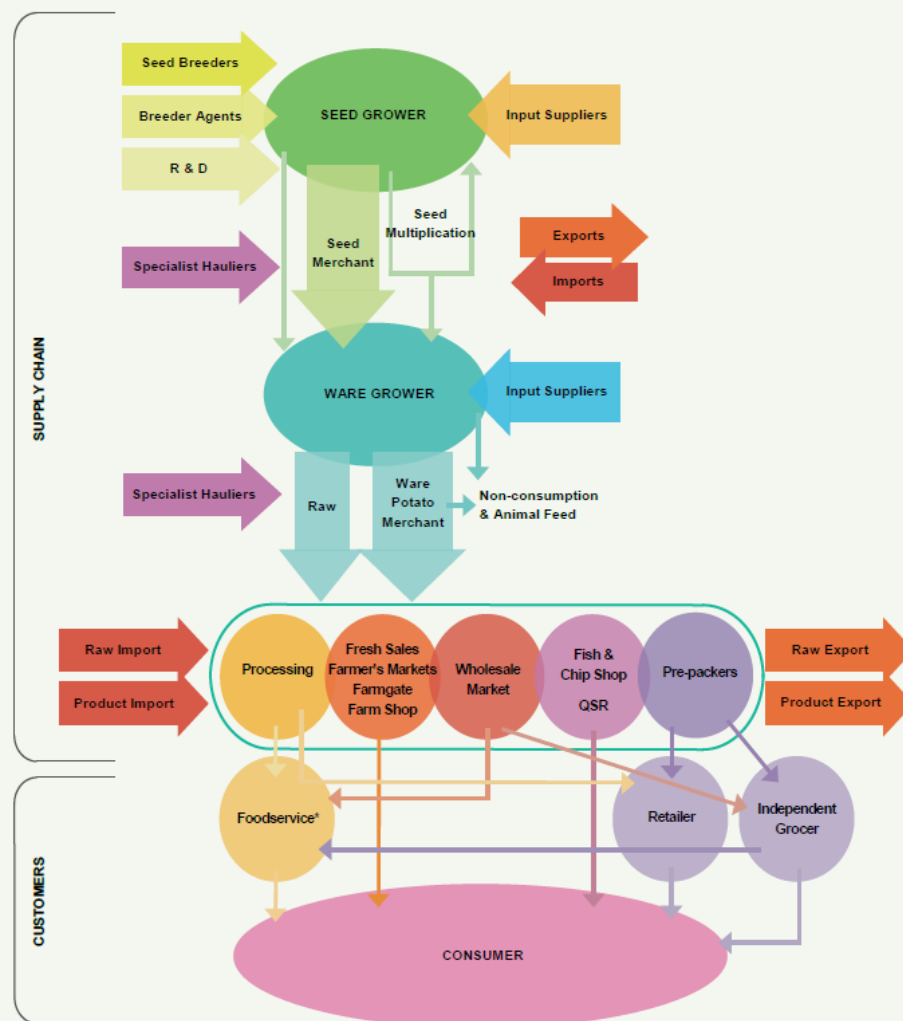
**Figure 1.**

Flowchart of the UK potato supply chain for June 2012 to May 2013 in 000 t raw equivalent  
Reproduced from  
Potato Council, 2014.



**Figure 2.**

Flow chart of all the component entities which form the UK potato supply chain.  
Reproduced from  
AHDB 2017a.



Costs of production are approximately one third lower in North-West Europe due to a combination of environmental and economic factors. These factors include fewer cultivation operations due to different soil types, less irrigation due to higher rainfall and higher usage of family labour. As a result it is impossible for the UK to export frozen processed potatoes and economically the UK industry is vulnerable to imports of cheaper products (Wootton 2015).

## 2.2 Value of products

The total retail volume of potatoes sold in the UK is c. 3 mt and they have a combined value of c. £2bn giving an average retail value of c. £1500 per tonne of fresh potatoes (Table 2). Considering the average farmgate price, the value of potatoes increases on average by 6-12 times through the supply chain. Fresh and frozen potatoes retail at similar average prices per tonne of fresh potatoes, whereas chilled potato products and crisps attract prices approximately double those of fresh and frozen potatoes (Table 2). Some products that are relatively new to the market have substantially higher values than the average of their category. For example, premium brand crisps retail for £13,000/t (£4,000/t fresh weight equivalent) and ready-cooked frozen baked potatoes retail for £3,000/t (Tesco 2017). Information on the mark-up made by retailers is not available.

By volume, the retail market accounts for c. 50 % of total UK production. Volumes and values to categories within the foodservice industry are not readily available. However, in 2016, 1.6 bn servings of potato were sold outside of the home, with

two-thirds of these being chips or French fries (AHDB 2017d). DEFRA (2017) reported that out-of-home potato purchases were c. 70 g per person per week although this excluded takeaway chips, comprising another c. 35 g per person per week. Combined this equates to c. 350 mt/year, but the fresh weight equivalent will be higher.

## 2.3. Losses

### 2.3.1. Wastage

Wastage in the fresh market is considerable, based on interviews with people in the sector; the Waste & Resources Action Programme estimated that 28-48 % of yield does not reach the consumer (Terry 2011). Data from individual packers corroborates these estimates (Table 3). Undoubtedly, the greatest wastage occurs during the packaging phase of production, although the ultimate causes of this waste were in the field phase of production. There are numerous causes for this waste during packing; potatoes can be too small or too large, be affected by tuber blemishing diseases, turn green due to exposure to light, be damaged physically during harvesting or have pest damage (Terry 2011; Coleman 2010; Andrews 2011). Older varieties (e.g. Maris Piper and King Edward) have higher amounts of waste during packing than newer varieties (WRAP 2014) but are demanded by consumers who are willing to pay a higher price for what is deemed a higher quality product. The industry either needs to establish how to reduce this waste through optimising production, or persuade consumers that other varieties are of equal quality.

**Table 2.**

Volume and value of retail potato products and their fresh weight equivalents (AHDB 2017c).

	Value (£m)	Volume (000 t)	Price (£/t)	Fresh volume equivalent† (000 t)	Fresh price equivalent (£/t)
<b>Total fresh</b>	1051	1294	812		
Loose	135	117	1151		
Pre-pack	916	1177	778		
Organic	12	10	1187		
<b>Total frozen</b>	710	467	1520	841	844
Chips	445	319	1395	574	775
Other frozen	265	150	1766	271	981
<b>Chilled</b>	266	74	3612	132	2007
<b>Canned</b>	12	16	711		
<b>Crisps</b>	880	135	6496	474	1856
<b>Snacks‡</b>	966	136	7094	477	2027
<b>Recon &amp; Conv.</b>	30	15	1946	92	324

† Retail volumes have been converted to fresh equivalents based on conversion values of 3.5:1 for crisps, 6:1 for dehydrated and 1.8:1 for frozen (AHDB 2016). ‡ Snacks includes other products that do not contain potatoes.



**Table 3.**

Percentage of yield wasted at different phases of potato production.

Phase of production	Source		
	Terry (2011)	Coleman (2010)	Andrews (2011)
<b>Field</b>	1-2		6
<b>Grading</b>	3-13		12
<b>Storage</b>	3-5		5
<b>Packaging</b>	20-25	29	22
<b>Retail waste</b>	1.5-3		< 5

WRAP (2014) noted that decreasing the minimum size of tubers could reduce wastage during grading, but this does not account for the fact that size has been ranked as one of the key attributes that consumers look for in the product (Kynoch 2013). An alternative is to ensure that optimal seed rates are used to reduce the number of small tubers, which also has the added benefit of reducing costs (Firman & Daniels 2011). The majority of wasted potatoes are destined for stock feed that is fed to livestock, attracting a very low price (Figure 1). Figures on wastage in the processing sector are not available but are probably lower due to surface blemishing diseases causing limited wastage as tubers are peeled. Since tubers are not sold whole, processing potatoes also allows tubers that would otherwise be wasted to be diverted into use in other products such as mashed or dehydrated potatoes (Willard 1993). The extent to which wastage from the fresh potato sector is diverted into the processing sector is uncertain.

### 2.3.2. Reduced yield

UK potato yields have plateaued at c. 45 t/ha since the mid-1990s (AHDB 2017a). Considering that the theoretical maximum yield in the UK is 100 t/ha (Allen & Scott 1980), the failure to achieve this represents a major loss of value. Numerous factors have been implicated in causing the yield plateau, including a shift in market requirements towards earlier and thus lower yielding crops,

increased prevalence of potato cyst nematodes on potato land, and breeders selecting for traits other than yield (Clarke 2014).

## 3. Key technologies

### 3.1. Production

Large amounts of specialist machinery are required for potato production, accounting for the high proportion of the cost of production. Soil cultivation, planting and harvesting require unique equipment, and regular crop spraying and irrigation also require large capital investments. Storage is a crucial phase of potato production since potatoes spend, on average, longer in storage than in the field (Terry 2011). Irrigation is vital to maximise potato yields, with potato crops consuming over 50 % of the water applied to crops in the UK. The majority of growers use only their own judgement to decide when to irrigate, which is prone to causing under- or over-application of water (Defra 2011), both of which can have detrimental effects on crop quality and therefore value. Wider use of models that calculate the daily water use of crops would alleviate these issues. Rainguns are the most widely used equipment for applying irrigation (Defra 2011), but are less efficient and uneven in applying water than booms, sprinklers and drip irrigation systems (Knox 2006).

**Table 4.**

Key technologies used in different phases of the production of potato products.

Phase of Production				
Establishment	Maintenance	Harvesting	Storage	Processing
Bed formers	Crop sprayers	Harvesters	Refrigerated stores	Graders
Destoners	Fungicides		Sprout suppressants	Washers
Planters	Molluscicides			Peelers
Seed	Irrigation			Slicers
Seed treatments				Packaging
Nematicides				
Fertilisers				
Herbicides				

### 3.1. Varieties

New varieties provide opportunities for growers to increase marketable yields by either reducing wastage or increasing total yield. For processors, new varieties can improve production efficiency by either reducing wastage or having better storage qualities. For consumers, the introduction of varieties can give them greater choice. The number of varieties included on the UK national list has grown substantially in recent years from 120 in 2006 to 175 in 2016. However, doubts have been raised as to the extent to which this increase in the number of varieties has benefited either the grower or consumer (Kellett 2016). Maris Piper, introduced in the 1960s, remains the most popular variety in part due to it having multiple markets as a fresh potato, chipping potato and for processing.

#### 3.2.1. Hybrid varieties

The vast majority of potatoes grown worldwide, and all those grown in the UK, are produced using planting seed tubers grown the previous year. The use of true potato seed (TPS) instead of seed tubers offers potential advantages since only c. 150 g of seed is required per hectare as opposed to 2 tonnes of seed tubers. While this has been recognised since the 1970s, commercial introduction has proven impossible due to the difficulty in establishing crops from seed, the longer growing season required and genetic heterogeneity between plants. Recently, several Dutch companies have developed hybrid varieties of potato that could revolutionise the way potatoes are bred and produced. It is expected that it will be easier and quicker to breed new traits into varieties, and these will be introduced more quickly as the varieties will be multiplied more rapidly. The most likely

change is that seed will replace the first field generations of seed tubers, but ware crops will continue to be produced from seed tubers. This should result in cleaner seed tubers being used with a knock-on effect on crop quality and profitability (Kooman 2017). With the minitubers used to establish the first field generation currently costing approximately £0.50 each, there are substantial opportunities to reduce the cost of producing high quality seed tubers.

#### 3.2.2. Genetically modified varieties

Potato varieties have been genetically modified to be resistant to various pests, diseases and physiological disorders. These offer potential advantages to the industry by either increasing yields, decreasing costs of production or by decreasing wastage. In the United States, Simplot have developed the 'Innate' system which uses only genes from potatoes to make varieties more resistant to late blight, bruising and decolouration and also to produce lower levels of the potential carcinogen acrylamide during frying. Similar techniques are currently being used to develop a genetically modified form of Maris Piper at the Sainsbury Laboratory in Norfolk, with nematode resistance as well as the traits introduced by Simplot (Orcutt 2015).

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## **C: Aligning Industrial Opportunities and Research Capabilities: Workshop Reports**

### **C1: Industry Workshop Report**

(Work Package 2)

**Identifying key opportunities for value capture:**  
towards an enhanced 'potato innovation ecosystem.'

13 July 2017

Institute for Manufacturing, University of Cambridge

## Introduction & Summary

The UK potato market has a value of 2 billion pounds with 115 thousand hectares of land planted for UK potato crops. Given the scale of the industry, the changing business environment, shifting consumer trends and increasingly tighter resource restrictions, exploring the opportunities for value capture and alignment of research goals with industry needs is a powerful exercise.

On the 13<sup>th</sup> of July 2017, the Institute for Manufacturing hosted a technology Roadmapping workshop co-organised by the University of Cambridge, NIAB CUF and Agri-Tech East. Individuals with a range of backgrounds were brought together for the workshop, including growers, breeders, equipment manufacturers, distributors, retailers, trade associations and academic researchers. The aim was to build connections between experts, bring together the full range of perspectives in the discussion, and ultimately pursue the common goal of innovation.

The major outputs of the workshop were to:

- Validate value capture opportunities in the potato value chain;
- Characterise and prioritise the industrial challenges;
- Create an 'inventory' of tools and techniques relevant to the industrial challenges;
- Create a list of relevant R&D domains to explore at the R&D alignment workshop in the autumn.

The Roadmapping method is widely used by companies, government organisations and academic institutions to establish and support strategy and innovation. The exercise is used to identify trends and drivers, the opportunities for increasing value, and the capabilities of the local ecosystem to exploit these opportunities. Comparing the feasibility of these opportunities with their potential impact sets the stage for a focused discussion on their bearing across a range of timescales. Roadmapping is a very structured, useful way to engage a large group of people and achieve focus. The format was well-received, and comments on the day described it as: 'smart', 'worked well' and 'took on everyone's perspective.'

Recurring discussion points on the day:

- How to approach increasingly tighter restrictions on water usage, pesticides and land;
- Uncertainty over changes to the regulatory environment created by Brexit;
- The need for more informative and automated data collection;
- The requirement for better communication between scientists and growers and the industrial translation of research work.

The seven opportunity areas selected for group discussion were:

- Hybrid/new varieties of potatoes with health benefits;
- Crop modelling;
- Smart farming techniques to improve water use efficiency;
- New industries from potatoes;
- Precision/digital farming systems;
- Development of new pesticides;
- Waste reduction across the value chain.

## Academic speaker presentations

Professor Howard Griffiths first summarised the background to the project. He described how the activities of the workshop are integral to achieving the aims of the Cambridge Global Food Security initiative and the integration of plant science research activities across the university. He described several forthcoming developments such as the Cambridge Centre for Crop Science (3CS), a collaboration between the University and the National Institute of Agricultural Botany (NIAB), and the new European Institute of Technology (EIT) Food consortium, of which the University is a member.

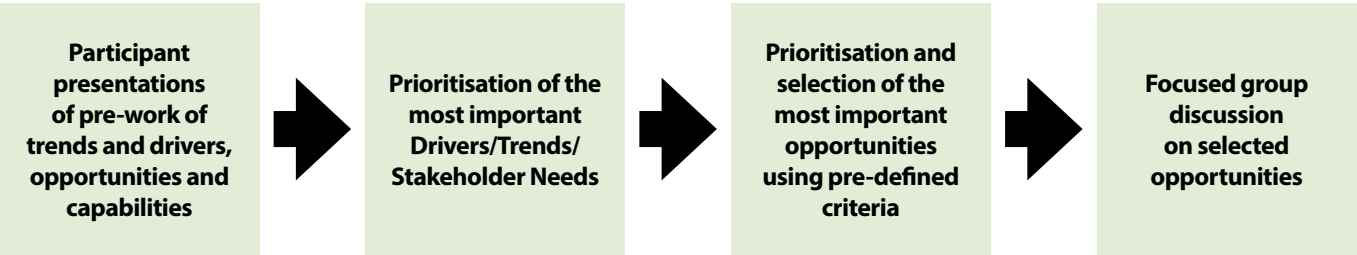
*"The project is aimed at identifying and supporting increased value capture in the potato industry through innovation."*

Professor Ottoline Leyser discussed the challenges of research translation in the agricultural sector. The current linear approach often fails to contribute tangible benefits or lasting value because it is incompatible with multi-stakeholder interactions needed to understand the relevant value chains and tools available to address them. In the agricultural context, many factors are at play, requiring an iterative process to identify problems and deliver solutions. Ottoline described the 'potato innovation ecosystem' project as a flagship to develop ways of working with a wide range of partners to make the best use of knowledge available in the Cambridge research base. Professor Ottoline Leyser described the importance of creating an efficient and effective system where all participants can understand each other.

*"We need to work in a way that captures the richness of the problem, a simple linear information flow does not result in good communication."*



Dr Nicky Athanassopoulou outlined the process of the day:

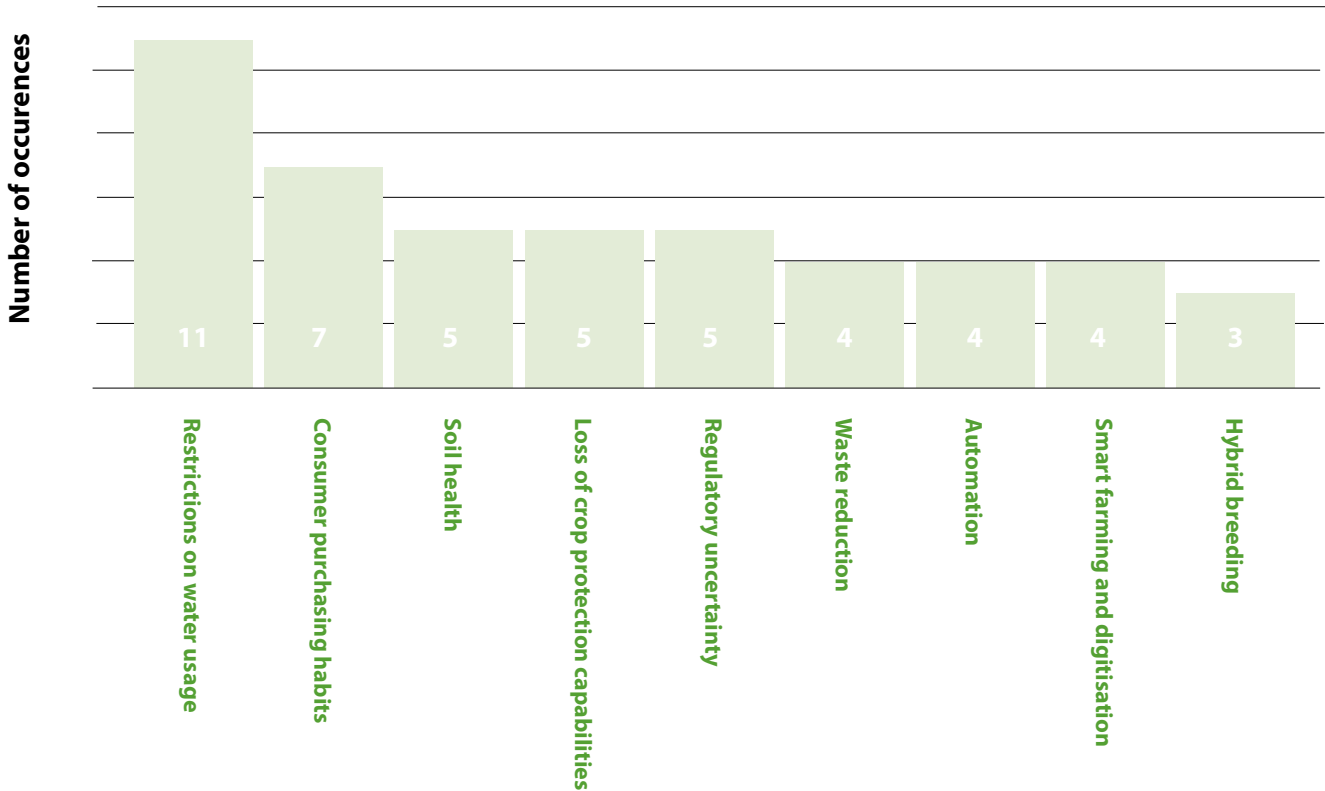


Pre-workshop participant slide presentations

In preparation for the workshop, participants were asked to complete a chart which would then be presented and discussed. The participants considered the trends and drivers, opportunities for increasing value in the potato industry, and the required local capabilities to exploit these opportunities. These factors were considered over short (3 years), medium (10 years) and long (20 years) term time scales.

When the participant responses were reported to the workshop several recurring themes became apparent; these indicated major drivers which would affect the industry at all levels. For the 15 participant responses, the most common drivers identified involved the effects of climate change, the drive for sustainability, changing consumer purchasing habits and regulatory uncertainty due to Brexit. Reduced water availability for irrigation was the most frequent driver reported, being particularly prevalent in the medium and long-term time scales. The number of occurrences of themes in the trends and drivers category are shown in the graph below.

**Fig:**  
The number of occurrences of themes in the trends and drivers category



The opportunities category produced more unique responses indicating the value of the diversity of backgrounds among those attending the workshop. Major technical commonalities involved the capabilities produced by automation, improved data collection and hybrid breeding. Recurring operations themes were: the opportunity to meet new consumer expectations through the development of new products, supply chain restructuring, improved knowledge transfer and sharing of resources.

#### Selection of the most-important opportunities by delegates

Participants were asked to prioritise the opportunities for value creation using the criteria of market potential, synergy opportunities and the intensity of competition in the East of

England region. The feasibility of opportunities was voted on with the criteria being technical certainty, regional capabilities and scalability.

The selection of the seven opportunities for further group discussion was carried out using an impact feasibility matrix. Participants were advised that if there was uncertainty on ideas they tend to cluster in the centre. Low feasibility ideas may be long term strategic opportunities but not feasible in the short term. The most pertinent ideas with high feasibility and large opportunities are the main targets for group discussion. Once the seven opportunities had been selected the workshop was split into small groups with a focused scope for investigation.

Large Opportunity, Low Feasibility	Large Opportunity, High Feasibility
Small Opportunity, Low Feasibility	Small Opportunity, High Feasibility

Code	Opportunity	Opportunity Votes	Feasibility Votes	Selected for group discussion
O45, 01, O49	Combined opportunities for hybrid potato varieties	21	14	X
O44, 032	Combined opportunities for smart farming techniques is to improve water use efficiency	13	19	X
O42	Crop modelling services to help growers optimise seed, nitrogen and irrigation and managing pests and diseases	9	10	X
O7	Precision/digital farming systems for improving production	9	7	X
O36	Development of new pesticides or retain current products	7	5	X
O4, O41, O21, O12	Combined opportunities for waste reduction across value chain	12	4	X
O37	New variable technology, linking satellite tech to GPS on machinery	8	3	
O15	Opportunities to add-value through new and improved processing techniques with higher efficiencies. Technology will provide significant platforms to reduce input, saving costs but also enhancing image	7	2	
O40	Centralised power hubs, next generation storage, grading and washing	4	7	
O35	Closer supply chain relationships. No annual pricing negotiations	4	3	
O50	New Industries from potatoes (Alcohol, flour, 1746 Eva Ekeblad...!)	4	2	
O13	Cost saving in all stages from field to fork	4	2	
O31	Better harvesting systems	4	2	
O55	Risk management/mitigation	3	2	

# Presentations of group discussion activity

## Combined opportunities for hybrid potato varieties

There is massive potential for innovative breeding programmes to deliver new varieties of potatoes, both seed and ware. This not only includes genetic modification and gene-editing technologies, but also techniques to speed up the breeding process. The aim of the project would be to develop agile breeding programmes in order to provide desirable characteristics to growers and consumers.

In the short term, the initial aim is to agree the priorities for the breeding programme, before identifying genes and markers that could be used. There is a potential barrier of cost and IP: in order to unlock the genetic knowledge we need to create mechanisms to get people working together and sharing information. In the longer term, technology might be able to address the issue of linked but non-desirable traits being bred in alongside desirable ones. However, early pioneers are needed to champion new technologies and breeding methods.

Lots of research and development needs were identified, including the need for tools to identify breeding priorities, techniques to enable collaboration, expertise in genetics, and communication and co-operation all along the stakeholder chain. Priorities are likely to be different depending on whether you talk to the consumer or grower, processor or distributor; direction and support is needed from industry to help resolve these and increase acceptance and uptake. Policy change may be needed for techniques that involve genetic modification (GM), and the UK is competing with countries (for example the Netherlands and the United States) that already have a lead in this area and others (for example China and India) that have growing populations and, therefore, a strong desire for increased productivity.

## Crop modelling services to help growers optimise seed, nitrogen and irrigation, and managing pests and diseases

The group added commercial crop metrics to the crop modelling discussion, NIAB CUF has already delivered modelling on 400 crops this year so a starting point has been established. The scope of the project includes reporting visuals of outputs, refining models when new varieties are introduced, data collection tools and methodology. Resolving the issue of who and how the data can be accessed is out of scope of the project, alongside selling the data and extrapolating data to national yields.

The aim of the project is global scale-up and roll-out of a potato industry recognised model. The model will make forward supply decisions easier, make input decisions better informed, allow better-informed marketing decisions and production planning decisions. The model could be transferable to other crops. Ultimately, the model will have built-in intelligence and provide self-diagnosis of the growing crop.

One of the major short-term challenges was identified as data collection; at the moment this is usually canopy observations and digs, and samples of the crop at a particular point in time – more and better data are needed to create a viable model. Other challenges identified were the resource required to operate the crop modelling system, how the system fits in with existing workflows, cost-effectiveness, allowing the system to examine all the crop, integration into the grower/supply chain, and having the discipline to use the model. Data challenges were around more efficient data collection, assessing the relevance of the data, converting the data into knowledge, formatting and timeliness of the data, and potential data sharing issues.

There are some big targets and opportunities in this area. Rather than digging the potatoes, a future system could move along the row and use ground penetrating imaging to capture the numbers of tubers and their weights, and be able to predict this.

Gaps were discussed such as tuber physiology, categorising new varieties, data capture and presentation – especially underground crop information.

Local networks including Agri-Tech East, CUPGRA, NIAB CUF, the University of Cambridge and KisanHub are already in place. These can help to develop and refine the model in a two-way process between the user and the developers.

Competition comes from overseas processors who are already looking to develop similar modelling platforms – we need to ensure there is an industry recognised standard to enable rapid deployment and uptake.

## Combined opportunities for smart farming techniques to improve water use efficiency

The group discussed software, hardware, data collection, automation and crop heterogeneity with respect to smart farming opportunities for improving water use efficiency. The group considered breeding out of scope, as this was being discussed by another group, and also water storage. The aim of the project is to maximise marketable yield whilst minimising water use.

Challenges identified were both technical and agronomic. In the short term there is a need to better assess the current irrigation status of a crop, so a project could look to evaluate the various methods in use and the area on which they are used by UK growers. There is a lot of knowledge already in this area that is not used to best effect; better communication on crop water requirements could encourage greater adoption of state-of-the-art scheduling. Better data collection is needed on rainfall, canopy cover, soil information, actual irrigation application quantity – satellite technologies could be used to address some of these.



There are many opportunities for local partnerships across industry and academia to tackle some of the challenges around platform and system development. One big opportunity is around the improvement of automation of application which would aim to result in a reduction in water use, use less labour and could make adjustments for in-field variability. Longer term, it may be possible to look at improved soil water retention and attempt to apply the knowledge on a more global basis.

The group also considered incentives for efficient water use and soil improvement.

### Precision/digital farming systems for improving production

The group acknowledged that this was a broad topic and chose to focus on yield monitoring, soil mapping, canopy mapping, variable seed rates, variable use of inputs, and depth of cultivation. The group decided not to discuss crop modelling or irrigation as these were covered by other groups.

The aim of the project is to harmonise technology and agronomy to increase profitability and sustainability.

One of the main agronomic challenges is accurate yield mapping, and one aspect could be to look at how calculating the yield from the harvester could be improved. There was a general feeling that there is a lack of follow-through on research projects to really deliver the benefits to growers. There is also a lack of agronomic understanding of within-field variation.

One challenge is that although we have the technology to apply seed and fertilisers and pesticides at different rates across the field, there is a lack of agronomic understanding to actually know how the inputs should be applied differently across the field. In the medium-term, the challenge will be to show that it is cost-effective to use precision technologies and that they have proven benefits. If we can't do that then they won't be adopted. The technology needs to be simple to use, and the group agreed with the crop modelling group that data needed to be standardised to enable them to be used.

Once we have an understanding of the causes of within-field variation we can start to work on how to reduce it. In the long-term, data can be used to drive decisions about rotations, and use of long-term data will make this more robust; automated collection of data would help with this.

To enable education and uptake it is essential to develop collaborations between researchers and industry, advisors and growers – innovation hubs were mentioned as a useful forum for this.

### Development of new pesticides or retain current products

The group renamed the project *Effective pest, weed and disease control* and considered synthetic biopesticides, full rotation management, integrated pest management, pull-push approaches, financial cost, trap cropping and analysis of changing practices in the scope of the discussion. The group decided not to discuss development of new pesticides as this would duplicate the work of agchem manufacturers.

The aim of the project is to reduce the total amount of plant protection products used in a fully integrated system where farmers can optimally manage pests and diseases, whilst optimising their return/profit. In addition to the trends and drivers already identified during the morning, the group considered that an integrated management approach could have increased marketing opportunities as consumers would prefer less pesticide use.

In the short term, projects could look at the interaction of potato pests and diseases in non-potato crops within the rotation; it would also be useful to map where new integrated pest management techniques could complement or replace plant protection products. Plant protection product delivery could also be optimised, using precision approaches, better targeting and novel methods of application to apply less. Regulation is a barrier to innovation, but smarter regulation – for example, the sequential use of different plant protection products – could be looked at. In the longer term, gene editing and remote sensors could have applications to address pests and diseases in a targeted way.

Research and development is needed a variety of areas, including by physiologists, soil scientists, nematologists, and experts in smart data capture, biochemical interactions and microbial activity. A commercial farm could act as a model, providing a long-term platform to understand the effect of interventions. Consumers could be engaged to enable understanding of the challenges of crop protection and the potential benefit of gene-editing approaches.

Ultimately, we should seek a decision support package that provides growers with the most appropriate pest and disease control approach in each season, for their crop, in their field, and their environment.

## Combined opportunities for waste reduction across the value chain

The group discussed waste reduction across the whole supply chain, initially focussing on waste at home and waste at retailers, and then discussing waste at the farm. There is already a large amount of knowledge about waste that could be applied to reduce waste, but there is a bottleneck caused by the lack of defined measurable targets for waste reduction at different points in the supply chain.

The discussion then focussed on home waste, including package size and package development, and included that cutting waste also cuts demand; other things considered included extending shelf-life and storability. They decided not to look at air technology, methods of re-using food waste, dynamic demand systems, or utilising co-products.

The aim of the project would be to cut waste by 50% by progressing targets for waste reduction at various points of the supply chain, which would include farm storage losses and a

consideration of incentives to reduce the amount of waste sent to land-fill. The project addresses many of the trends and drivers identified during the earlier work and also includes important additions such as consumer habits.

In the short-term, projects could look at knowledge exchange or research and development activities. There is existing knowledge that is not applied: better communication systems between the various parties could help address this. R&D projects could look at extending shelf-life in store and at home, including remote sensing in stores to identify volatiles. Harvesting and packaging technologies and better planting and blight controls could also be investigated, as could the development of secondary industries and products for potatoes.

An important consideration could be the creation of a centralised storage and commercial testing facilities, a supplier-led network of grower groups could possibly fund this. Overall two-way communication, and better communication mechanisms, could implement many opportunities for waste reduction across the value chain, however leadership is needed.

## Attendees

### ORGANISERS

<b>Mariana Fazenda</b>	CambPlants Hub, University of Cambridge
<b>Simon Smart</b>	NIAB CUF
<b>Belinda Clarke</b>	Agri-Tech East
<b>Jacqueline Garget</b>	Global Food Security Initiative, University of Cambridge
<b>Kate Parsley</b>	School of the Biological Sciences, University of Cambridge

### DELEGATES

<b>David Almond</b>	CUPGRA	Translation
<b>Nicky Athanassopoulou</b>	IfM ECS	Research
<b>Jeff Beever</b>	McCain	Processor
<b>Peter Blaylock</b>	E Park & Sons	Packer
<b>Alistair Edwards</b>	KisanHub	Technology
<b>David Firman</b>	NIAB	Research
<b>Andrew Francis</b>	Elveden	Grower
<b>Howard Griffiths</b>	University of Cambridge	Research
<b>Patrick Grote</b>	Grimme	Equipment/Machinery
<b>Vee Gururajan</b>	Branston	Packer
<b>Sharon Hall</b>	Potato Processors Association	Trade Association
<b>Stephen Humphries</b>	Bayer	Agrochemical
<b>Tina Jeary</b>	Albert Bartlett	Packer
<b>Ronnie Lang</b>	Omnivent	Equipment/Machinery
<b>Ottoline Leyser</b>	University of Cambridge	Research
<b>Carlos López-Gómez</b>	Policy Links	Research
<b>Michele Palladino</b>	Policy Links	Research
<b>Darryl Shailes</b>	Hutchinson	Distributor (Agronomist)
<b>William Shakeshaft</b>	Greenseed	Breeder & Seed Supply
<b>Andrew Starbuck</b>	Grimme	Equipment/Machinery
<b>Allan Stevenson</b>	RJ & AE Godfrey & NFU potato committee	Grower
<b>Mark Taylor</b>	Asda	End User (Retailer)
<b>Gavin Towers</b>	Agrico	Breeder & Seed Supply
<b>David Walker</b>	Fresh potato suppliers association	Trade Association
<b>Jack Watts</b>	AHDB	Translation







## **C: Aligning Industrial Opportunities and Research Capabilities: Workshop Reports**

### **C2: R & D Alignment Workshop Report**

(Work Package 4)

#### **Aligning industrial opportunities and research capabilities:**

towards an enhanced 'potato innovation ecosystem.'

13 November 2017

Institute for Manufacturing, University of Cambridge

## Introduction

This report summarises the R&D alignment workshop held on 13<sup>th</sup> November 2017, the final workshop in our pilot project. The key objectives of this workshop were to:

- validate previous findings of the project with respect to R&D domains relevant to improving the potato value chain
- explore partnership and collaboration opportunities between Industry and academia
- make it happen – pump-prime projects via the BBSRC AgriFood Technology Seeding Catalyst

An earlier workshop evaluated the needs of industry and produced key opportunity areas for value capture. This final workshop in the series aimed to align these opportunities with academic research capabilities. It brought together experts in the targeted opportunity areas for a focused brainstorming session, followed by a detailed discussion to produce a research project proposal and action plan. Sectors represented included breeders, growers, agrochemists, packers, distributors, machinery and equipment specialists, researchers and retailers. Organisations represented included NIAB, AHDB, Asda, Bayer, Albert Bartlett, Agrico, Omnivent, NFU, CUPGRA, KisanHub and the University of Cambridge.

## The R&D alignment workshop

The aim of the final workshop was to identify clear, targeted projects that could lead to innovative ways of capturing additional value in the potato supply chain. The 'Roadmapping' approach was utilised for its effectiveness in focusing the sector expertise present to better define the most appropriate key challenges to be addressed, and bringing together teams to address those challenges effectively.

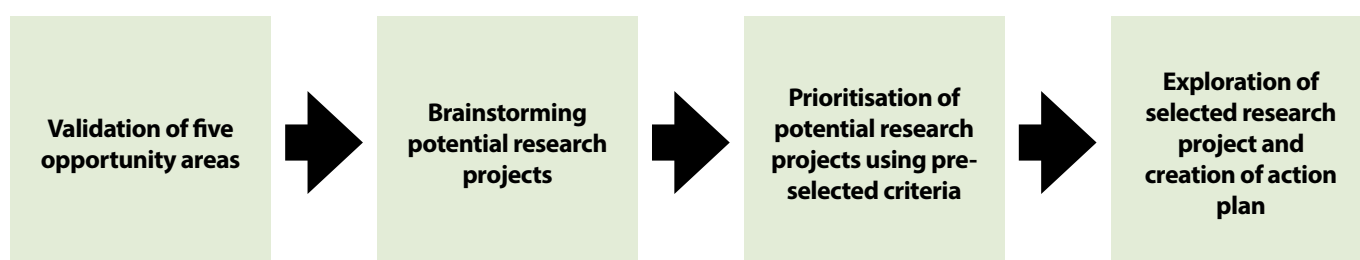
Professor Ottoline Leyser (Sainsbury Laboratory, University of Cambridge) introduced the workshop as the culmination of a process to make new and better connections across the research, innovation and Agri-tech ecosystem. This process has aimed to improve the translation and flow of information by bringing together expertise in the potato value chain and related research areas. The agricultural context is particularly challenging for research translation, because of the complex distributions of value through supply chains such that incentives for investment in interventions at any single point are weak. This contrasts to traditional areas for translation such as the pharmaceutical or engineering industries, where the focus is on producing and selling a specific product.

Dr Carlos Lopez-Gomez (Policy Links) subsequently described the approach and ambitions of the project. The IfM is a research institution that focuses on manufacturing, management and policy issues. Policy Links is a not-for-profit consultancy based at the IfM, which aims to help government make research more effective.

Dr Nicky Athanassopoulou (IfM Education and Consultancy Services) outlined the workshop process. The aims of the day were to validate the identified challenges in the value chain, and to identify tangible research projects for academic research in collaboration with the potato industry. A Roadmapping process was used to take on board different perspectives, link the external drivers with real opportunities and to summarise the outcomes into a one-page strategy. During the morning session the participants looked at the opportunity areas and brainstormed potential projects; these were then prioritised as the best candidates according to opportunity and feasibility-related criteria (figure 1). The afternoon session explored the selected projects in detail to answer the questions: *Where do we want to go? Where are we now? How do we bridge the gap?*

**Figure 1.**

Diagram of the discussions workflow during the Roadmapping process.





**Figure 2.** A working group during the afternoon session

The five projects identified during this process are outlined on the following pages.

Dr Kate Parsley (Bioscience Impact Team) presented the BBSRC Agri-Food Technology Seeding Catalyst Award. This funding has been awarded to the University of Cambridge with the aim of increasing productivity in the agri-food sector, providing healthy, safe, high quality and nutritious food for UK consumers in global markets, and ensuring supply chain integrity and long-term environmental resilience. A portion of the award was allocated to deliver the workshop and to pump-prime projects arising from the R&D alignment process. The funding allows for proof-of-concept exploration, ways for users to understand the benefits of novel ideas, and access to expertise to enable exploitation and translation.

The projects were then discussed in more detail, in order to develop an action plan and to identify any areas where the funding could be used for pump-priming or to address knowledge gaps.

Dr David Firman (NIAB CUF) concluded the day's proceedings and described the next steps. NIAB has had very good engagement with industry for many years. The workshop has provided an opportunity to extend this industrial engagement to parts of the University with less of a direct connection to the potato supply chain, but with a lot to offer for the future of the potato industry. This may include topics that are not immediately obvious to industry or to individual researchers. The process of distilling the broad areas into specific research projects has been challenging, but the process will hopefully create opportunities for the future, which will link with the Cambridge Centre for Crop Science (3CS), an initiative being developed jointly by NIAB and the University. The aim is to take these projects forward in the future, maintain the links in the community and keep the process moving as 3CS develops.

The final research project proposals were:



## 1. Breeding for hybrid/new varieties of potatoes with health benefits

### Project Name:

SPUD (Speedy Potato Under Development).

### Project Aims:

Develop new breeding methods to create potato varieties with nutritional benefits and reduced environmental impact

The project will develop a breeding programme based on genomic selection, a contemporary breeding method that has revolutionised dairy cattle breeding and is beginning to have a great impact in crops. In order to establish the speed breeding platform, reliable genetic markers and phenotyping systems would need to be developed, alongside the establishment of appropriate IT infrastructure. The platform establishment is expected to take two to three years, after which a selection programme could be run indefinitely. The funding requirement was estimated at £1.5 million per year for the first three years and £1 million per year subsequently. On top of the selection programme, improved clones will be tested on farms with the aim of registration on the national list.

The team identified that sufficient germplasm would need to be available to prioritise traits, and that initial focus may need to be on low-hanging fruit. The group suggested potato cyst nematode resistance and/or improving acceptability to customers. There is a significant commercial research interest in potato breeding with big industry players investing large amounts of money. This project will be discriminated by the selected traits, as, unlike a commercial breeder, these do not have to be focused on immediate market impact.



## 2. Smart farming techniques to improve water use efficiency

### Project Name:

Data capture and integration to improve efficiency of irrigation systems by exploiting feedback from crops and the environment.

### Project Aims:

Capture water application and weather data in real time and utilise remotely-sensed thermal imaging of crops. Implement a crop growth and irrigation scheduling model taking account of crop heterogeneity within the field and using soil mapping to create different management zones.

The proposed project aims for the real-time integration of crop and environmental data to improve irrigation efficiency. The first phase will involve a three-year program to create better knowledge on flow telemetry for irrigators. Emerging technologies such as thermal imaging of potato crops looking at water stress need to be brought together and integrated with existing solar mapping systems and crop growth and irrigation systems. The project will aim to bring this all together in real time to manage irrigation of the crop. To achieve this, there are capability gaps that must be bridged in the understanding of flow telemetry and solar mapping technologies, which would require bringing in expertise for the first three-year phase. The second phase will last for two years and will cover implementation in the industry, validation of systems and getting feedback on the performance of the system. This will aim to produce very robust data and metrics about the benefits delivered by the improved system. The project was forecasted to require funding of £900,000.



### 3. Precision/digital farming systems

#### Project Name:

Spud metrics, developing sustainability metrics for the potato supply chain.

#### Project Aims:

Develop infrastructure to curate data on sustainability metrics on potato crops.

This project aims to collate existing data in the potato supply chain, for example inputs, yield and waste. This will be used to inform consumers and provide feedback to reward good growers, processors and others. The worst performers can be informed of the actions they can take to improve their sustainability. This project will look at all the different factors such as crop production, transport, storage and waste. There is some commercially sensitive data that will be avoided where possible. The main aim will be to develop software tools to link existing data. The project could be started with a short study to obtain more information on the types of data growers are already collecting and in what format, and look at how to integrate this into a single format, consistent across the supply chain. Standardised data will be important to develop benchmarks to indicate good practice for growers and consumers, potentially through a traffic light system. It may be difficult to get growers to participate; one consideration will be how to convince industry groups to nudge growers into getting involved. The cost of this project was projected at £3 million over four to five years.







#### 4. Effective pest, disease and weed control

**Project Name:**

Innovative nematode control strategies.

**Project Aims:**

Identify nematode-attracting potato semiochemicals, understand signals and factors to help identify optimum rotation, to manipulate biosynthesis of nematode attractants and inhibit host-susceptibility factors via gene editing, to engage consumers and to provide evidence-based support for outcomes.

The project will explore an innovative nematode control strategy. The aim of the project will be to decrease the impact of potato cyst nematodes (PCN) and free-living nematodes on potato production. Deliverables will be to identify and understand nematode attracting potato semiochemicals, with a long-term view to manipulate these to reduce nematode impact. This could be done through gene editing to try and control PCN, or by better understanding how nematodes could be controlled within the rotation. There is an important social element to this project as it will be necessary to understand how consumers feel about gene editing, and the project could also therefore include a consumer survey about pesticide use versus gene editing technology.

In the short-term, the project will assess current nematode assays, control strategies and semiochemical analyses. The project will also aim to set up potato transformation lines and gene editing protocols. Once the target genes have been identified, they can be manipulated by gene editing to validate their effect on the nematodes – those with a positive effect could then be used in a traditional breeding program.

Several capability gaps were identified that could potentially need support from NIAB and other areas; the project may benefit from being a joined-up industry initiative or industry wide solution. A cost of £1.5 million was forecasted for the research project to understand what signals and chemicals are affecting the nematodes before further funding is sought for marker-assisted breeding or gene editing.

## 5. Waste reduction across the value chain

### Project Name:

Monitoring, measuring and best practices.

### Project Aims:

To develop a toolbox and approach to evaluate and map supply chains, to identify waste hot spots and opportunities and to explore best practices across various food products.

The project will start with supply chain mapping to understand the current potato supply chain and to identify sources of waste and opportunities for waste reduction. It was projected as being a more immediate project, with the short, medium and long time-scales narrowed down to one, two and three years. The project will target a 50% target waste reduction; this would be delivered through informing supply chains. The project will try to engage with industry collaborators whilst being conscious that some of the information could be commercially sensitive. It will be valuable to collaborate with organisations such as WRAP, which are set up to drive this area of research to benefit from the data that has been derived to date. Trade associations will be involved for good industry representation, to cover the processing and fresh sectors along with AHDB. The action plan was to organise an industry workshop to bring key collaborators together.





## Conclusions and Next Steps

Building on the project's brainstorm exercise described above, applications were submitted to the BBSRC Agri-Food Technology Seeding Catalyst Award. The projects looking at "Waste reduction across the value chain" and "Smart farming techniques to improve water use efficiency" were subsequently selected for pump-prime funding.

Feedback on the day described the value of having discussions and dialogue outside of the typical day-to-day channels. It was challenging to formulate projects in a short space of time with broadly defined challenge areas. Participants were optimistic about the outcomes of the workshop and next steps to move forward with the proposed projects.

A reception is planned at the conclusion of the pilot project to bring everyone together who has participated in the process. The reception will enable continuing momentum for the network of stakeholders, and allow the results of the pump-prime projects to be discussed and developed further. The novel industry and academic alignment process will also be written up as a White Paper, to be launched at the reception. This will reflect the systematic approach used, which will:

- identify existing bottlenecks and high value opportunities in the potato value chain;
- articulate capability challenges (related to such bottlenecks and opportunities);
- identify research opportunities (to address such capabilities challenges.)

## Attendees

<b>David Almond</b>	CUPGRA	Translation
<b>Foivos Anastasiadis</b>	University of Cambridge	Research
<b>Nicky Athanassopoulou</b>	IfM ECS	Research
<b>Jeff Beever</b>	McCain	Processor
<b>Henry Blain</b>	Tesco	
<b>Peter Blaylock</b>	E Park & Sons	Packer
<b>Mario Caccamo</b>	NIAB	Research
<b>John Carr</b>	University of Cambridge	Research
<b>Belinda Clarke</b>	Agri-Tech East	Translation
<b>David Coomes</b>	University of Cambridge	Research
<b>David Firman</b>	NIAB	Research
<b>Jacqueline Garget</b>	Cambridge Global Food Security IRC	Organiser
<b>Ksenia Gerasimova</b>	University of Cambridge	Research
<b>Howard Griffiths</b>	University of Cambridge	Research
<b>Vee Gururajan</b>	Branston	Packer
<b>Yjro Helaruitta</b>	University of Cambridge	Research
<b>Maria Huerte-Ortega</b>	University of Cambridge	Research
<b>Imoh Illevbare</b>	IfM ECS	Research
<b>Mukesh Kumar</b>	IfM	Research
<b>Ronnie Laing</b>	Omnivent	Equipment/ Machinery
<b>Ottoline Leyser</b>	University of Cambridge	Research
<b>Carlos Lopez-Gomez</b>	Policy Links	Organiser
<b>Ian Mackay</b>	NIAB	Research
<b>Michele Palladino</b>	Policy Links	Organiser
<b>Kate Parsley</b>	Biosciences Impact Team, University of Cambridge	Organiser
<b>Sachin Shende</b>	KisanHub	Technology
<b>John Sedgwick</b>	LambWeston	
<b>William Shakeshaft</b>	Greenseed	Breeder & Seed Supply
<b>Simon Smart</b>	NIAB CUF	Research
<b>Lydia Smith</b>	NIAB	Translation
<b>Mike Storey</b>	AHDB	Translation
<b>Mark Taylor</b>	IPL	Procurement & Logistics
<b>Gavin Towers</b>	Agrico	Breeder & Seed Supply
<b>Naoum Tsolakis</b>	University of Cambridge	Research

# D: Funded Collaborative Research

## Project 1

### **System requirement specifications for improved water management of potatoes using real-time crop and environmental data**

**Lead academic:** Professor David Coomes, Department of Plant Sciences, University of Cambridge

**Collaborators:** Dr David Firman, NIAB CUF  
Dr Mike Storey, AHDB  
Dr Sachin Shende, KisanHub

The objective of the project is to develop Systems Requirement Specifications (SRSs) to integrate various hardware components into a cloud infrastructure, in order to be in a position to develop improved water management systems.

The R&D alignment workshop identified a need for real-time integration of crop and environmental data to improve the irrigation efficiency of potatoes. Delegates discussed that the ideal system would involve real-time telemetry of water application from flow meters, thermal imagery of potato crops to indicate water stress, and the integration of soil maps, irrigation model predictions and metrological data.

A report will be produced that reviews the current irrigation control systems, hardware and mapping approaches, and conceptualises an idealised crop monitoring system capable of delivering highly efficient irrigation. The economic feasibility of the integrated system will be examined in consultation with industry experts.

This collaborative project includes Professor David Coomes (University of Cambridge) reviewing recent developments in thermal imaging of water stress, Dr Mike Storey (AHDB) reviewing state-of-the-art methods for regulating irrigation of potato crops in the UK and other crops elsewhere in the world, Dr David Firman (NIAB CUF) reviewing ecophysiological crop models and Dr Sachin Shende (KisanHub) developing SRSs. All partners are also identifying currently available hardware.

It is envisaged that the project will develop a blue-print for an integrated system that controls water flows to potato crops. Once this has been done, further funding could be sought to test the system and eventually bring it to market.

## Project 2

### Mapping of waste in the potato supply chain: a scoping study

**Lead academic:** Dr Mukesh Kumar, Institute for Manufacturing, University of Cambridge

**Collaborators:** Dr David Almond, CUPGRA/IPL (Asda)  
Mark Taylor, IPL (Asda)

The objective of the project is to conduct a preliminary study on the relationship between food product categories and waste types, with a particular focus on pre-factory potato supply chain. This project will provide an opportunity to scope the potato supply chain research within the context of waste minimisation.

This collaborative project aims to develop an approach to assess the potato-waste nexus, map the potato end-to-end supply chain, identify waste hot-spots and related reduction opportunities, and identify and explore the best waste mitigation practices that are or could be effectively applied to akin food product supply networks.

Project activities are focussed on increasing business-academic engagement and enabling multi- and inter-disciplinary research around the potato waste issue. Key to the project is the exchange of existing technological and agronomic knowledge about potato waste reduction at different supply chain intervention points. It is essential to look at the problem from an end-to-end supply chain perspective and consider any waste reduction

practices alongside maximising marketable yield and firm profitability.

A desk-based study mapping the current potato supply chain will be followed by a workshop bringing together a consortium of potential future partners such as AHDB, NIAB, Waste and Resources Action Programme (WRAP), the Fresh Potatoes Suppliers Association (FPSA) and the Potato Processors Association (PPA). The workshop will evaluate existing methods, identify opportunities, and develop a grant proposal for a project aiming to test interventions and create an industry-focussed best practices blueprint to reduce potato waste by 50%.







## E: Participant biographies and contact details

The following people were involved in the process described in this booklet:

### Robert Allen

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Robert is Research Manager and Data Analyst at Greenvale AP, leading suppliers of fresh potatoes. He has responsibility for field trials including new variety evaluation, variety specific agronomy and product testing. Alongside the trials programme, Robert has been implementing agronomically focused data solutions to deliver crop insight to Greenvale. Prior to Greenvale Robert worked as a Senior Data Analyst at Landmark Information Group, the UK's largest provider of geo-spatial and environmental risk data. Robert is a Nuffield Farming Scholar, member of DEFRA's agri-food technology council and co-chair of Agri-tech East's data special interest group.

### David Almond

CUPGRA  
[da@dauidalmondac.co.uk](mailto:da@dauidalmondac.co.uk)



David has a 39-year career in farm management, root crop production, potato supply chain management with Greens of Soham Ltd, part of Spearhead International Ltd Group, who farm 80,000ha in UK and Eastern Europe. He is ex-MD of Greenseed International Ltd and Spearhead Marketing Ltd,

producing and supplying 40,000t seed and salad potatoes, 150,000t of processing potatoes annually to growers, packers and processors, and CUPGRA deputy chairman. David now provides consultancy services in potato enterprise resource evaluation, root crop business strategy and development, and coaching and mentoring. His interests lie in all aspects of the potato supply and value chain, improving potato growing and storage, and innovation and the application of R&D.

### Dr Foivos Anastasiadis

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### Dr Nicky Athanassopoulou

Senior Industrial Fellow, Institute for Manufacturing, University of Cambridge  
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Nicky is a Senior Industrial Fellow at IfM Education and Consultancy Services (IfM ECS). She is responsible for developing custom-designed services to support the strategy and innovation activities of companies of all sizes. She has helped numerous companies to develop their strategy, innovation, technology and product-development processes. She has also managed and participated in several European consortia to develop strategic research and technology roadmaps to facilitate the commercialisation of novel technologies and new engineering approaches. Nicky has a B.Sc. in Physics from Athens University and an M.Phil. and Ph.D. in Solid State Physics from the

University of Cambridge. She holds a CMI Level 5 Award in Management Coaching and Mentoring and is a qualified PRINCE2 project manager.

### Dr Tina Barsby

CEO, NIAB  
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Tina is a plant geneticist well-known for her scientific achievements and significant experience in the agricultural crop sector. CEO of NIAB since 2008, her strong leadership skills and supportive staff have enabled Tina to position NIAB where it is today as an internationally recognised and innovative organisation. Tina has a first degree in Agricultural Botany from the University of Wales at Bangor, and a Ph.D. from the University of Nottingham. She spent a postdoctoral period at Kansas State University, and worked at Allelix Inc, Ontario, Canada for several years before returning to the UK in 1989. She joined Nickerson UK (now part of the Limagrain Group) where she remained until joining NIAB in 2006. As well as being a Trustee of the John Innes Foundation, Tina is a Fellow of St Edmund's College, Cambridge, a Fellow of the Royal Society of Biology, a Trustee of the Lawes Agricultural Trust, a member of the Board of Agrimetrics, a member of the Agri-Food Technology Council, and an Associate of the Royal Agricultural Societies. She was awarded an OBE in the 2018 New Year Honours List for services to agricultural science and biotechnology.

### Professor Sir David Baulcombe

Regius Professor of Botany, Department of Plant Sciences, University of Cambridge  
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David Baulcombe is Regius Professor of Botany at Cambridge University. His research interests involve plants and he focuses on gene silencing and epigenetics – the science of how nurture can influence nature. His discoveries changed thinking about the role of RNA in the regulation of gene expression of animals, plants and fungi. David is also interested in the application of science to develop sustainable agriculture.

### Jeff Beever

Agronomist, McCain Foods Ltd  
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### Peter Blaylock

E Park & Sons Ltd.  
[PeterBlaylock@epark.co.uk](mailto:PeterBlaylock@epark.co.uk)



Peter is currently employed as the company agronomist for the potato packer E Park & Sons Ltd. He has broad and wide-ranging experience in agronomy. The early part of his career focussed on agrochemical advice, sales and technical support for distributors, contractors, manufacturers and latterly potato growers and packers. Focussing on potato agronomy with a special interest in potato cyst nematode (PCN) he has developed an in-depth knowledge of production, pest and disease control, storage systems and compliance. Current projects include trial work with newly bred clones seeking PCN 'double resistors' in a collaborative group including James

Hutton Ltd. He has a deep passion for sustainable potato production, integrated crop management and recently published a poster at the Annual Association of Applied Biologist's annual Advances in Nematology conference: 'Multiplication of *Globodera pallida* in response to growing Innovator and Arsenal at different planting densities.

### Professor Mario Caccamo

Managing Director of NIAB EMR and Head of Crop Bioinformatics, NIAB  
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Professor Mario Caccamo is head of Crop Bioinformatics at NIAB and holds an honorary professorship at the University of East Anglia. His current research interests are focused on the improvement of crops by using data-driven approaches. At NIAB Caccamo has led the implementation of NIAB CUF's potato yield model in a software package that is widely used to support UK growers. Previously Professor Caccamo directed the Earlham Institute (formerly known as The Genome Analysis Centre) where he helped to set up one of the largest European DNA sequencing and bioinformatics centres. Since April 2017 Professor Caccamo is also Managing Director of NIAB EMR.

### Dr John Carr

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John is Reader in Plant Virology at Cambridge University's Department of Plant Sciences. Prior to working at Cambridge, John worked at the University

of Utah Medical School in Salt Lake City, The Waksman Institute of Microbiology Rutgers University in New Jersey with Dan Klessig, and at Cornell University's Department of Plant Pathology in Ithaca New York with Milton Zaitlin. He did his Ph.D. work at the University of Liverpool with Mike Wilson and at Rothamsted Research with John Antoniwi and Ray White. John's research interests include plant defensive signal transduction, plant-pathogen interactions (especially plant resistance), viral silencing suppressors, and plant-virus-insect interactions. He is an Affiliated Scientist at the BeCA-ILRI Hub Nairobi, and an editorial board member for 'Virology'.

### Dr Belinda Clarke

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Dr Belinda Clarke is the Director of Agri-tech East, the membership organisation connecting farmers and growers with researchers, technologists, entrepreneurs and investors using innovation to enhance the economic growth, agricultural productivity and environmental sustainability of the agri-food value chain. Belinda is a member of BBSRC Council and a Trustee of the Royal Norfolk Agricultural Association, as well as a Board member of Agrimetrics. She has a first degree in Natural Sciences (Part II Plant Sciences) from the University of Cambridge and a Ph.D. from the John Innes Centre. She is a Nuffield Scholar, Associate of the Royal Agricultural Councils, Fellow of the Royal Society of Biology and a qualified business coach.

### Paul Coleman

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### Professor David Coomes

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David Coomes is a Professor in the Department of Plant Sciences. His group specialises in applying cutting-edge remote sensing approaches to monitor agricultural land and natural ecosystems. The group works with laser scanning, hyperspectral and thermal imaging. These techniques deliver more meaningful information on vegetation stress than conventional photographic approaches.

### Dr Robert Doubleday

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### Dr David Firman

Head of NIAB CUF  
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David Firman is Head of the Potato Agronomy Group at NIAB CUF. He obtained a degree in Natural Sciences at the University of Cambridge where he remained to complete a Ph.D. on leaf growth and senescence in potato. His research interests have spanned a wide

range of projects from crop nutrition, foliar and tuber diseases, seed physiology and crop modelling. These projects have led to many practical applications adopted by potato growers in the UK and elsewhere including variety specific nitrogen rates, control of tuber blemishing diseases, limiting virus spread and seed rates that maximise marketable yield.

### Dr David Flanders

CEO, Agrimetrics  
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David Flanders is CEO of Agrimetrics, the UK government-funded Agri-tech centre on big data and sustainability metrics. David has 25+ years' international experience across the life sciences. Previously, he was CEO/Co-Founder of an ag-tech start-up, CEO of Eagle Genomics, UK Site Head for a US stem cell company, COO of a proteomics and systems biology start-up, and at life-science software provider Lion Bioscience. He has US experience at Stanford University and with a major ag-tech company. He has a degree in Agricultural Biology from Newcastle University and a Ph.D. in Developmental Biology from the Australian National University.

### Andrew Francis

Farm Manager, Elveden Estate  
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Andrew Francis is a first-generation farmer and Senior Farm Manager at the Elveden Estate. Andrew is directly responsible for all elements of farming on the 9,500-hectare estate on the Norfolk Suffolk Border plus 1,700 hectares of external farming.

Andrew manages a team of 50 workers working together with them to look at long term approaches to land and water management, food production and environmental sustainability. Being a LEAF Demonstration Farm, McDonalds Flagship Farm and the current host of AHDB SPoT Farm East, Andrew welcomes various groups of people to the Estate throughout the year.

### Jacqueline Garget

Coordinator, Cambridge Global Food Security, University of Cambridge  
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Jacqueline Garget is Coordinator of Cambridge Global Food Security, an Interdisciplinary Research Centre at the University of Cambridge. The Centre is a virtual network connecting the interests of 150 researchers across 24 departments of the University, spanning the whole food system from production to consumption. Jacqueline's role is to promote the research expertise within the Initiative, support fundraising for interdisciplinary projects, and organise events to facilitate interdisciplinary networking and collaborations on topics relating to Global Food Security.

### Dr Ksenia Gerasimova

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### Professor Howard Griffiths

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Professor Howard Griffiths is the Principal Investigator on the new GCRF-funded TIGR2ESS project, co-Chair of the Cambridge Global Food Security Initiative, and has been helping to establish the new Cambridge Centre for Crop Science with collaborators at NIAB. As the Professor of Plant Ecology, his research encompasses molecular mechanisms that enhance plant productivity, the use of water and nitrogen by crops, as well as tropical forests and their epiphytes.

### Patrick Grote

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Philip is the Director of Research and Finance in the Department of Engineering, and also the Deputy Head of Department for Strategy and Operations. He guides and supports the development and expression of research strategies, gathers intelligence on funding opportunities, and through his Research and Finance Office teams provides a professional service to support academics in winning and managing grants. He also helps companies and institutions to build relationships with the Department.

While Philip is neither an academic nor researcher, he uses his prior consulting experience to design and facilitate business and research strategy sessions with academics and industrialists.

### Vidyanath Gururajan

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Vidyanath (Vee) Gururajan is Innovations Director at Branston Limited. He is responsible for varied portfolios in the Executive Board: major capital expenditure projects, sustainability, IT and innovation. Vee also heads up the variety development programme. Vee served as an advisory board member for Tesco Producer Network and Tesco's Responsible Sourcing advisory panel. He is a board member of the National Centre for Precision Farming, UAS specific interest group. Vee is a Chartered Mechanical Engineer, and has a Masters in Engineering Management.

### Dr Sharon Hall

Director General, Potato Processors' Association  
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Dr Sharon Hall is Director General of the Potato Processors' Association (PPA), which represents the interests of UK manufacturers of frozen & chilled potato products and savoury snacks. Dr Hall has a degree in Applied Biology, a Masters in Science Communication and a Ph.D. in Molecular Plant Pathology. She is a member of the European Potato Processors' Association (EUPPA) Board, the Red Tractor Fresh Produce Board

and chairs the Nematicide Stewardship Programme. She is committed to the communication of best practice in the supply chain and the enhancement of the reputation of processed potato products and snacks.

### Professor Yrjo Helariutta

Professor of Plant Developmental Biology,  
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Yka (Yrjo) Helariutta is a Group Leader and Professor of Plant Developmental Biology at the Sainsbury Laboratory, Cambridge University. He is studying vascular development in plants. This involves how plant cells establish their identities and how they proliferate when the tissues for long distance transport are elaborated. Plant vascular development involves several adaptations. One such adaptation are the various edible storage organs, such as potato. The Helariutta lab is currently establishing the model plant *Arabidopsis thaliana* as a system to investigate the morphogenesis of storage organs.

### Professor Ian Hodge

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### Dr Maria Huete-Ortega

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Maria received her B.Sc. Degree in Biological Sciences at the University of

Santiago de Compostela (Spain) in 2005. In 2011 she was awarded her Ph.D. in Biology at the University of Vigo (Spain), obtained after conducting her doctoral thesis on the study of the structure and function of microalgal communities in the marine ecosystem. In 2012 she moved to the UK to continue her career as postdoctoral researcher in microalgal eco-physiology, systems biology and biotechnology, first at the University of Essex and later at the University of Sheffield. In June 2017 she joined the Department of Plant Sciences at the University of Cambridge where she works as the Innovation and Enterprise Project Officer of the CambPlants Hub, coordinating all plant related activities across the University of Cambridge.

### **Dr Stephen Humphreys**

Food Industry Manager, Bayer CropScience Ltd

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Stephen Humphreys has worked in the agrochemical industry for over 25 years. He has worked in a range of business areas including analytical chemistry, biology, field trials and regulatory affairs. His current role as Food Industry Manager for Bayer CropScience involves interactions with UK retailers and suppliers including the major potato packers and processors. He also represents the Crop Protection Association on the Technical Advisory Committee for Red Tractor Produce.

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### **Tina Jeary**

Technical Development Director, Albert Bartlett

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Tina joined Albert Bartlett in 2014 and was promoted to the board as Technical Development Director in 2016. She has responsibility with her team for the technical and product development aspects of the business across fresh, manufacturing and Scotty Brand products. After graduating in Nutrition and Food Science, Tina has worked in a number of product technical and development roles in retail and manufacturing both in the UK and internationally. Prior to joining Albert Bartlett, her most recent roles were as General Manager for private label at Coles Supermarkets and as Head of Product Development and Technology – fresh foods at Sainsbury's. She has a keen interest in healthy eating and innovation and is constantly looking for new ideas.

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Mukesh Kumar is a University Lecturer at the Department of Engineering,

University of Cambridge. He is based at the Institute for Manufacturing and leading research on industrial resilience. His research interest in the field of risk management and manufacturing came from an early career in the financial industry, where he was responsible for corporate evaluation of investment decisions made by manufacturing companies. Since joining the University, his research has included food product safety management from developed and developing country perspectives, risk evaluation in pharmaceutical supply, and environment sustainability assessment in global supply networks in four sectors: food, pharmaceuticals, automotive and aerospace. His research continues to focus on sustainability and resilience but closely related to the emerging manufacturing paradigm of "Distributed Manufacturing".

### **Ronnie Laing**

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### **Ben Lang**

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Ben Lang is a Principle Research Associate and Manager of the Rural Business Unit at the University of Cambridge, where they carry out policy work on Farming and Agri Environment. He manages the Farm Business Survey (FBS) in the East of England and is a member of Rural Business Research Management Group, responsible for the FBS in England. He is a BASIS qualified agronomist and Principle Investigator for research projects into the economics of crop production and measurement of business performance in the UK. This work continues internationally through the agri benchmark Cash Crop Network.



### Professor Dame Ottoline Leyser

Director, Sainsbury Laboratory, University of Cambridge

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Ottoline Leyser is Professor of Plant Development and Director of the Sainsbury Laboratory Cambridge University. Her research uses the control of shoot branching in *Arabidopsis* as a model system to understand plant developmental plasticity and the integration of endogenous and environmental factors in development. She is a Fellow of the Royal Society and a Foreign Associate of the US National Academy of Sciences. She currently serves on the Prime Minister's Committee on Science and Technology, and Chairs the Royal Society's Science Policy Committee. In 2017 she was appointed Dame Commander of the Order of the British Empire for services to plant science, science in society and equality and diversity in science.

### Dr Carlos López-Gómez

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Dr Carlos Lopez-Gomez is Head of the Policy Links Unit, the knowledge exchange unit of the Centre for Science, Technology and Innovation Policy (CSTI), University of Cambridge. He has expertise in the field of National Value Capture through Manufacturing, Industrial Strategy and Manufacturing Policy and Manufacturing Futures. Carlos has advised governments and international institutions including the UK Department for Business, Energy and

Industrial Strategy (BEIS), the UNIDO, the European Commission as well as regional governments and cluster organisations in Mexico, Spain and UK. Carlos holds a Ph.D. in industrial economics and innovation policy from the University of Cambridge.

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### Professor Ian Mackay

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Professor Ian Mackay's principal research interest is quantitative genetics and plant breeding. He has published in areas covering experimental design, selection methods, improved approaches to trait mapping, and genomic selection. He has developed and teaches intensive courses in genetics and plant breeding. Ian worked at NIAB for 12 years until December 2017, when he established IMplant Consultancy Ltd., consulting in quantitative genetics and breeding. He has also run the statistical genetics department of drug discovery company Oxagen Ltd. and worked as a commercial plant breeder, including nine years as co-founder and research director of Lion Seeds Ltd.

### Conor McMahon

Senior Consultant, ADAS

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Conor is a senior consultant in the Sustainable Food and Farming team at

ADAS. His team delivers consultancy to government and industry clients on topics related to agriculture and the food chain. Conor has a particular interest in creating and implementing responsible procurement strategies in food businesses, supporting them in managing their relationships with suppliers, compliance monitoring and reporting. Conor has experience working on projects across the potato value chain and was part of the PepsiCo "50 in 5" project helping Walkers Crisps potato growers to achieve an average reduction in GHG emissions of 50% per tonne of potato.

### Professor Graham Moore

Programme Leader, John Innes Centre

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Current position: Lead for BBSRC's wheat coordinated (DFW) programme. Career: Pasteur Institute France, ICRF London, PBI Cambridge, and JIC Norwich. Selected examples of Board membership: CGIAR WHEAT programme covering CIMMYT-ICARDA programmes to breed wheat for the resource-poor in the developing World; Wheat Initiative (Established by the G20 Agricultural Ministers)

Research: Graham developed the concept of cereal synteny, which enabled genes for wheat traits to be more rapidly identified, for which he was awarded the Royal Society Darwin Medal; he characterised wheat's major domestication locus, Ph1, and has published eight wheat papers in *Nature* or its sister journals.

### Keith Norman

Technical Director, Velcourt Ltd  
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Keith graduated from Newcastle University specialising in Crop Production. Keith then followed a career in practical farm management for six years, initially as a working farm manager and eventually becoming arable manager on a 1200 hectares estate in Lincolnshire. Keith then changed to a more technically based role as Technical Director, supporting Velcourt's team of 45 farm managers in crop production technology and managing Velcourt's in-house research and development activity in 1989. Velcourt currently manage 53,000ha in the UK. Keith has worked on various overseas projects in Spain, France, Germany and Zambia and is actively involved in Velcourt's activities in Russia and the Ukraine. Velcourt's R&D is primarily to provide its team of 46 farm managers with independent technical information. Velcourt are also partners in many collaborative projects. Velcourt R&D also work with all the major agrochemical manufacturers, providing independent evaluation of new and existing active ingredients.

### Dr Eoin O'Sullivan

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### Dr Michele Palladino

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Dr Michele Palladino is a policy analyst of the Policy Links Unit, the knowledge exchange unit of the Centre for Science, Technology and Innovation Policy (CSTI), University of Cambridge. Michele provides expertise in industrial economics. Before joining Policy Links, he worked as an economist advising the UK Government and the European Commission on European policy evaluation and industry sector analysis. Michele has also consulting experience in Italy and Brazil, focusing on programmes supporting the manufacturing sector. Michele holds a Ph.D. in Development Economics from the University of Insubria (Italy) and an M.Sc. in Development Economics from the University of Sussex.

### Dr Kate Parsley

Impact Facilitator, Bioscience Impact Team, University of Cambridge  
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Kate Parsley is an Impact Facilitator in the Bioscience Impact Team at the University of Cambridge. Kate's role is to generate impact from research in Agri-tech and Animal Health within the School of Biological Sciences, via delivery of BBSRC Impact Acceleration Accounts. Kate is a plant scientist by background, has a Ph.D. from the University of Cambridge in wheat genetics and has over 7 years' Post-Doctoral experience gained at the Universities of Adelaide and Cambridge. Prior to her current role Kate was

instrumental in building NIAB Innovation Farm up from a pilot project into a vital agricultural knowledge exchange hub.

### Dr Vibhuti Patel

Translational Research Manager, Bioscience Impact Team, University of Cambridge  
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Vibhuti heads the Impact Team for the School of the Biological Sciences, which works to support researchers with all aspects of translational research, such as identifying funding sources, enabling relevant industrial contact, liaising with partners, supporting entrepreneurship, preparing for REF and providing training on routes to impact. Vibhuti joined the University of Cambridge in March 2017 from the Royal Society of Chemistry where, most recently, she worked in Strategic Partnerships, liaising with companies, government bodies and philanthropic donors to run joint programmes for a number of audiences in the chemical sciences community. Prior to this she worked in International Development, setting up the RSC's operations in India. Vibhuti has a B.Sc. in biochemistry and Ph.D. in biological mass spectrometry, both from the University of Warwick.

### Professor Dale Sanders

Director, John Innes Centre  
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Dale Sanders obtained his Bachelor degree from the University of York and a Ph.D. in Plant Biophysics from Cambridge University. He spent five years as a

research fellow at Yale University School of Medicine using fungi as model systems to understand how plants absorb mineral ions. Dale returned to York as a lecturer in 1983. Discoveries in the Sanders Lab in the field of plant nutrition led to awards that included the Koerber European Science Prize and election as a Fellow of the Royal Society. After heading the Biology Department at York for six years, in 2010 Dale was appointed as Director of the John Innes Centre. A current major research focus relates to improving the micronutrient content of cereal grains.

### **Dr Sachin Shende**

CEO, KisanHub

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Sachin grew up on a farm, and combines the insights of a rural upbringing with recognised expertise in the development of data analytics and research platforms. After first degrees in agricultural engineering and water resources management, Sachin began his career building reservoir decision-support systems. Sachin holds a Ph.D. in Computational Hydraulics, and prior to founding KisanHub in 2012, managed the development of bond trading and research analytics platforms for Barclays Global Investors and BlackRock.

### **John Sedgwick**

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### **William Shakeshaft**

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Will is a director of Spearhead Marketing Ltd, part of Greens of Soham, based in Cambridgeshire. Will is currently heading up the Spearhead potatoes processing division. With over 17 years in the potato sector, Will brings a depth of experience in the supply chain management as well as growing crops, working with growers and also retailers. He has always had farming in his blood, and from a young age he has spent many hours working on the Lancashire moors before he moved over to East Anglia in 1996.

### **Dr Simon Smart**

Research Associate, NIAB CUF

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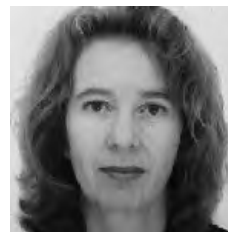


Simon Smart is a Research Associate at NIAB CUF and in 2016 was awarded his Ph.D. from the University of Cambridge on the causes of plant-to-plant variation within the potato crop and how this affects uniformity of tuber size. He has subsequently conducted research on the causes of tuber greening using a Fellowship awarded by AHDB Potatoes.

### **Dr Lydia Smith**

Head of Innovation Farm & Innovation Hub, NIAB

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Lydia Smith is Head of Innovation Farm & Innovation Hub at NIAB, Cambridge. She leads interactive farmer-facing research into sustainable farming, especially crop genetic improvement and waste minimisation. Joining NIAB in 1997, Lydia built up research and focused on crop product improvement and new methods for utilisation and characterisation in the novel and non-food crop areas. The broad need for industry participation and demonstration in NIAB research led to the 'Innovation Farm' concept, for practical grower-facing research with knowledge exchange and route to application for end-users at its core. Since 2016 Lydia has led the East Agri-tech Innovation Hub: providing a pilot study resource for farmers and researchers to minimise waste in farming.

### **Andrew Spencer**

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### **Andrew Starbuck**

UK Sales Manager, Grimme UK Ltd

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Andrew Starbuck is the UK Sales Manager for German root crop machinery manufacturer Grimme based in Lincolnshire where he has been with the company for 9 years; his previous position in the company include Area Sales Manager, which he held for 5 years.



Growing up on the family farm in central Nottinghamshire is really where his interest in agriculture began, which led him complete a B.Sc. Honours degree in Agriculture and Land Management at the University of the West of England in 2004; his dissertation thesis was “The efficiency of herbicides when apply growth stimulants to potato crops.”

**Allan Stevenson**  
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**Dr Mike Storey**  
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Dr Mike Storey leads the technical team that develops and manages levy-funded research on soils (Great Soils), nutrients (RB209) & water, and exploiting precision technology – robotics, sensors to satellites. He has specialist knowledge of the GB potato sector and represents AHDB on government and industry technical advisory groups, including Red Tractor Assurance, SARIC, UK Plant Health Strategic Advisory Forum and he chairs the industry CIPC stewardship group.

**Professor Roger Sylvester-Bradley**  
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Roger is a Head of Crop Performance with ADAS and honorary professor of temperate crop physiology with the University of Nottingham. After working on crop productivity and nutritional

efficiency for over 40 years, Roger says there has never been a more exciting time to be a crop scientist, so he refuses to retire! His new interests are in phosphorus, and in on-farm innovation and experimentation. His work is published in over 200 scientific papers and reports.

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Leon Terry B.Sc. (Hons) ARCS M.Sc. Ph.D. PGCert. FIAgrE FRSB FHEA holds a Personal Chair in Plant Sciences and was appointed as the Director of Environment and Agrifood at Cranfield University in 2014. Leon is an appointed member of the BBSRC Agriculture and Food Security Strategy Advisory Panel. His personal scholarship has been driven by a need to preserve and maintain the quality and safety of fresh produce by better understanding the physiological, biochemical and molecular changes which occur after harvest in order to reduce waste and thereby help ensure greater food security across the world.

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Dr Naoum Tsolakis is a Research Associate in Industrial Systems and Network Analysis at the Centre for International Manufacturing, Institute for Manufacturing, Department of Engineering, University of Cambridge. Dr Tsolakis's main research and practice interests are in the areas of simulation modelling and analysis of sustainable supply chains design and management in the circular economy era, along with intelligent autonomous systems, for the industrial manufacturing, agri-food and pharmaceutical sectors. His research output is both academic- and business-driven owing to his participation in a plethora of research projects and consortia.

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