Agricultural Productivity
Working Group

Report to the Food and Drink Sector Council

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Foreword

From global integration of food markets to changing consumer behaviour, the UK farming and growing industry has proved remarkably adaptable and resilient to change. Yet the circumstances facing the industry – greater exposure to global markets, changes to support policies, climate change and commitments to achieve net zero emissions – mean that the scale of transformation that will be required from our primary production is seismic.

At the centre of these issues lies the need to bolster the productivity of farming and growing. Like our economy as a whole, farming productivity growth is below its potential and the rate of growth is lower than many of our major competitors. Left untouched, our industry will decline, denying consumers and our domestic food industry the affordable, sustainably produced agricultural goods they demand.

The opportunity to do something significant is now. Accelerating technological development means that farmers and growers stand on the cusp of another revolution which could potentially transform productivity. And the government's Industrial Strategy has created a catalyst for change. Through the Food & Drink Sector Council, industry and government have a unique chance to come together to address some of the systemic weaknesses highlighted in this report and bring about the conditions in which our industry can thrive.

The objectives are emphatically not about producing more with no thought to the environmental consequences or consumer expectations. On the contrary, the prize of greater productivity is significantly better use of our natural, environmental resources. And if we get it right, the benefits to our rural economy could be substantial.

This report identifies a series of recommendations that, together, could go a significant way to putting our agricultural productivity growth back on track. Government plays a key role in many of these recommendations, putting in place some of the critical enablers that are required from investment in infrastructure to the right policy incentives.

But they also require the industry and the key players within it to come together and lead the ambition. Above all, there is a critical need to empower, mobilise and motivate farmers and growers to embrace change, to share data and knowledge, compare their performance and buy into the numbers. Bringing together this body of work on has already galvanised key players in the industry who have the energy do something really special.

This report to the Sector Council does not provide all the answers; the recommendations are a roadmap that need to be developed further to identify who needs to do what, where, and at what cost. But they provide a significant and comprehensive platform which the industry and government, together, can get behind.

Peter Kendall
Food & Drink Sector Council Member and Chair of the Agricultural Productivity Working Group

Executive Summary

Productivity is a measure of how efficiently resources (including natural resources) are converted to outputs rather than production. The rate of productivity growth in UK agriculture lags behind that of many of our major competitors. This undermines our industry's ability to compete in a more globalised market, deliver against consumer expectations and add value to the economy. Higher productivity growth would also positively affect the industry's sustainability since it can be closely correlated to lower environmental impacts.

Low productivity growth in UK farming and growing appears to be the result of a combination of factors which can be overcome through:

1) Harnessing the power of data and inspiring farming businesses to measure performance
2) Bringing co-ordination to our innovation system and ensuring investment in innovation targets key productivity and sustainability constraints
3) Defragmenting the landscape of knowledge exchange and providing more opportunities for farmers and growers to learn from the best
4) Facilitating investment in capital, skills, training and continuous professional development

The Agricultural Productivity Working Group (APWG) was established by mandate of the Food and Drink Sector Council and the chairmanship of Peter Kendall to identify how, working in partnership, industry and government could unlock greater productivity growth. The APWG's vision is for a world-leading, competitive and sustainable agriculture and horticulture industry that can meet consumer demands for high quality products at every price point. The group has avoided setting arbitrary targets but recognises a massive acceleration in agricultural productivity growth is needed urgently to achieve this vision.

The report starts with a vision for the future, setting out how the industry might look over the coming decades. It moves on to explain what we mean by productivity, what we understand of the problem and where the opportunity lies to address it (page 10). The report moves on to identify a package of five high level recommendations that the APWG sees as fundamental to achieving a step change in productivity growth. Each contains a series of actions, some of which build on previous initiatives such as the Agri-Tech Strategy and require momentum from both industry and government to succeed.

Recommendation 1 (page 16) focuses on the fundamental need for **UK agriculture to become more data driven**, allowing performance measurement and the sharing of data to compare between farms. The recommendation highlights the need for **simple, entry-point KPIs** to be established and for policy incentives to promote data capture, use and sharing in a standardised way. It also acknowledges the need for culture change across the industry through a cohesive industry campaign to communicate the benefits for farm businesses of data collection and use for management. The recommendation also addresses the necessary structural change, emphasising:

1) The need for a **code of practice on agricultural data** to establish trust around data sharing and use
2) The need to ensure **common standards of interoperability** between data holding/management systems to enable effective data sharing
3) The need to **establish a trusted method of collecting and sharing data** in the UK agricultural sector

Recommendation 2 (page 20) advocates the need to develop the **Evidence for Farming Initiative** (EFI) to address the fragmentation that surrounds our knowledge exchange landscape. This is characterised by a wide range of delivery bodies, limited co-ordination of effort, variable messaging and no central point where quality assured advice can be obtained.

EFI is based on principles underpinning the What Works network, which currently identifies and shares best practice across a range of public organisations in the UK. EFI will be industry-facing, focussing on the collation of evidence-based best practice recommendations, commercial testing of advice to provide quality assurance, and wide-scale dissemination of information for use by decision-makers.

It will provide:
- A single physical and digital hub for evidence-based best practice
- Scientific rigour, independence and objectivity
- Farm and practitioner-led identification of research needs and generation of evidence.
- Dynamic analysis, review of the available evidence and identification of gaps.
- A comprehensive and co-ordinated means of disseminating knowledge through multiple channels
- Recommendations to practitioners, decision makers, funding bodies, consultants, advisers, colleges and assurance schemes.

Whilst the initiative should be led and owned by industry stakeholders, it could play a powerful role in identifying innovation priorities and support evidence-based policy-making by government. Secure sharing of farm data via EFI will enhance impact, allowing monitoring of progress, both individually and as a wider industry.

The recommendation also identifies the opportunity to better co-ordinate existing activities to demonstrate best practice via **demonstration farms** as well as the potential to grow the network to provide more opportunities for farmers to learn from other farmers. This is seen as an important and proven means of facilitating engagement and uptake.

Recommendation 3 (page 24) addresses the need to **align innovation funding and strategy** to the needs of the industry. Innovation drives the frontier of technical efficiency forward and is seen as the most important long-term driver of productivity growth in the sector. However, the uptake of innovation at scale appears to be poor. This report identifies key actions to improve the UK's innovation pipeline:

1. The need for greater industry leadership in determining innovation priorities. Industry representatives recognise that a more co-ordinated, evidence-led approach to identifying strategic research priorities is needed, informed by the Evidence for Farming Initiative.
2. A focus on strategic, transformative research 'missions'. This approach would see all actors in the knowledge and innovation system focusing their effort collaboratively in addressing a discrete series of strategic challenges for UK agriculture and horticulture, for example, how to achieve a net zero position in terms of emissions.
3. A multi and inter-disciplinary approach to innovation enabling all the fields of science that are relevant to productive, sustainable agriculture to work together. This approach would be further bolstered by multidisciplinary and inter-disciplinary calls.
4. Clearer pathways for innovation funding, including funding for farmer-led innovation
5. An ability to overcome regulatory hurdles that inhibit the development of potentially useful opportunities such as insect biomass
6. Improved connectivity between R&D funding and more targeted and sustained funding for translational research
7. Up-weighting of uptake and impact on the domestic industry in research funding criteria

Recommendation 4 (page 29) deals with the low uptake of **agricultural skills and training**. In 2013, only 18% of farm managers in England had full agricultural training, with 61% relying solely on practical experience. As well as cultural barriers to uptake, agricultural training in is provided by a wide range of organisations, across a wide range of topics. There is no single register of training organisations, or a central record of qualifications awarded. This fragmentation contributes to the low training uptake. The APWG has identified the following required actions drawn from the industry's Skills Leadership Group:

1) Create a central **Professional Body for Farming and Horticulture** which will serve as the home of professional development and training in England. The facility will implement a new skills strategy for industry; provide a framework for professional development; endorse curriculum development, signpost training courses and training providers and manage a central register for skills qualifications awarded
2) Create incentives through policy mechanisms that motivate farmers towards CPD and training uptake
3) Embed a culture of continuous improvement in the industry
4) Build a stronger profile of a dynamic industry to new entrants and recognise agriculture as a STEM industry

Recommendation 5 (page 32) emphasises the need for **infrastructure and policy** to enable productivity gains both in terms of the wider economy and on farm. The achievement of several of the recommendations and case studies in this report is dependent on the provision of this infrastructure.

High capacity data flow is fundamental to artificial intelligence, an essential component of future high productivity farming & growing. 4G is currently adequate for the control and management of current equipment but will not meet future needs and is not securely available across rural areas. Farming and growing will require 5G coverage across all parts of the UK in order to harness the potential of precision technology, robotics and autonomous systems.

If the net zero carbon ambition is to be achieved by our industry, electrification of heavy farm machinery must be facilitated. Nationwide reinforcement of rural electricity infrastructure, including buffer battery storage systems, will be essential to deliver the required electrical flow for 'smart charging' of multiple high capacity batteries at times of peak activity in the farming calendar.

Facilitating investment in on farm infrastructure and capital are also seen as vital to long-term productivity growth and meeting the challenge of net zero. Land mobility is also seen as low in many parts of the UK, and access to long-term land lets is restricted, which can hinder the expansion of farms and see land remain under the control of those towards the end of their career Facilitating the management of land by those who will adopt new tools, technologies and practices could have a subsequent positive impact on productivity.

The following actions are required:
1. Invest in **5G infrastructure** to enable required future data flow
2. **Upgrade the rural electricity network** to enable electrification of farm equipment
3. Facilitate the **active management of land** by productive, proficient farmers using different business models such as contract farming
4. Encourage **business focused investment** in primary agriculture

The report concludes by providing a summary of the key actions that will be needed from both industry and government to turn these high level recommendations into delivery plans (page 35).

The key priorities for industry are:
- Agreeing simple-entry point KPIs and getting them embedded into the culture of the farming and growing industry
- Establishing the blueprint for Evidence for Farming and ensuring buy-in to it from key industry players
- Collaborating more to showcase best practice, innovation and data
- Leading a campaign to promote skills, professionalism and life-long learning in the farming and growing sectors

The key priorities for government are:
- Providing the right policy incentives for data capture, sharing and skills uptake
- Getting behind Evidence for Farming as a critical part of the new infrastructure to improve the knowledge and innovation system
- Maintaining the directional shift in innovation funding and commissioning so that industry feels greater buy-in, there's more collaboration and focus behind a shared series of key 'missions'
- Facilitating the critical infrastructure in rural areas and on farms that will be needed to underpin greater productivity and sustainability as well as enable new technologies to be utilised at scale

A vision of the future

Seeking to predict the future of our industry is fraught with danger. Nonetheless, this report starts by casting a vision of the characteristics of farming and growing over the coming decades[1].

Structural change can be expected to drive significant consolidation in the number of enterprises. New enterprises and start-ups have created a more diverse industry in which the nature of farming and growing has changed with more professional farming businesses and contractors. More significantly there has been a massive shift in mindset towards continuous improvement with producers actively seeking out and adopting new ideas and hungry for regular insight into sector and system performance indicators.

New production methods have developed, with vertical horticulture and protein biomass production becoming more widely distributed. At the same time many farmers have pursued energy generation and the **production of public goods** as business enterprises.

Automation and autonomous systems are becoming widespread and have largely taken the place of people in many aspects of production. Guided by high data flow systems and video analysis, fleets of robots now carry out fieldwork on a 24/7 basis. Integrated farm management is standard and expert understanding of soil science underpins farm performance. Autonomous soil testing combined with the use of small, light fleets of robots for fieldwork has helped to reduce compaction. As a result, soil health has dramatically improved whilst use of inputs such as fertiliser has declined. The advent of electric farm vehicles has created the potential for a further deep decarbonisation of farming systems.

Data is central to enabling these new systems and technology to operate seamlessly. Data flow from farms provides constant reassurance and immediate response to threats. Information flow to consumers and stakeholders now includes real-time data to assure animal welfare, environmental practice and production standards. This has opened and expanded many global markets and whilst the main market remains the UK itself, the proportion and volume of exports has grown.

Integration of data and technical knowledge are pivotal to generating actionable insights on which producers can take real time decisions. Advanced diagnostics from remote sensing and autonomous collection help to produce specific best practice guidance for individual farms. Trust around data sharing is high as producers see the benefits. What's more, the central curation of data and knowledge is helping inform a strategic innovation agenda that puts producers one step ahead of the competition.

An extensive **network of experimental and demonstration farms** tests and demonstrates innovation and best practice in an environment that producers can relate to. This has been effective in driving uptake of innovation at scale and reduced the range of farm business performance.

The **skillset** has changed with the industry seen as modern and professional. It now attracts new entrants from non-traditional backgrounds including IT, engineering and accounting. Their ability to manage technology, interpret data and apply the findings has driven large performance increases. Continuous professional development of all staff is normal industry practice. The work-life balance of farming and growing has improved, further raising the attractiveness of agriculture as a career for entrants from outside the industry.

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[1] The NFU's Future of Food 2040 report sets out a number of key drivers and dynamics that will shape farming and growing up to 2040 https://www.nfuonline.com/nfu-online/news/the-future-of-food-2040/

Agriculture has become the solution to many environmental challenges using new technology and practice. A range of new methods of reusing farm by-products has minimised waste and the industry is close to achieving carbon and energy neutrality.

The recommendations outlined in this report can bring this vision to life. Figure 1 paints a visual picture of how the industry could look if we get it right.

Figure 1: The Agricultural Industry in 2035
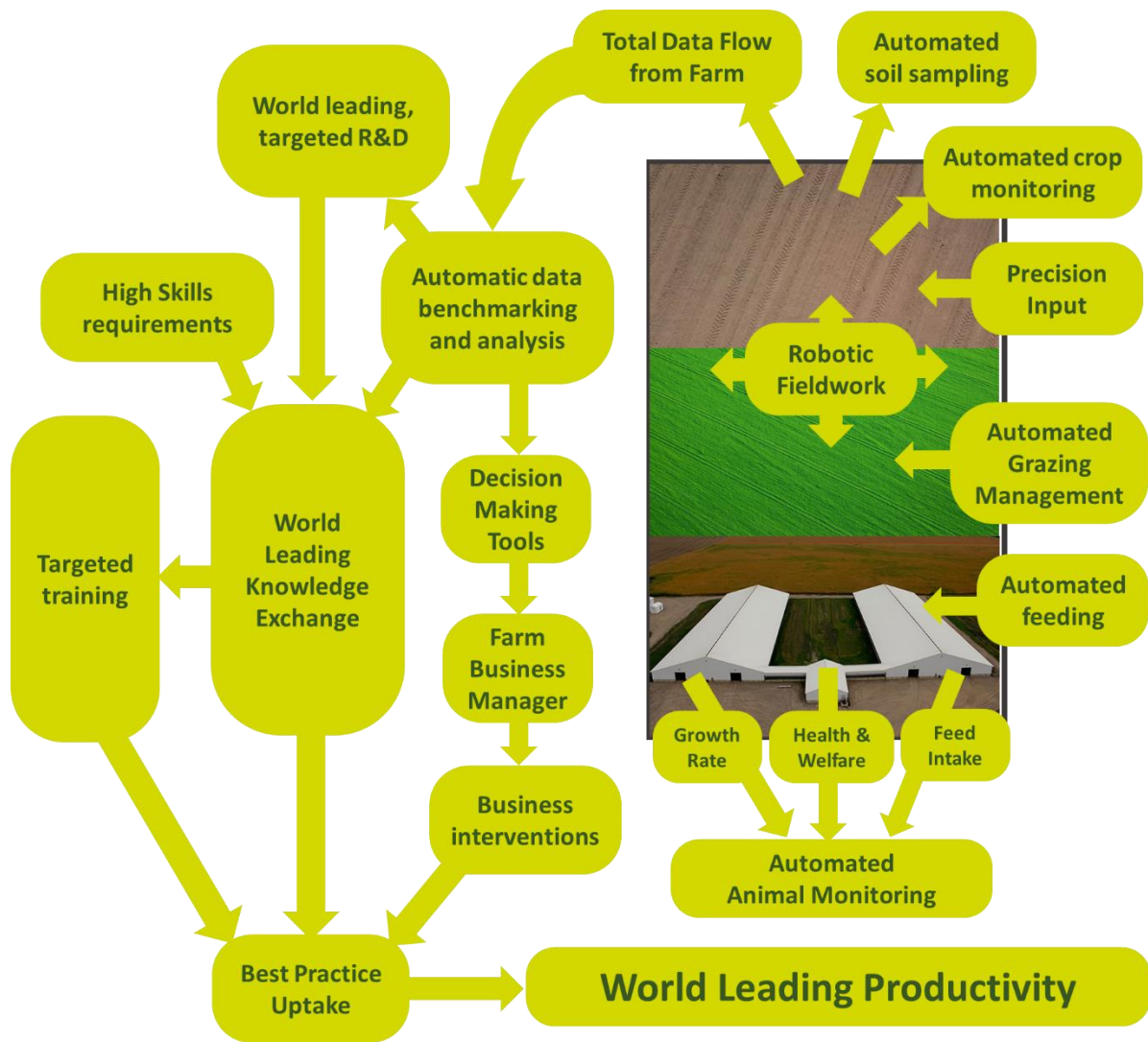
Introduction

The Agricultural Productivity Working Group (APWG) was established as a designated workstream of the Food and Drink Sector Council. It has come together over an 18 month period to identify the key priorities to enable greater productivity in agriculture and horticulture.

The group's vision is for **a world-leading, competitive and sustainable UK agriculture and horticulture industry that can meet consumer demands for high quality products at every price point**. The APWG is chaired by Peter Kendall and comprises a range of individuals drawn from industry, government and academia. All members share a collective belief that addressing sustainable growth in agricultural productivity holds the key to meeting the vision set out above.

The APWG findings have been informed by a range of Task and Finish Groups, which were established to identify the key development needs in the industry. All groups included a range of industry practitioners and experts and consultations with those outside the APWG also took place. Over 150 people and organisations have been involved in development of the recommendations in this report, which represents a synthesis of this combined input. A full terms of reference is provided in Appendix 1.

The Government's Industrial Strategy[2] offers the chance to create the long-term foundations for success through allowing the agriculture sector to identify incremental and transformative changes that can be jointly addressed in partnership with government.

The report acknowledges the importance of previous steps and has produced recommendations which build on previous foundations including the Agri-tech Strategy. The recommendations are complementary, and, if implemented, will combine to deliver an agricultural industry with world leading productivity.

What is Agricultural Productivity?

Productivity is about the rate at which inputs (land, water, labour, capital) are converted into outputs. It is a measure of the ***efficiency of production*** not the quantity of output produced. Increasing productivity can mean producing more output for the same amount of input or producing the same output for reduced levels of input.

Raising productivity is usually associated with increased competitiveness – producing outputs more efficiently typically reduces unit costs. Nonetheless, competitiveness can also be driven by external economic factors such as currency fluctuations. Productivity should also be seen as a key driver of business profitability. The APWG has focussed on productivity as a better measure of real-world agricultural performance than profitability for three reasons:

1) Profit can be influenced by market price which is usually outside the control of the farmer
2) Short-term profit can be boosted in the short-term by unsustainable practices, through for example, underinvestment in replacement machinery. However, this simply transfers required investment into a following year, showing a profit, which is not actually reflective of true farm performance.
3) Productivity considers long term sustainability of a business, whereas profit may not

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[2] https://www.gov.uk/government/publications/industrial-strategy-the-foundations/industrial-strategy-the-5-foundations

Two broad measures are often used to track the rate of productivity growth over time. Total Factor Productivity (TFP) measures how efficiently agriculture and horticulture convert all inputs to outputs. Average Labour Productivity (ALP) measures the amount of output per worker or per hour over time. Industry figures are aggregated across the whole of agriculture and horticulture, meaning it is challenging to identify whether particular sectors or regions contribute more or less to overall growth.

The AHDB has identified six factors that are fundamental drivers of productivity growth in agriculture and horticulture[3]:

1) The **business environment** in which farming and growing operates, including regulation, taxation, inflation and growth, planning and infrastructure.
2) **Natural capital**, including topography, soil condition, access to water and climate.
3) **Competitive pressures**. Greater exposure to competition spurs businesses to innovate and reduce costs.
4) **Policy**. Specific policy incentives can play a part in increasing productivity growth through promoting incentives for new entrants, incentivising skills and capital investment
5) **Ideas.** Innovation can push the frontier of technical knowledge. Taken up at scale it can lead to significant improvements in productivity
6) **People**. Improving skills are critical to productivity growth in any sector of the economy

These six factors correlate closely with the five foundations identified in the Industrial Strategy:

1. **Ideas** – i.e innovation and the rate at which it is taken up
2. **People** – skills not only improve performance but better jobs increase earning power
3. **Infrastructure** – seen as a critical enabler to growth
4. **Business environment** – in which businesses can invest and prosper
5. **Places** – recognising the need for prosperous communities across the UK (including rural areas).

Productivity and sustainability

The APWG is clear that raising productivity and caring for the environment should not be viewed as an 'either/or'. In fact, the group starts from the premise that there is a close relationship between productivity and environmental impact. There is evidence that demonstrates the effect that increasing productivity can support environmental outcomes. Where productivity is focused on improving resource efficiency, in most cases increased productivity should also benefit the environment.

Work by DAERA in Northern Ireland has demonstrated that greenhouse gas emissions per unit of production in NI dairy farms dropped by just over 30% between 1990 and 2014. Yields per cow increased by 67% over this period and this spread emissions from each dairy cow over a greater production volume[4].

Reduction of crude protein in pig diets[5] from 180 to 130 g/kg can significantly reduce the volume of slurry produced and ammonia emitted by 49%, provided amino acids are adequately supplied.

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[3] https://ahdb.org.uk/knowledge-library/driving-productivity-growth-together-2-january-2018
[4] https://www.daera-ni.gov.uk/articles/northern-ireland-carbon-intensity-indicators
[5] Lowering dietary crude protein in pig diets: ammonia, odour and slurry production from finishing pigs. BSAS Abstract, 2019

Precision agriculture has access to a growing range of modern technologies[6][7] which are able to measure inputs for different areas of a field or production site. The application of precision agriculture can reduce GHG emissions by:

- Raising the ability of the soil to store carbon through reduced tillage and lowering the amount of fertiliser used
- Improving fuel consumption by reducing the amount of in-field operations with tractors
- Lowering inputs for agricultural field operations

The problem

Agricultural productivity growth in the UK lags behind our major competitors. UK TFP has grown by 18% since 1991, a rate of improvement that has not kept pace with other competitor countries such as the Netherlands (52%) and France (82%)[8].

With UK agriculture's costs of production exceeding £20bn[9], small savings make big differences. If productivity gains give a 1% saving in costs, that translates to over £200 million in returns back to the industry.

Figure 2 - International comparisons of Total Factor Productivity growth, percentage change since 1991[10]
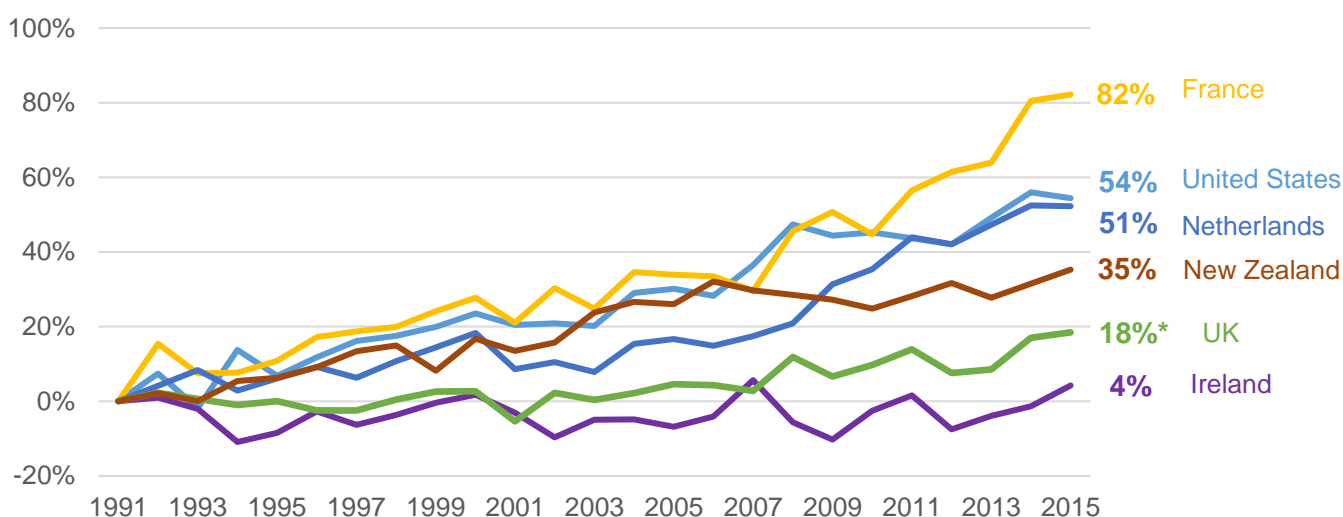
Annual changes can show large fluctuations meaning the trend over time is a better indicator of changes in performance. Nonetheless, agricultural productivity growth in the UK declined by 2.1%

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[6] https://www.iof2020.eu/latest/news/2018/01/ghg-emissions

[7] Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. *Sustainability* **2017**, *9*(8), 1339; https://doi.org/10.3390/su9081339

[8] Defra's Evidence compendium provides a range of analysis on the productivity and performance of the agricultural sector – see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/802006/evidence_compendium_16may19.pdf

[9] Agriculture in the UK 2018, Defra

[10] Defra analysis of USDA international agricultural productivity data from USDA ERS

between 2017 and 2018[11]. Care must be taken when interpreting these numbers as they only tell us so much. They don't tell us where the UK started from in absolute terms or whether our industry is competitive overall vis a vis other countries. But they indicate that, left untouched, the UK will lose ground.

This matters because it:

- Denies manufacturers and consumers access to farm products produced sustainably in the UK
- Makes us more dependent on overseas imports and increases risks
- Reduces the ability of the industry to add value through displacing imports or growing exports
- Reduces employment and economic activity in rural areas
- Exports our sustainability challenges overseas

There is no single reason that explains the slower rate of productivity growth: a combination of factors appear to hold the industry back[12].

1) Co-ordination failures in the innovation pipeline between the critical needs of UK farmers and growers and fundamental innovation undertaken in the UK
2) Limited investment in applied R&D adversely impacting the adoption of innovation at scale
3) Inherent fragmentation in the knowledge exchange systems across the UK with multiple actors and a general disconnect between scientists, academics and practitioners (i.e farmers and their advisers)
4) Cultural challenges marked by lower levels of investment in skills, training and continuous professional development amongst UK farmers and growers relative to their main competitors

In spite of these factors, it does appear that the best farmers are able to acquire, adopt and put in place new knowledge, techniques and skills. Figure 3 below highlights the spread of performance across farms in England in terms of output per hour, demonstrating the wide distribution of farm business performance.

This range of performance reveals the existing potential for productivity increase in UK farming and growing, even before new technologies and practices are developed and introduced.

Part of the challenge therefore appears to be as much about **appetite** – how to encourage the overwhelming majority of professional farmers to understand and take-up the knowledge that is out there?

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[11] Total factor productivity of the agricultural industry, Defra, 2019
[12] For further analysis on productivity in UK agriculture see
https://www.ofc.org.uk/sites/ofc/files/research/ofcreport2015.pdf and https://ahdb.org.uk/knowledge-library/driving-productivity-growth-together-2-january-2018

Figure 3 - Distribution of performance across farms 2016/17; England only[13]
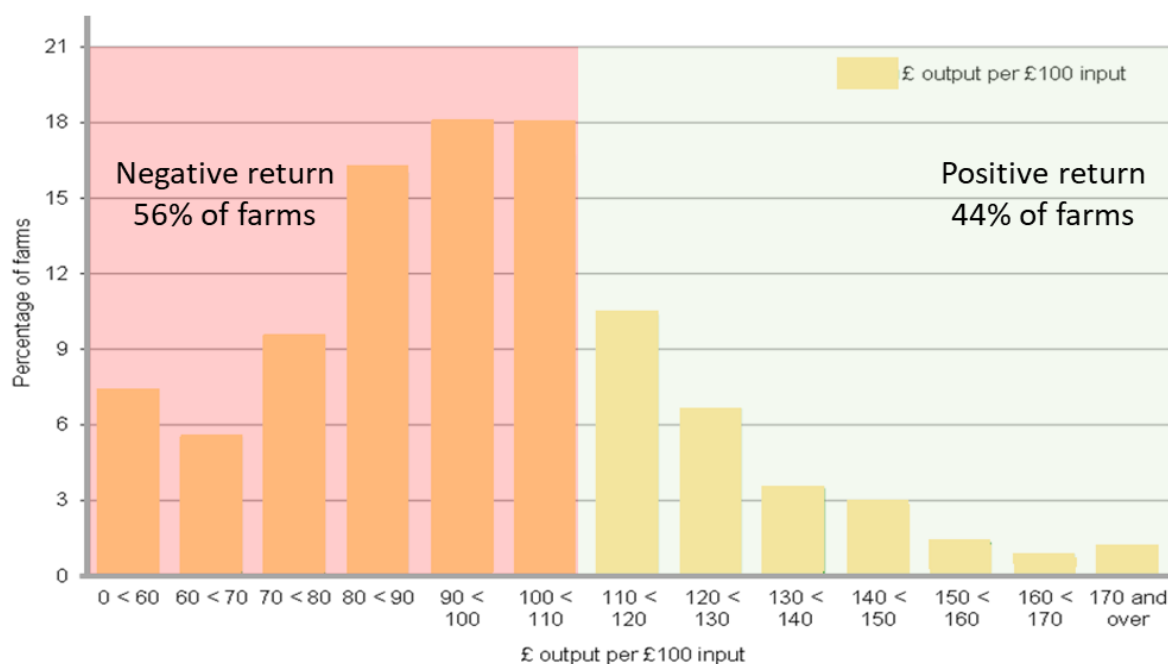
The opportunity

This report makes a series of complementary recommendations and actions that are grouped into five key areas. These areas relate closely to the foundations of productivity identified in the Industrial Strategy. They are based on the premise that whilst transformational change is required, we must also support our current industry to adapt, change and improve overall productivity growth.

There is a clear sequential journey through the five recommendations that is seen as critical to overcoming the fundamental challenge of low productivity growth. It starts with the industry, farmers and growers taking ownership of the problem. To do this individual businesses need to know where they stand. The adoption of simple key performance indicators (KPIs) of performance and sustainability could be a key way to driving the appetite for change.

These numbers can only mean something if they are compared and aggregated, centrally and independently. To achieve this requires trust and confidence amongst farmers in sharing data. To make things simple and avoid multiple data collection, sources of data also need to talk to each other in a common language.

Aggregation of data on performance helps to highlight the evidence of what does and does not work. Through the Evidence for Farming Initiative, proven best practice guidance can be more widely dispersed and shared. It also enables industry as a whole to understand where the knowledge gaps lie and thus inform a more strategic innovation agenda. The ability to adapt to new technologies and make the most of talent coming onto farms requires the industry to bolster its skills and continuous professional development.

Finally, none of this is possible without the right infrastructure on farms and in fields. Creating an enabling environment through our rural infrastructure plays a critical role.

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[13] Farm Business Performance, Agriculture in the UK 2017, Defra 2019

These recommendations are high-level. They articulate a direction of travel rather than a detailed blueprint identifying specifically who needs to do what, where, when and at what cost. They seek to strike a balance between government intervention and industry action. Success can and will only happen if a new partnership is adopted and is based on a mutually shared vision of the future between industry and government.

Whilst the APWG has drawn in expertise from across the UK, the group is acutely mindful of the different policy, regulatory powers and delivery frameworks that exist across the Devolved Administrations. Where proposals in this relate to policy matters that are devolved they are aimed specifically at England. Nonetheless, the group hopes that the recommendations may provide inspiration for other parts of the UK.

Recommendation 1: Drive Effective Use of Data

Data referred to in this section takes account of both metrics, which allow farm performance to be quantified and to data sets, which can be combined with farm data to manage performance (such as weather data, soil/field mapping etc). Data has different layers of complexity, but even simple data can be used to drive substantial progress. However, it is the information derived from the data that will enable improvements.

The problem

Businesses manage what they measure. Whilst most farmers file accounts, relatively few measure their farm's technical performance. Some farms are collecting minimal data, others are collecting a lot but not using it and relatively few compare themselves to others. According to DEFRA[14] only 21% of farmers carried out any enterprise level benchmarking in 2016/17.

Recent advances in sensors, automation and precision agriculture technology enable extensive growth of on-farm data collection. As the ability to collect all sorts of data mushrooms, it becomes much more difficult for farmers to identify which data they really need and which they can ignore. In addition, other industries have embraced advanced analytics, but agriculture appears to be behind the curve[15]. There is a trust deficit in the industry in which farmers and growers are anxious about how their data might be exploited for others' gain.

Compounding the problem, access to public data can be difficult and Open Government data initiatives[16] fall short of ensuring that all taxpayer-funded data (such as Rural Payment Agency field maps) are freely and easily available to market participants. Often, complex data ownership and the structure of Government organisations inhibit easy access to such data, falling far behind standards set in countries like the USA[17].

The opportunity

For businesses themselves the opportunity comes from understanding how they perform, where their strengths and weaknesses lie and where the opportunities could be to improve. Understanding current farm performance (by increasing data collection), determining what is possible (by sharing and comparing data) and utilising other data (such as weather data, field maps etc) can provide additional insight can enable substantial productivity improvement.

Over time, advanced analytics, machine learning and artificial intelligence will help shift and accelerate the discussion from "What happened?" or "Why did it happen?" to "What's going to happen?" and even "How do we make it happen?".

Interoperability of systems to enable effective data sharing has been highlighted as one of the six big challenges by Big Data Europe[18]. True interoperability will enable data harvesting from a range

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[14] DEFRA Farm Business Survey 2016/17

[15] https://towardsdatascience.com/top-10-sectors-making-use-of-big-data-analytics-be79d2301e79

[16] https://data.gov.uk/

[17] https://www.data.gov/food/

[18] https://www.big-data-europe.eu/six-challenges-for-agriculture/

of sources. This is important because much useful data is available from processors, feed suppliers, veterinary practices, software companies, Government agencies and so on meaning that farms can receive useful management information for limited effort. Increasing layers of (more difficult to access) data can be sequentially added as required, once managers are persuaded of the benefits of good data practice. The New Zealand Datalinker system (see Case Study 1) demonstrates one potential method by which the wider agricultural industry can exchange and utilise data.

Effective data use can transform an industry as illustrated by Case Study 3 on the Northern Ireland Pig Case Study. Data collection enabled analysis and benchmarking between different farms, and in combination with interpretation, advice and use of new technology, industry productivity has risen very substantially. The importance of the new Livestock Information Programme (Case Study 2) cannot be over-emphasised. If delivered correctly, it will gather, collate and leverage data from across the industry to deliver benefit at farm and customer level.

The APWG recognises several challenges facing the ambition of making UK farming data driven (including a basic lack of data collection, reluctance to share collected data, lack of involvement in benchmarking, data being difficult to interpret etc), but these can and must be addressed. Both Industry and Government have significant roles to play in effecting change around data.

Recommended actions

1. **Establishing standard, entry-point KPIs**
   Understanding and comparing key performance data is seen as a powerful means of driving empowerment and mindset change on farm. Packages exist[19] that allow producers to understand and compare their performance, but benchmarking can be daunting for many farmers and growers. A key action is the need for industry to identify simple, entry-point KPIs covering key productivity and sustainability factors for each sector. These must be:
   - Standardised – i.e industry stakeholders need to align around which indicators should be measured
   - Simple – there should be relatively few of them and be easy to calculate. They needn't cover the totality of farm business performance or sustainability outcomes but act as a proxy (i.e those few indicators that represent 80% of performance)
   - Produced in a generalised format but able to be interpreted by sub-sector, farm type and geographical region
   - Linked to existing data collected on farm via farm business software and accountancy packages. Avoiding duplication in data entry is as vital as normalising the adoption of KPIs
   - Centrally collated by an independent body to protect individual farmers' data but ensure that aggregated analysis can be produced to allow producers to benchmark against the best whilst giving industry valuable insights. The Evidence for Farming Initiative could play a critical role in curating and analysing data that can then be shared with farmers in a clearly understandable and usable form.

   The ambition is that every farmer in every sector should know their KPIs. Although further scoping and road testing will be needed, the mobilisation of farmers, growers and industry

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[19] As an example, AHDB's Farmbench programme allows whole-farm, multi-enterprise benchmarking of farms

around KPIs and data could be massively enhanced by the use of incentives within future farm policy mechanisms to encourage farmers and growers to capture and share data.

2. **Showcasing the benefits of data capture, sharing and use**
   The industry needs to overcome perceived cultural barriers to sharing data amongst farmers and growers. Industry stakeholders need to be more united in championing the potential benefits of data sharing whilst being mindful of the risks. Companies up and down the supply chain need to provide reassurances to farmers about how their data will and will not be used.

   A major gap exists in being able to demonstrate the benefits of data sharing in a practical and applied sense. Bringing to life the power of data sharing through the work of professional advisers, farmer to farmer learning and digital platforms will be essential. A major opportunity exists via the Livestock Identification Programme to harness collection of data from public and private sources to deliver genuine benefit to producers through risk-based trading of livestock, integration of animal health and performance data and enhanced traceability (see Case Study 2)

3. **Deliver and implement a code of conduct for data sharing**
   Other countries have encountered the same trust-deficit as the UK in relation to data sharing. This is where an industry-led code of conduct could play an important role to ensure clarity around data ownership, handling and use. This will increase the confidence of those sharing the data, leading to ever increasing levels of data sharing.

   The AHDB has initiated the development of a draft code although more work is needed on the most appropriate ownership and governance model for industry to take forward. Learnings can also be taken from the EU Code of Conduct[20] and the New Zealand Farm Data Code[21].

4. **Common standards of interoperability of hardware and software.**
   Data needs to speak in a common language. With a proliferation in farm software packages now commercially available an opportunity risks being missed to ensure the interoperability of data. This limits the opportunity for shared-data sets to create actionable insights and leads to frustrations among farmers with regard to data ownership, transferability and duplication.

   This is why the APWG is keen to see a mechanism that will require agricultural systems in the UK to operate to common standards for interoperability in the UK, drawing on the experience of different countries and territories. The industry itself is best placed to specify methods of addressing the interoperability problem drawing on the expertise of commercial players and Agri-tech Innovation Centres, notably Agrimetrics.

5. **A trusted method of collecting and sharing data in the UK agricultural sector.**
   The industry has identified two alternative approaches to collecting and sharing data:
   - A central independent organisation which gathers data, combines, analyses it and makes it available to the industry

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[20]https://cema-agri.org/publications/19-brochures-publications/37-eu-code-of-conduct-on-agricultural-data-sharing
[21] https://www.rmpp.co.nz/page/datalinker

- A non-centralised aggregation method which can be used to enable much higher levels of data combination, sharing, analysis and use

Further consideration, consultation and agreement is needed on the most appropriate approach.

The introduction of industry wide data capture and sharing should be phased to ease introduction. Initially, data should be captured from existing sources, which could include farms, government, feed suppliers, processors, vet and accountants.

What's for industry?

- Lead campaign to drive mindset and culture change in industry
- Develop & agree entry-point KPIs
- Consult with accountants, software providers, farm business consultants etc to integrate KPIs into existing packages
- Showcasing benefits of data sharing via demonstration farms, knowledge exchange, press and other media
- Identifying key added value components from LIP
- Agreeing and determining governance mechanisms for data code
- Draw up standards of interoperability and determine most appropriate method of data sharing

What's for government?

- Policy incentives for sharing of KPIs and other farm data
- Endorsement of industry code of conduct and backing as necessary for standards of interoperability
- Support for Evidence for Farming
- Sharing or providing access to key sources of public or government funded data such as Farm Business Survey

Recommendation 2: Transform Knowledge Exchange

Knowledge exchange in agriculture and horticulture typically refers to the two-way transfer of technical and business information between farmers and knowledge generators (technical experts and professionals, academics etc) with the purpose of increasing uptake of innovation, improving farm performance and using feedback loops to inform research and innovation priorities. It can also refer to the flow of information between farmers and growers themselves.

The problem

The range of farm business performance across the UK indicates that whilst the best producers are able to access the knowledge they need to perform at their optimum, this is not widely generalised. Co-ordination failures within knowledge exchange networks across the UK (and in England in particular) are seen as an important contributory factor. These networks are widely viewed as highly fragmented, with a wide range of delivery bodies, variable messaging and no central point where quality assured advice can be obtained. These characteristics have been set out in the EU Commission funded ProAKIS report of agricultural knowledge and innovation systems across the EU[22]. The AIC's Value of Advice report also highlights the complexity of sources of advice across the commercial and public sector to farmers and the confusion this generates[23].

The problem may be compounded by limited demand for and provision of technical and business advice to certain groups of farmers. A decline in applied demonstration following the demise of ADAS in the late 1990s is also felt to have played a part in the problem. The knowledge exchange network is widely considered to be less effective than it could be, and engagement with the R&D landscape is very difficult for most farmers.

The opportunity

Evidence and experience from other countries demonstrates that those with more integrated, coordinated KE frameworks stand a better chance of growing productivity as they appear better able to drive the uptake of innovation and best practice at scale. The AHDB's report "Driving Productivity Together" indicated that there is an opportunity for existing stakeholders and government to co-ordinate their resources in a more effective way in order to overcome the evident fragmentation in knowledge exchange and R&D[24].

The APWG has identified two key opportunities to address the problems of fragmentation and under-provision. The first comes in the establishment of the **Evidence for Farming Initiative**. This is seen as a centre-piece for this report. Based on similar principles to those underpinning the existing 'What Works Network" of centres and institutes, the Initiative would focus on the collation of evidence-based practice, provide dynamic review of the available evidence, issue recommendations and become a hub for the accessibility and dissemination of peer-reviewed information. A significant amount of input from key stakeholders across practitioner and academic communities has already been provided which has seen the concept of EFI evolve.

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[22]http://proakis.webarchive.hutton.ac.uk/sites/www.proakis.eu/files/AKIS_characterisation_briefing_final.pdf
[23] https://www.agindustries.org.uk/.../**value-of-advice**-project-report/vap-report-**2013**.pdf
[24] AHDB Horizon, Jan 2018

The second comes from building on the success of existing **farmer to farmer learning** platforms in engaging farmers and growers to bring greater co-ordination, increase their scale and reach and ensure focus on practical on-farm improvements relating to major productivity and sustainability challenges.

Recommended Actions

1) **Develop the 'Evidence for Farming Initiative'**
   The creation of the Evidence for Farming Initiative is central to these recommendations. Fundamentally, the EFI concept is based on creating a single hub for evidence-based best practice for farming and growing, collated from international sources, peer reviewed and made widely available to practitioners (farmers and growers, and those advising them), wider commercial farming industry, and policy makers. This would be supplemented by evidence captured and collated from on-farm performance metrics, to validate and further refine the knowledge base. The Evidence for Farming Initiative would simplify access to the best information by acting as a hub, which translates research into practice, helps shape future research priorities and informs evidence-based regulation and policy making.

   Key characteristics of EFI
   - A physical and digital centre that is open and accessible to all
   - Based on principles of scientific rigour, independence and objectivity
   - Assimilates knowledge and evidence from global sources. Undertakes peer review of new knowledge to ensure its robustness
   - Undertakes dynamic analysis, review of the available evidence and identification of gaps
   - Issues recommendations designed for practitioners, decision makers, funding bodies, consultants, advisers, colleges and assurance schemes
   - Provides vehicle for identifying evidence gaps and research needs of farmers and other practitioners
   - Secure sharing of farm data will enhance impact, allow monitoring of progress, both individually and as a wider industry.

   Where does it sit?
   - EFI is an industry-led initiative and industry ownership and leadership is seen as critical to delivering value from the Initiative. To be effective, close relationships with practitioner communities (eg agronomists, farm business consultants, nutritionists, vets) will be vital to ensuring the Initiative adds value to beneficiaries. The concept is currently being developed into a delivery plan by a group of stakeholders drawn from across industry, policy, academic and practitioner communities
   - EFI should be delivered through an existing body. There is no appetite for further duplication and fragmentation of effort. Government should use the Request for Views on AHDB as an opportunity to consider the role it could play in underpinning EFI
   - Elements of other existing organisations also deliver certain aspects and coordination through EFI would increase their value and reach

   Relationship to government
   - Clear government endorsement, buy-in and genuine alignment with policy and legislative mechanisms including regulatory regimes, research funding programmes and strategies.

- Whilst EFI is an industry-facing body, it should be a critical source of knowledge to inform evidence-based policy making and regulation
- Government should take part in co-design of EFI amongst stakeholders representing practitioners and sources of knowledge. It should recognise the role that EFI could play in disseminating evidence-based practice improvements, taking its role into account when developing innovation proposals and policy measures post-Brexit
- Recognition of EFI as part of the existing What Works Network

2) Develop and bolster the demonstration farm network to support uptake, at scale of evidence-based best practice

As highlighted above, there is an opportunity to build on the effectiveness and power of farmer to farmer learning by increasing the scale and reach of industry and government led on-farm demonstration activities. A number of industry initiatives have developed over recent years. Governments across the UK have also played an important role for example the Farming Connect focus farms in Wales and SRDP-funded Monitor Farms in Scotland.

To develop and bolster this network there are actions both government and industry could undertake:
- Industry partners to work in a spirit of openness and collaboration in terms of farmer to farmer demonstration & engagement (for example co-ordinating activities more effectively)
- Utilise existing farm networks to assess recommended practice claims under commercial conditions.
- New demonstration farms could be established focussed on particular gaps or needs in terms of on-farm knowledge and practice
- The number of demonstration sites could be bolstered through government funding similar to the approach in Scotland and Wales
- Existing farm networks and groups could be harnessed to help disseminate best practice recommendations as well as methods of obtaining ongoing, accurate feedback on effectiveness of different farm practices on commercial farms to inform best practice and shape future science investment.
- Sites could play a key role in trialling near market innovation
- Measure and benchmark performance according to agreed industry KPIs and demonstrate the value of data sharing
- Consider how the demonstration element of Transforming Food Production would align to make best use of current funding and achieve greatest returns on that investment
- Align uptake of knowledge exchange and continuous professional development with new government policy and farm support mechanisms

What's for industry?

- Continue and complete system design and road testing for Evidence for Farming Initiative
- Building industry support and momentum for the EFI concept
- Collaboration and sharing of experience across existing demonstration farm initiatives

What's for government?

- Recognition of Evidence for Farming in design of future policy mechanisms and incentives

- Take account of EFI when concluding Request for Views on AHDB
- Integration of EFI within What Works network
- Support for further open demonstration farm activity

Figure 4 - Evidence for Farming Initiative – how it might work?
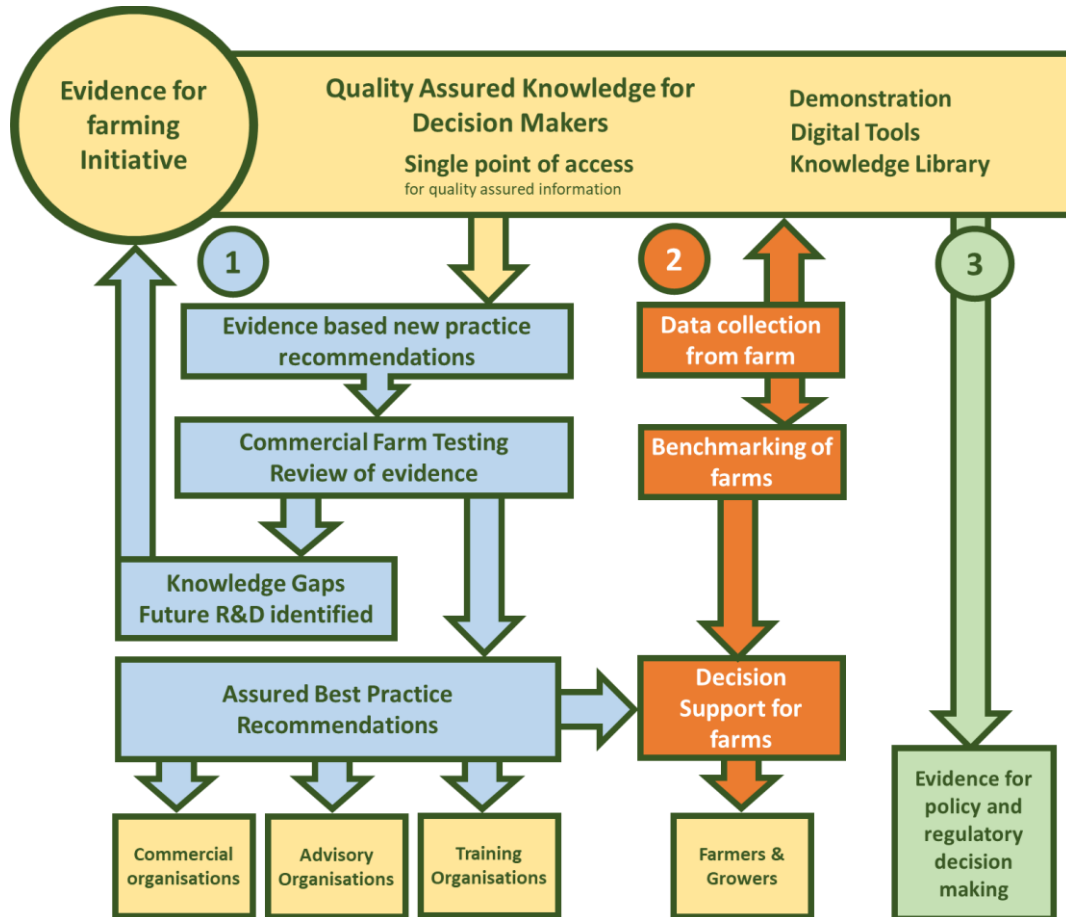
Recommendation 3: A Collaborative, mission-led approach to innovation

Innovation is about taking the frontier of knowledge forwards. It is seen as the single most important long-term driver of productivity growth in the sector, with the OECD estimating global rates of return from investment in innovation in agriculture at between 20% & 80% per annum[25]. Accelerating the uptake of innovation at scale is critical to enabling sustainable, long-term growth in agricultural productivity.

The UK has an exceptionally strong research base, with world leading excellence in agricultural, biological, environmental sciences, artificial intelligence, robotics and autonomous systems[26]. The capability of our research infrastructure has been bolstered by UK Government's Agri-Tech strategy in which £90 million has been invested in four centres of agricultural innovation. The Industrial Strategy Challenge Fund has allocated £90m over four years to transform food production. In addition, Defra and devolved administrations are considering how best future agricultural policies in the UK can bolster the uptake of innovation on farms with Defra developing proposals for supporting R&D post EU-Exit as part of the new agricultural policy aimed at accelerating innovation and increasing the uptake of new technology[27].

The problem

Public sector spending in the UK on R&D is strong with £360 million invested in agricultural R&D in 2016. At 4.4% of agricultural gross value added (GVA) this is higher or at least comparable with other EU member states. However, this does not appear to have translated into higher productivity growth in the UK.

Figure 5 - Public Agricultural R&D as a percentage of agricultural GVA (average 2008-2017)[28]

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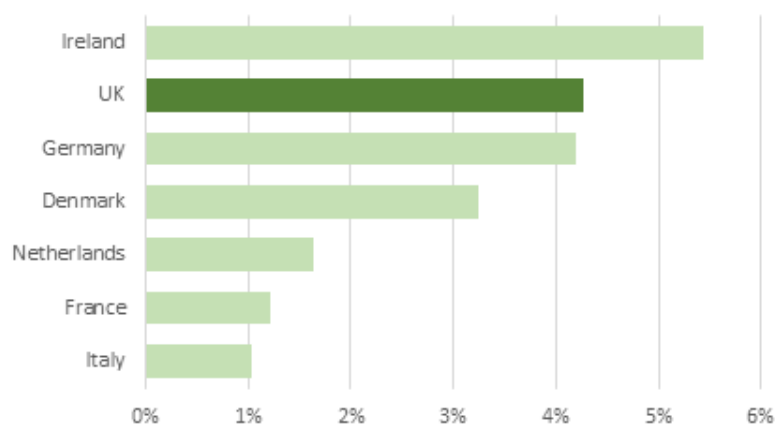
[25]www.oecd.org/tad/fostering-productivity-and-competitiveness-in-agriculture-9789264166820-en.htm
[26] SCIMAGO Country Rank, measured by H index 1996-2014, www.scimagojr.com
[27]https://www.gov.uk/government/publications/the-future-for-food-farming-and-the-environment-policy-statement-2018/health-and-harmony-the-future-for-food-farming-and-the-environment-in-a-green-brexit-policy-statement

[28] Defra Analysis of Eurostat Data

Various factors have been identified as contributory to this, which can be loosely grouped in three areas:

1. **The choice of which research should be prioritised.**
   - Limited industry leadership in driving strategic research priorities.
   - Industry impact has not always played an important role in determining research priorities leading to limited tangible evidence for return on investment.
   - The absence of a shared, strategic innovation strategy between beneficiaries and government
   - A disconnect between researchers and end users of innovation. Research committees often dominated by academics.
   - Low levels of public funding directed towards applied research and a high degree of risk involved in commercialisation and acceleration of uptake of new technology on farm.

2. **The process used to identify priorities and fund them**
   - A culture of discipline-focused science has hampered the multidisciplinary and inter-disciplinary thinking needed to address some of the significant challenges and opportunities faced by the industry.
   - A complex funding landscape combined with often short-term pots of industry-related funding.
   - Excessive competition between universities and research establishments and some evidence of duplication rather than collaboration around a shared agenda.
   - A widely dispersed academic and research base mean the benefits of clustering seen in some other EU member states (e.g. the Netherlands) have yet to materialise in the UK.
   - Committees and governance membership of key bodies do not align with the current and emerging strategic priorities for the sector.
   - Lack of career incentive for applied researchers.

3. **Adoption of insights to drive productivity growth and sustainability at scale**
   - Fragmentation in the UK innovation system with large numbers of bodies and organisations involved in the process of driving and disseminating innovation.
   - Pathways to identify potential adopters and signpost them are unclear.
   - No holistic approach to identifying other potential blockers to adoption such as skills, capital investment and additional management.

The opportunity

Some of these challenges are widely seen as difficult to fix. Nonetheless, there is clear recognition within the APWG that Government is taking many of the right steps to address some of these challenges. There have been various examples of funders and government departments increasing collaboration, notably through the Agri-Tech Strategy. The Transforming Food Production Challenge Fund has recently created funding opportunities for industry and academic partners to develop applied innovation proposals. The creation of UKRI brings Research Councils and Innovate UK together to help foster a more coherent and multidisciplinary approach in which quality and the impact of innovation can be equally considered and collaboration improved.

Recommended Actions

To reinforce the direction of travel the APWG believes a number of key issues need to be addressed by industry and government. Fundamentally, this requires a new, much closer and long-term partnership between Government, UKRI, HEIs and industry.

1. **Industry leadership in determining innovation priorities.**
   a. Industry representatives recognise that a more co-ordinated, evidence-led approach to identifying strategic research priorities is needed. Any approach should build on initiatives such as the NFU-led Feeding the Future[29] reports and learn from the experience of the Agri-food Technology Council (and association Agri-Tech Centres) and other previous attempts at driving industry involvement in setting innovation priorities.
   b. The proposed Evidence for Farming Initiative is seen as pivotal, not only driving connectivity and co-ordination, but also in consolidating pre-competitive research priorities based on an evidence-based view of the key knowledge gaps and the feedback loops from producers and advisors in the field. Encouragement and support for the Evidence for Farming concept from both government and industry is therefore an integral component of these recommendations.
   c. At the same time, there remains an opportunity to learn from experience in countries such as the Netherlands where the 'Top Sector' concept is held up as a model for shared, strategic collaboration between industry, government and academia.
   d. Aligning both industry and academic representation in relevant NDPB committees and governance structures and refreshing emerging priorities within any remit would be a key enabler to enhance strategic collaboration and deliver impact.

2. **A focus on strategic, transformative research 'missions'.**
   This principle would see all actors in the knowledge and innovation system focus their collective effort on addressing a discrete series of missions that represent the key strategic challenges and opportunities for UK agriculture and horticulture. These in turn should be informed by the process of assimilating evidence and information in a co-ordinated way via the Evidence for Farming initiative.

   Whilst the APWG has not sought to narrowly define the missions a number of areas have been highlighted by the group. These include:
   i. The elimination of endemic livestock diseases
   ii. Addressing the protein challenge through the potential offered by insect biomass (Case Study 4)
   iii. Seizing the opportunity in robotics, automation and autonomous systems (Case Study 5)
   iv. Transforming horticultural production systems
   v. A paradigm shift in crop and soil health

3. **A multidisciplinary approach to innovation.**
   Whilst the right steps are being taken, there is further scope to encourage and facilitate interdisciplinary, cross departmental innovation which brings experts from diverse fields of engineering, genetics, social sciences and data together, in other words, all the fields of science that are relevant to productive, sustainable agriculture. The advent of UKRI

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[29] https://www.nfuonline.com/cross-sector/science-and-technology/research-and-innovation-news/feeding-the-future-four-years-on-a-review-of-innovation-needs-for-british-farming/

represents a major step forward in this regard but there is further scope to build on and strengthen collaboration between UKRI and other significant funders in agricultural R&D together. This approach would be further bolstered by multidisciplinary and inter-disciplinary calls, themed around key missions identified in partnership between industry and government.

4. **Clear pathways for innovation.** This works at various levels:
    a. Funding for R&D, which will "jump-start" farmer-led innovation and accelerate the uptake of innovative practices. The high variability in farming systems means that farmer-led approaches have significant transformative potential, particularly in combination with big data analytics and clear strategic missions.
    b. Pathways through the funding, regulatory and approval process. Where a new industry or sub-sector is emerging, regulation does not always keep pace with innovation and can hamper its development and dissemination. This challenge has been identified by our Task & Finish groups on insect biomass and robotics and are detailed in case studies to this report.
    c. Government and Industry to develop/agree a method of 'short-term' approval to test products for safety and acceptability, enabling fast-track regulation change if products prove safe and effective.
    d. Clarity and visibility of all pathways for funding innovation. The Evidence for Farming Initiative could help bring much needed clarity on the opportunities available to industry.
    e. UKRI inter-Council collaboration structures could unlock the potential of true inter-disciplinary and collaborative research.

5. **Improved connectivity between R&D funding and more targeted and sustained funding for translational research**
There is a recognition that steps are being taken by Government to address this, notably through the ISCF and plans for agricultural policy post-Brexit. There are some further practical steps that could be taken. For example, industry levy funds should be considered as match funding. Experience in countries such as Australia where levy funds for innovation are matched by state governments has played a vital role in industry ownership, dissemination and implementation of innovation.

6. **Up-weighting of industry impact in research funding criteria**
Whilst the review of the Research Excellence Framework has acknowledged the greater relevance of impact and its assessment as a contributor to the overall mark of our HEI sector, it remains striking that industry performance and sustainability are not seen as fundamental KPIs for innovation investment. Further up-weighting of industry impact in assessment criteria for both relevant strategic research calls and Research Excellence Frameworks is therefore needed.

What's for industry?

- Leadership in identifying key long-term innovation priorities
- Greater collaboration and structured co-ordination between practitioner and academic communities in determining the key missions for UK agriculture and horticulture
- Sharing of insight, data and evidence from practitioners via Evidence for Farming

What's for government?

- Recognition of Evidence for Farming as critical source of information to determine funding priorities and facilitate knowledge exchange at scale
- Continue to support multi and inter-disciplinary approaches to innovation
- Co-creation with key industry players of key research missions
- Clarify and simplify funding pathways for businesses and consortia
- Develop short-term approval to test new products and technologies where necessary
- Increased funding for translation research and farmer-led innovation
- Consider levy funds as industry match funding
- Up-weighting of industry impact when determining research funding criteria

Recommendation 4: Drive Uptake of Professional Training & Development

In the context of this report, professional training and development refers to either:

1. Obtaining formal educational qualifications from a college or university which are relevant to the agricultural sector
2. Undertaking recognised training on technical and business practice which enables uptake of best practice

Actions under this recommendation have been drawn from the work of the industry's Skills Leadership Group.

The problem

In 2015 there were wide differences in the proportion of staff trained by industry sectors. Employers in health and social work trained the highest proportion of staff (78%), while employers in agriculture trained the lowest (40%). Only 14% per cent of this training was around management[30]. In 2013, only 18% of farm managers in England had full agricultural training, with 61% having only practical experience. There is poor uptake of both formal training qualifications and continuous professional development in agriculture, which has a negative impact on existing farm operators and farm employees, as well as any potential new entrants that might want to come in to the sector.

Business productivity suffers as a result of this skills challenge. The lack of full staff proficiency drove up the operating costs of 38% of agricultural employers with skills gaps in 2015. Evidence from the Irish Revenue shows that trained farmers in Ireland have, on average, a 12% higher profit margin than untrained farmers. Targeted professional development in UK agriculture is likely to have a similar effect.

Attitudes to training and professionalism are largely borne out of a lack of awareness of options and benefits, a mismatch in funding and industry needs, and inertia in understanding the value to the business of developing people and teams. The current agriculture and horticulture skills landscape is fragmented and characterised by a wide range of bodies and duplication of effort. Career routes are not clear for those already working in the industry and for those who might be interested in it following education or coming in from other professions or backgrounds.

Several professional schemes already operate in UK agriculture. Some of these including BASIS, FACTS and FEMAS are recognised as being among the best in Europe. However, uptake is patchy and participation in these schemes and other training is not consistently recorded.

The opportunity

Cultural and structural change around training provision is required. The farming sector must be able to recognise the technical and financial value of training, whilst simplified access to training will enable increased uptake. More training in future needs to be focussed on meeting employer needs. Central recording of training will allow employers to select the best qualified employees and will enable uptake of training to be linked to funding under revised farm support mechanisms.

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[30] UK Commission for Employment & Skills

Several good examples of professional recognition exist in other industries and these are covered in Case Study 6. Exploitation of new technology will require new skills to be adopted by the industry.

Recommended Actions

1) **Create a centralised Professional Body for Farming and Horticulture, which will serve as the home of professional development and training across the UK**
   a. The Professional Body will oversee a professional framework under which development is managed. It will also oversee curriculum development and clarification & signposting of training courses and training providers
   b. The Professional Body will manage a central register for skills recording and monitoring. This register will enable verification of training uptake in relation to farm support payments
   c. A central register of available courses across the UK will be created, including both long term education and short-term specific industry training
   d. Targeted training should be linked to performance gaps identified by the Evidence for Farming Initiative
   e. Rationalisation of training provision in the UK needs to be undertaken

2) **Policy mechanisms to incentivise and motivate farmers towards knowledge and training uptake**
   a. Skills development should be seen as a key building block towards increased productivity and environmental performance on farm
   b. Farm support schemes should incentivise the uptake of Continuous Professional Development
   c. Links should be created between Government education policy and farm support, encouraging the uptake of courses relevant to agriculture from school level upwards

3) **Embed a culture of continuous improvement in the industry through a large-scale industry campaign around data uptake, benchmarking and training uptake**
   a. Co-ordinate the Farm Business Survey (modified appropriately) with Catalyst Centre research to generate labour market information, which will inform immediate and future labour/skills needs
   b. A cross-industry campaign, supported by stakeholders, to drive positive attitudes and greater engagement around skills and knowledge exchange
   c. Clear messaging for use by the whole industry around the value and benefits of training for delivery by the combined agricultural industry. Similar Government messaging should support this
   d. Industry to focus on the long-term creation of a culture in the agricultural sector which encourages the uptake of Continual Professional Development, cutting edge best practice and strong business management
   e. Professionalism in farming to be recognised through recording of skills training undertaken and linking this to farm support policy
   f. Require all government/levy board/research council funding to clearly identify the impact on labour/skills need of all new research and innovation

4) **Build a stronger, dynamic profile for agriculture and horticulture amongst potential new entrants, particularly from urban areas and other professions.**

a. Continue to develop and support further apprenticeships[31] that attract high quality recruits and reflect the need of the industry. Funding levels should be linked to potential impact on the economy, not numbers of students
b. Government to recognise agriculture as a STEM industry all levels of education including the T Levels
c. Promote the increasing number of non-sector specific roles within the industry
d. Create appropriate educational materials to demonstrate the innovative, scientific and progressive nature of agriculture across all curriculum areas to appeal to the brightest young people
e. Appeal to the healthy food and environmental consciousness of the next generation.

What's for industry?

- Maintain industry momentum through Skills Leadership Group in England
- Continue system design and testing of Professional Body for Farming and Horticulture. Clarify relationship to Evidence for Farming
- Alignment and integration of existing initiatives on skills and professional development within the Professional Body
- Sharing by practitioners/ farmers and growers of labour market information to inform future labour needs
- Position industry as a modern, professional, high-skilled industry & promotion of careers
- Lead industry campaign on skills and CPD

What's for government?

- Endorsement and support for the Professional Body
- Policy incentives to promote proficiency and skills
- Provide relevant government data and statistics to inform labour market information
- Recognition of agriculture and horticulture as STEM industries

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[31] Members of the Skills Leadership group have already facilitated the development of three standards, Crop Technician, Stockperson and Packhouse Line Leader.

Recommendation 5: Enabling rural infrastructure

Infrastructure comprises the physical and other capital assets that enable productivity growth to occur, especially in rural areas. It comprises communications and transport networks, energy supply as well as the infrastructure within farm businesses themselves. They are not in, themselves, the end goal, but are critical to creating an environment in which sustainable productivity growth can be realised.

The problem

A strong rural infrastructure is critical to the delivery of agricultural productivity and several of the recommendations in this report are either completely or partially dependent on the provision of the efficient infrastructure for a modern economy such as 5G and a more flexible high capacity electricity supply.

High capacity data flow is essential to enable video-based artificial intelligence, an essential component of future high productivity farming & growing. 4G is currently adequate for the control and management of current equipment but will not be sufficient to meet future needs from driverless tractors to high level optical recognition. Ofcom states that 65% of UK landmass has 4G coverage from all four mobile network operators, but 9.3% has no coverage from any operator. In order to harness the full potential of precision technology, robotics and autonomous systems, 5G coverage across the whole of the UK is a must. The robotics case study (Case Study 5) of this report emphasises the need for this level of coverage. The APWG endorses the work of 5Gruralfirst.

If the net zero carbon challenge for agriculture is to be achieved, electrification of heavy farm machinery must be facilitated. Nationwide reinforcement of rural electricity infrastructure, including buffer battery storage systems, will be essential to deliver the required electrical flow for 'smart charging' of multiple high capacity vehicle batteries (see Case Study 7) but this is not currently the case.

Having the right infrastructure on-farm in terms of land, buildings and other assets will also be vital to ensuring long-term growth in productivity and reduction of emissions. Whilst hard evidence is patchy there is a widespread perception that significant investment to update farm infrastructure is needed. Land mobility in parts of the UK is low. In addition, access to long-term lets is restricted. This can inhibit the expansion of farms, deter investment and reduce opportunities for new entrants.

The opportunity

Implementation of productivity enablers will permit much faster productivity gains. Effective automation will substantially improve labour productivity and data collection. High capacity artificial intelligence, enabled by high data connectivity will allow a much higher level of precision use of inputs, improving both resource productivity and environmental impact. Enabling electrification of the machinery fleet will improve energy productivity and, in time, will improve machinery productivity through changing the nature of machinery ownership and operation in combination with automation and autonomous systems.

Improving access to land by productive, proficient farmers and growers with experience or specific training could accelerate uptake of new technologies and practices. The development of new

agricultural policy and concepts such as delinking may provide some impetus for greater land mobility. Case Study 8 provides an illustration of how taxation has been used to this effect in Ireland.

Recommended actions

1. **Invest in 5G infrastructure to enable required future high-capacity data flow.**
   a. Complete 4G coverage across the UK is a critical enabler for today's technology and should be an aspiration
   b. In the medium to long-term all agricultural regions will need access to 5G to enable the large data flows associated with new technology
   c. The expected vast increase in connected devices (e.g. "wearable" sensors on livestock) means that many more devices will require connectivity and therefore marginal cost of connectivity can be built in to new business models on service providers, to provide low cost connectivity to (for example) livestock keepers in remote areas
   d. 5G access for all farms will also mean that new businesses are able to develop in rural areas. This is critical because future agriculture will have higher labour productivity, meaning that there will be fewer people working on each farm. New businesses are required to maintain rural populations and a functioning rural economy

2. **Upgrade the rural electricity network to enable electrification of farm equipment.**
   a. The grid must enable the charging of heavy machinery:
      - Heavy machinery will become electrified which will offer control, environmental and cost advantages, increasing productivity
      - Robotics will become essential to the industry and this will not happen effectively without an electricity grid which is fit for purpose
      - The growth of controlled environment farming will also place heavier demand on rural electricity grids
   b. The rural electricity grid must be engineered for two-way flows of power, enabling rural businesses to make greater use of emerging technology, and radically improving the ability to be self-sufficient and sustainable. The grid should support production using existing renewable energy systems as well as electricity storage, utilising electricity from heavy batteries at peak demand times (e.g. vehicle-to-grid services) and returning it at times of lesser demand

3. **Facilitate active management of land by proficient, productive farmers**
   a. Investigate the use of income tax relief related to the length of land letting term
   b. Using policies through the Brexit transition to encourage retirement and management of land to move to others through letting, contract farming, joint ventures or change of ownership
   c. Facilitate and promote options for housing to support structural change in farming
   d. Industry to encourage flexibility in land occupation to drive innovation in the sector through highlighting the options for land management (rather than standard contracts
   e. Industry drive and government support for 'FreshStart' initiative to become an information and advice hub for joint venture opportunities

4. **Encourage business focused investment**
   Provide attractive fiscal (eg capital allowances) and other financial incentives such as facilitated loans to encourage investment in:

a. Buildings that improve animal health, welfare and/or limit environmental impacts
b. Other farm infrastructure that facilitates emissions reduction or other environmental management (eg covered slurry stores, new water lagoons)
c. New technologies
d. Implementation of equipment and facilities to monitor and improve farm performance

What's for industry?

- Promote flexibility in land occupation and diverse business models
- Evidence to underpin infrastructure investment needs

What's for government?

- Universal 4G coverage and commitment to extensive coverage in rural areas in roll-out of 5G
- Adaptation of rural energy grid to facilitate two-way electricity flow
- Investigate income tax relief in relation to land mobility
- Policy incentives to promote structure change in farming
- Incentives for capital investment in on-farm infrastructure

Conclusions

This report sets out a series of high-level recommendations and actions that, as a package, could overcome the systemic barriers to productivity growth and, over time, enable its acceleration. The knock-on benefits for our environment and land management could be significant. The Working Group behind these recommendations acknowledges that they represent a direction of travel rather than an end destination. Subject to feedback from the Food and Drink Sector Council and government, further substantive work will be needed to covert theory into practice and specify the steps required to complete the journey.

These recommendations strike a balance between industry leadership and government intervention. Substantial energy and momentum has been built up within industry to seize the opportunity that the industrial strategy presents.

The key priorities for industry are:
- Agreeing simple-entry point KPIs and getting them embedded into the culture of the farming and growing industry
- Establishing the blueprint for Evidence for Farming and ensuring buy-in to it from key industry players
- Collaborating more to showcase best practice, innovation and data
- Leading a campaign to promote skills, professionalism and life-long learning in the farming and growing sectors

The key priorities for government are:
- Providing the right policy incentives for data capture & sharing and skills uptake
- Getting behind Evidence for Farming as a critical part of the new infrastructure to improve the knowledge and innovation system
- Maintaining the directional shift in innovation funding and commissioning so that industry feels greater buy-in, there's more collaboration and focus behind a shared series of key 'missions'
- Facilitating the critical infrastructure in rural areas and on farms that will be needed to underpin greater productivity and sustainability as well as enable new technologies to be utilised at scale

Case Studies & Appendices

Case study 1 - DataLinker, New Zealand

Overcoming some of the practical barriers that inhibit the consistent sharing of data from different sources is a critical part of the journey to adding value to raw data. In New Zealand[32], a number of agricultural organisations recognised the potential advantages from effective data sharing and combined to create a system to enable this using government and industry funding. Datalinker[33] was the result. It is an initiative designed to help farmers and others to simplify and streamline how they capture and share data.

DataLinker is a membership-based community using APIs[34] to share data between different organisations and databases. Organisations that use DataLinker pay a fee which covers the cost of maintaining and improving the service. There is no requirement to deliver a financial return to shareholders – DataLinker exists for the benefit of the primary sector. An organisation can be both a Provider and a Consumer of APIs for the single fee. The annual fee covers governance costs and provides support for collaboration on standards.

Members take part in groups to discuss and define API and data standards. The directory allows members to have visibility of which organisations provide which service and who implements each API. Each organisation chooses the terms on which they will make data available. Once agreements and permissions are sorted, data moves between the API Provider and API Consumer systems directly, rather than through a central hub.

The Datalinker is only one protocol for data sharing in the agricultural industry, but it was the solution deemed most appropriate for New Zealand as it was believed that it was the one with which the maximum number of organisations would interact. In DataLinker, each company retains ownership of its own information and chooses what organisations it can be shared with.

Datalinker operates according to the New Zealand Farm Data Code of Practice, which provides an accreditation process that helps farmers and organisations to achieve a more transparent understanding of how data will be collected and used, encouraging trust.

The code is administered by Federated Farmers, Beef+Lamb NZ, DairyNZ, the Dairy Companies Association, Meat Industry Association, NZ Veterinary Association, and Te Tuma Paeroa Accreditation by an independent review panel provides assurance for farmers that organisations have clear terms that help farmers understand how their data may be used, and appropriate policies and controls around data access.

The Datalinker system models one route by which data sharing could be accelerated within the UK and should be considered as a potential, but not the only, option.

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[32] https://www.datalinker.org.nz/
[33]https://www.stuff.co.nz/business/farming/opinion/92854601/big-benefits-for-farmers-in-data-ownership.
[34] An API is a set of functions and procedures which allow the creation of applications that access the features or data of an operating system, application, or other service

Case Study 2 - Livestock Information Programme

Global exports of livestock products are expected to grow by 16% (from their current £2.4 billion) over the next decade, which represents a huge opportunity for UK products to sell into higher value markets. The ability to fully exploit this opportunity hinges on improved productivity, competitiveness and demonstrably better credentials around traceability, food safety, provenance, welfare and environmental standards.

The industry and Government are jointly developing a database and a service, which is able to deliver the future levels of traceability and information required by the livestock industry. Working in partnership, AHDB and Defra have created a new company, Livestock Information Limited to deliver the Livestock Information Programme (LIP). The programme will create a new multi-species livestock information, identification and tracking service, which will deliver value back at farm level, as well as to customers and consumers.

A Traceability Design User Group (TDUG) comprised of 35 industry and government stakeholders is working to co-design and deliver LIP. The ambition is to create world leading levels of traceability, while enabling industry to co-invest added value options and stimulate further innovation by commercial operators, technology providers and the science base.

The core service will offer multiple benefits for the livestock industry, including:
- A single, multispecies point of access making it quicker and easier to record livestock moves, births and deaths.
- Digital assist support, for those less able to use smart-phones and computers, or those without internet connection.
- Functionality which enables quicker and more targeted responses by government and industry to disease outbreaks.
- Supporting infrastructure to manage eradication programmes for endemic disease.
- A platform for the development of innovative solutions that improve productivity, animal health, welfare and environmental performance.
- Future flexibility to collect information which supports the retention and development of overseas markets, and/or provide a competitive trade advantage.

The recommendations from this report are important to ensure that LIP operates with maximum effectiveness.
1) Development of appropriate key performance indicators which can be used to assess farm performance across the UK.
2) Promotion of an environment conducive to data sharing, which emphasises the value which can be created.
3) Facilitating access to usable government-held data, as well as ensuring that systems are interoperable, allowing industry to innovate and deliver added value benefits
4) A policy environment which incentivises compliance and good behaviour
5) Adequate digital connectivity for data capture and reporting.
6) Additional strategic investment to update critical upstream Government systems, essential to support the level of functionality delivered by LIP.

This programme highlights the fundamental need to prioritise efforts on driving value from data, ensuring interoperability between systems, data analysis, benchmarking and feedback mechanisms, in order to enable informed decision making at farm level.

Case Study 3: Knowledge exchange in the Northern Irish pig sector

This case study illustrates the effect a well-structured knowledge exchange system can have on an industry. There are several learnings for the development of the Evidence for Farming Initiative around structure and operation.

The Northern Ireland pig industry is compact, accounting for around a tenth of the UK pig herd and 16% of pig meat production. In the late 1990s the industry was reduced to approximately half its previous size following a catastrophic fire in one of the main processing plants which was immediately followed by a severe price crash. The industry could have disappeared but didn't. Instead, it staged a recovery through a data driven approach to farm management.

NI pig performance is now amongst the highest in the world, with improvement being driven through the uptake of best practice in a number of areas including nutrition, genetics, technology, medicine and management. These improvements are primarily driven through the well organised and delivered Pig Knowledge Exchange system, which operates as follows:

1. Two programmes are operated: Business Development Groups (BDG) and Farming Family Knowledge Skills (FFKS). These are specifically targeted at improving productivity, sustainability and resilience and in supporting sustainable industry growth.
   - BDGs use peer learning and knowledge exchange to enhance business and management skills, innovation and adoption of new technologies. BDG members must agree to host a training event, develop an active business development plan and share information.
   - The farms involved in the BDG must submit data (which is quality checked) and anonymously benchmark between themselves.
   - The Farm Family Key Skills (FFKS) programme exists for those farmers who cannot commit to the Business Development Group. The FFKS gives specific training in key area and helps with decision making and business management.

2. Knowledge transfer is mainly carried out by the Colleges for Agriculture, Forestry and the Rural Economy (CAFRE). The BDGs and FFKS are part of the DAERA Knowledge Transfer Programme and are a key element of the Farm Business Information Service (FBIS).

3. Two key pig advisors work with 60 farms each. These advisors are responsible for benchmarking, farmer meetings, technology transfer, on-farm management of projects to test best practice and sharing of best practice. Over 85% of NI pig production is covered.
   - The advisors are widely trusted, discreet and have built up a reputation for sound advice. Farmers listen to what they say, often because it is backed up by practical testing of ideas on farms within the group.
   - AFBI often runs research programmes to address knowledge gaps, before feeding the findings back to CAFRE for transfer to farm level.

4. Pig research is carried out by the Agri-Food and Biosciences Institute of Northern Ireland. Pig advisors have a close relationship with researchers at AFBI and not only discuss new research ideas generated from experiences at farm level, but assess the results and practical implications.

The system reflects much of what is being suggested in the Evidence for Farming Initiative, with on farm data capture informing farmers about their potential for development, testing of recommendations on-farm leading to conclusions about absolute best practice, as well as

feedback to research level about knowledge requirements. The system has proven effective in raising productivity in Northern Ireland pig farming and although more difficult to replicate in beef and lamb, still carries clear lessons which will underpin the set-up of the EFI.

Figure 6 - annual productivity improvement in NI pig production
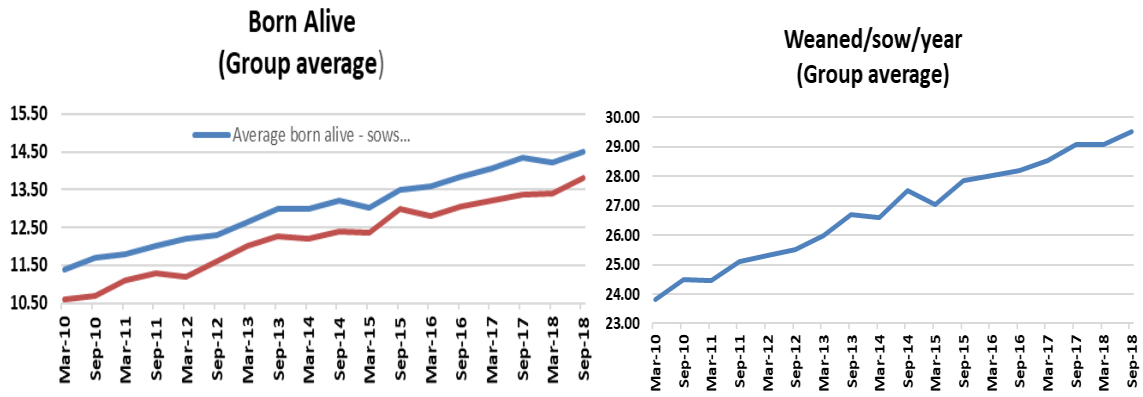
Case Study 4 - Insect Biomass

Insect biomass is a rapidly developing sector of global agriculture with the potential to help meet global protein requirement. The relatively slow rate of development of the insect biomass industry in the UK illustrates the importance of several of the actions under Recommendation 3. UK development in this area is lagging significantly behind mainland Europe (particularly France, The Netherlands, Belgium, Spain) as well as the USA, Canada and South Africa in the scalable development and delivery of insect biomass, protein plus added value by-products for animal feed and other innovative applications.

Countries and companies at international and European levels are progressing swiftly to develop this important sector through high level government policy statements, R&D investment and financial incentives. Rapid growth is being enabled by substantial sector investment, which at c. $175 m in 2018, was 40% higher than the sum of investments received over the last 4 years[35]. European insect producers represented by the International Platform for Insects as Food & Feed (IPIFF) are expecting to raise more than €2 billion in investment by 2025, generating a total of circa.100 000 jobs.

UK scientists, SMEs and feed companies have and continue to lead and contribute significantly. The commercial development of the industry has, however, been held back by a number of structural failings. There is a need for Government to act swiftly to ensure the UK does not loose further ground in this rapidly developing global market. Key challenges are outlined below.

1. The lack of overt encouragement from government for the development of this sector reduces the rate of progress.
2. The lack of a central strategic support strategy for the industry makes it difficult to swiftly develop the sector through R&D investment, financial incentives and derestriction of markets.
3. Industry development is inhibited by restrictions around the substrates which can be used to produce insects and around the animals to which the resulting output can be fed.
4. Industry development is inhibited by the lack of a regulatory framework covering the use of insect residues as biofertilisers.
5. Increased Government collaboration with private industry is required to secure dedicated funds to help insect producers reach the market, achieve cost competitiveness, respond to the identified research and process development gaps and to open up new lines of commercial opportunity.

The Task and Finish Group has identified the following actions as important to the rapid development of the industry in the UK.

1. Central government strategic policy framework and statements to be issued to support a national insect biomass conversion industry and global business potential (protein production, waste valorisation, novel products).
2. Government and industry to support a central body to bring all stakeholders together to achieve aligned, rapid development. Government to provide seed funding to launch an Insect Biomass Conversion Stakeholder Hub (IBCSH); co-funded by industry to validate and determine robust economic technical facts unique to the UK to substantiate the business opportunity (including socio-economic evaluation via funding for market intelligence and consumer perception).

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[35] Rabobank Dec 2018 report

3. Government to enable rapid clarification of UK regulatory framework and legislation with revisions to enable the use of insect protein and associated products (e.g. chitin) in commercial scale poultry and pig feeding trials, enabling testing to permit regulatory change.
4. Industry and Govt/ Research Council Funding to fill knowledge gaps in R&D along with the necessary infrastructure (Insect Biomass Conversion Research Centre-IBCRC) to provide the necessary assets to deliver the science framework to permit growth of the industry.
5. Government to review best practise amongst existing fiscal incentive schemes and deploy (e.g. feed in tariff, tax relief and related schemes) to stimulate sector break through.

The challenges experienced by the Protein Biomass industry clearly illustrate the difficulties, which the recommended actions from the overall report are attempting to resolve.

1. Restrictive regulation and legislation.
2. Non-ideal funding packages and limited assistance around commercialisation.
3. Lack of knowledge in specific areas, particularly around safety issues, substrates etc.

More detail is provided in the Insect Biomass Task and Finish Group report, which is available on request.

Case Study 5 - Robotics and autonomous systems

Labour productivity in UK agriculture is low and the availability of staff to carry out unskilled, repetitive tasks is likely to diminish substantially in the next few years, putting some enterprises at serious risk. The ONS Labour Market survey showed a drop over the last year of 132,000 EU nationals working in the UK to a total pool now of 2.25m people, evidencing the need for labour replacement, even in the short-term.

The development of robotics in the farming & growing industry can solve this problem in the medium term by enabling the following:
1. Replacement of low-skilled jobs usually serviced by seasonal and immigrant workers.
2. Improved labour productivity, enabling higher wages to be paid in the agricultural sector, attracting well qualified graduates.
3. Autonomous collection and monitoring of farm performance.
4. Automation of repetitive fieldwork, freeing up more time for management activity.

The USA, Japan and China have backed significant investment in Agri-robotics research, realising the need to drive productivity, replace the reducing labour pool and maintain cost-competitiveness. A report from NFU/Andersons suggests that the UK horticulture sector alone is facing an employment cost increase of 35% per hour between 2016-2021.

However, significant challenges exist around the implementation of robotics and autonomous systems in the UK, requiring considerably more and better coordinated research than is currently being undertaken.

The key challenges are:
1. The implementation of interoperable fleets of small lightweight robots, operating autonomously across large arable fields.
2. The development and implementation of a new generation of field robots equipped to conduct specialist tasks and augment agronomists
3. The development of intelligent farm equipment that fits on standard agricultural vehicles.
4. The development of equipment, which enables automation across a wide range of sectors and applications, all of which present their own challenges (Top fruit, Produce, Arable, Livestock).
5. The implementation of suitable 5G infrastructure, which enables artificial intelligence.

The Robotics Task and Finish Group believes that the sectors with the highest labour pools (soft and top fruit, asparagus picking, field vegetables, salads, mushroom and flower picking) have the most pressing needs. Each of these currently require large number of labourers as the jobs undertaken require very high degrees of human dexterity that cannot, at the moment, be automated with conventional machines.

This level of automation is highly complex, involving image analysis, motion control and soft-harvesting techniques. Fruits should only be harvested when ripe and must not be bruised during picking or handling. The robot must be able to work synchronously with other robots, must not present health and safety risk to human operators and operate reliably throughout harvest.

Existing robotics teams in the UK have expressed concern that there is a lack of UK and EU trained robotic engineers available to drive the technology forwards and implement it a commercial level. The UK industry and research community does not have the capacity or market size to deliver solutions for all crops. The group believes that it is critically important for the UK to consider effective methods of enabling collaboration between different research programmes, both nationally and internationally.

For this reason, a 'Moonshot' project is proposed. This project should have the following characteristics:

1) It should attempt to address a very large technical challenge.
2) It should involve research teams across the UK.
3) It should involve international research teams.
4) It should introduce new researchers to robotics research (primarily through PhDs)
5) It should run over a long period of time (7-10 years)
6) It should be interdisciplinary, including different technical disciplines and funding streams.

More detail is provided in the Robotics Task and Finish Group report which is available on request.

Case Study 6 - Professional Training

A number of organisations operate professional training registers similar to that proposed for the agricultural industry. They have been successful in normalising ongoing training and professional registration in their industries. Many of the challenges faced by these industries are similar to those of the agricultural industry and there are a number of key learnings. Two examples of relevant schemes are shown below:

Institute of the Motor Industry

The Institute of the Motor Industry[36] oversees professional competency in the motor trade. They operate a professional register to make sure consumers end up in skilled, competent and trustworthy hands. The Register is an industry-wide database of professional individuals recognised for maintaining their knowledge, skills and competency. These individuals have committed to achieving 90 credits of continuing professional development (CPD) within a three-year cycle (about four days of training/development per year).

The Institute also operates a mechanism for recognising employers who commit to CPD – those who have at least 50% of their staff on the Professional Register. The IMI supports its members by offering a range of discounted automotive-specific CPD courses, designed to help you maintain professional competence. The IMI outlines the following benefits for both individuals and for the public:

For the individual
- A public display of current knowledge and skills within the industry.
- Increased employability by maintaining your current competence and increasing skill set.
- Access to a platform to log all learning, no matter where or how it was completed.

For the public
- Access to a register of automotive professionals, who are accountable under the IMI Code of Conduct.
- Ability to find and verify competent, committed and professional individuals.
- Increased consumer confidence in the industry.

To remain on the Professional Register, IMI members must complete a required amount of CPD credits allocated within a three-year cycle. More details can be found in the FAQs in the 'Downloads' section. To maintain accredited status, accreditation must be renewed every three years, either through a full reassessment or, for technicians, through flexible update modules.

The Construction Industry Training Board (CITB)

The Construction Industry Training Board[37] is the Industry Training Board for the construction industry. It is a partner in ConstructionSkills, a Sector Skills Council. Its stated vision is for British construction to have a recognised**,** world-class**,** innovative approach to developing its workforce to deliver quality in the built environment. The CITB maintains a list of approved training providers and also maintains a Construction Training Directory which signposts training that is delivered by CITB Approved Training Organisations (ATOs).

The CITB facilitates the National Skills Academy for Construction (NSAfC). This is an industry-led framework supporting clients and contractors to identify, develop and realise employment and

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[36] https://www.theimi.org.uk
[37] https://www.citb.co.uk/

skills solutions across construction projects. At a national level the National Construction Skills Academy Group (NCSAG) provides strategic overview and direction.

The CITB serves as a 'one stop shop' signposting to skills provision and relevant tools and guidance and is a good model for the proposed Agri-Skills Professional Body. It has had some success promoting dynamic construction careers and changing industry perceptions to diverse audiences through the development of a careers website GoConstruct[38].

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[38] https://www.goconstruct.org/

Case Study 7 - Electricity Requirements for Agricultural Vehicles

All commentators recognise that electricity utilisation at farm level is going to rise. Electric vehicles will gradually replace diesel versions, there is likely to be a growth in controlled environment farming and energy generation on-farm is likely to become commonplace. As farms move away from dependence on fossil fuels as their primary power source, so the electricity grid will need to be upgraded to ensure it is fit for purpose. The primary driver of this need is vehicle electrification, which is relatively near market.

An NFU study[39] from 2017 states that most of the technological progress seen to date in electrification of transport has been in light electric and plug-in hybrid vehicles (private cars and delivery vans), with more limited expectations for heavy goods vehicles, buses and other commercial/ industrial vehicles carrying large payloads or travelling long distances daily.

The report highlights that recent announcements from Mercedes-Benz, Tesla Motors and others suggest that the prospects for both range and payloads of heavy electric vehicles may change markedly over the next 5-10 years. Daimler Benz has already demonstrated a Fuso light truck with a 2-tonne payload and 100 km range in Portugal2, while Mercedes has shown a pre-production version of its heavy duty 'Urban eTruck' (26-tonne, 200 km range), aimed at clean-air city deliveries in the early 2020s. John Deere and Fendt/AGCO are also investing heavily in the development of electrical tractors[40]. Electrification farm machinery eases the process by which robotization and automation can take place.

The Hands-Free Hectare is a project at Harper Adams University, which planted, tended and harvested a crop with only drones and autonomous vehicles. It is now in year three and clearly demonstrates how close the technology for autonomous field management really is.

A review paper[41] by Moreda et al. (2016) outlines some of the potential advantages of electrifying machinery. The need to reduce carbon emissions calls for energy-efficient mobile work machines, which electricity provides. Electrification allows for precise speed control, noise reduction and flexible design. The paper also notes that energy recovery is possible from some operations, further improving efficiency.

More detail is provided in the Vehicle to Grid Task and Finish Group report which is available on request.

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[39] Electric tractors by 2020? – a review of advanced vehicle technology in the agricultural sector
[40] https://www.agriculture.com/machinery/tractors/improving-tractors-implements-with-electrification
[41] High voltage electrification of tractor and agricultural machinery – A review. *Energy Conversion and Management*; *Volume 115*, 1 May 2016, Pages 117-131

Case Study 8 - Ireland: Succession Farm Partnership Tax Concessions

Recognising the challenge around agricultural productivity, the Republic of Ireland has implemented taxation changes around farming to incentivise the uptake of training and to encourage the movement of control of land to younger farmers who have been professionally trained.

Green Cert training is a national range of agricultural courses, which qualify a person as a 'Young, trained farmer'. The Green Cert must be complete by 35 and the farm handed over to the young farmer via a Succession Farm Partnership. This enables hereditary tax to be avoided. It is tied in with earned recognition, farm assurance and professional memberships. The year of transfer must be after 3 years and before 10 years of registering on the succession register to claim the tax credit.

The incentive in registering a Succession Farm Partnership is an annual income tax credit of €5,000 for up to five years. The credit is split annually based on the profit-sharing ratio of the partnership between the farmer and the successor. Potentially, the scheme is worth up to €25,000 over a five-year period.

The Farmer and the Successor must sign a succession agreement, which contains an undertaking that a minimum of 80% of the farm assets outlined in the succession agreement must be transferred. The Successor can only claim the relief up to age 40.

The scheme was introduced less than three years ago, and its effectiveness will only become clear over the next few years, but it stands as an example of how other governments are incentivising good behaviour through policy and statutory changes.

Appendix 1 - APWG Membership & Terms of Reference

The Agricultural Productivity Working Group is comprised of individuals drawn from industry and government who have specific expertise or responsibility for supporting productivity growth in agriculture & horticulture. The group is chaired by Peter Kendall.

APWG Membership
Peter Kendall (AHDB, Chair)
Jonathan Birnie (Birnie Consulting, project manager)
Nick Whelan (Dale Farm)
Andy Richardson (Volac)
Tim Breitmeyer/ Susan Twining (CLA)
Helen Ferrier/ Jonathan Scurlock (NFU)
David Caffall (AIC)
Kate Rowell (QMS)
Liz Quigley (AB Agri)
Tom Hind (AHDB)
Dave Ross (Agri-Epi)
Belinda Clarke (Agri-tech East)
Caroline Povey (DEFRA)
Stephen Fernando (DEFRA)
Helen Fox/ Kathryn Brown (BEIS)
Andy Cureton (BBSRC)
Calum Murray (Innovate UK)

Terms of Reference
Vision: A world-leading, competitive and sustainable UK agriculture and horticulture industry that can meet consumer demands for high quality products at every price point.

Objective: Increase the rate of growth of agricultural productivity to match the best in the world. Provide high level industry leadership to identify how, in partnership, farmers and growers, academics, agricultural supply businesses, the food industry and government can bring this about.

Scope: Agriculture and horticulture (including non-food). Significant links to working groups on innovation and workforce

The group will make recommendations to the Food & Drink Sector Council on how the Council can help deliver the objective of accelerating productivity growth in agriculture and horticulture. Its key actions were to:

1) Identify & agreeing the key barriers
2) Promote the creation of Task & Finish groups to explore specific areas and propose solutions
3) Ensure there is a clear timeline and project plan for the delivery of work to the Council
4) Draw up recommendations for the Sector Council to consider & approve
5) Champion the best proposals with the Council and with decision makers more widely

Task and Finish Groups
Task & Finish Groups were established to develop specific proposals to unlock productivity growth in agriculture & horticulture. These groups provided recommendations to the Agricultural Productivity Working Group with the purpose of informing FDSC recommendations.
The main tasks of the Task & Finish Groups were to:
- Agree the scope of their work.

- To diagnose the problem and propose concrete solutions.
- To specify what government needs to put in place (e.g. by way of policy or regulatory change) to enable the solution and to identify what industry must commit to enable change to happen.

Groups which have reported:

Group Title	Group Focus
KE and Research Governance	This group was led by the NFU and AHDB and focused on two main areas, Knowledge Exchange and the Governance of R&D in Farming and Growing Sector in order to enable improved productivity. The group developed the Evidence for Farming concept in collaboration with experts drawn from across academia and input from the practitioner (i.e advisory) community.
Skills	The Skills Leadership Group supports the APWG and Workforce working groups. It focusses on how professionalism could be recognised in the agricultural sector and how training could be taken up on an ongoing basis.
Livestock Data	This group was led by the AHDB and focused primarily on how to develop the architecture for better data exchange via the Livestock Information Programme (which is currently focused on traceability. It also studied how to develop a proposition on a mechanism to coordinate and deliver on animal health
Robotics	This group was led by Lincoln University. It focused on how best to address the need to accelerate the uptake of robotics and autonomous systems in farming and growing, with a key focus on improving overall labour productivity
Addressing the Protein Challenge	This group was led by FERA and highlighted opportunities for supporting the emerging insect biomass production sector in the UK
Vehicle to Grid	This group was led by the NFU and focussed on methods of effectively electrifying heavy farm machinery, by assessing the impact of charging large battery electric vehicles on weak rural electricity networks and proposing vehicle-to-grid and smart charging solutions
Data access, analysis & productivity	This group was led by Agrimetrics and focussed on addressing the challenges associated with the sharing and effective use of data. Barriers to data collection and effective use of data were explored and potential solutions identified.
Land Occupation	The work of this group was led by the CLA and CAAV who sought to identify how policy and fiscal measures could be used to help facilitate the acquisition and/or management of agricultural land by trained and proficient farmers and businesses.
Dairy Productivity	This group was led by Volac and focussed on practical measures to improve the productivity of dairy producers. The group examined opportunities and how to remove barriers to improving dairy farm productivity through tangible supply chain collaboration. The findings of the group were considered applicable to almost all sectors.

Groups yet to report

Group Title	Group Focus
Crop and Soil Health	This group was led by AHDB and focused on the effect of soil management on productivity. The work of this group is still continuing and is examining future challenges around pesticide availability, resistance, crop health, soil

	management and in particular the best methods of addressing the decline in soil quality.
Urban horticulture	This group was led by AHDB and focused on methods of addressing the future need for increased agricultural output. Vertical Horticulture offers a real opportunity to use small amounts of space to produce large food outputs, but several challenges exist. This group is searching for the necessary steps to obtain a full understanding of the opportunities, challenges and solutions for business, society and the environment.
APEG (Economics Group)	An existing advisory group led by Defra and involves NFU, Andersons, FBS partners and AHDB. It supports the underpinning evidence surrounding productivity in agriculture and horticulture.

Appendix 2 - What Works centres

The What Works network is made up of 7 independent What Works Centres and 2 affiliate members. Together these centres cover policy areas which receive public spending of more than £200 billion. The What Works Network uses evidence to make better decisions to improve public services and are primarily to tool to inform government policy. What Works Centres are different from standard research centres. They enable policy makers, commissioners and practitioners to make decisions based upon strong evidence of what works and to provide cost-efficient, useful services.

The centres help to ensure that thorough, high quality, independently assessed evidence shapes decision-making at every level by:

- collating existing evidence on how effective policy programmes and practices are
- producing high quality synthesis reports and systematic reviews in areas where they do not currently exist
- assessing how effective policies and practices are against an agreed set of outcomes
- sharing findings in an accessible way
- encouraging practitioners, commissioners and policymakers to use these findings to inform their decisions

Current What Works Centres include:

National Institute for Health and Care Excellence (NICE)	Health and social care
Sutton Trust/Educational Endowment Foundation	Educational achievement
College of Policing What Works Centre for Crime Reduction	Crime reduction
Early Intervention Foundation	Early intervention
What Works Centre for Local Economic Growth (hosted by LSE, Arup, Centre for Cities)	Local economic growth
Centre for Ageing Better	Improved quality of life for older people
What Works Centre for Wellbeing	Wellbeing
Affiliate: Public Policy Institute for Wales	
Affiliate: What Works Scotland	

The What Works Centres are seen as useful models on which the development of the Evidence for Farming Initiative could be based.

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