PUBLIC POLICY PROJECTS

INSIGHTS

Innovation in the food supply chain: Unlocking AgriTech for net zero

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ABOUT PUBLIC POLICY PROJECTS

Public Policy Projects (PPP) is a global policy institute offering practical analysis and development across a range of sectors, including energy and climate change. The institute is independent and cross-party, and brings together public and private sector leaders, investors, policymakers and commentators with a common interest in the future of public policy. Public Policy Projects publishes reports in a series of policy areas, including integrated care, social care, genomics, rare diseases, women's health, health inequalities, environment and energy. All these programmes, and their corresponding events, publications and conferences, receive contributions from sector leaders from around the world.

ABOUT BAYER CROP SCIENCE

No one can see into the future, but we can all work together to shape it. At Bayer, we're committed to building a world where hunger and climate change are terms relegated to history books. It can be done—and innovations on the farm can help get us there. That's why we're pursuing new possibilities in agriculture that are helping address some of humanity's greatest challenges so that everyone can enjoy a more sustainable future.

Farming has always thrived on innovation. From the very beginning, farmers have sought better ways to nourish themselves, their families and their communities. This commitment continues today as we continually strive to find more sustainable solutions that can help farmers grow enough for a growing world—all without starving the planet.

ABOUT AGRI-EPI CENTRE

Agri-EPI Centre Ltd was established as part of the UK government's Agri-Tech Strategy to develop, fund, and commercialise new precision agricultural technologies by fostering relationships between researchers, start-ups, investors, and farmers to bring the latest innovations to reality.
Agri-EPI has a strong network of contacts and facilities with a proven track-record of taking new ideas from theory to practice, in a way that honours our two core goals: maximising profitability and enhancing the sustainability of the supply chains that feed the world. So, if you have a new agricultural idea, solution, or technology — we want to hear about it.

We are grateful for the opportunity to co-sponsor this report with its valuable insights, and also support its independent remit, that may not necessarily align with co-sponsor views or recommendations.

ABOUT THE CHAIR OF THE ROUNDTABLES

Simon has been responsible for founding and developing the Lincoln Institute of Agri Food Technology (LIAT), now recognised as "world leading" within the 2021 BEIS Innovation Strategy, Creating the Future. His group have helped pioneer the development of advanced robotic systems, machine learning, artificial intelligence and digital systems for UK agriculture. These systems are now entering the marketplace and in 2021, 12 Saga Thorvald robot systems co-developed with the Lincoln team, achieved the milestone of 10,000km of on-farm autonomy. In 2021, he co-chaired the DEFRA Automation and Robotics Review with former Secretary of State George Eustice.

Over the last 7 years, Simon's group have leveraged over £73M of collaborative research and development funding to underpin an extensive range of agricultural technologies. This includes co-leadership of the EPSRC AgriForwards Centre for Doctoral Training cohort of 50 PhD's, joint with the Universities of Cambridge and East Anglia - one of the largest global cohorts of agri-robotics PhD's - bringing in new talent to the industry; key people who will help resolve complex challenges across agriculture. Prior to joining Lincoln, Simon was Director of a farming company producing cut flowers in Lincolnshire and Cornwall. He grew up in South Lincolnshire, where his family produced vegetable and cereal crops.

For his contribution to the sector, he was awarded the 2022 RASE Science and Technology Award.

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This report is authored by PPP Policy Analyst Eliot Gillings, who has also project-managed the roundtables that informed this report.

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Executive Summary

While delivering on the UK's net zero ambitions will necessitate contributions from every corner of the economy, it must be acknowledged that certain sectors will be more difficult to decarbonise than others. However, even amongst the 'hard to abate' sectors, agriculture faces a unique set of challenges.

The production of food is of fundamental importance to human health and wellbeing – and as such a strategy predicated on demand reduction remains an unfeasible solution to the 24.8 $MtCO_2e$ that is produced through agriculture in the UK every year. A shift towards less intensive methods of farming also remains impractical in the UK – in large part because the UK already utilises 71 per cent of its total land mass to produce food. Add in the Government's Food Strategy's commitments to improve food security, and agriculture finds itself faced with the task of producing more food in the same (or less) space while decreasing GHG outputs.

In order to achieve emissions reductions under these conditions, the UK must develop and employ new technological solutions to reduce the impact of various agricultural activities. The UK must also continue to develop frameworks and guidelines to encourage mitigations, such as carbon sequestration, that are able to support decarbonisation within agriculture and beyond. Finally, the UK must also improve its ability to measure GHG outputs – and utilise and contextualise them more effectively.

However, the challenge of decarbonising agriculture in the UK can also be framed as an opportunity. Needing to expand production, while reducing emissions and ensuring farms do not geographically expand, there is a strong set of drivers to encourage the development and uptake of new mitigations and adaptions at an unprecedented scale. Moreover, the UK approaches its task from a position of relative strength – possessing a well-connected public sector and a strong agricultural sector.

UK industry also has an outstanding track record in responding to challenges within the sector – having gradually improved productivity with the development of novel technologies such as new crop varieties, IPM systems, robotics and precision agriculture. In the context of these strengths, and a growing international commercial interest in supporting the development of agricultural solutions, the UK has the opportunity to transform agriculture and embrace novel technologies that work for all in the food chain including consumers. This report highlights those opportunities and provide momentum for onward action.

Recommendations

1. The National Science and Technology Council should include the Secretary of State for Environment, Food and Rural Affairs, and should seek to evaluate the impacts of continued AgriTech investment in the context of the UK's broader net zero ambitions.
2. UKRI should seek to support the development of key products through the creation of Small Business Research Initiatives (SBRI). These initiatives would seek to finance solutions to specific blockers currently problematising the decarbonisation of the UK's food system.
3. Defra should launch a project investigating the potential to develop a metric to accurately and productively assess the emissions generated by agriculture focus on emissions per unit of food, in addition to emission per unit of land.
4. The AHDB should be encouraged to establish a single What Works Network to monitor the effect of policy and practice on farming and diets. Though this single centre would be tasked with tracking a broad range of impacts, a single centre for the assessment of policy would help to break down silos within the sector and would encourage policymakers and industry to better represent the relationship between the production and consumption of food.
5. BEIS and UKRI should seek to relaunch the Agri-Tech Catalyst (ATC) programme. Reviews of the programme have shown its positive impact on UK-based innovation.
6. UK legislators should revise the terms of the Competition Act 1998 and the Enterprise Act 2002 to ensure they do not limit data exchange between private businesses that will be essential to capturing consistent data throughout supply chains, not least where exchanged data might enable public goods.
7. Defra should embed novel data collection, sharing processes and requirements into environmental land management schemes – thereby streamlining reporting processes and providing clarity for data capture for farmers.
8. Working with the FSA, Defra should establish a series of case studies to encourage support of the Food Data Transparency Partnership as a decentralised library linking data collected from throughout the supply chain.
9. Key insights gleaned via the Food Data Transparency Partnership should be made available on centralised libraries such as the AHDB's planned What Works Centre.
10. The Rural Payments Agency should seek to establish a carbon credit scheme for farmers driven by the insights reported through environmental land management schemes. This would ensure farmers see clear benefits to increased reporting and implementation. Credit trading, however, should be closely monitored to ensure that agricultural production is maintained and not disincentivised.
11. The UKRI and BBSRC should establish new guidance for the trialling of novel AgriTech products, such that they encompass metrics pertaining to sustainability value alongside more traditional metrics.
12. A National AgriTech Trialling Advisory Group should be temporarily created through UKRI and BBSRC, in conjunction with the Advisory Committee for Releases to the Environment (ACRE), to inform stakeholders of updates to the process of getting new products into trials under updated regulation.
13. Considering Defra's success establishing a consistent definition for precision bred organisms, the department should continue to review inherited regulation of other technologies currently restricted by the regulation of GMOs.
14. Defra should publish revised labelling guidance for retailers to encourage greater consumer awareness of the sustainability impacts of products. A timeline for the integration of kg CO_2e cost (per tonne or kg) data into labels should be developed.

Introduction

Since the European Court of Justice's (ECJ) 2018 decision that all gene-edited organisms should be legally regulated as genetically modified organisms (GMOs), the EU has been isolated from a growing interest in the development of precision breeding solutions. As a result, while global investment into precision agriculture has grown 1100 per cent between 2012 and 2021, investment in crop science has flowed away from the UK and the EU and towards more favourable regulatory environments in North and South America.[1]

The introduction of the Genetic Technology (Precision Breeding) Bill to Parliament on 22nd May 2022, therefore, marked a significant moment for England following the UK's departure from the EU. By removing precision breeding from the regulatory framework governing GMOs, new opportunities were created to drive investment, "encourage agricultural and scientific innovation in the UK" and "unlock the potential of new technologies to promote sustainable and efficient farming and food production."[2]

The commitments outlined in the precision breeding bill were followed, less than a month later, on 13th June 2022, by the Government food strategy policy paper. Outlining the UK's intentions to deliver a "prosperous agri-food sector that delivers healthier, more sustainable and affordable diets for all," the strategy made a point of highlighting the importance of new agricultural technologies to the realisation of those ambitions. This includes a commitment to the "quick and effective deployment of new technologies at the highest consumer standards."[3]

The government's response sets out clear ambitions to reduce emissions in the livestock and protein sectors through the implementation of new technologies – specifically supported through Defra's Farming Innovation Programme. It also sets forward the objective of improving support for the various AgriTech projects currently being undertaken by industry and UK Research & Innovation (UKRI) and driving confidence and uptake for the products of those programmes.[4]

82 per cent of farmers feel restoring soil health and improving sustainability are of fundamental importance, but are they investing accordingly?

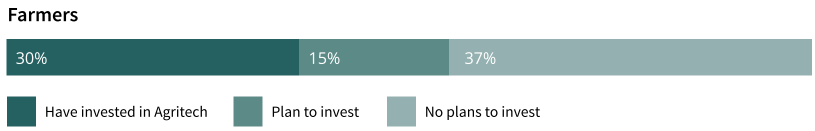


Figure 1: Source: Barclays AI in UK AgriTech – 2021 and beyond

However, while the strategy correctly states that the delivery of government targets for the improvement of the food system will require the implementation of new technological solutions, it arguably understates the importance of AgriTech development to the UK's broader net zero ambitions.

Presently, agriculture is the fifth most polluting National Communication (NC) sector, behind transport, energy supply, business and the residential sector. It is responsible for 11 per cent of the UK's total greenhouse gas (GHG) emissions, creating 46.3 Mt CO_2e per year.[5] However, this impact grows even further when it considers emissions created by the production and sale of food beyond the farm – it has been estimated that when all emissions attributable to the production, transport and sale of food are considered, the UK's food system accounts for 35 per cent of the UK's total emissions.[6]

However, even when focusing solely on the impacts of agriculture within the food system, its 11 per cent share in the UK's GHG emissions totals can be misleading. This is because agricultural emissions, unlike most other NC sectors, are primarily comprised of methane (56 per cent of agricultural emissions) and nitrous oxide (31 per cent).[7] These gases have a much greater global warming potential (GWP) than carbon dioxide. They also interact with other GHGs (particularly shortly after their emission), further magnifying their impact.

Overall, the main contributors to the agricultural sector's GHG emissions are methane and nitrous oxide from fertilisers. While carbon dioxide is generated, the amount produced by the sector is relatively negligible (comprising only 12 per cent). Broken down by farming activity, 47 per cent of these emissions come from ruminant livestock (cattle and sheep), 25 per cent from soils (which emit GHG because of biological fixation of nitrogen by crops, ploughing in crop residues, and the cultivation of organic soils), and 15 per cent from waste and manure management.[8]

The agricultural sector is, as such, the most significant contributor to current methane and nitrous oxide emissions levels. In fact, as of 2020, 48 per cent of the UK's total methane output, and 69 per cent of all nitrous oxide emissions, originated from the agricultural sector – while it was responsible for only 1.7 per cent of carbon dioxide emissions.[9]

The profile of emissions generated by agriculture, however, is the not the only factor differentiating it from other NC sectors. While other sectors could conceivably lower their emissions output through encouraging reductions in demand, agriculture has no such recourse. Should food production in the UK slow, or shift towards a less intensive model, the UK will not actually reduce the emissions output of its food system. It will instead be outsourcing those emissions elsewhere.

Agriculture is also bound by the geographical constraints of the UK. The 216,000 farm holdings that make up the UK agricultural industry utilise nearly 17.2 million hectares of land – or roughly 71 per cent of the UK's land.[10] As such, though the decarbonisation of the UK food system is imperative, agriculture in the UK must maintain (and eventually succeed) current levels of production without physical expansion.

Without the ability to curb demand or expand farming practices to de-intensify production and reduce inputs, UK agriculture sector must look towards novel solutions to reduce its emissions. These factors make AgriTech a vital consideration for the UK's broader net zero ambitions.

The UK must, accordingly, seek to improve the efficiency of its development and implementation of these technologies. While the UK maintains some of the world's leading agricultural research institutions, and UK-based companies have developed devices and platforms that are currently being employed on farms around the world, the UK does not perform as strongly when it comes to attracting investment and getting this innovation into the hands of farmers. As such, while the UK is ranked fourth in the Global Innovation Index (GII) for 2022, and third for innovation outputs (i.e., knowledge and technology-based products and creative products) it places seventh for research inputs (i.e., institutions, human resources, infrastructure, market sophistication, business sophistication, etc.)[11]

This is not due to a lack of interest from farmers. In the roundtables that preceded the publication of this report, the overwhelming sentiment from contributors was that farmers were interested in implementing new devices and techniques on their farms – but the majority lacked the knowledge

UK territorial GHG emissions by gas and NC sector in M_tCO_2e (2019)

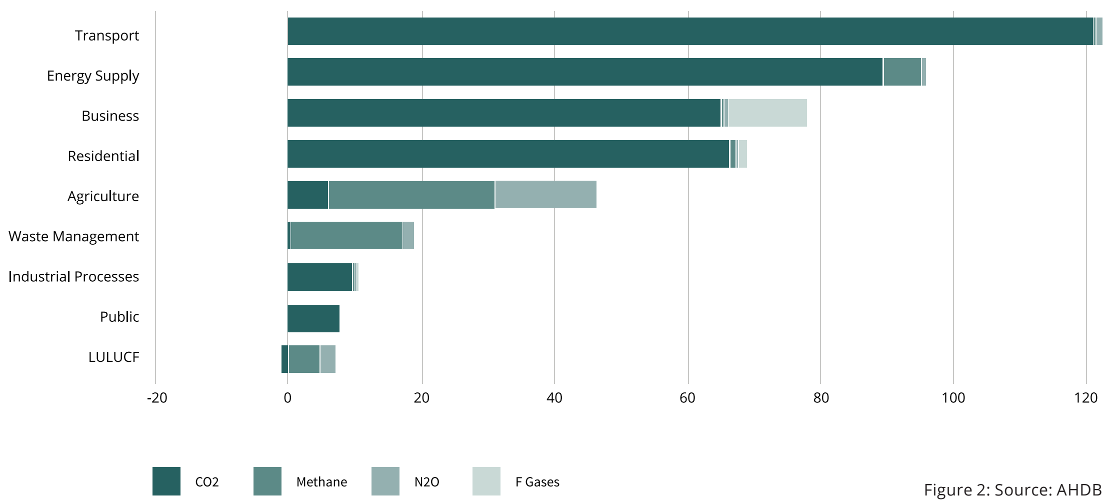


Figure 2: Source: AHDB

and capital to do so. This correlates with the available data on farmer interest in new technologies. A 2021 survey from Propel revealed that 76 per cent of farmers were “exploring the use of high-tech equipment on their farms,” however in a survey from NFU Mutual in 2022, only 14 per cent of farmers “planned to invest in AgriTech in 2022.”[12]

It then follows that improved support for existing knowledge sharing networks and grant schemes will be essential to supporting the transformation of the UK’s food system, as will the creation of new networks where necessary. However, to fully unlock the benefits of AgriTech, the UK must also re-evaluate the innovation pathways for new agricultural technologies to ensure they meet the needs of farmers and are practical to implement. The incentives and regulations that drive the procurement of processors, distributors and retailers must be revised accordingly to ensure they more accurately reflect the government’s ambitions for the UK food system and the reduction of overall emissions.

This report outlines a series of recommendations that, accordingly, seek to improve the efficiency of AgriTech development and implementation – while ensuring that the incentives to drive uptake accurately reflect the government’s broader ambitions for improved food security, nutrition and sustainability. Divided into four sections (The innovation pathway, data, trialling and customer engagement) this report summarises and contextualises a series of four virtual roundtables that took place from June to September 2022 – and were attended by a cohort of researchers, farmers, industry leaders and policymakers from various government departments, and private and public sector organisations. This report also features case studies, showcasing the value of AgriTech and current pathways supporting its development.

Global averages for Poore and Nemecek GHG emissions per kilogram of food product

Emissions are measured in carbon dioxide equivalents (CO_2eq). This means non-CO_2 gases are weighted by the amount of warming over a 100-year timescale.

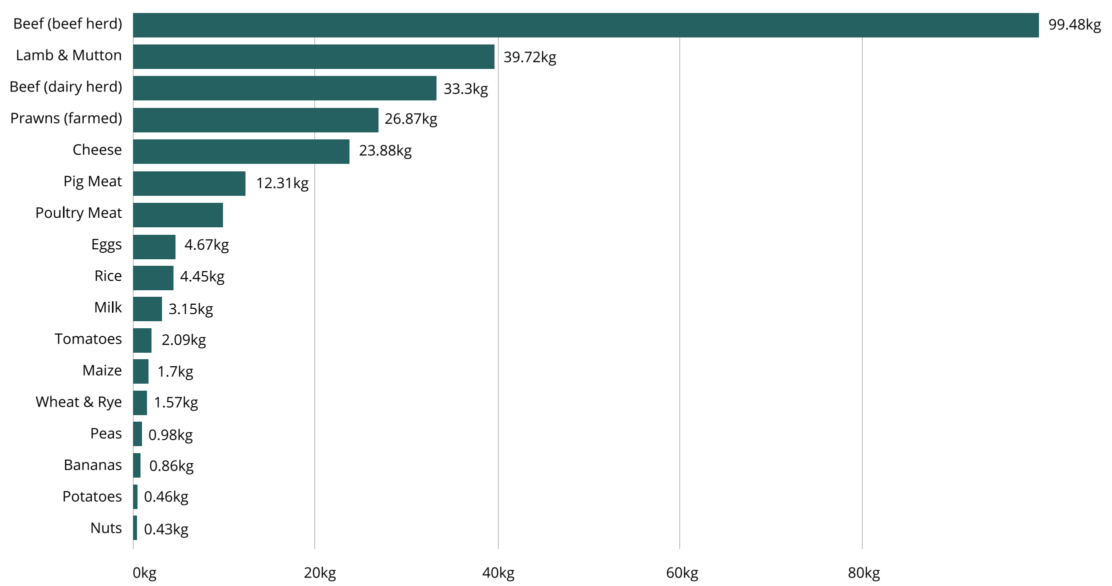


Figure 3: Source: Poore and Nemecek (2018) Reducing food’s environmental impacts through producers and consumers

CONTEXTUALISING THE UK FOOD SYSTEM'S CHALLENGE

A food system encompasses the entirety of the producing, processing, retailing and consuming process – and all individuals and organisations that interact to deliver those processes. While stakeholders within the system have different (and often competing) objectives, they nonetheless collectively contribute to the practices (and impacts) of the food supply chain.
As such, improving efficiency within the UK's food system demands an understanding of how various agricultural and supply chain activities impact one another, as well as how they are affected by the wider policy environment. It is also key to understand the unique qualities of the UK that differentiate it from other food systems.

As in many countries, methane and nitrous oxide emissions are the most significant element of the UK agriculture sector's GHG outputs – methane from agriculture alone comprises roughly 5.5 per cent of the UK's total emissions – and these emissions largely come from activities associated with livestock production.[13] There is, as such, a particularly significant role for the livestock industry to play in helping the UK deliver on its decarbonisation goals.

However, it is important note that the livestock sector has thus far been one of the most progressive elements of the UK agricultural sector in terms of its relative footprint. For instance, while EU livestock is estimated to be responsible for 9.1 per cent of the region's total emissions, UK livestock only accounts for 5 per cent of territorial emissions.[14] In fact, the UK performs better than the global average in terms of kg CO_2e/kg of product in dairy, beef, sheep and pigs.[15] Moreover, livestock farming produces value through converting otherwise inedible crop residue and waste – the Food and Agriculture Organization (FAO) estimates that 86 per cent of livestock feed is inedible for humans.[16]

There are also a number of mitigations that can further improve the production efficiency of beef, dairy and sheep systems in the UK. These extend to animal management, mitigation of individual feed ingredients, manure management and land management. While the implementation of these solutions necessitates investment and systems changes on farms, these mitigations can improve outputs to the extent that smaller herds can demonstrate the same level of productivity as larger ones. This, in turn, opens new opportunities for alternative use of land that is presently engaged in agricultural production which could potentially deliver further emissions reducing benefits. CIEL, for instance, has suggested that improved production efficiency enabled by existing mitigations combined with afforestation of released land could result in a 200-cow dairy herd reducing its emissions by 15 per cent.[17]

Similarly, anaerobic digestion (AD) of manure offers a unique solution for farms to reduce the usage of fossil fuels. However, in part because the National Inventory only references agriculture, the cross-sectoral benefit of such a practice remains difficult to judge.

It must, however, be noted that existing mitigations will not be sufficient to decarbonise livestock production in its entirety. As noted within the Net Zero Carbon & UK Livestock August 2022 report, a 100 per cent adoption amongst farmers of some of the most meaningful mitigations presently available (as assessed by CIEL) would only result in a 23 per cent reduction in GHG and a 15 per cent reduction in ammonia emissions.[18] As such, if the UK is to meet the Committee for Climate Change's (CCC) suggested target of reducing total emissions by 15.5Mt CO_2e each year between 2018 and 2050 – and the NFU's even more ambitious goal of reaching net zero greenhouse gas (GHG) emissions across the whole of agriculture in England and Wales by 2040 – policymakers and regulators must begin to view the support of AgriTech innovation as an area of priority.

It is also worth noting that the livestock sector plays a significant role in supporting the health of the UK population. While the UK does consume about 70 per cent more protein than the World Health Organisation (WHO) recommends, the consumption of milk, eggs and meat plays an important role in providing the population with highly bio-accessible and convenient sources of iron, zinc and calcium.[19]

As such, while a reduction in the average consumption of protein in the UK could translate into a reduction in agricultural emissions, it is important that policymakers and regulators assess the impacts of the livestock sector (and the agricultural sector more broadly) in the context of these overall emissions contribution being balanced against the sector's contribution to public good.

These considerations should, accordingly, also consider the emissions of the UK's crop sector. Of the 6 million hectares of croppable land in the UK roughly 75 per cent is devoted to cereal production, with the remainder being split between oilseeds, potatoes and horticultural crops.[20] While emissions of methane and nitrous oxide (and GHGs more broadly) are lower per unit of food in crop production, the sector nonetheless produces a significant carbon footprint. The chief culprits for these outputs are nitrogen fertiliser manufacture, nitrous oxide emitted directly from soil denitrification, fuel use, crop residue management and nitrous oxide emitted indirectly via ammonia or nitrate pathways – though it is important to note that the impacts of each of these factors varies dependent on the type of crop production (fuel use in the production of legume crops is significantly higher than in the production of arable crops, for instance).

As such, in their Benchmarking greenhouse gas emissions for the UK arable and horticultural sector 2022 report, CHAP noted that innovators and farmers alike should focus on reducing emissions from the use of fertilisers and the use of fuel. With regards to the latter, the report notes that "as significant decarbonisation occurs across all sectors of the economy, there will be benefits for the cropping sector from increasing use of renewable electricity, innovations in transport and agricultural machinery to replace diesel, and low emission fertiliser manufacture."[21] In the short-term, however, it is key for farmers to continue to grow their understanding of their carbon footprint and optimise their systems with available mitigations. This will also play an essential role in establishing a clear understanding of adaptation needs and developing combined mitigation/adaptation approaches.

It is also important to note that while crop production can be made increasingly efficient to reduce emission., the process of farming crops will always have a carbon footprint because of the biological need for nitrogen. As such, it is important that farmers continue to explore their role as purveyors of some of the largest stores of GHGs (vegetation and soils). This same potential exists in the livestock sector. As such, like the Net Zero Carbon and UK Livestock October 2022 report, this report suggests that while the potential to sequester carbon on farms in the UK remains unclear, this is a knowledge gap that requires significant attention.

However, it is also important to note that these opportunities for sequestration will not be equal in every region – and the decarbonisation of agricultural production will not occur proportionately across the UK. As the CCC has noted, certain areas and devolved authorities have greater opportunities to sequester carbon – meaning that while Wales will not be able to reach net zero greenhouse gas emissions by 2050, Scotland (with incredibly high potential for emissions removal) could credibly adopt and even more ambitious target. Devolved administrations are planning accordingly. Scotland, for instance, has set itself the target of net zero by 2045, while Wales has set its sights on a 95 per cent reduction in emissions by 2050. England, meanwhile, has established several taskforces to meet its emissions targets for the third carbon budget period (2018-2022).

These initiatives, which utilise the UK's regional variance to develop targeted solutions within a cooperative context, must play a crucial role in the UK's strategies to address agricultural emissions reductions – and GHG emissions more broadly. The cross-sector 'Green Growth' Strategy, presently in place in Northern Ireland (and led by the Defra) is a prime example of the utility of this approach.[22]

Unlocking the true value of these initiatives, however, will require improved access to, and utility of, data – which in turn will necessitate the UK developing solutions to improve the efficiency of product development and implementation.

The UK, however, does have the ability to make the necessary changes. As one roundtable contributor noted, "the UK has a strong public sector, strong research and agricultural sectors, and they are relatively well connected." The strength of the UK's food system is, therefore, not the concern of this report – rather this report aims to put forward suggestions to maximise that strength in service of the UK's net zero and levelling up goals.

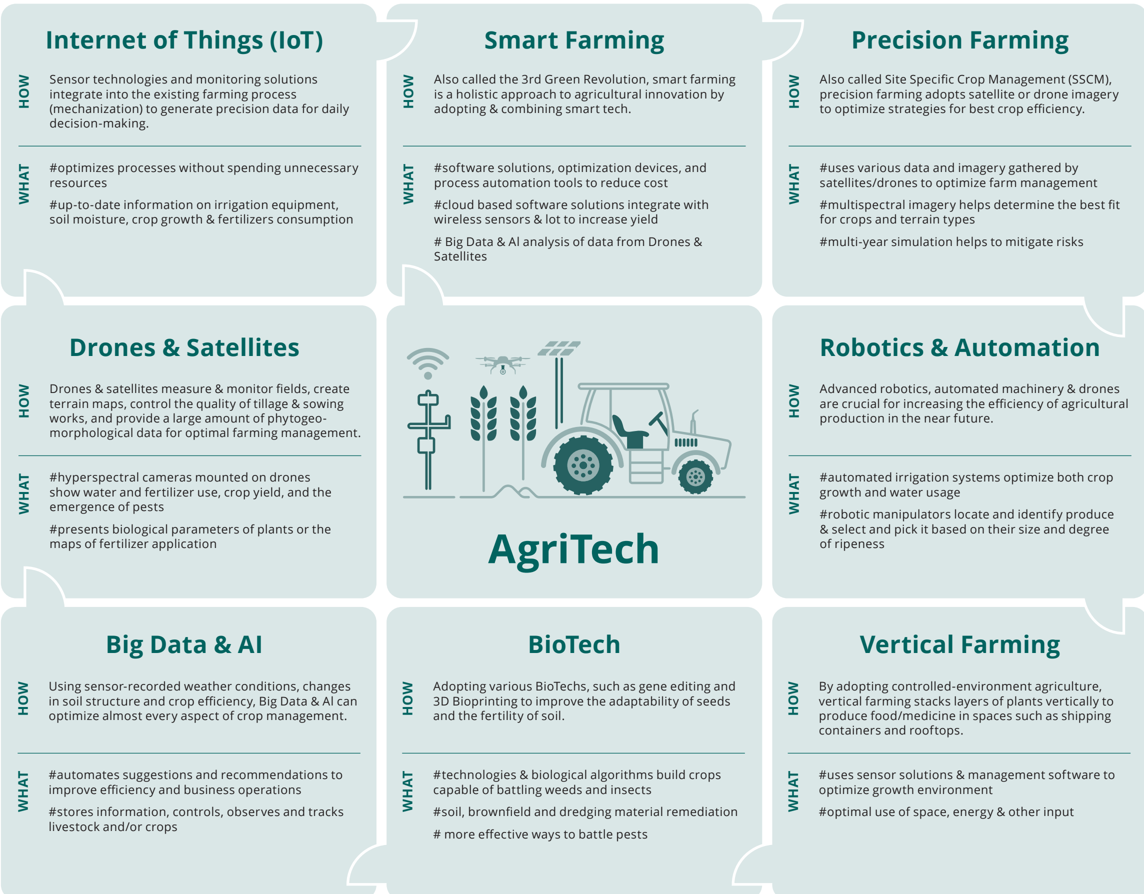


Figure 4: Source: StartUs Insights

Chapter One

FACILITATING COLLABORATION IN THE INNOVATION PATHWAY

The UK government's commitment to invest 2.4 per cent of its GDP into R&D by 2027 signify the strength and ambition of innovation within the UK. However, as one contributor to a roundtable noted, while the UK is "good at inventing, [it's] not good at innovating."

In the case of UK AgriTech, despite significant interest in new technologies and their potential benefits from the entire supply chain, uptake remains suboptimal and programmes to support the implementation of tech at farms typically find only "a tiny percentage of farmers actually get involved." Illumina Research found in 2020, for instance, that only 30 per cent of UK farmers had invested in "emerging tech," 82 per cent of those same farmers stated that they felt sustainability and soil health were of fundamental importance.[23]

Poor uptake numbers can be explained by four interlinked factors: poor financial incentives, suboptimal communication, poor private investment and a lack of overall clarity regarding the future of AgriTech. While the UK presently possesses one of the world's strongest R&D capacities, private investment into innovation is presently suboptimal. Within the private plant-based genetics sector there has been a gradual diminishing of investment in Europe and the UK – in part due to difficulties in implementing new plant varieties under existing regulation. As such, while universities continue to engage in world-leading research, the private apparatus to take that innovation to market currently does not exist in the UK at the required level. Accordingly, the UK finds itself in a strange position. Because of strong public support for innovation, but poor private support (partially due to a lack of confidence from the private sector) the UK is, as one contributor quipped, "both a leader in this space and a laggard."

We need to recognise something that is a bit unique in the farming sector. Most natural learning happens in the farming community by peer networks

However, while private investment flows can be partially explained in reference to broader trends within global venture capital (VC) funding, there is a clear relationship between the relatively poor growth of private AgriTech R&D investment in the UK and the complexity of coordinating between the various stakeholders engaged with AgriTech innovation. Cohesion can, and should, be improved by the standardisation of carbon accounting and reporting methodologies. However, the development of an agreed upon standard for assessing the totality of the agricultural sector's environmental impacts is problematised by the complexity of agricultural production.

Though the 2019 Refinement to the 2006 IPCC Guidelines on National Greenhouse Gas Inventories provides updated values of some emission factors used to link the emission of a greenhouse gas for a particular source to the amount of activity causing the emission, the IPCC inventory is only able to provide a narrow picture of farm-based emissions.[24] It does not account for all emissions that can be associated with agricultural production, – which aims to account for these broader impacts – remains the most effective approach to understand the true impact of farming methods (and to develop effective tools to reduce those impacts).

Although there are many tools enabling farmers to conduct life cycle assessments, differentiations in methodology and inventory limit the interoperability of their findings. Several studies recently conducted into the value of various carbon calculators found that while a number do offer significant benefit to users, there remains no clear favourite with the highest-ranking tool receiving only a 54 per cent score for overall performance.[25]

The development of a clear methodology to evaluate the impact of the UK's agricultural sector is further problematised by the unequal and interlinked impacts of the various GHGs produced by different methods of agricultural production – particularly the emissions produced by livestock production.

There are two main GHGs emitted from livestock production

- Methane (CH_4) primarily produced by the digestion processes of ruminants (enteric fermentation) and the storage of slurry
- Nitrous oxide (N_2O) created through nitrogen management and application in ruminants and monogastric systems i.e., manure and fertiliser

Carbon dioxide (CO_2) is also emitted, but in significantly lesser quantities than methane and nitrous oxide. Ammonia (NH_3) should also be included in broader LCA calculations of livestock's GHG impact, as ammonia levels provide a strong indication of the impact of livestock farming on air quality. Whether quality standards are required to deliver associated assessments should be considered.

Methane and nitrous oxide both have significantly greater Global Warming Potential (GWP) than carbon dioxide. According to GWP100 methodology, which calculates the global warming potential of gases over a span of 100 years, methane is 25 times more potent as a heat absorber than carbon dioxide while nitrous oxide is 298 times more potent (according to GWP100 methodology, version AR4).[26] It is worth noting, however, that in 2019 this number was revised, and now nitrous oxide is seen to have 265 times the impact of carbon dioxide.[27]

These figures, however, do not tell the full story. GWP 100, being agnostic to the differing impacts of GHGs over their lifespan, overstates the impact of existing methane in the atmosphere (by a factor of 3 or 4) but significantly underplays the effect of new emissions (which can be 4 to 5 times more harmful than presently modelled by GWP100).[28]

The most common methodology, and the one used in the National Inventory, is GWP100, however alternative methods for capturing climate change effects of GHGs have been developed, such as GWP*. The GWP* methodology offers a more considered means to assess the holistic impact of various GHGs – particularly as it accounts for the differing impacts of certain short- and long-lived GHGs in a method that GWP100 calculation do not.[29] However, the utility of GWP* calculations are reliant on predicted emission levels being met, and as such these predictions are extremely sensitive to changing circumstance.

It is also key that metrics developed to assess the emissions generated by agriculture focus on emissions per unit of food, in addition to emission per unit of land (or area-based emissions). This is because, as present policy commitments are based solely on territorial emissions data, as pressure to reduce agricultural emissions and enhance carbon sequestration continues to grow, there will be increased pressure on owners to find alternative uses for land currently engaged in intensive agricultural production. Lest this pressure result in an overall decrease in domestic production, the UK must establish a method to judge the agriculture sector's progress towards net zero in terms of how efficiently units of food can be produced. Figures for the average emissions intensity numbers published by CHAP and CIEL could be used as a baseline to inform these metrics.

The development of such a methodology, which could compare kg CO_2e/tonne or kg data against an established baseline, would necessitate the establishment of carbon footprints, in line with the IPCC approach. However, an understanding of the overall lifecycle of the carbon produced within the food system will be key to ensure that the UK not only produces food more effectively – but does so in a manner that also brings down the national volume of GHG emissions. Defra should, accordingly, launch a research project focused specifically on developing a viable methodology for the creation of such a set of metrics.

Developing a clear vision for how the sector will monitor and judge its own progress is also likely to positively impact the UK's ability to attract AgriTech investment. However, the AgriTech sector must also contend with the UK's poor record of supporting scale ups - while the OECD ranked the UK in 2017 as the third most attractive start up destination in its global index, the UK found itself ranked thirteenth amongst scale up destinations.[30] While this performance can be partially explained by the UK, and Europe more broadly, having a smaller pool of available finance than the US or China the performance of UK start-ups and scale ups could certainly be improved through the institution of clearer priorities.[31]

However, the UK should also not underestimate its role as a global leader in agriculture. AgriTech approaches developed in the UK regularly garner interest from larger international markets, and the UK should accordingly target the development of these approaches as a significant growth opportunity. As one contributor noted “We need to be a bit clearer about where our key priority markets are internationally, and where our big bets are in terms of where we want to invest in R&D and innovation.” The innovation pathway for AgriTech in the UK could benefit accordingly from clearer priorities and goals – and this is likely to be most effectively delivered in the form of top-down guidance.

Figure 5: Source: Barclays AI in UK AgriTech – 2021 and beyond

The National Science and Technology Council should, accordingly, include the Secretary of State for Environment, Food and Rural Affairs, and should seek to evaluate the impacts of continued AgriTech investment in the context of the UK’s broader net zero ambitions. The AgriTech Strategy and AgriTech Catalyst programmes, both introduced in 2013, should also be revived by the DIT, the AgriTech Centres, BEIS and UKRI. These programmes both had positive impacts that set forward clear priorities for the development and integration of new products. Within its role supporting the development of the UK’s science and technology strategies, BEIS should also seek to support the development of specific technologies through the creation of new Small Business Research Initiatives (SBRI).

The AgriFood sector must also do better to support smaller SMEs – which often find themselves barred from participating in schemes due to a lack of capital. Particularly within the agricultural space, existing frameworks for the financing of innovation currently exclude smaller SMEs thus limiting their scope for development. One contributor stated, “one of the main vehicles that we have for scaling up research into outcomes with the commercial sector are through grants. These grants operate through schemes where a certain percentage of investment for the project must come from the private sector. That determines the size of the project and the amount of the research that can be carried by that project. That means if you are a small industry, and you cannot make a substantial contribution, then you are going to end up with a small project.” Continuing, they noted that “there’s a gap with smaller SMEs and their opportunity to scale, and we need to come up with investment schemes or proposal schemes where they can participate.”

The Biologicals Pipeline Accelerator and Demonstrator, devised by CHAP, offers a pertinent exemplar of what outreach to SMEs should look like.[32] The provision links SMEs to the expertise and facilities they need for successful product development, supported by a network of field and farm trial sites. As such, beyond enabling the scaling up of production, product testing, regulatory compliance insight, registration support, investment and funding, the accelerator and demonstrator also avails significant benefits to the UK’s universities by better connecting them to the innovation ecosystem. The recently launched Agri-EPI Centre investment platform, Agritech Investment Advisory Ltd, plays a similar role by connecting investors with companies seeking investment to take their AgriTech solutions forwards.

While many universities are engaged in world-leading research within various AgriTech spaces, a lack of support for spinouts has limited the impact of this innovation. As one contributor noted, "without the ability to create spin-outs, there is nowhere for the tech to go and it just dies, while the university moves on to the next bit of innovation." Nonetheless, the Ceres Agri-Tech Partnership (which links the Universities of Cambridge, Lincoln, Reading, Hertfordshire, and East Anglia) has proven the success of supporting universities with translational funding to drive commercialisation of AgriTech research and innovation.[33]

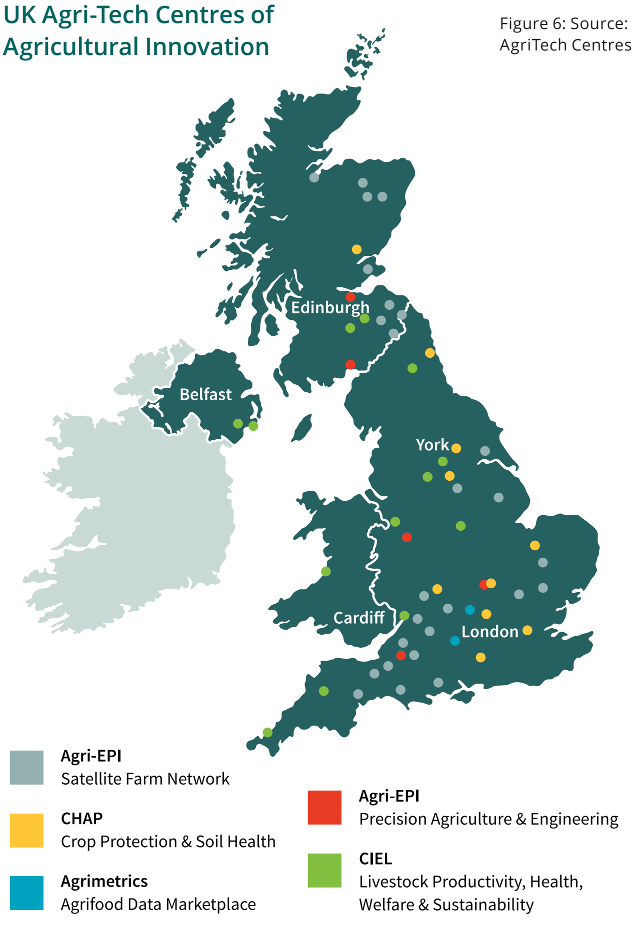
It is also key that these new programmes seek to develop closer working ties between innovators and regulators. As one contributor noted, "innovators are very focused on their product, their technique, they're focused on getting their start-up funding, they're focused on proof of concept and they're perhaps less focused on the demands of the regulatory bodies." Moreover, as the sector seeks to respond to climate challenges that are increasing in their impact, close ties between developers and regulators will only improve the responsiveness of the sector. Improved connectivity between regulators and researchers is also likely to reduce risk exposure for industry. Accordingly, the development of guidance to ensure founders understand the markets and regulations with which their engaging will be a crucial task for UKRI, Biotechnology and Biological Sciences Research Council (BBSRC) and the FSA. This could also include creating opportunities for physical interaction. One contributor noted that the John Innes Centre (JIC), for instance, recently invited staff from the FSA and Defra to engage with their team of innovators, creating a unique opportunity for what was as "necessary two-way learning."

By bringing together multiple players, each of whom can react and work with regulators, these sorts of consortia "speed up the process of doing the research and gathering the evidence." However, until a process of early review is formally put into place, regulators are liable to find themselves needing to "stop the clock and open a dialogue with the applicants," unless greater top-down clarity on standards and regulations is provided.

A similar logic applies to collaboration with farmers. Developing the appropriate mixture of 'carrots and sticks' for stakeholders using regulation and market commitments will be essential to creating an efficient innovation pipeline. "Ultimately a farmer is not going to plant a seed that's not going to make money," as one contributor

UK Agri-Tech Centres of Agricultural Innovation

Figure 6: Source: AgriTech Centres



I am guilty of putting farmers into the same bucket banks, but what we have is quite a complex demographic in what is quite a fragmented industry. We traditionally cut it by sector and region and our own organisations, but those boundaries do not necessarily work

noted. Policymakers should accordingly take note of where the UK is already experiencing success facilitating innovation – and where it has had trouble as well. Looking towards the example of variable rate fertilisers, though the technology has been available since the 1990s its adoption has been rather modest. This is, in large part, due to the fact that in most applications the profitability of variable rate fertiliser is not consistent. Where there has been greater consistency in profitability, uptake has been proportionally higher. As such for niche uses (e.g., variable rate nitrogen on sugar beets, variable rate lime on soils with high pH variability), where profitability is quite reliable, there have been much higher adoption levels.[34]

Ensuring profitability, however, is a matter of "knowledge application and getting the right knowledge to the relevant people in a timely manner." As such, programmes such as the Farming Innovation Programme have succeeded in supporting the development of numerous products, and these products in turn tend to have benefitted from founders being supported by the expertise of institutions familiar with regulatory standards – and the needs of farmers.

As one contributor noted, the scale of change required within the agricultural and food sectors will require a "massive change of culture." It is, however, key that the gains being made by ongoing programs are not sacrificed. Programmes such as the Defra-led Farming Innovation Programme (which is investing £270 million in R&D and innovation over the course of the agricultural transition through to 2028)[35] and the Farming Investment Fund (which is working to help farmers access technology that is already available on the market) are presently offering key support to a number of farmers and innovators – and the development of guidance from the FSA and UKRI should seek to minimally impact the ongoing work of these programs.[36]

Accordingly, this may involve expanding or altering the remits of existing public bodies or the creation of a new body, or bodies, altogether. Genomics England, for example, could be empowered to work outside of the Department for Health and Social Care (DHSC) and provide guidance across all applications of Genomics in the UK (thereby opening new possibilities for cross-sector collaboration. This model has precedent, as Genome Canada (which is specifically tasked with delivering economic growth through research applications), have had considerable success guiding the implementation of innovation across a spectrum of applications within a framework that allows for easy knowledge-sharing.[37]

However, while setting forward a commitment that encourages immediate action amongst stakeholders is important, so too is setting forward a strategy to evaluate the effectiveness of these changes to policy. The National Food Strategy recommends for two new What Works Centres to be established (one of which is the AHDB's proposed What Works Centre, which will succeed the Evidence for Farming Initiative). These centres would monitor the effects of policy and practice on both diet and farming. This report, however, advises that a single overarching centre would be best placed to track impacts through evidence and data. While this single centre would be tasked with briefing farmers and policymakers, a single centre would help to break down silos within the sector and would encourage policymakers and industry to better represent the spectrum of the agricultural sectors impacts more accurately within their assessments – while still offering the benefit of better connecting the agriculture sector with the activities of other sectors in the UK.

Why are farmers hesitant about investing in AgriTech?

Figure 7: Source: NFU Mutual 2022

The information gleaned by this What Works Centre, in turn, is likely to engender a more holistic understanding of skills gaps within the sector. "Developing the CPD and apprenticeships and making sure that we have a really strong professional framework" will be key to ensuring that "once we have that technology on board, we have the skill set to actually use that technology and make the most of it." As one contributor noted, "we're taking examples from New Zealand, Australia on how they have a very kind of holistic approach to labour market insights (LMI)," which has enabled the sector in those countries to better assess the relationship between skills development in various sectors. It is accordingly key that this sort of LMI analysis is embedded within any SBRI or LMS put forward to promote the implementation of AgriTech within the UK.

Maximising the value of approaches informed by AgriTech and data, however, will require access to more and better data. As such, the adoption of new technologies which produce data on farms is a key facilitator for agricultural decarbonisation. These can be processes, hardware, software and other technology-based interventions. While these are currently focused within the marketplace on productivity and efficiency benefits, there is a clear win-win opportunity with productivity and lowering carbon footprints. The innovator actors in the sector, predominantly SME's supplying systems to primary producers and the supply chain, generally provide said systems on the basis of an economic benefit, and a significant percentage will harness data from the biological processes that consist of our primary food "feedstocks." Encouraging use and interrogation of these rich datasets on farm, interlinking different datasets etc, can realise both significant productivity and net zero benefits. Recent Defra support for the Farm Equipment and Technology Fund launch and expedition has been a positive move to encourage adoption and will hopefully be followed by similar initiatives.

CASE STUDY 1

In 2021 Antobot secured a £1.2 million investment from Intron Technology Holdings Limited. The investment, designated to support Antobot's scale up and to help bring their InsightTM robots to market, marked a seminal step in the young company's development.

Antobot's InsightTM robot responds to a growing demand from retailers for tools that can be employed by farmers to improve their reporting on yield estimations. A scout robot that utilises core embedded AI (making the robot ultra-adaptable), the InsightTM robot is capable of autonomously collecting data on count, size and ripeness – giving farmers and retailers clearer insights and a better understanding of their respective future needs.

However, while the InsightTM robot responds to an acute and obvious need, a product's investment readiness is also determined by the innovator's broader understanding of the AgriTech market and the scale up ecosystem. To this end, as noted by Antobot's Business Development Manager Zoë Stockton, "one of the greatest benefits of our relationship with Agri-EPI Centre has been the expert knowledge they have, particularly about funding streams."

Agri-EPI Centre has, accordingly, played an instrumental role in the development of Antobot's business. Prior to accepting the £1.2 million investment from Intron, Antobot participated (with the aid of the Agri-EPI Centre) in Innovate UK's Edge Pitchfest. Antobot also achieved considerable success applying for a number of Innovate grants including; being awarded £89,548 by Innovate UK's Sustainable Innovation Fund in 2020; launching Project Air, a 12-month feasibility study funded by the Farming Innovation Pathways program provided by Defra and UKRI in October 2021; and Project Insight, also in the FIP program, and supported closely by Agri-EPI.

Speaking about Antobot's acceptance into the Project Insight program, Stockton noted "[Agri-EPI Centre] were really useful when we were going through that funding application. We had applied for a couple of things before that one and they were very helpful with their advice." Continuing, Stockton noted "Agri-EPI have [also] put us in touch with so many different companies that are part of their network and which we now work with… and we have attended multiple farm visits organised by Agri-EPI which have been highly valuable."

The InsightTM robot is one of two devices currently in development by Antobot – the other being the AssistTM robot which helps provide logistical data to farmers. Both devices are currently undergoing field trials.

CASE STUDY 2

GenomeCanada

Genome Canada's Climate-Smart Agriculture and Food Systems Genomics Challenge responds to the imperative of reducing emissions within agriculture through strategic and innovative national investments in climate-smart agriculture and food systems.

Launched in May 2022, the initiative is investing $60 million CAD—half through Genome Canada, the other half through co-funding—in genomic research and innovation aimed at reducing the carbon footprint of Canada's food system, deploying a novel portfolio-based model and engaging with a broad range of stakeholders to create solution-oriented innovation ecosystems.

Targeted areas of concern include the development of net-zero carbon food systems, biological carbon sequestration, resilient and sustainable food systems and scalable biology-based solutions (i.e., novel nature-based processes that can reduce carbon intensity). The initiative aims to facilitate an optimized exchange of data, and as such Genome Canada endeavours to establish an organisational framework that allows teams to maximally impact each other's work while remaining solution-oriented in their focus.

The Climate-Smart Agriculture and Food Systems Initiative will invest in a portfolio of interdisciplinary (fundamental and applied) genomics research projects aimed at reducing from the carbon footprint of food production and improving overall agricultural performance. The Interdisciplinary Challenge Teams, who will receive approximately $24 million CAD, will seek to address specific questions around the impact of genomics solutions on climate change mitigation and action – such as the over-wintering of honeybees, improving crop resilience, or omega-3 fatty acid production from algae.

The portfolio approach to investment will unlock the value of genomic technologies and data for the benefit of all Canadians and is propelled by two important and integrated Hubs.

- The Knowledge Mobilization Hub, which will receive approximately $2 million CAD, will be tasked with developing and implementing mobilisation strategies that ensure the projects undertaken by the Interdisciplinary Challenge Teams are maximally impactful. This centre will also work to establish guidance for researching the Environmental, Economic, Ethical, Legal and Social impacts of said projects.

- The Climate-Smart Agriculture and Food Systems Genomics Initiative will also fund the establishment of a Data Coordination Hub, which will receive $4 million CAD in funding to develop a framework coordinating the sharing of data generated by the projects. This data sharing framework will increase portfolio value potential and facilitate optimal knowledge mobilisation.

The Climate-Smart Agriculture and Food Systems Genomics Challenge is presently receiving applications and will convene research teams in Summer 2023.

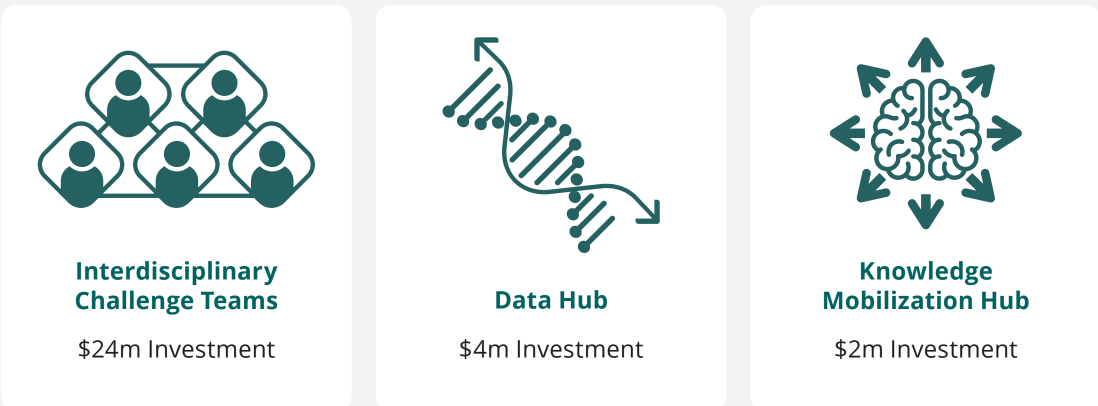


Figure 8: Source: Genome Canada

RECOMMENDATIONS:

1. The National Science and Technology Council should include the Secretary of State for Environment, Food and Rural Affairs, and should seek to evaluate the impacts of continued AgriTech investment in the context of the UK's broader net zero ambitions.

2. UKRI should seek to support the development of key products through the creation of Small Business Research Initiatives (SBRI). These initiatives would seek to finance solutions to specific blockers currently problematising the decarbonisation of the UK's food system.

3. Defra should launch a project investigating the potential to develop a metric to accurately and productively assess the emissions generated by agriculture focus on emissions per unit of food, in addition to emission per unit of land.

4. The AHDB should be encouraged to establish a single What Works Network to monitor the effect of policy and practice on farming and diets. Though this single centre would be tasked with tracking a broad range of impacts, a single centre for the assessment of policy would help to break down silos within the sector and would encourage policymakers and industry to better represent the relationship between the production and consumption of food.

5. BEIS and UKRI should seek to relaunch the Agri-Tech Catalyst (ATC) programme. Reviews of the programme have shown its positive impact on UK-based innovation.

Chapter Two

GETTING THE RIGHT DATA, AND GETTING THE MOST OUT OF IT

Advancements in automated and autonomous systems, and digital technologies, have created new opportunities to monitor and measure the impacts of food production. Sharing data also opens new opportunities for cross-sector collaboration and learning. As one member of the cohort stated, “those that are working in the livestock science community may not share the same language [as those in the crop sector] but the data can be interpreted by one another and used to tackle specific issues and important interdisciplinary questions… when we are talking with our colleagues about our experiences in plants and the new precision breeding technologies of plants, we want to compare that with the implications in livestock.”

New methods of data collection and sharing, accordingly, present a myriad of opportunities for cross-pollination and improved market insights. For instance, as sustainability becomes an increasingly important factor to inform the purchases of supply chain stakeholders and consumers alike, easy access to the data of the supply chains stakeholders will facilitate the tracking of scope 2 and 3 emissions and thereby support the food system in becoming increasingly responsive to climate impacts.

Exchanges of information within the sector, however, are presently limited by point-to point sharing agreements that govern many data exchanges. Even though the 2017 Digital Economy Act explicitly promotes the sharing of data (including personal data) between public authorities, the Public Service Delivery powers outlined in the act have not been exercised as frequently as anticipated and data collaborations between the private and public sectors are sporadic and rarely aim to maximise the interoperability of outcomes.[38]

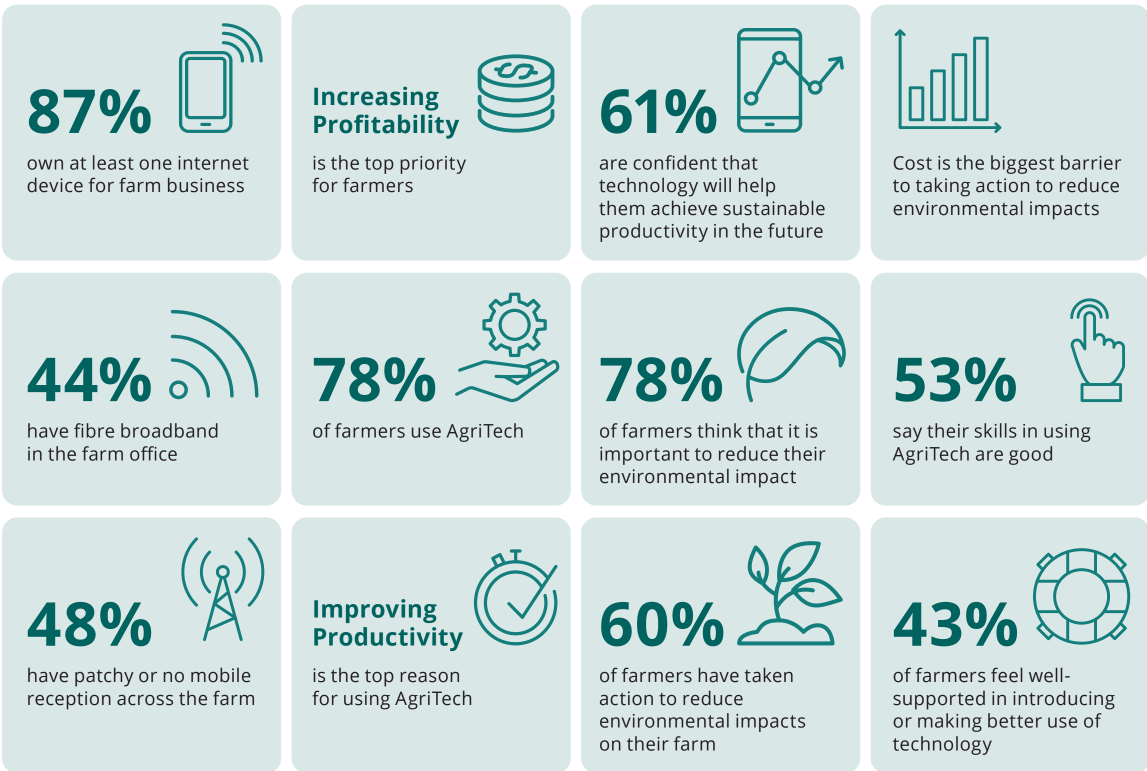


Figure 9: Source: the Agri-EPI Centre

Data-sharing collaborations, particularly between the public and private sectors, must contend with challenges regarding security and intellectual property ownership. Under the Competition Act 1998 and the Enterprise Act 2002, which currently form the basis of competition law in the UK, much of the data sharing that is necessary to support stakeholders to accurately assess the impact of their supply chains would be considered collusive.[39]

Updating legislation to account for forms of inter-organisational cooperation that serve to support the UK's broader developmental ambitions will be key, however there is also a general sense of distrust within the sector regarding the sharing of data. As one contributor noted, "obviously people want to protect their intellectual property, and they underestimate the requirements of producing evidence to the regulator and the overhead of going through the regulatory process. That creates quite a lot of fear within businesses around sharing ownership of data and whether they are going to get exploited." As another contributor remarked, "looking at sensitive topics like traceability and sustainability, often where there is an end user (i.e., the farmer or landowner) there is a real issue with data sensitivity. They are worried about that data being misused by the supply chain."

These fears can, in part, be explained by a lack of clarity. Presently, many within the supply chain remain unclear on the impact of General Data Protection Regulation (GDPR) on potential data-sharing collaborations, and this lack of awareness has negatively impacted confidence. As one contributor noted, "there is currently this conflation between personal data and private-public B2B data. Clarity on ownership sharing and what is expected will be really helpful, as there are always problems and barriers with data sharing." The UK must, accordingly, not only revisit its approaches to competition law – but also provide greater clarity on its impacts.

The revisitation of the Competition Act 1998 and the Enterprise Act 2002 also presents UK legislators with the opportunity to devote greater attention to the collection and usage of data, and the monitoring of those processes. As noted in the 2018 report Data Ownership: Rights and Controls: Reaching a Common Understanding, where the UK does deal with data its focus is typically on the ownership of data.[40] As one roundtable contributor noted, "being able to integrate this massive amount of complex data is going to be very interesting and difficult. But it also presents the opportunity to perhaps overcome some challenges with IP, because data then resides in a public domain type setting. Finding ways to come around and share elements that create value for all, while respecting the needs for downstream players to receive a return on investment, is going to be very important."

A lack of data exchange within the food sector is currently inhibiting public good co-operation and preventing the food sector from delivering gains from a health economics and environmental economics perspective. Moreover, maximising the availability of data will allow the UK to gain the full utility of AI and machine learning systems, facilitating productivity gains across a host of technologies. Accordingly, as a contributor noted, "developing new organisational methods to ensure the variety of data collected can be processed and used to add value will be key. There is a lot of data out there. Speaking purely from a farming point of view, it is in at least a dozen different formats, plus on paper plus in the mind of the farmer. So, the data in theory is there, it is how we mobilise it." In a similar vein, another remarked, "we have got to achieve interoperability of data [collected from different agricultural practices], and that is the single most challenging part of establishing [an improved] data infrastructure. It is not a matter of standardising data so that all data conforms to some readily agreed standard that will never be achieved. It is about creating domain models that allow us to map data from different areas onto a common reference point."

Many have suggested that the UK would benefit from the creation of a food data trust that could incorporate the public and private sector – notably within the government-backed report Growing the Artificial Intelligence Industry in the UK and the Open Data Institute's proposed model for AI-related information sharing.[41] A data trust is typically envisaged as a centralised library that is shared by users for their mutual benefit – and where the data hosted within that library is held under the stewardship of a body, or group of bodies, entrusted with setting standards for its use and sharing. However, while a data trust could offer significant benefits to stakeholders through essentially creating an environment for the frictionless exchange of data, concerns regarding security and privacy presently pose significant blockers.

The Food Standards Agency's (FSA) scoping work on the potential of a Food Data Transparency Partnership (FDTP) has been suggested that these blockers could be surmounted through the use of a decentralised platform for sharing data to inform food standards, which would allow private stakeholders to access and exchanges anonymised portions of their commercial data holdings.[42] A decentralised platform for data sharing would enable the data to be retained by its original owners within distributed data storage system and would be mediated by a body able to facilitate the swift exchange of data without seeing the data itself.

Distributed data stores are a particularly key element of the proposed network, as the ability to store data within multiple locations within a network could facilitate the rapid sharing of segments of data, while allowing independent organisations to still maintain ownership over their data and determine what is and is not available to other stakeholders.

> *Once you start to see transactional data sharing happening, you actually start to see that you re getting value back from sharing your data or making it available*

To ensure the exchange of information within a decentralised framework, encounters should be regulated in a manner such that no additional permissions or protocols are required for stakeholders to access data that they would typically request (such as data shared between producers and retailers). The invocation of special protocols or permissions should, as such, be reserved for exceptional instances (such as a product recall). These regulations should, in turn, be supported by the utilisation of a distribution software that separates the managing of the information network from the management of data flows, to ensure that the network is maximally adaptable.

This is especially important given the sheer variety of information systems, data architectures, vocabularies and metadata schemas utilised by the food supply chains various stakeholders. To ensure that information is readily available, usable and visible to different stakeholders, the creation of any decentralised data sharing platform should also be accompanied by new guidance for the linking of independent data sets. This could involve the use of semantic web standards, such as Resource Description Framework (RDF) or Web Ontology Language (OWL).

The Netherlands Organisation for Applied Scientific Research (TNO) has already established guidance for overcoming challenges regarding pedigree and traceability requirements within their TNO Green Print – offering a useful blueprint for the UK as it looks to develop its own trust mechanisms that can validate information as it is passed between stakeholders.[43] The more robust these mechanisms, the more effectively stakeholders can parcel their data to be used to respond to specific scenarios. Defra and the FSA, accordingly, should support the development of case studies to showcase the value of the FDTP and grow support from the supply chain.

It should also be noted that the Open Ecosystem Federation (OEF), led by a coalition of government departments including HMRC, Future Borders and the FSA, has been developing a "service that enables a technology-agnostic toolkit to support collaboration between people, organisations, and machines in a way that is scalable, repeatable, and extensible."[44] The guidance and toolkits developed by the OEF should be utilised not only by farmers, but throughout the food system, to facilitate the improvement of business processes and decision making, and to improve the interoperability of data practices.

However, while decentralisation presents a host of opportunities for secure and private, but nonetheless free flowing exchanges of data, centralised platforms will still play a crucial role in the development of an efficient data sharing framework for the UK food system. For farmers in particular, the ability to access a centralised library of information without the need for permissions will be key to promoting knowledge sharing within the sector.

An example of this sort of framework can be found within the AHDB's planned What Works Centre, which succeeds the Evidence for Farming Initiative (EFI) and works to "improve agricultural performance through providing farmers, growers and their advisers with easy access to the best available evidence on effective and cost-effective practices to carry out both emission reduction and opportunities for carbon capture and sequestration," often preparing reports for farmers with recommendations sourced from primary research.[45] These reports serve as accessible tools that promote best practice and brings together the expertise of numerous public bodies (including the FDF and NFU).

It is not a matter of standardising data so it all conforms to some readily agreed standard. That will never be achieved. It is about creating domain models that allow us to map data from different areas onto a common reference point

The creation of a decentralised platform should accordingly serve as an opportunity to also connect programs such as the What Works Centre and the Defra Data Services platform, which serves as a portal to access Defra-owned data, to create better value from the establishment of the FDTP. An emphasis on translational research also has the benefit of improving trust and collaboration between farmers and researchers. One contributor noted that "once you start to see transactional data sharing happening, you actually start to see that you're getting value back from sharing your data or making it available." In this sense, it is imperative that policymakers consider not only the role of regulation, but also of reward, in driving behaviour. Accordingly, ensuring that investment into data is visible to farmers should be a key consideration – as should ensuring that new collection and reporting mechanism do not create additional burdens without reward.

Defra's Environmental Land Management schemes (ELMs) – Sustainable Farming Incentive[46], Local Nature Recovery[47] and Landscape Recovery Central[48] – offer a unique opportunity to embed new collection and reporting methods into existing support schemes. As each of these schemes will pay farmers for undertaking actions to improve the environment and will necessitate the sharing of certain points of information (especially data points that can inform wider public goods), Defra should consider how they can embed data reporting processes into existing schemes.

Given that these data points may not immediately pertain to the mission of the ELMs, and therefore may not offer a clear benefit to farmers, the Rural Payments Agency should also consider the implementation of a carbon credit market for farmers. This would ensure rewards for collecting and submitting data (and integrating the technologies enabling those submissions) are clear and obvious to farmers. The Land Registry should support this initiative, providing oversight to ensure warrants are associated to specific land parcels. However, it would be crucial to ensure carbon credit trading does not de-incentivise productivity. Therefore, a credit system should seek to utilise emissions reductions per unit of food (when compared to average emissions intensity in kg CO_2e/tonne or kg) in conjunction with existing area-based metrics.

"Giving the industry and supply chains a better means of ranking innovation and technology by its impact on sustainability goals, and generally helping that conversation to be more scientific and evidence-based," will help to create a clear but comprehensive picture of AgriTech's role relative to the UK's decarbonisation ambitions. It will also play a crucial role in informing trade policy by providing the necessary data points (such as kg CO_2e/tonne or kg cost) to fairly judge UK farms in comparison to their international counterparts. As one contributor stated, "I think that's a real plea for research here to try and get these baselines and these methods and the metrics that we want to measure and the methods by which we measure them." Continuing, another noted that "we are always going to work with imperfect knowledge, and so we will get stuff wrong. But that should not stop us from improving on the 80 per cent that we can do better on. So, let us focus on those sustainability metrics that we think are the most important to measure and then let us start to measure them such that someone independent can demonstrate a government position and can demonstrate the direction of travel to all stakeholders."

However, it is key that as improved approaches to the sharing and utilisation of data continue to open new possibilities for translational research, policymakers must remain cognisant that “there is still a need for fundamental good research and we shouldn’t put that at risk with the idea that the only answer is to collaborate very closely with farmers, at the expense of fundamental and rigorous science.” Opportunities to expand the collection of field data should be fully explored, but policymakers should not view this form of research as a replacement for more traditional research. Rather, field data should be viewed as a supplement to the findings from more rigorous laboratory-based research.

International outreach will also be a key consideration for the collection and optimisation of data. One contributor noted that while their organisation has access to a broad network of facilities spanning four continents, they still feel they lack sufficient resource to collect the data they need. Continuing to support international collaboration and knowledge sharing networks will, as such, be a key consideration in reference to any domestic food system reform. So too will be the development of the infrastructure necessary to support the collection of data. On this point in particular, The Department for Digital, Culture, Media and Sport (DCMS) and BEIS must collaborate to develop a plan to improve rural connectivity – and ensure digital services are maximally accessible to farmers.

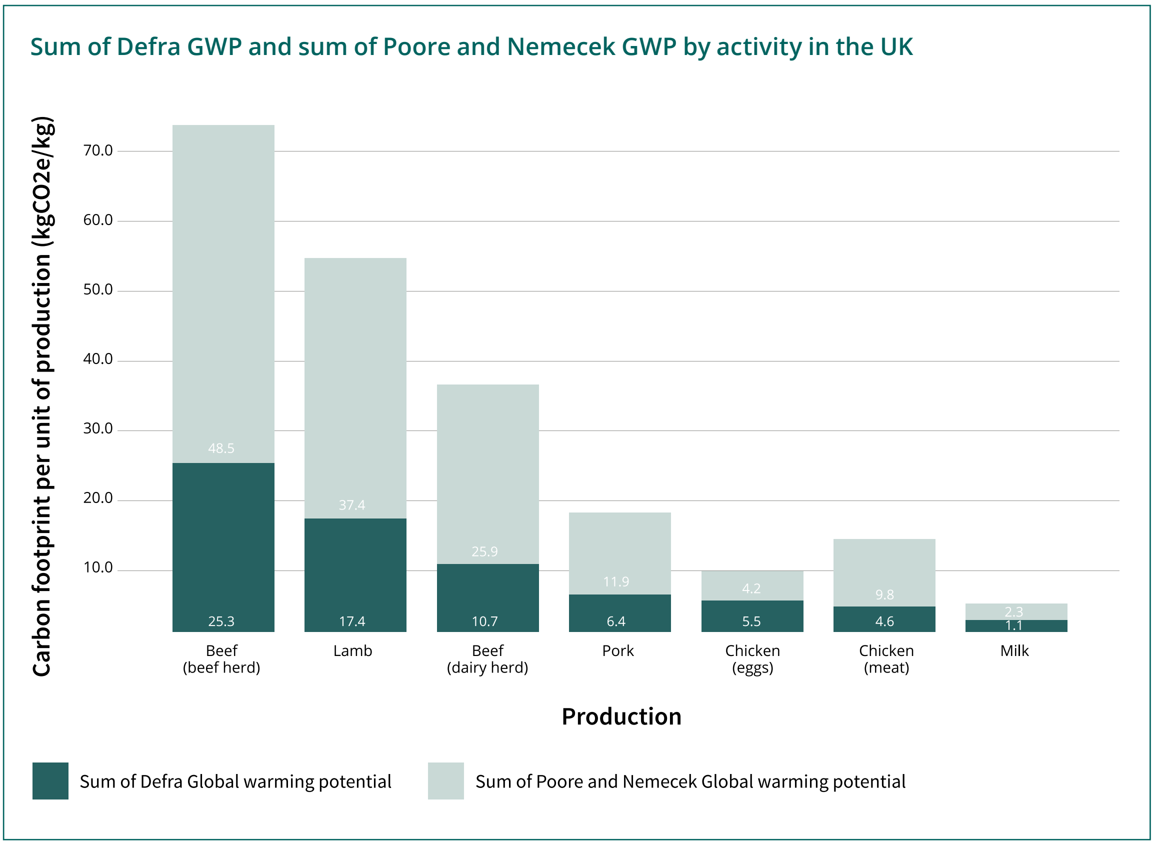


Figure 10: Source: CIEL Net Zero Carbon & UK Livestock October 2020. The scope of Defra’s calculations are from cradle to farmgate, whereas the P&N methodology analyses emissions from cradle to retail (based on their model for life-cycle environmental impacts of food and drink products published in 2018)

CASE STUDY 3

Regenerative agriculture is an approach to food and farming that addresses major ecological and environmental challenges such as soil restoration, improving biodiversity, and increasing carbon sequestration. In turn, farmers benefit from increased land value, cost-reductions though the reduction of inputs, and alignment with future regulatory and subsidy models.

As part of this movement, global compliance organisation, Peterson Control Union Group, have released Regenagri, a regenerative agriculture platform, with data and technology from Agrimetrics. Regenagri's engagement model is based around a digital hub that brings together different aspects of a community to provide actionable insights on regenerative agriculture. Franco Constantini, MD at Control Union UK, said "Regenagri is a membership platform designed for continuous improvement of agricultural practice. It promotes holistic farming techniques that increase soil organic matter, encourage biodiversity, and sequester CO_2 from the atmosphere. The platform is aimed at farms and organisations looking to restore land and make it carbon positive. We will empower farmers to transition towards more ecologically sustainable practices via the Regenagri digital hub, consultancy, and certification." Members of Regenagri gain numerous benefits including greater access to relevant data and markets, training, and accreditation from a global certifying body. There are benefits for yields and profitability too.

To make Regenagri successful, Control Union required an integrated platform capable of collecting and assessing a wide variety of data points of an agricultural business, including operational practices and environmental data. Users then needed an automated recommendation based on this assessment which had to be simple, easy, and digital. This is where Agrimetrics applied their technological and data expertise to provide a solution. "Having the correct digital platform for data collection is important for two reasons," explains Richard Tiffin, Agrimetrics Chief Scientific Officer. "Users are more likely to engage with a platform if the user experience is clean and easy. And secondly, collecting the data digitally and in the right format is essential for auditing activity and effective data analysis."

The platform also provides carbon data verification for farmers to access potential funds through carbon credit markets. Carbon sequestration is an aspect of regenerative agriculture that promises substantial benefits for industry, farmers and the public. However, estimating and managing carbon sequestration is heavily reliant on the availability of data. Indeed, the carbon sequestration potential of a farm is influenced by a range of factors such as what the land is being used for and how production is being managed. "Obtaining and relating data on these key factors is an essential first-step for estimating carbon sequestration," continues Richard Tiffin. "Through our Data Marketplace, Agrimetrics have created the infrastructure to enable the necessary data to be brought together from the different providers in a cost-effective way, which can then ultimately be turned into tradable carbon credits for the farmer or initiative funder. "Improving and monitoring biodiversity is similarly reliant on linked data. For example, connecting and analysing a range of data is central to natural capital and sustainability accounting. "A Data Marketplace that provides value back to data owners and simplifies access for consumers is the most effective way of getting people to share vital data," says Richard. "Behind the scenes we deploy the latest linked data technologies to help connect data, making regenerative agriculture initiatives like carbon sequestration and natural capital accounting possible."

RECOMMENDATIONS:

1. UK legislators should revise the terms of the Competition Act 1998 and the Enterprise Act 2002 to ensure they do not limit data exchange between private businesses that will be essential to capturing consistent data throughout supply chains, not least where exchanged data might enable public goods.

2. Defra should embed novel data collection, sharing processes and requirements into environmental land management schemes – thereby streamlining reporting processes and providing clarity for data capture for farmers.

3. Working with the FSA, Defra should establish a series of case studies to encourage support of the Food Data Transparency Partnership as a decentralised library linking data collected from throughout the supply chain.

4. Key insights gleaned via the Food Data Transparency Partnership should be made available on centralised libraries such as the AHDB's planned What Works Centre.

5. The Rural Payments Agency should seek to establish a carbon credit scheme for farmers driven by the insights reported through environmental land management schemes. This would ensure farmers see clear benefits to increased reporting and implementation. Credit trading, however, should be closely monitored to ensure that agricultural production is maintained and not disincentivised.

Chapter Three

REFLECTING SECTOR PRIORITIES IN APPROACHES TO TRIALLING

Access to effective trialling is a significant determining factor in the success of any AgriTech. As the final step of the innovation pathway, before a product is brought to market, the trialling stage is arguably the most crucially anticipated phase of AgriTech development, and one that plays an instrumental role determining the focus of innovators.

Trialling in the UK, however, is a rather complicated process relative to comparable markets. Though field testing products in any country necessarily involves several stakeholders, and their competing interests can occasionally pose a blocker to speedy testing anywhere, trialling in the UK is particularly fraught as a result of the UK's highly varied terrain.

Topographical and geographic variances, plus product and system diversity, mean that farms in close proximity to one another may have to approach their practices radically differently. As a result, the UK domestic market demands a higher level of adaptability from the technologies it employs. As one contributor to the roundtable sessions remarked, farmers "want to know does it work in all geographies? Does it work in different soil types? Does it work over rotations, over several seasons?"

Furthermore, trialling requirements do not presently reflect the full scope of the UK's ambitions for its food system. For instance, most testing of new genetically edited products revolves around either Distinctness, Uniformity and Stability (DUS) or Value for Cultivation and Use (VCU).[49]

While both of these metrics play an important role in evaluating the economy and desirability of new products and techniques, they do not contain any specific measures pertaining to environmental sustainability. UKRI and BBSRC must, accordingly, establish new guidance for the trialling of novel AgriTech products, such that they encompass metrics pertaining to sustainability value alongside more traditional metrics.

However, the impact of introducing new metrics to the evaluation processes of the UK's various trialling networks must also be adequately accounted for. Trialling in the UK is presently governed through a series of networks that connect innovators to interested farmers. These networks are operated by the AHDB, Defra, the UK's AgriTech institutions, agricultural research institutions, various private sector

We should be placing big bets and turbocharging investments in particular technologies or particular mission

accelerators, and private sector organisations. Each network plays a fundamental role by connecting innovators to farmers, who can give them feedback on the performance of their products and support them in meeting regulatory standards. These networks also tend to maintain close personal relationships with farmers, making them a valuable resource for a sector that often struggles to connect stakeholders.

Trialling networks in the UK, however, are presently not connected. This leaves the UK without the ability to conduct nationwide trials, and often unable to offer clear pathways for innovation to the relevant parties. It also complicates the process of fostering broader co-operation between farmers and technology developers – both of whom currently remain disconnected outside of specific networks. While many networks are trying to "take tech companies to the farmers and say, 'these are the problems they have got. Do you have anything that will solve it?'" with the hopes of fostering a co-developing and co-owning thesis, most of this collaboration is isolated to specific trailing networks.

As such, as the UK seeks to fast-track the development and implementation of AgriTech products in the hope of meetings its goals for the food system, the trialling system that serves to prove the efficacy of products must be streamlined. The UK's regional peculiarities (particularly its devolved entities) and topographical variance, however, preclude the consolidation of trialling networks. The recent gene-editing bill, for instance, applies to England, but not Wales.[50]

Moreover, various insurance and risk management decisions must be made by farmers prior to engaging with trials, regardless of size, and the bespoke support currently offered by existing networks plays a crucial role in surmounting these barriers.

Instead, many contributors expressed agreement that "our regional climate should be a framework for us to think about priorities regionally." Accordingly, policymakers should explore opportunities to encourage greater consistency and fluidity within and between existing trialling networks via the creation of a temporary National AgriTech Trialling Advisory Group (NATAG). The NATAG would be established by UKRI and BBSRC, in coordination with ACRE, and would serve as an advisory group to guide the meeting of new regulatory standards – as well as helping to connect farmers and innovators with the appropriate networks. This temporary network would also work between the UK's various organisations supporting trialling to ensure "there can be some coordination of the knowledge and the evidence that's being generated by feedback systems so that we are getting knowledge and expertise back from the farmers who are involved in these projects, or just trying new things out on their farms."

Such a system of interactive regional organisations is not without precedent. As described by one contributor, "in Canada and other countries, you have a collaborative system where provinces are effectively taking on the responsibility for policy and operation and have to work together." These partnerships, such as the Canadian Agricultural Partnership, oversee a number of trialling initiatives (such as New Brunswick's Enabling Agricultural Research and Innovation programme) that deal with particular regional needs while remaining consistent with broader national ambitions.[51] While establishing such partnerships in the UK may prove initially troublesome, particularly as a result of devolution settlements, one contributor noted, "if you can't link up over your home nations, how much can you actually capitalise on [the UK's role as an R&D leader] in the long run, and what does that mean for your commercial markets?"

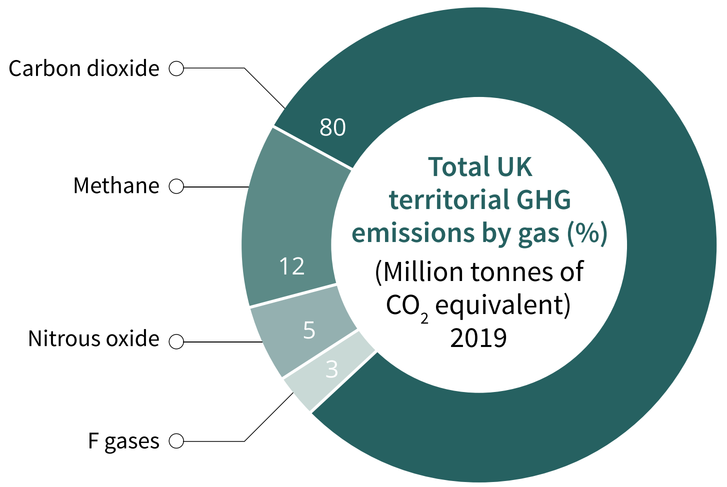


Figure 11: Source: AHDB

It is also, however, key to ensure new approaches to trialling are considered in the context of how they may be supported or hindered by other areas of policy. While initiatives such as Defra's equity strategy (published in 2013) and the Transforming Feed Production Challenge are two examples of funding programmes that have helped to promote change in the industry, the impact of these efforts have been limited by a lack of auxiliary support. In simple terms, "AgriTech doesn't exist in isolation." Instead, it is "a key part of, and is supported by, various other strategies," as the Defra-led Automation in horticulture review elucidated.[52] For AgriTech, other strategies that impact agriculture, research networks, or net zero targets are all capable of affecting either the development or the rollout of new technologies to farmers, and policymaking must take these impacts into account.

Metrics to evaluate the sustainability value of new AgriTech must also be carefully considered. In 2015 the Centre for Agricultural Informatics and Metrics of Sustainability was created to "exploit the potential of big data and informatics" to the benefit of the UK's net zero mission. However, the results of the centre's research have been inconclusive and there remains no clearly established metric (or metrics) to evaluate the environmental impacts of AgriTech products consistently.[53] Presently, it remains unclear whether carbon sequestration, carbon inputs or productivity should be prioritised within sustainability metrics – though the sheer number of variables impacting measures of inputs or productivity makes soil carbon the most likely of the three.

Beyond selecting the metrics by which AgriTech innovation will be judged, UKRI and BBSRC must also establish how these metrics will be evaluated. Presently, remote collection capabilities necessitate on-site collection for information such as soil carbon – and this will necessitate significant investment into the employment of on-site assessors. While innovation may present opportunities in the future to collect this information via remote sensing, these technologies are not yet available (though there certainly is a case for selecting it as a key area of innovation within a revived ATC.)

It is also key to consider how these metrics, once collected, will be assessed and utilised. For instance, evaluating the soil carbon value of a new AgriTech product necessitates the existence of a baseline against which the impact of the product can be judged. However, data is typically not available from farmers not already engaged with a trialling scheme. Policymakers must, therefore, seek to broaden reporting requirements and should aim to embed these within existing processes to support the establishment of a baseline and provide innovators and farmers with a clearer view of the value of new products.

CASE STUDY 4

Helping arable farmers to overcome wheat disease Septoria is the focus of CHAP's project with biotechnology company, Bactobio Ltd. The work, funded by Defra and UKRI, aims to screen bacteria for use as natural fungicide products. This will be achieved by identifying bacteria with modes of action against ascomycete fungus Zymoseptoria tritici, commonly known as Septoria, using Bactobio's BACCU technology (Bacteria Community Cultivation platform).

With the potential to identify up to 10 active natural compounds with control activity, this will provide a diverse range of genetic backgrounds, reducing the likelihood of future resistance issues, whilst lowering the environmental impact of wheat production and helping to protect yield potential.

The project work uses CHAP's National Reference Collection of live fungi and bacteria isolates, providing field samples of Z. tritici for use in Bactobio's compound screening. Following this, CHAP's partner Rothamsted Research will run glasshouse trials to test the efficacy of the potential bio-fungicides.

As farmers are faced with an ever-diminishing number of synthetic chemicals in the crop protection toolbox, alternatives are critical to safeguard yield and therefore ensure financial viability. This challenge is concurrent to that of global warming, achieving the net zero target and increasing our awareness of the environmental impact of the food chain. Natural compound use within crop protection will play a leading role in helping to address these issues.

Furthermore, a commitment to supporting farmers in implementing new technologies and practices is demonstrated through the DeCyst trap crop project.

This collaborative work is being conducted by CHAP alongside Produce Solutions, Harper Adams University and VCS Potatoes, supported by five potato growers. It aims to improve the reliability of trap cropping, to help farmers overcome potato cyst nematode (PCN) pressure.

Solanaceous trap crops stimulate PCN to hatch at a different point in the rotation to when potatoes are planted. As a result, mature female PCN are prevented from completing their lifecycle, reducing the impact on potato crops. Grown optimally, S. sisymbriifolium (DeCyst-Prickly) can reduce PCN populations by more than 75 per cent, but inconsistent establishment has impacted adoption on-farm. It is hoped that by understanding agronomic best practice such as sowing dates, weed control and general management, trap crops will become more appealing to growers. With increasing pressure on chemical nematicides, adoption of solanaceous trap crops could mean an increase in resilience and maintain productivity for the UK potato industry.

These initiatives focused on getting new technologies into the hands of farmers must accordingly be integrated with other initiatives impacting the industry. However, it is key that this programme still demonstrates a tangible benefit to the farmers who participate – both through making information that can improve the value of their farms more easily available and offering tangible rewards for the support of trials for net-zero AgriTech.

RECOMMENDATIONS:

1. **The UKRI and BBSRC should establish new guidance for the trialling of novel AgriTech products, such that they encompass metrics pertaining to sustainability value alongside more traditional metrics.**

2. **A National AgriTech Trialling Advisory Group should be temporarily created through UKRI and BBSRC, in conjunction with the Advisory Committee for Releases to the Environment (ACRE), to inform stakeholders of updates to the process of getting new products into trials under updated regulation.**

Chapter Four

BRINGING CONSUMERS INTO THE CONVERSATION

The development of AgriTech products does not serve a single market. As one contributor to the roundtables noted, “there are two marketplaces. One is the farm uptake of AgriTech, and then [there is the] ultimate marketplace [which] is the customer’s purchase of agricultural produce.” Consumers of food products are the final set of stakeholders in any supply chain – and their values (and their perceptions of the food they consume) must play a role in impacting the decision making of stakeholders elsewhere in the supply chain.

However, consumer trust in the food system is low. According to the 2020 EIT Food Trust Report, consumer trust in the agrifood industry has recently increased in the EU, but not significantly. As the report noted, only 40 per cent of EU consumers believe the products that they are purchasing are ‘authentic’ (meaning “they are what they say they are and include the correct, original information on the label”) and only 30 per cent are confident that those products have been produced sustainably.[54] This lack of trust poses a significant blocker to the integration of new AgriTech products – particularly to precision-bred products which are currently subject to a negative association with genetically modified organisms (GMOs).

At the same time, consumers are growing more conscious of sustainability when making food choices. In the same survey, 76 per cent of respondents said they felt “a moral obligation to use environmentally friendly products,” and another 60 per cent reported that they tried to choose sustainable goods over those that are not.[55] Operating in a similar market and having yet fully

If we really want these innovations to be taken up, we actually have to have the stakeholders driving it and doing that education and engagement.

determined the terms of its exit from the EU's Common Agricultural Policy, the UK's food system faces a similar challenge to their EU counterparts in terms of improving consumer trust – but also has the same opportunities.
Between sustainability, combined with cost-of-living concerns, and a growing consumer appetite for sustainable options, the AgriFood has an obvious and acute set of consumer needs to cater to – and this provides a new opportunity to regain public trust. As one contributor noted, "this summer has been a turning point for many people. I think the prospect of having a degree of insurance against climate change and climate shocks in the food production system is a very positive thing. But it is something that we have not really talked about – and how we can use AgriTech to provide this insurance has not been very well articulated."

In order to effectively highlight the value of AgriTech products to consumers it is key to understand behaviour. As a roundtable contributor commented, it is key to ensure that the sector does not come to think of consumers as a homogenous unit. "It is not a silver bullet that is going to do all this. It is going to be a range of different messages that we get through." In some cases, consumers are motivated by their collective interests (such as concerns around the ethics of certain consumption patterns) and individual interests (such as cost or health impacts). As one contributor noted, "if you make [products] tastier, if you make them cheaper and if you make them with a clear benefit to the consumer," consumer trust is likely to grow. Accordingly, finding a balance between messaging to communities and messaging to individuals will be key.

The messaging of public outreach regarding AgriTech should, accordingly, seek to emphasise outcomes and benefits – as opposed to the technologies themselves. This not only helps to clarify the reasoning behind the integration of new products, but also avoids negative comparisons to the GM food debate of the 1990s which remains fresh in the mind of many consumers. In fact, as one contributor to the roundtable session noted, the sense of distrust that surrounded genetically modified crops in the 1990s was largely spurred by an overwhelming feeling that the transition to GM foods would deliver negligible benefits to consumers.

Lessons should also be taken from responses to safety concerns during the Covid-19 pandemic – and the opportunity to build on the pandemic's impact on the profile of genetic innovation should also be capitalised on. As one contributor illustrated, "we have seen a change and we actually think Covid helped." Public education, however, will be essential to facilitating this communication. There is presently a significant gap in the public's knowledge of the various technologies subsumed within the concept of AgriTech, and their impacts (existing and future) on the food system. As one contributor noted, referencing the most presently active area of debate for AgriTech, "the vast majority of consumers have never heard of [gene-edited products], they don't know what they are, [and] they are very uncertain about them."

The government's precision breeding bill, for example, has amended the Environmental Protection Act 1990 to clarify the distinction between precision bred organisms (PBOs) and genetically modified organisms (GMOs) – clarifying that the presence of active trans genes is the main determining factor.[56] This definition provides a great deal of clarity for consumers and producers alike, and Defra must continue to revise the impacts of inherited regulation on potentially beneficial technologies. However, as Defra noted in their 2021 Summary of responses to a consultation on the regulation of genetic technologies, the majority of "individuals (88 per cent) and businesses (64 per cent) still supported continuing the regulation of genetically engineered organisms as GMOs."[57]

Looking further into the same report, Defra states that "those in favour of continuing regulation viewed traditional breeding methods as having an established safe history, and the scientific understanding of GE (gene editing) as incomplete." It follows that the communication regarding regulation of technologies relating to food (particularly those that involve genomics) moves towards a more science-agnostic outlook – instead discussing regulatory changes with individuals and communities in terms of a technology's ability to help produce "affordable, nutritious food in the most sustainable way."[58]

As such, the FSA should, accordingly, also seek to incorporate an emphasis on outcomes within their existing roles, rather than aiming to develop entirely new means of outreach. On the matter of food labelling, for instance, considering impacts on consumer perceptions could have a significant impact on public support for new products. It was argued that while labelling PBOs may initially improve consumer trust in the AgriFood industry, this may entrench perceptions that certain technologies are not safe. "Is it in the consumer interests for the regulators to reinforce perceptions by labelling not only this, but perhaps a whole list of other future new technologies that might be coming along? Especially when, if you probe a little more and delve a little deeper, you can start to understand why it is that consumers are feeling uncertain and what things you can do to build trust." Instead, changes to labelling should focus on the integration of new metrics on labels that encourage consumers to support broader initiatives within the sector (such as integrating kg CO_2e cost/tonne or kg information onto labels) – and Defra should take steps to publish guidance for retailers on this matter.

As contributors acknowledged, safety measures were more of a 'hygiene factor' than a selling point. To make the case that AgriTech provides benefits – be it to communities or individuals – organisations who are already engaged with the selling of products should be encouraged to rethink the impact of their strategies on AgriTech's development. Moreover, as one contributor stated, the burden for the progression of the food sector should not fall squarely on the public sector either. "As a funding agency who spends a lot of money on funding the science, we are putting, almost half of our money now into public education awareness… if we really want these innovations to be taken up, we actually have to have the stakeholders driving it and doing that education and engagement."

There is, therefore, a particularly important role for retailers and supermarkets to play. As one contributor indicated, "we need to reinvent agriculture on a sustainable pathway, and the extent to which supermarkets support that narrative will play a huge role." Consumers largely interact with the AgriFood sector through the mediation of retailers, and it follows that the latter's support will be essential to improving trust in the sector. As another contributor argued, "if we go back to the GM debate of the 1990s, the supermarkets took a position and from that point forward, the debate was finished."

Retailers should, accordingly, be encouraged to promote the benefits of new AgriTech products – emphasising the outcomes and impacts of the products as opposed the technologies enabling them. It is essential, however, that these communications do not shy away from discussing complex concepts. As one contributor explained, “we’re going to have to have more of these conversations with consumers and with supermarkets to make sure that we’re not oversimplifying in ways that reduce trust.”

For example, the alternative protein market has seen significant growth in recent years and has been supported by an innovative supply chain and growing consumer demand. In 2018 Mintel reported that meat-free products saw a 22 per cent growth in sales between 2013 and 2018, and that this increase was expected to reach 44 per cent by 2023 (bringing the meat-free product market up to a value of £1.1 billion).[59] This growth has, in part, been supported by messaging from brands selling alternative meat products emphasising the sustainability value of those items. Where possible, retailers should look to incorporate certain metrics and information to promote new products.

Working with supermarkets to promote and sustain innovation is, however, complicated by the relatively short-term planning of retailers. As one contributor noted, “we can’t really engage the supermarkets until we’re much nearer the market in Britain.” Retailers, like consumers, will generally prioritise products that they can utilise in the near term. “So, if you’re a technology developer and you’re looking at beginning a project that may produce results in 5-to-10 years, [retailers] don’t have time for you.” Similarly for consumers, “it’s very hard for consumers to engage with the product until you’ve at least got it in trials and at least a couple of years of commercialisation.”

Many contributors expressed concern that, without government guidance and co-ordination, retailers will lack the necessary incentives to take an active role in promoting the benefits of AgriFood innovation. While the FSA’s current Novel foods authorisation guidance offers a valuable resource to retailers, there is a need for a clear strategy to enable trusted consumer choice.[60] Accordingly, the FSA should look to update novel food guidance with a guide to highlighting its approaches to safety and underlining the safety of its regulations of new AgriTech products to consumers.

Ultimately, the sector’s goal should be to feed information regarding consumer preferences, concerns and trends into the innovation pathways, and thereby ensure innovation responds to the needs of consumers effectively. Retailers should, be included into any data trust or data sharing framework that is utilised to inform the development of AgriTech products. Other stakeholders in the supply chain, however, also have a role to play. As one contributor explained, “we need to be able to put more case studies forward and more and situations where farmers and ultimately the shoppers can actually see they see the benefits.”

CASE STUDY 5

Fat supplements are routinely incorporated into dairy diets to provide energy and enable cows to maintain butterfat levels. Most of those used in the UK are currently formulated with palm acid oil. While there is nothing nutritionally wrong with this, palm oil production in general is associated with deforestation and a high carbon footprint – and is increasingly being shunned by consumers.

Nutrition and supplement company UFAC-UK partnered with the University of Nottingham for a CIEL-supported research project focussed on the development of a new approach to feeding ruminants. Utilising the research capabilities within the Centre for Dairy Science Innovation

(CDSI), the project aimed to increase the environmental sustainability of UK dairy farming, improve productivity and enhance animal health and welfare.

The project compared a new palm-free fat supplement developed by UK nutrition and supplement company UFAC-UK, manufactured from locally sourced vegetable oils together with marine oils, against a palmoil-based control diet. The overwhelmingly positive results from the trial also revealed cows were more efficient when fed on the new fat supplement, increasing milk yields and protein concentrations, with no difference in dry matter intake.

Results demonstrated clear performance benefits: increased milk yield, fat and protein; enhanced cow health and reproduction; and improved production efficiency. Initial results point at a potential financial benefit to the entire UK dairy herd in excess of £85m, based on April 2022 market prices for the products under trial and liquid milk.

Significantly, the feed carbon footprint of the new fat supplement, named Enviro-lac, was approximately one third of the footprint of the control palm-based supplement, reducing the feed carbon footprint per kg of milk by 11 per cent. The reduction in carbon footprint could

also help to reduce land use change associated with growing palm trees. The lower carbon footprint and zero reliance upon palm oil and palm oil derivatives could additionally stimulate local crop production, reducing dependency on imports.

RECOMMENDATIONS:

1. **Considering Defra's success establishing a consistent definition for precision bred organisms, the department should continue to review inherited regulation of other technologies currently restricted by the regulation of GMOs.**

2. **Defra should publish revised labelling guidance for retailers to encourage greater consumer awareness of the sustainability impacts of products. A timeline for the integration of kg CO_2e cost (per tonne or kg) data into labels should be developed.**

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