Livestock and Aquaculture Innovation:

Shaping the next 10 years

A report by the UK Agri-Tech Centre
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Foreword by Phil Bicknell, CEO of UK Agri-Tech Centre

The UK Agri-Tech Centre has a vital role to play in horizon scanning.

The UK Agri-Tech Centre endeavours to get as far ahead of the curve as possible. It is important we help identify current and future challenges; to study and understand them in detail; and to define the positive role that agri-tech innovation can play. Research and innovation in our sector is characterised by long lead times and I believe we need to start preparing for future challenges as early as possible.

This report aims to be the catalyst for future innovation, by defining the research and innovation needs of the UK's livestock and aquaculture industries. We set out to provide a comprehensive picture of industry requirements. Many have contributed to the creation of this report, with a range of input from our members and sector specialists. Consequently, it provides the latest evidence around innovation needs in the livestock and aquaculture industries and points to the long-term solutions required.

For some, the innovation hotspots and themes identified in this report will be familiar. However, we have endeavoured to examine the subjects and topics that are less likely to grab the headlines, ensuring attention on all areas where innovation can have an impact.

I am always mindful of what gets in the way of great ideas having impact, such as funding and finance, the challenges of scaling up, industry uptake and adoption. These are the problems which the UK Agri-Tech Centre exists to resolve through our world-class network of experts and research facilities to test, demonstrate and validate new ideas and to drive their adoption, effectively addressing challenges that no one part of the sector can address alone. We are able to do this through our widespread relationships with policy-makers, funders, and the wider agri-industries and on the basis of our expert staff and world-class, UK-wide facilities.

We, for our part, are eager not only to share this evidence and information, but to use it as a springboard to drive research priorities, ideas for projects, collaborative programmes of action, and to define areas for investment, such as capital infrastructure.

It is not enough for this report to highlight the issues that we face; it should act as a catalyst for businesses and stakeholders across the entire supply chain, be that in food, farming, aquaculture, science or government, or a combination of areas with different backgrounds and skill-sets, to come together and see what we can do for this sector.

We want to work with you and hear what you have to say. What would help to move the dial in your area of the sector? The steps that we take now will affect what happens in the future. Animal health faces changing disease pressures, and we have opportunities around areas such as engineering biology which are not being fully utilised. What opportunities would you like us to maximise?

We trust that you will find this report of value, and we look forward to hearing your reaction to its contents and ideas for progress. If it has sparked ideas, please get in touch with our expert team in the areas of livestock and aquaculture science, project management, business and investment. We look forward to addressing livestock and agriculture challenges and assisting the sector in reaching its goals.

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01 Executive Summary

In the coming decade and beyond, we must accelerate the development of resilient, sustainable systems that support global food security and One Health – for people, animals and ecosystems. The livestock and aquaculture sectors face multiple challenges including the increasing global demand for food and a growing pressure to reduce and reverse environmental impact. As a vital source of innovation, these sectors play a leading role in shaping and delivering commercially viable solutions across the supply chain. The UK Agri-Tech Centre is a catalyst in this innovation ecosystem, connecting science, industry and government to realise real world opportunities. A cornerstone of this work is ensuring a deep understanding of sector priorities, which acts as an enabler for collaborative solution development.

In this report we consulted with over 150 stakeholders, representing commercial, academic and representative organisations from across the supply chain through a series of surveys, workshops and interviews. The findings from this consultative research identify thematic cross sector, and sector level priorities for livestock (dairy, beef, sheep, pigs and poultry) and aquaculture. The report also reflects stakeholder views on the foundational elements needed to drive research and innovation, from funding and capabilities to networks that drive adoption, and learnings from international experience. The identified priorities, which are focused on developing tools and practices that enable sustainable development across the sectors, are mapped to the UK Agri-Tech Centres four strategic themes, One Health, Sustainable Production, Resilient Food Systems and Intelligent Agriculture.

These wide ranging and often cross-cutting themes form a vision for the livestock and aquaculture sectors that utilises climate smart technology,

builds resilient ecosystems and improves biodiversity underpinned by circular economy principles. Solutions are needed that enable systems optimisation, including physical, economic, and environmental improvements in livestock and aquatic production, to sustainably improve productivity. The complexity of the challenges facing livestock and aquaculture, and a drive for circular solutions, points to a need for more research and a better evidence base in solution development on inter-relationships at the systems level. This is layered with sector specific requirements spanning dairy, beef, sheep, pig, poultry and aquaculture, exemplifying their unique characteristics, challenges and ambitions.

Key drivers of high quality and innovative research and development include the structure and scope of funding and investment, an availability of capabilities including infrastructure and expertise. A recognised gap in funding for long-term systems-based research was identified, in addition to a funding mechanism to accelerate urgent research projects. Across sectors, there is a shared ambition for improved development and delivery of research and innovation through collaboration and knowledge exchange.

Finally, we hear a stakeholder view on the role of UK Agri-Tech Centre and where it can offer greatest impact across the livestock and aquaculture innovation landscape. These views are consistent with the UK Agri-Tech Centre being ideally placed with complete life cycle support to shape and drive innovative agri-tech research, development and adoption. Strengthening connections between science, business, funders and policymakers, our ambition is to collaboratively work with stakeholders on shared priorities, identifying strategic opportunities to drive impactful change.

02 Thematic Priorities

Eleven thematic research and innovation priority areas were identified. These themes point to where innovative solutions, including tools and practices, are needed to support sustainability and resilience across the livestock and aquaculture sectors. That includes commercial viability, but also meeting consumer and societal expectations, delivering sustainable ecosystems at local, regional and national levels, achieving carbon neutrality and reversing biodiversity loss. The following section illustrates these thematic priorities, mapped to the UK Agri-Tech Centre's four strategic themes: One Health, Sustainable Production, Resilient Food Systems and Intelligent Agriculture, and explains why they are important including stakeholder and UK Agri-Tech Centre viewpoints.

One Health
Strategic Theme 1

One Health is an integrated approach that considers the interconnected health of people, animals and ecosystems, and their holistic management. Through this strategic theme the UK Agri-Tech Centre is delivering innovation including the development of novel diagnostics, and solutions for disease prevention and treatment. With specialist expertise, and over 30 dedicated livestock and aquaculture research facilities, our ambition is to deliver rapid and impactful change.

Sustainable Production
Strategic Theme 2

Agri-tech innovation is key to building more sustainable agriculture, and aquaculture production systems, and is pivotal to our climate change ambition. Innovative technologies can reduce methane emissions from livestock, improve soil health and sequester carbon. Along with life cycle analysis, we can establish the environmental impact of feed and food products, aiding decision making on ingredients with the lowest impacts.

Resilient Food Systems
Strategic Theme 3

Agri-tech innovation will be central to the future success and viability of the agri-food system. These innovations will enable a more resilient food system by delivering climate adaptation, diversifying land use and production systems, improving access to risk-based decision-making tools, and valorising waste within circular economies.

Intelligent Agriculture
Strategic Theme 4

Agriculture is entering its fourth revolution, utilising data, remote sensing robotics and AI, to enhance and transform current agriculture practice. This approach will tackle current challenges facing the sector such as climate change, resource limitation, labour shortages and regulatory requirements.

One Health
Strategic Theme 1

- Animal Health
- Animal Welfare
- Food Safety, Quality and Nutritional Content

Sustainable Production
Strategic Theme 2

- Climate-Smart Solutions
- Productivity
- Optimised Diets

Resilient Food Systems
Strategic Theme 3

- Ecosystems and Biodiversity Improvement
- Optimised Land Performance
- Optimised Systems

Intelligent Agriculture
Strategic Theme 4

- Data Assets
- Technology

Animal Health

What is this?

Strategies and practices implemented to protect the health and welfare of livestock and aquaculture species. These include the prevention of disease through biosecurity, vaccination, management practices, nutrition, genetics and appropriate housing across production systems, along with the timely detection and treatment of disease.

What our stakeholders told us

Research and innovation priorities for improving animal health include:

1. Genes and genetic markers that improve animal health - greatest potential in extensive sectors and aquaculture - improve commercial and environmental performance

2. Enhanced disease prevention and treatments - new antibiotics, vaccines, and parasite control methods

3. Reducing antibiotic use - monitoring and rapid diagnostic tools

4. Evidence based on benefits of preventative health measures - focus on population-level studies in ruminants

5. Housing that optimises health

6. Impact of stocking density on performance, health and environment - aquaculture and livestock

7. Methods of delivering effective health management in extensive systems

8. Extend the productive life of the breeding herd

Why is it important?

Healthy animals are more productive, which enhances farm profitability and food security. Effective health management improves food safety, and reduces reliance on antibiotics, addressing public health concerns about antibiotic resistance. Improved health and animal welfare aligns with consumer and societal expectations. Healthy livestock contribute to environmental sustainability by optimising resource use and reducing GHG emissions.

What UK Agri-Tech Centre has to say

The priorities highlighted by stakeholders illustrate the wide range of interventions that can enhance animal health and contribute to sustainable livestock farming and aquaculture practices. This is reflected in our work with projects including the development of new diagnostics, alternatives to antibiotics, rumen bolus technology, wearable devices, and using AI and sensor technology to detect preclinical disease. Future priorities will include developing the next generation of solutions for endemic and exotic disease e.g. lameness and mastitis in cattle, sea lice in salmon and porcine reproductive and respiratory syndrome (PRRS) in pigs.

Animal Welfare

What is this?

The practices and standards implemented to ensure the well-being of livestock and aquatic species throughout their lives. This includes providing environments that allow animals to express natural behaviours, ensuring proper nutrition, health care, and humane treatment during transportation and slaughter. Good animal welfare practices aim to minimise stress, prevent disease, and improve the overall quality of life. Welfare is increasingly important as it aligns with consumer ethics and societal expectations, and sustainable farming practices.

What our stakeholders told us

Research and innovation priorities for improving animal welfare include:

1. Enrichment of the animal's environment - intensive systems

2. Housing design appropriate to genetic profile of the animal - intensive systems

3. Welfare of non-housed animals – impacts of climate change

4. Effective, sustainable free-farrowing systems

5. Welfare during transport

6. Welfare at slaughter - poultry and pigs

7. Real time, welfare indicators – AI/sensor technology - future farm assurance

8. Animal behaviour - livestock, aquatic species, insects

9. Alternatives to mutilations - improvements in current practices

Why is it important?

Ensuring high standards of animal welfare aligns with consumer and societal consumer expectations, contributing to marketability and public trust in livestock and aquaculture derived products. Good animal welfare is needed in addition to animal health to support productivity, profitability and sustainable production.

What UK Agri-Tech Centre has to say

Developments in sensor and imaging technology, as well as remote monitoring, are making significant improvements in monitoring behaviour and welfare. Our work in this area includes a focus on harnessing AI with new monitoring technologies enabling production systems to detect and respond to animal welfare challenges. Practical solutions are needed in a variety of production systems such as using AI and sensors to monitor fish and water, reducing handling and stress, monitoring welfare in cage-free systems for laying hens, and methods to reduce tail biting in pigs.

Food Safety, Quality and Nutritional Content

What is this?

Food safety, quality and the nutritional content of food collectively refer to approaches that safeguard the safety of food and produce high-quality and nutritious livestock and aquaculture-derived food products. Food production needs to meet evolving consumer and societal expectations, understanding what consumers expect in terms of health benefits, welfare standards and safety assurances. It also includes aligning production practices to deliver consistent, high-quality products. By focusing on these improvements, the agricultural and aquaculture sectors aim to provide nutritious, safe and desirable food products that satisfy both consumer demand and societal needs, while also supporting sustainable farming practices.

What our stakeholders told us

Research and innovation priorities for improving food safety, quality and nutritional content include:

1. Food production aligned to consumer and societal expectations and product assurance – health, welfare, safety, nutritional content, eating quality, product life, cost

2. Eating quality – supply chain optimisation and reaction of food waste

3. Food waste – extending shelf life and reduced environmental impact

4. Food safety – on farm and processor – disease control, rapid tests for contamination

5. Nutritional content – role of livestock and aquaculture diets on food products

Why is it important?

It ensures that livestock products meet the growing consumer demand for safe, high-quality and nutritious food. Enhancing nutritional content and eating quality aligns with consumer expectations, increasing the marketability of products. Ensuring food safety and reducing waste through better production and processing practices also addresses public health concerns and environmental sustainability. These improvements support the livestock and aquaculture food sector's economic viability and its commitment to providing healthy, sustainable food.

What UK Agri-Tech Centre has to say

The UK Agri-Tech Centre is driving innovation that supports public health and food security through innovations such as novel diagnostic technology being developed to detect foodborne pathogens such as Listeria and norovirus in food processing plants. One of the UK Agri-Tech Centres research capabilities includes a plasma research facility focusing on potential uses of the antimicrobial properties of cold plasma for livestock health, biosecurity, food hygiene and shelf-life extension in agri-food products.

Climate-Smart Solutions

What is this?

Climate-smart solutions refer to a comprehensive approach aimed at reducing the environmental impact of livestock and aquaculture production. The concept emphasises the need for systematic changes in farm management to achieve sustainability goals while maintaining productivity. This includes understanding the environmental footprint of various activities and implementing practices that balance economic viability with ecological responsibility.

What the industry told us

Research and innovation priorities for climate-smart solutions include:

1. Resource use efficiency at farm level

2. GHG output - methodologies for frequent measurement

3. Metrics for monitoring

4. Carbon performance reporting – simple, rapid methods and technologies

5. Feed additives - reduce carbon emissions

6. Nitrogen loss - control measures, slurry additives and land treatment

7. Gut microbiome - understanding and modification

8. Genetic markers - GHG efficiency and inclusion in breeding indexes

9. Capture and increase carbon storage on farm - methods and technologies

10. Carbon credits and carbon market - measurement and reporting tools

Why is it important?

Implementing climate-smart solutions is crucial for reducing the environmental footprint of the UK livestock and aquaculture sectors. By adopting these strategies, the industry can contribute to national and global climate targets, ensure long-term viability and resilience, and respond to increasing regulatory and societal demands for environmentally responsible food production.

What UK Agri-Tech Centre has to say

We work with the whole supply chain on climate smart solutions, e.g. with farmers and carbon calculator businesses, to update toolkits making them locally and regionally specific. Our ambition is to develop data driven insights that support the management of natural capital and ecosystems, and sustainable food production. We can improve ESG transparency and accountability by joining up technology and practice to provide an evidence base for sustainable livestock and aquaculture production. We are investigating a diverse range of GHG mitigation technologies including biochar production, novel slurry management technologies, feed additives, breeding low methane sheep, and have capability to measure livestock emissions in the field.

Productivity

What is this?

Raising productivity in agriculture and aquaculture is fundamental to achieving sustainable food production systems. It involves increasing farm output to meet global food demand while simultaneously reducing the environmental impact. Productivity improvements must be addressed at both the farm and individual animal levels. This means enhancing the efficiency and effectiveness of farming practices to produce more food with fewer resources, ensuring that agriculture remains viable and environmentally responsible. By focusing on these aspects, the industry aims to create resilient, high-performing farming systems that support global food security.

What our stakeholders told us

Research and innovation priorities for improving productivity include:

1. Animal performance - growth rate/output- GHG reduction - considers genetics, management, health, nutrition and housing

2. Genetics - improve health, output, resource efficiency, potential of gene editing

3. Reproductive performance of breeding herd - ruminant sectors, GHG intensity, economic performance

4. Animal nutrition for sustainable production - interaction between animal, genetics and microbiome - 'systems approach' - protein alternatives to soya

Why is it important?

A sustainable supply of food is needed to support global food security. Higher productivity means more efficient use of resources and reducing the environmental footprint of farming activities. This includes lower GHG emissions and better management of natural resources. Additionally, improved productivity enhances the economic viability of farms, making agriculture and aquaculture more resilient and capable of adapting to future challenges.

What UK Agri-Tech Centre has to say

There is scope for a range of innovations to sustainably enhance productivity. Utilising seaweed crops to create both soil biostimulants and animal feed is providing a link between the blue and green economy and supporting improved productivity without increasing the pressure on farmland. Genetic improvement, and its interactions with the environment, health management and production practices, the impact of the microbiome and nutrition, intersect as important research and innovation themes, in a systems-based approach.

Optimised Diets

What is this?

Optimised diets refer to the precise formulation and management of animal feed to support growth, health, and production efficiency while reducing waste and environmental impact. This involves research and development to ensure that feed remains appropriate as animal genetics evolve and new feed types are introduced.

What our stakeholders told us

Research and innovation priorities for optimising diets include:

1. Diets appropriate to changing genetics – dietary efficiency of feedstuffs for livestock and aquatic farming – feed digestibility – optimisation of protein content and utilisation – impact of rumen microbiome

2. Animal nutrition strategies to address new/novel animal feeds

3. Efficiency of use of forage – optimisation of forage-based systems to lower GHG impact and cost of production

Why is it important?

Appropriately formulated diets need to meet requirements for growth, provide feed efficiency, reduce waste and lower GHG emissions. As animal genetics evolve and new feed types are introduced, ongoing research and development ensures that diets remain effective and sustainable. This focus on precision nutrition is essential for maintaining high production standards, minimising environmental impact, and supporting the economic viability of the livestock and aquaculture sectors.

What UK Agri-Tech Centre has to say

Innovation in alternative feeds can unlock more efficient and sustainable production. This includes research to validate novel feed sources that could enhance overall efficiency, and increase the circularity across livestock and aquaculture, by utilising red seaweed to feed poultry as a soya replacement to reduce the environmental impact of poultry feed. We are also investigating fish feed derived from UK only ingredients, examining the commercial and environmental impacts.

Ecosystems and Biodiversity Improvement

What is this?

Resilient ecosystems and biodiversity improvement refer to the practices and strategies aimed at reversing biodiversity loss and promoting ecological health. This concept emphasises the importance of implementing nature-positive practices that enhance biodiversity while also supporting economic and environmental sustainability. Additionally, it focuses on creating systems that integrate high productivity with high biodiversity, ensuring that farming practices support robust and resilient ecosystems. This involves developing methods for rapid, cost-effective monitoring of habitat quality, biodiversity performance, and air and water quality at the farm level. By doing so, farmers can quickly assess the impact of their practices and make necessary adjustments to minimise negative effects.

What the industry told us

Research and innovation priorities for ecosystems and biodiversity improvement include:

1. Habitat, biodiversity, air and water quality - rapid and affordable farm level measuring and monitoring - indicators and metrics - technology - measure impact with actionable insights

2. Sustainable systems - economic and environmental sustainability in productive and biodiverse systems - interventions to improve ecosystem health, synergistic actions, afforestation and deforestation impacts, species mix for range of production systems

3. Environmental impact feed in animal nutrition - low impact feedstuffs and protein sources to reduce GHG impact

4. Pollution - siting of farms, control measures to manage pollution threats

5. Circular systems - high priority - optimise inputs/output - manures, slurries and litter to offset artificial fertiliser - energy production - use of co-products and by-products

6. Human edible food in animal diets - optimisation of land use - pig, poultry and dairy production in particular

Why is it important?

Biodiversity improvement is essential for the health and resilience of ecosystems, which directly supports the productivity and sustainability of the livestock and aquaculture sectors. Developing systems that integrate high productivity with biodiversity can lead to more robust and sustainable farming practices. Delivering essential ecosystem functions such as soil health, water purification and pest control contributes to economic viability by stabilising agricultural yields. Additionally, biodiverse ecosystems help mitigate climate change by sequestering carbon, thus reducing GHG emissions. Meeting regulatory and market demands for environmentally responsible farming practices also becomes more achievable with enhanced biodiversity.

What UK Agri-Tech Centre has to say

We have developed and deployed innovative technologies on commercial farms measuring and monitoring biodiversity, the environment and habitat quality. We see great potential in exploring the utilisation of integrated multi-tropic aquaculture systems to reduce environmental impacts and support a broader range of food production with a smaller footprint e.g. growing seaweed and salmon together, where seaweed may also provide a natural 'reef' for wildlife.

Optimised Land Performance

What is this?

Optimised land performance involves enhancing the productivity and sustainability of agricultural land from both environmental and production perspectives. It is crucial for various sectors, particularly ruminant farming, but also includes managing the use of manures and slurries from poultry and pig production.

What our stakeholders told us

Research and innovation priorities for optimised land performance include:

1. Grazing management - grassland species mixes and grassland management practices - systems approach to interactions between animal type, genetics, production practices and landscape

2. UK soil database - soil condition in each local region across the UK

3. Soil health - physical, chemical, and in particular, biological health - soil microbiome

4. Carbon storage - carbon soil dynamics

5. Microplastics - contamination of soil and impacts on wider ecosystems

6. Soil health - reliable and rapid indicators

7. Livestock and soil interactions - impacts of livestock on soil under different soil conditions

8. Land use strategy - land use at local, regional and national levels

Why is it important?

Efficient land management ensures that soil remains healthy and fertile, which is essential for crop growth and livestock grazing. It also helps in managing waste from poultry and pig production, reducing environmental pollution. By improving land performance, farmers can enhance yields, reduce greenhouse gas emissions, and support biodiversity. This holistic approach ensures that agricultural practices are sustainable and resilient, supporting the long-term viability of the farming sector.

What UK Agri-Tech Centre has to say

We work in collaboration with technology providers to link soil health to root health e.g. using on-farm innovation to monitor effects of treatments on root health, using VOC sensing, CT scanning and shotgun sequencing. We have also managed a national grassland project, GrassCheckGB, which is a collaborative initiative to empower farmers to enhance their grassland productivity and overall farm profitability.

Optimised Systems

What is this?

Optimised systems refer to the comprehensive, interconnected systems-based approach to improving livestock and aquaculture production. This involves understanding and enhancing the interrelationships between various components such as animal genetics, management systems, nutrition, health management, land type, and topography. The goal is to develop integrated systems that maximise productivity and sustainability.

What our stakeholders told us

Research and innovation priorities for optimised systems include:

1. Inter-relationships in a system – between genetics, management, nutrition, health, land type and topography – high priority due to complexity and interconnectedness of components within livestock and aquatic production

2. Intensive and extensive production balance – combinations of actions for biodiversity and GHG improvements at a systems level – performance measures in extensive systems

3. Mixed farming systems – models to understand complexity to identify mutually beneficial activities

Why is it important?

By developing systems-based, integrated approaches, farmers can achieve higher productivity, better resource efficiency, and enhanced environmental sustainability. This systems-based research helps in creating tailored solutions for different regions and farm types, ensuring that agriculture and aquaculture practices are economically viable, environmentally friendly and adaptable to changing conditions.

What UK Agri-Tech Centre has to say

We work closely with commercial farmers on different systems and scales to capture and integrate data, across multiple points on farm, that can benchmark future innovation trials. This enables holistic research examining several elements of production to maximise efficiencies. Novel technology can also help with waste from aquaculture systems, that can then be used to grow new crops for feed or food.

Data Assets

What is this?

The infrastructure and tools necessary for collecting, storing, analysing, and utilising large volumes of agricultural and aquaculture data. This includes automated data collection systems, data storage facilities, and advanced data analysis tools capable of delivering predictive analytics. The aim is to improve both horizontal and vertical data connectivity, enabling effective benchmarking of farm performance and seamless data sharing across the supply chain.

What our stakeholders told us

Research and innovation priorities for data assets include:

1. Automated monitoring systems – academic role in identification of metrics and data points, commercial organisation to drive development and adaptation of technology to collect and report information

2. Real time (or frequent) information flow – underpin management decision making, assurance to consumer on welfare and environmental performance with metrics and technology needed to achieve this

3. Horizontal and vertical data connectivity – horizontal benchmarking of performance, vertical data flows for market opportunities and technical performance improvement

Why is it important?

Essential for informed decision making and innovation. By improving data connectivity and benchmarking, farmers can compare performance, optimise practices, and enhance productivity. Effective data sharing along the supply chain unlocks market opportunities and drives technical improvements. Additionally, real-time data flow supports better management of animal welfare and environmental performance, meeting consumer expectations and regulatory requirements.

What UK Agri-Tech Centre has to say

The UK Agri-Tech Centre has developed a data platform that centralises data from a number of on-farm sources for operational and research purposes. This data collection helps us understand farm systems and aids in the development of new, focused technologies for improving key areas of farming. The data platform has been used in a number of projects enabling data analysis, hyperspectral image processing, the generation of ground truth datasets and the development of AI-assisted image annotation. We have worked closely to break down barriers related to rural connectivity, the security and safety of data assets on farm and across the food supply chain.

Technology

What is this?

Developing appropriate technology refers to the creation and implementation of advanced tools and systems that enhance farm performance and sustainability. This includes technologies for accurately measuring and reporting various aspects of farm operations such as animal growth rates, health, welfare, feed intake, reproductive performance, and environmental impacts like greenhouse gas emissions and habitat quality.

What our stakeholders told us

Research and innovation priorities for technology include:

1. Modelling tools - for farm, local, regional and national levels

2. Automation - robotics for repetitive processes, raise productivity

3. Data collection - automation, analysis for decision making

4. Advanced data technology - aggregation of multiple complex data streams, deliver analysis and actionable insights with horizontal and vertical data flow capability

5. Precision technology - widespread adoption for resource use efficiency

6. Vision technology - monitoring behaviour, health, water quality, feed quality, grass growth, biodiversity, habitat quantity and quality and guidance for autonomous vehicles

7. Sensor technology - multiple applications - role for commercial sectors in delivery

8. Drone technology - survey and fieldwork

9. Autonomous vehicle technology - adoption, legislative barriers to use, safety in farming environments

Why is it important?

Developing appropriate technology is crucial for UK agriculture as it addresses the need for increased efficiency, productivity, and sustainability in farming practices. Advanced technologies enable precise measurement and management of farm activities, leading to better resource utilisation, reduced environmental impact, and improved animal welfare.

What UK Agri-Tech Centre has to say

The development and validation of new technology in a real-world scenario is critical to ensure that agri-tech is robust and works in field or in water. We have a number of trial sites and experts who can enable robust trials and data to take technology from idea to impact. For example, technology developers using AI, and developing and testing equipment, to monitor fish welfare in water. UK Agri-Tech capabilities can support this research and the improvement of data gathering, reducing the handling stress of fish in farms.

03 Sector Level Priorities

Building on the thematic research and innovation priorities and principles, the following table summarises more specific topics as priorities for the dairy, beef, sheep, pig, poultry and aquaculture sectors. There are challenges in common across several sectors, reflecting an opportunity for cross-sector knowledge sharing and the development of innovative solutions with multiple, varied applications. It is also recognised that those very specific challenges faced by each sector require specialist research and development capabilities.

	Dairy	Beef	Sheep	Pig	Poultry	Aqua
Intensive versus extensive production and relative biodiversity and GHG performance	●					
Reducing, mitigating carbon/GHG output	●	●	●	●	●	●
Adaptation to climate change	●	●	●	●	●	●
Biodiversity improvement	●	●	●	●	●	●
Extending the production life of the breeding herd	●	●	●	●		
Optimising dairy and beef production systems	●	●				
Improving genetic progress through uptake of best practice		●	●			
Developing breeding practices to enable the widespread use of optimal genetics			●			●
Maximising output per suckler cow		●				
Increasing understanding of optimum sire genetics for the most common crossbred ewe types, as well as for purebred flocks		●	●			
Development of alternative uses for wool			●			
Enhanced housing designs delivering continuous advancement with a focus on heating methods, prevention of transmission of disease, optimisation of feed delivery and monitoring of animal performance	●			●	●	
Maintaining high growth rates and high food efficiency while eliminating welfare challenges such as bone structure problems and movement issues					●	
Determination and minimisation of environmental impact of outdoor production				●		
Minimising hatching and culling of male chicks. This is seen as a genuine threat to the sector and is one of the most significant perceived welfare challenges to be addressed					●	
Development of invasive and non-invasive in-ova sexing techniques, with the aim of accelerating genetic progress and removing the need to cull male chicks					●	
Management of/development of resistance to avian flu					●	

	Dairy	Beef	Sheep	Pig	Poultry	Aqua
Enhanced disease and parasite control. A key challenge for the production of land-based and aquatic production is the control of disease through the use of vaccines, antibiotics and other methods	●	●	●	●	●	●
Preventing contamination of wild genetics by escaped farmed fish. As farmed species become increasingly domesticated, the impact of genetic contamination will grow, and consequently there is a need for research into both the impact of the contamination and into methods of preventing the contamination from taking place						●
Improved system resilience. Some livestock and aquatic production systems are highly sensitive to small changes. There is a need to understand the impact of these changes on the most significant production sectors and to determine the adjustments which are required to enable efficient and sustainable production	●	●	●	●	●	●
Improved welfare of aquatic species. Legislation does not necessarily recognise some aquatic livestock as animals, and there is less emphasis on creating conditions which deliver good welfare (in comparison to that for land species). It is expected that the demand for ethical production will grow for the aquaculture sectors, meaning that there is a need to deliver research around indicators of welfare, measurement against those indicators, and of methods of improving welfare						●
Determination of the behavioural needs of fish including qualitative assessment methods for monitoring fish behaviour (through use of AI, video and other technologies)						●
Welfare at slaughter and the development of cost-effective methods and equipment to enable humane slaughter				●	●	●
Use of acoustic deterrent devices and the disturbance caused by these devices within different environments and habitats, including impact on other non-target species						●
Determination of impact of predators on fish health and welfare including measuring the effect of predators on economic performance, physical performance and measurable welfare changes						●
Development of parasite management strategies to minimise the use of chemicals			●			●
Improving gill health including amoebic gill disease prevention and treatment – current treatment is freshwater and hydrogen peroxide baths, and there is a need to find more appropriate alternatives						●
Manure management including optimisation of storage and application methods of manure to maximise nutrient retention along with a range of effective mitigation and control measures is required to manage the release of ammonia and compounds from slurry and manure.	●	●	●	●	●	

Research, Development and Innovation Landscape

The livestock and aquaculture sectors require a research, development and innovation ecosystem that spans basic or fundamental research through to technical development and applied research with application to deliver impact. Critical components needed to accelerate innovation include world class capabilities, including infrastructure and expertise, along with appropriate funding models. Long-term research, development and innovation plans must consider appropriate requirements and potential gaps across TRLs (Technology Readiness Levels). Knowledge Exchange, communication, collaboration and learning from international experience are all identified as critical in delivering more and better opportunities for research, development and innovation in the UK.

Infrastructure and facilities

The majority of stakeholders across academia and industry reported that infrastructure and facilities to deliver research in the UK are generally of a good standard. One key need was highlighted – an expansion in the number of large-scale facilities which can deliver whole system, multi-target research, as well as funding to deliver instrumentation of the relevant landscapes. Due to the wide variation of climatic conditions, land types and topography across the UK, it was emphasised that research facilities must collectively be able to produce research findings which are relevant to localised conditions. The livestock and aquaculture research and development landscape in the UK is broad and diverse but lacks a coordinated directory of current UK capability including facilities, equipment and expertise. The following areas were identified as gaps, which would help raise industry performance;

Facilities to enable systems research/whole life cycle research: systems research was recognised as high priority by several stakeholders. However, the development of appropriate systems requires large-scale research facilities and instrumentation which can test at a commercial as well as a scientific level.

Tools to facilitate accurate modelling: the importance of accurately modelling the effect of individual and systems change was repeatedly highlighted, and the development/provision of tools and facilities to enable this was strongly recommended.

Circular facilities to test concepts: the need for circularity was regularly raised during the research, mainly focused on the use of existing techniques and technologies to make most effective use of slurries and manures, as well as some other byproducts from farm. The ability to test circular concepts was an important component of the research capability in the UK.

On-farm research tools: the most identified equipment need was for large volumes of on-farm measurement equipment to enable instrumentation of the landscape. This included (amongst others) equipment for measuring feed intake, health, behaviour, biodiversity, habitat, and GHG output.

Enhanced data collection facilities and equipment: increasing the data collection capability at individual animal level, and more significantly, at a landscape and system level was highlighted as crucial at a commercial level as well as for research.

Data storage capability: the ability to store, analyse and use data is recognised as an ongoing and urgent need for the sector due to the constant increase in data collection. Without adequate data holding and analysis capability, industry research and progress will be hindered.

Meat science capability: the agri-food industry currently has very few places to obtain advice should an eating quality challenge emerge. The beef sector in particular raised the need to be able to eliminate the outliers which cause the majority of complaints in the sector, as well as the need to raise the overall average and consistency of quality.

Wet chemistry laboratory facilities: a minority of stakeholders identified the need for additional wet chemistry labs to deliver additional analytical capability.

02 Expertise

An overarching need was identified for funding additional researchers, enabling expansion and more rapid delivery of urgent work, as well as enabling more effective succession planning. Urgent requirements for specific expertise included the need for many more data scientists and bioinformatics specialists. The level of increase in data collection, likely over the coming decade to be unprecedented, and the need to make full use of the potential of data, means many more specialists are required. The critical need for the expansion of systems-level research also demands a substantial increase in the number of agri-food systems specialists with the expertise to understand interactions within and between different systems. An increased need for animal nutrition researchers was also identified, whilst low numbers of meat quality researchers were reported.

Key expertise requirements include:

Additional funding for more research staff: multiple organisations identified the need for better funding of research staff. Many expressed the opinion that the UK was broadly well-equipped from a facilities perspective, and that support is required to rapidly accelerate the entry of well-qualified staff into the sector.

Data scientists, biostatisticians and systems researchers: the analysis and interpretation of large data sets is a key priority for the research sector. There is currently a shortage of data scientists and biostatisticians. This absence is a threat to the sector, and will in the future restrict the ability of the sector to analyse the data that is being produced, reduce the ability to identify research needs and to subsequently deliver effective research. The absence of sufficient systems researchers will severely impact what is seen as one of the next decade's most important research areas, which needs to be urgently addressed.

03 Funding Provision

Good access to funding opportunities was recognised for most research. However, some gaps were identified mainly around the provision for long-term systems-based research and modelling where the effect of specific combinations of actions is studied. The understanding the overall effects of combinations of structure and practices within a system can require five or more years. In general, this is not reflected by funding organisations as almost all funding periods are too short-term. As most funding is broadly directed by government policy and priorities, stakeholders reported that it is critically important to accurately inform government to ensure appropriate funding and support is in place. The UK Agri-Tech Centre was recognised as having an important role in this dialogue with government and funders in providing guidance and informing the direction of research funding, including identifying the key research needs, facilities and expertise, and funding requirements. Funding should consider support across capabilities, research activity itself and knowledge exchange through to implementation.

04 Research and Innovation Network Development:

The communication of scientific findings to industry was recognised as vital and is perceived as a weak area for the scientific and commercial community. Multiple stakeholders identified the Knowledge Exchange network as the key to driving scientific impact as well as for the identification of emerging research needs. There is considerable interest in the creation of structures to validate and communicate advice and to receive feedback. Knowledge Exchange is a two-way process and should be considered within the design process of most projects, and the view was repeatedly expressed that Knowledge Exchange should be funded within this, with a focus on including commercial organisations such as processors

or breed societies as part of the programme. Behavioural and cultural change is also important to accelerate the uptake of best practice, and there is an ongoing need for social science research to identify methods of promoting best practice most effectively.

Collaborative working is key to the effective delivery of research, development and innovation over the next decade.

This includes the concepts of project co-design with industry, including (amongst others); challenge identification; joint target setting; planning of Knowledge Exchange at the design stage of the project; collaboration in the delivery of post-project knowledge; and gathering of feedback.

The collaboration aspect of research, and application of findings is hindered by the absence of a comprehensive directory of expertise, facilities and equipment, and by the lack of awareness of commercial organisations that have interests in specific aspects of research.

The research landscape in the UK is highly competitive, resulting in a protective and insular environment which can result in duplication of research work. A key recommendation from stakeholders was the need for measures to be implemented to enable recognised experts from different institutes within the UK to better work together to maximise progress.

Collaboration between industry and academia is equally important with effective communication a critical factor to enable improvement through increasing awareness of current and proposed activity, as well as of those organisations which have interests in funding, delivery or implementation of the research and the subsequent findings.

Enabling collaborative working was highlighted as the single most desirable function of the new UK Agri-Tech Centre. The UK Agri-Tech Centre is deemed to be well placed to build relationships, to understand industry need, and to facilitate the delivery of the required research, development and innovation.

Industry communication was identified as an area for improvement within the Research and Innovation sector. The development and execution of an effective communication plan for the sector, crossing the academic, advisory and commercial sectors was seen as necessary and should include the following components:

Capturing current and proposed research: there was a strong recommendation for capturing and communicating current research in the sector, intended outcomes, progress and expected completion dates, parties delivering the research, and their expertise. This recommendation includes the communication of early-stage applications for research funding for all livestock and aquaculture research in the UK, enabling interested partners to potentially become involved.

Informing research direction: effective ongoing communication of future research needs within the sector to government and funding organisations is needed, and this activity must be well-structured and evidenced-based.

Funding availability: the UK funding landscape is fragmented and can be challenging to identify appropriate funding. Effective 'one-stop shop' communication of funding opportunities to the industry and academia is required.

Industry capability and willingness to become involved in research: a knowledge gap was identified relating to commercial partners who would potentially be prepared to become involved in specific research areas. A register of interested parties could accelerate industry involved in research and the likelihood of commercial implementation.

Communication of research findings: enhanced communication of scientific findings to the industry was clearly indicated. There is a role for the UK Agri-Tech Centre in ensuring that insights are readily available to relevant organisations and there is collaboration between the academic and commercial sectors in the communication of findings. Communication should include not only the most recent research findings, but should also identify, standardise, and communicate current best practice, as well as collecting feedback which can inform appropriate modifications to the advice or generate a basis for additional research.

Enhancing communication to facilitate collaboration: collaboration between industry and academia was highlighted as being important by a very large number of respondents. Effective communication was identified as the factor which can underpin improvement by increasing awareness of current and proposed activity to facilitate collaboration between academic organisations and commercial businesses.

International Research, Development, and Innovation Frameworks

Appropriate frameworks are needed to encourage effective research and development and the adoption of best practice at farm level and across the supply chain. Stakeholders highlighted that although the UK was broadly a good place in which to carry out research and development, international frameworks and practice, that could deliver benefits within the UK would be useful to explore. In particular, the Netherlands and Brazil were identified as potential study models, with the 'Dutch Diamond' seen as an ideal way of ensuring good collaboration between industry, academia, government and society. Brazil's regulatory framework and commitment to ongoing development of industry performance was highlighted as being world leading and worthy of further study.

International examples include:

USA: an extension service which delivers effective Knowledge Exchange, industry links and cooperation within the USA. This is viewed as something that should be encouraged and enabled within the UK. The willingness of commercial organisations to work cooperatively on commercially advantageous projects enables faster progress against key challenges.

Republic of Ireland: the system of Farm Advisors and Knowledge Exchange, which is operated through Teagasc is seen as a 'gold standard' and something which could be considered. The collection of phenotypic data from cattle in the Republic of Ireland and its use to drive a genetic improvement programme (International Cattle Breeding Federation, ICBF) is the type of project which could be developed and used within the UK – essentially a whole industry programme working towards the delivery of rapid, whole-industry progress.

Netherlands: highlighted as having integrated collaboration between industry, research and government with a model that could be applied in the UK. Many stakeholders identified the Netherlands as perhaps the single most important example of coordinated industry development.

Canada: the funding system for applied research in Canada is also seen as a potentially helpful method of encouraging systems research and for proving the effectiveness of early-stage solutions within a commercial environment.

France: the links between research services in France were seen as beneficial and that they should be considered when determining how research collaboration between institutes could be facilitated within the UK.

Brazil: the Brazilian Agricultural Research Corporation (Embrapa) delivers research for the industry, sitting under the Brazilian Ministry of Agriculture, Livestock, and Food Supply has focused on providing research to enable the growth of the industry and to address the policy needs of the sector. Several stakeholders identified Brazil as a good example of industry coordination and joint action and noted the proportionally high levels of funding for agricultural and agri-food research that was available in this region.
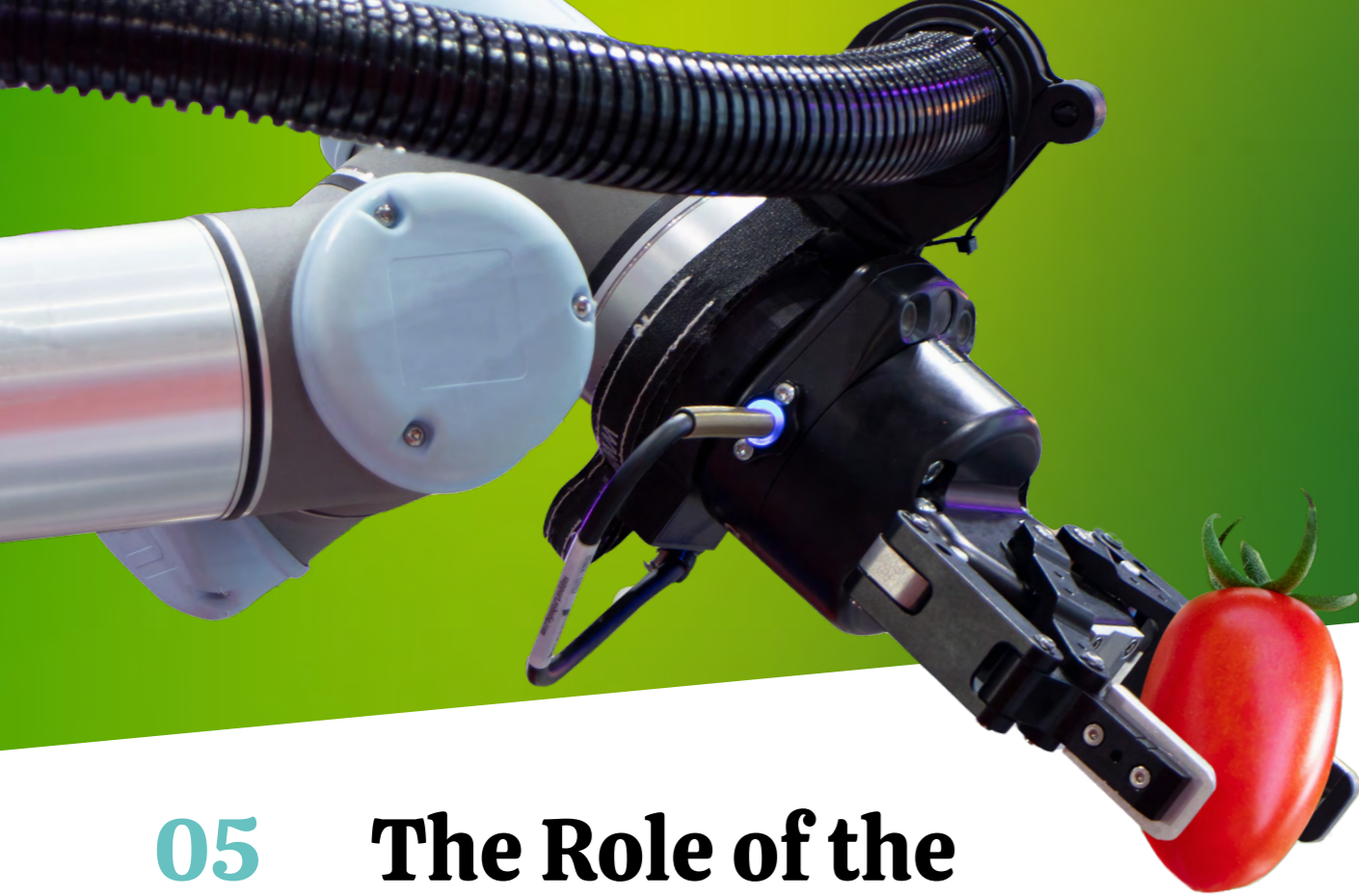
05

The Role of the UK Agri-Tech Centre

Stakeholders identified the following functions and actions for the UK Agri-Tech Centre, working alongside collaborators in the livestock and aquaculture research, development, and innovation sectors.

Capturing and showcasing capabilities: facilities and expertise: commercial organisations, particularly those engaged with data gathering processes highlighted their absence of knowledge around who the key specialists are within research areas which are of interest to them. Easy access to a directory of expertise created and maintained by the UK Agri-Tech Centre was suggested as the most appropriate solution to the challenge. A similar lack of knowledge (or lack of access to knowledge) about the available livestock and aquaculture research facilities within the UK was highlighted. Stakeholders indicated that they simply were unaware of the range of facilities which are available and did not know where to go to find this out. This was also true about research equipment, and academic organisations suggested that the ability to share equipment between different institutes would be a big benefit, but more often than not, they were not aware of who held what equipment, or which had specific facilities that would be appropriate for different research strands. Both the commercial and academic organisations saw a role for the UK Agri-Tech Centre in creating and maintaining a directory of facilities and equipment, and in making this accessible.

Facilitation of collaborative research: industry was highly supportive of a more centrally organised research environment, which reduces duplication of effort, and maximises information sharing, joint working, and a focus on application within the farm and processing sectors. Government and the UK Agri-Tech Centre have a role to play in this area, where the ambition is for funding to be directed as appropriate towards identified grand challenges. The objective is for more effective and inclusive interdisciplinary collaboration across the four nations, including with commercial organisations who are highly aware of practice in the sector where, for example, there is a need to increase output and improve biodiversity, or where behavioural research would maximise implementation.

Reshaping of funding: funding was reported to be more often available for immediate challenges, or for high profile research areas, but a long-term view of research is not necessarily factored into funding streams as they are being designed. This has meant that research resource has been directed to areas which are not able to offer the same level of benefit as other research areas could (given a longer timescale). This does raise the concept of the need for an overall livestock and aquaculture research strategy, which can be adopted by government, industry and research sectors, and which can be used to direct funding to where it will be most effective, and which considers long-term needs and not just the immediate. The UK Agri-Tech Centre could have a role in facilitating high level direction, providing strategic advice on research priorities for funding.

Data handling and analysis capability: one of the biggest challenges raised by commercial organisations was the importance of handling and managing data correctly. Several organisations noted that very large amounts of data were now being collected at farm level and through the production process, and this data was not being analysed appropriately, meaning that patterns and links between production and environmental factors were being missed, reducing the opportunity to identify opportunities for improvement (research needs, practice change requirements). Commercial organisations highlighted their absence of knowledge around who the key specialists are for research areas which are of interest to them.

Proactive partner-matching for research and Knowledge Exchange: proactive partner matching could be led by the UK Agri-Tech Centre actively seeking commercial partners willing to participate in research or apply findings. This could be delivered alongside measures to coordinate research, which would enable larger coalitions, with specialist expert partners delivering appropriate components of each project, from research through to testing, to Knowledge Exchange and implementation at a commercial level.

Coordination of research: commercial organisations highlighted the need for several changes to ensure that the maximum benefit is obtained from research funding. This would include the following:

- Up to date mapping of planned, current and delivered research within each species group.

- Identification and flagging of planned research with a long enough lead time to allow commercial companies to become involved.

- Identification of the opportunities for Knowledge Exchange as part of an overall delivery programme and engagement of commercial partners who are incentivised by early access to new research knowledge.

- Proactive partner searches and building of consortiums, which take into account both development and commercial delivery or implementation.

- Proactive development of consortiums which include potentially competing organisations, which are prepared to work jointly to deliver benefit to the wider industry.

There was a significant focus on ensuring that research funding within the sector was as effective as possible, and all organisations were keen to see funding targeted at the most important challenges. As indicated earlier in this report, enabling collaborative working to achieve this was the single most highlighted desirable function of the UK Agri-Tech Centre.

Informing funding organisations and government: stakeholders recognised the need for appropriate guidance and direction of research through funding. It was noted that research tends to be guided by the funding which is made available for research which is broadly directed by government policy. The Agri-Teach Centre can have an important role within this, identifying the key research needs, the available facilities and expertise, identifying the necessary spend, and then representing this to government. The following funding areas should be considered including support for employment and expertise, facilities and equipment, research activity, and Knowledge Exchange and implementation.

Provision of project management/professional services to facilitate the delivery of research: a repeated theme from academic organisations was the significant time challenge around the administration of research. The level of administration required detracts from the delivery of research, and a potential solution was the provision of central administration facilities for large research projects through the UK Agri-Tech Centre, as well the provision of project management services to ensure that larger collaborative projects operate to schedule and budget.

Provision of assistance around application for funding: another repeated theme from academic organisations was the challenge around applications for funding and grants, which is time consuming and not always successful. The UK Agri-Tech Centre could provide assistance around the application for funding, which would reduce the time taken for application, concentrate expertise across the UK Agri-Tech Centre collaborative network, and would offer the opportunity to inform and coordinate research and research partners.

Communication of succinct, relevant information across the sector: information bulletins, with the latest relevant information for the sector, should form part of the ongoing service provided by the UK Agri-Tech Centre.

Ensuring equitable distribution of funding and engagement in research: a number of organisations and individuals highlighted the need for the new centre to be transparent in its dealings with research organisations and institutes, and to make strong efforts to engage and coordinate all available expertise across the UK.

06 Conclusion

The UK Agri-Tech Centre works at the intersection of science, industry and government, in a diverse research, development, and innovation ecosystem to deliver meaningful impact. This report was commissioned to capture priorities across the livestock and aquaculture sectors and represents our continued commitment to collaboratively identify opportunities to accelerate innovation over the next 10 years and beyond. Those opportunities are found throughout this report, within the thematic and sector level priorities, and significantly in stakeholder views on the role of the UK Agri-Tech Centre.

They collectively articulate an ambition and shared vision for the livestock and aquaculture sectors, linked to four strategic themes. One Health features improved health and welfare of livestock and aquatic animals, including measurement enabling assurance of high welfare to consumers, and a greater understanding of the contribution of higher health status to environmental sustainability and productivity improvement. Sustainable Production includes climate smart livestock and aquatic production systems, that enable the production of healthy, nutritious food at an economically and environmentally sustainable level. This means taking a whole systems approach to deliver, and report environmental performance, reductions in GHG, improvements in biodiversity, efficiency, and productivity. Resilient Food Systems require the identification of appropriate land use, improvements in biodiversity and optimising land performance and resources. Intelligent Agriculture harnesses data and technology to enable informed decision making in sustainable precision livestock and aquaculture production.

In addition to the role of the UK Agri-Tech Centre in developing research and innovation projects across these thematic areas, stakeholders also articulated the following roles for the UK Agri-Tech Centre;

01
Showcase capabilities
across the UK to illuminate the scale and scope of facilities and expertise, acting as a portal to a landscape of research, development and innovation opportunity.

02
Spotlight the breadth of research, development and innovation
across the livestock and aquaculture sectors – to flag opportunities for collaboration, avoiding duplication of costs and effort, and improve dissemination and impact of research findings.

03
Provide evidenced based strategic direction
to funders and policymakers to help establish a long-term coherent funding framework that reflects key priorities.

04
Champion collaborative partnerships
to convene and harness UK wide interdisciplinary expertise, industry know how and investment to deliver real impact.

05
Facilitate horizontal and vertical data utilisation
to facilitate research and knowledge exchange.

06
Focus on systems level research
and modelling to deliver fully circular and sustainable production, identified as the single most important theme over the next decade. Understanding the impact of technologies and practices is crucial, along with how they should be combined within a local, regional and national context.

07
Enable longer term research
longer funding terms are needed to support systems-based research, which meets the challenges faced by society and the associated research, development and innovation needs across academia and industry.

Ultimately, the challenges for the livestock and aquaculture sectors are familiar, if not more urgent, but there are clear opportunities for collaborative or strategic partnerships to develop innovative solutions within the UK Agri-Tech Centre ecosystem. We look forward to exploring these sector priorities and our shared ambitions for livestock and aquaculture innovation, shaping the next 10 years and beyond.

UK Agri-Tech Centre

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