CIEL

INVESTING IN ANIMAL HEALTH

UKRI Innovate UK

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Foreword

There is a rich animal health ecosystem in the UK related to farmed, equine and companion animals, and across value chains associated with food production, animal care and recreational activities.

There is a clear need for these strengths to be capitalised on to deliver enhanced animal health and welfare outcomes which support sustainable farming systems while delivering universally high standards of animal care. This need is particularly pressing in relation to delivering ambitious goals rapidly, such as those for achieving Net Zero in the UK by 2050.

Grand challenges such as climate change, food security and endemic disease require adoption of innovative technologies to improve animal health and welfare. Collaboration and capability will be critical for success in achieving this. We need to invest in new or improved animal health products and services.

'Investing in Animal Health' draws together the breadth of opportunities in animal health where investment can make a significant difference. It makes the case for the UK being ideally positioned for such investment, with the benefits able to be captured by integrated supply chains here and rolled out overseas. It covers the livestock, aquaculture, equine and companion animal sectors to highlight common challenges and opportunities – many of which are cross cutting.

CIEL is ideally positioned to facilitate initiatives in research and innovation, being highly engaged with industry, academia and government in the UK. We are seeking to use this report to highlight the importance of animal health to the future of our food industry and for animals we count as companions and partners in our recreational activity.

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Executive Summary

There are a wide range of benefits that stem from investing in animal health summarised in this report. Delivering these requires innovation in multiple disciplines, expertise and research, coupled with strong industry engagement to provide value to stakeholders.

Collaboration is needed within and across science, business, and government. The UK animal health ecosystem combines world-leading expertise in animal health, promoting connectivity, stimulating economic development, and driving innovation to make it ideally placed to deliver industry relevant innovations for animal health and welfare.

A key benefit of improving animal health is to tackle current and future grand challenges

Grand challenges facing the livestock sector, such as achieving Net Zero, reducing environmental impact, producing food sustainably, and tackling fundamental issues to One Health and animal welfare, require innovative animal health solutions. We similarly share a responsibility to protect the welfare of our companion animals and horses, with animal health a common prerequisite to achieving these ambitions. This vision can be realised with a One Health approach that considers people and animals within our shared environment.

The animal health ecosystem is evolving to meet grand challenges

We are now in the fourth industrial age as the digital revolution changes every aspect of our lives. The surge of new knowledge and innovation in data science opens new opportunities to solve the issues we must address. To deliver the gains wanted, and to do so in the timeframes required to achieve Net Zero ambitions, we need a creative balance of science and business to innovate, develop and implement new ways of working. Invariably this will change existing business models, some to a greater degree than others. Successful businesses are doing this already, offering broader ranges of products and services for companion and production animals, such as therapeutics, diagnostics, vaccines, nutrition, and digital solutions. Driven by data and developments in biotechnology and genomics, to name a few, health is increasingly being managed preventatively with early detection promising precision medicine.

The UK has world leading animal health capability

The UK enjoys a globally renowned reputation for excellence in research and education for animal health and welfare. A vibrant community develops, attracts and nurtures innovation from startups, SMEs and global companies. There is both a depth and breadth of livestock research capacity and capability, with world class facilities, several of which are supported by CIEL. Examples include the Large Animal Research and Imaging Facility (LARIF) at the University of Edinburgh and the University of Nottingham Centre for Dairy Science Innovation (CDSI). In addition, the Pirbright Institute, a site of global strategic importance in animal health, and a network of research-intensive veterinary universities, together with the Animal and Plant Health Agency (APHA), are collectively key elements in a diverse and active animal health ecosystem across the UK.

There is a mature but developing animal health market for livestock and companion animals

Livestock are integral to our way of life, providing high quality nutrients to feed our growing population, whilst companion animals are at the heart of families, providing companionship and assistance. Pet ownership is growing and serviced by an array of companion animal health and associated care products and services. Further improvements in livestock production efficiency require higher health systems, and demand also arises from the drive for more sustainable food production and reduced carbon emissions, the threats of endemic and exotic diseases, and potential trade restrictions. Data and data science are providing opportunities for both livestock and companion animals through the added value delivered by new digital technologies and business models focussed on enhancing quality of life, improving preventative medicine, and delivering precision veterinary medicine.

The UK animal health sector is a globally connected innovation investment opportunity

The thriving UK animal health sector is globally connected with established supply chains and links to markets and other science-driven economies. With the presence of leading multi-national and local animal health companies, whose portfolios span products and services for companion and production animals such as therapeutics, diagnostics, vaccines, nutrition, and digital solutions, the UK is well-positioned to drive innovation, collaboration and promote sustainable practices across the animal health sector.

Facts and figures highlighted in this report were taken from recognised sources, many of which can be found in the selected bibliography.

1 Sector Overviews

The UK has approximately:

10 million
Cattle

33 million
Sheep

190 million
Poultry

5 million
Pigs

Overview of the

UK Livestock Sector

Products derived from animal production are also used as ingredients in manufactured foods. In addition to food, livestock provide leather, fibre and other by-products.

Whilst global demand for meat continues to grow, in Europe demand is expected to stabilise or decline modestly. Changes in meat consumption are expected as consumer preferences change, resulting from factors such as advice to reduce total meat or red meat consumed, reduced consumption of preserved meat, and concerns about the impact livestock farming has on climate change. However, these issues are often justified without reference to nutritional adequacy of alternate diets. Livestock can provide ecosystem services, such as conservation grazing and use of grazing land margins for encouraging biodiversity. Investment in ecosystem services will be rewarded in the UK under the principles of the Environmental Land Management Schemes (ELMS). More research is warranted to better define the roles for different livestock types in sustainable agriculture for the future, in the UK and other countries.

The livestock value chain

Animal health contributes to efficient food production for society. The livestock value chain covers the path from animal feeds, through farming and harvesting of meat, eggs and milk, followed by processing, manufacture and distribution to catering and retail markets. In the UK, often this involves a complex network of stakeholders including transport, abattoirs, meat packers, dairy and egg processors, supermarkets, hospitality, industry associations, government authorities and non-governmental organisations (NGOs), with consumers the ultimate stakeholder in food quality and sustainability. These value chains contribute to food security, the rural economy, and export revenues. Overall, the agrifood sector employs 4 million people, contributing £116 billion Gross Value Added (GVA) to the wider economy.

Each stage of the value chain aims to be profitable, but value of products varies due to demand, availability and quality. Volatility in markets present particular challenges to farmers. Supply contracts can lock in prices, subject to meeting standards which may include health protocols. Supermarkets are aware of key challenges and the need for innovation to overcome these, and many work with contracted farmer producer groups. UK consumers have been accustomed to low and relatively stable prices for food until very recently, when costs of energy and feed

components rose dramatically, fuelling food inflation that peaked near 20%. For poultry, these challenging financial conditions were compounded by an Avian Influenza epidemic, reducing availability of eggs and poultry meat while increasing costs of production due to the enforced housing of poultry in regions of the UK from October 2022 to April 2023.

Innovation beyond the farm gate brings benefits through reducing costs, wastage and negative environmental impact, and offers the potential for better returns to farmers, enabling them to invest in improving health and production efficiency. Organisations such as the British Poultry Council (BPC) and Dairy UK promote their industry and develop innovative policies that deliver value across the value chain. Innovative technologies can help support standards and provenance, with blockchain providing assurance along the supply chain. The Digital Dairy Chain initiative is a UK Research and Innovation (UKRI)-funded £21 million investment intended to do just this, by driving integrated innovation in Cumbria and Southwest Scotland. Throughout the value chain, from farmers to processors and retail, a common message is that good animal health and welfare is a prerequisite for efficient production and for retaining consumer confidence.

Expertise in maximising value chain productivity in the UK can be translated for application globally, including to low- and middle-income countries (LMICs), where wastage along the chain can be considerable, jeopardising food security and investments made in enhancing animal health. Smart investments into livestock value chains that ensure global collaboration and cooperation can further offset environmental and climate change, contributing to mitigation of global threats, including population displacements, for benefit of future generations.

The livestock value chain is an integral part of the UK animal health ecosystem, playing a key role in identifying key issues and rolling out innovative solutions.

The UK livestock sector is adopting new technologies and sustainable practices to improve efficiency, reduce waste, and minimise environmental impact.

These include:

- Analysis of food production process to identify inefficiencies
- Incorporating Information Technology (IT) and Artificial Intelligence (AI) technologies for smart planning and processing
- Using ethical data storage and processing techniques
- Finding sustainable solutions for waste, moving to a more circular food system
- Introducing environmentally-friendly food production and processing technologies
- Discouraging food wastage throughout the food chain
- Advocating for improved policies and technologies in inefficient food production zones
- Promoting international collaboration for sustainable livestock food chain solutions
- Developing systems to detect food fraud
- Enhancing global surveillance systems

Focus on livestock type

Dairy Cattle

Dairy farming is largely focussed on areas of **reliable grass growth** such as the Southwest of England, Scotland and Northern Ireland.

Approximately **1.1 million cows** produce **12.4 billion litres** of milk per year.

Although cow numbers have reduced, **productivity per head has increased** such that overall volume of milk produced has changed little.

Milk accounted for **16.4% of total agricultural output** in the UK and was worth **£4.4 billion**.

Of an estimated 7,850 dairy producers in Great Britain, **60% have fewer than 100 cows**, while **1.5% have over 500**.

Larger farms typically use **robotic parlours** and are more likely to be **zero-grazed**.

Dairy calf and cow health

Calf health is fundamental to longevity, quality of life and productivity. Calfhood diseases may contribute to 20% of replacement heifers not joining the milking herd. Common calfhood and youngstock diseases include the bovine respiratory disease complex and enteritis.

A 30% dairy herd replacement rate shows that many cows have a relatively short productive life. This can be due to problems managing their nutritional needs, disease or problems with reproduction. High production dairy cows require a precisely balanced ration, especially in early lactation. Early lactation cows with the greatest mobilisation of fat reserves had milk yield reduced by 1 litre/day; were 4 times more likely to develop metritis or a twisted stomach; and 15% less likely to get back in calf, demonstrating the inter-relationship between nutrition, production and health.

Around 25% of dairy cows experience a degree of lameness at any one time at an average cost of £180 per incident. Lameness is associated with longer lying times, increasing risk of mastitis. Gait scoring by stockpersons can monitor lameness but is subject to operator differences. Smart video analysis promises an innovative approach to early detection and treatment. Aggregation of uniform data from many farms, with capture of related risk factors, could enable "big data" approaches to be employed to better elucidate aetiology.

Mastitis is a serious and common illness in dairy cows, reducing milk production, body condition and fertility, so increasing the risk of culling. Estimated costs of mastitis vary from £70 – £250 per cow/year. It is the most financially significant disease of dairy cows. Research has defined control strategies, including the DairyCo Mastitis Control Plan. Bovine tuberculosis (bTB) costs taxpayers an estimated £70 million/year with further costs to industry of £50 million. Field trials for a cattle vaccine began in 2023, associated with a new Detect Infected among Vaccinated (DIVA) test. The Enferplex Bovine TB Antibody test, which detects antibodies in serum or milk, and the Bovigam gamma interferon test are possible options for diagnosis. Integrating new tests into the national control strategy is urgently needed but not simple to do.

Data capture and welfare

New data management systems can integrate data from different on-farm sources to maximise welfare and economic return from each cow. For example, data from automated milking systems and a range of sensors or cameras to analyse milk volume, number of milkings, milk composition, cell counts, cow activity, rumination times and other physiological parameters such as body temperature on a 24/7, 365 day basis without human engagement. Other examples include DeLaval DelPro™, which uses camera mapping of body condition and big data analysis to provide in-depth assessment of individual and herd level issues, giving farmers snapshots of performance and flagging concerns often before signs are visible. Simpler systems, such as CowManager, work on a single sensor in an ear tag, collecting data including physiological parameters. Derived information is readily viewed by stock people on a computer or smart phone, with graphical displays providing at a glance information.

Animal welfare can be utilised in brand promotion by retailers to emphasise their values and ethics as part of a drive to secure market share. Supermarkets form farm producer groups that support each other and maintain standards such as Red Tractor food assurance or high welfare. These are associated with awards from entities such as Compassion in World Farming.

Challenges and new innovations

Development of new diagnostic tests, especially where these can be used on-farm, will enable early detection, while vaccination offers a cost-effective approach to prevention and reduces the need for antibiotic treatment which reduces the rate at which antimicrobial resistance (AMR) develops.

Hygiene is important in dairy because raw milk product is produced daily. An area of current innovation relates to the sterilisation of water for dairy cattle. This may increase animal productivity and lower disease incidence while reducing pollution from use of chemical cleaning agents.

The Centre for Dairy Science Innovation (CDSI), based at the University of Nottingham and co-developed with CIEL, with a 340 head dairy herd is providing insights into issues such as AMR, emissions, lameness, mastitis and wearable technologies. Data are being collected from a range of sensors and subjected to different interpretation tools. For example, machine learning has been used to better predict onset of mastitis. A number of promising commercial systems are also being used to monitor cow health and welfare from captured video of them leaving milking (e.g., CattleEye).

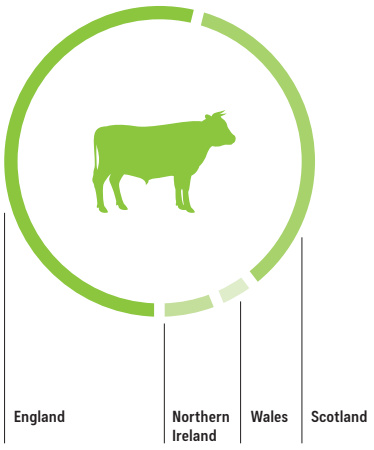
Focus on livestock type

Beef Cattle

Most suckler (cow) beef farms in the UK are **extensive, predominantly forage-based systems** which may be supplemented with grain or concentrate feeds.

In England, **2.1 million beef cattle are kept on approximately 45,000 farms, 25% of which are in less favoured areas**.

There are **~1.4 million beef cattle in Scotland, ~168,000 beef cows in Wales and ~246,000 beef cows in Northern Ireland**.



Traditionally, calves from pure dairy breeds were not favoured by the meat industry due to poor carcass conformation. However, judicious use of sexed semen, which accounts for ~70% of dairy semen sales, and putting cows not used to breed replacements to beef bulls, enables more valuable calves to be bred from dairy cows, which is highly efficient as one cow produces both a calf and milk each season.

In 2022, the UK produced over 900,000 tonnes of beef of which 14% was exported. Direct value of beef produced was £3.3 billion, and total value of beef manufacturing, including processed and preserved meat, was £10.0 billion. This figure has seen continuous growth in recent years.

Challenges and new innovations

Public perception of red meat effects on human health and environmental costs are the biggest concerns to the sector. Increasingly the focus is on sustainability, but evidence to provide a balanced assessment of this is difficult to obtain. New innovations are needed to make this easier to achieve. Key dimensions of value from beef are lacking, so it is not surprising that much focus is on the costs of beef production. To help farmers implement changes to make their farms more efficient, we need better information about how genetics, nutrition, animal health, stock management systems and target end points interact to influence carcass and meat qualities, efficiency of production and environmental impact.

Efficiency and sustainability of beef systems are significantly affected by production and infectious diseases. Priority diseases vary by age and system. Lameness is less prevalent than in dairy cattle, but liable to be under-reported. Simple automated gait monitoring devices may help identify affected animals, but data transfer is a challenge at pasture. A common problem is that of sub-clinical disease which reduces productivity and increasing susceptibility to other health problems e.g., liver fluke, lungworm, or gastro-intestinal parasites. Pasture management and strategic use of anthelminthics can treat and control these conditions, but parasite resistance to anthelmintics is an increasing issue.

A range of high-profile diseases are subject to control schemes, but these can vary between the four nations that comprise the UK, with some compulsory and others voluntary. Bovine Viral Diarrhoea (BVD) costs industry up to £61 million/year. Crucial is the detection and removal of persistently-infected cattle (PIs) which were infected in utero and so transmit high levels of virus for life. Other schemes focus efforts on different disease e.g., the Premium Cattle Health Scheme in Scotland promotes accreditation for a range of diseases, including Johne's disease and neosporosis, while the Ruminant Health and Welfare group (RH&W) is a cross-industry partnership to support all farmers in improving animal health and production efficiency. A 2022 report by the Moredun Research Institute on behalf of RH&W concluded that control of endemic diseases could contribute to a 10% reduction in greenhouse gas (GHG) emissions from ruminants.

Beef remains a key commodity in the UK and there are opportunities to enhance animal health and improve sustainability through prevention, early detection and treatment of disease. Innovation in areas including vaccination, parasite control, animal monitoring and testing promise to deliver sector-wide benefits.

Focus on livestock type

Sheep

There are approximately 33 million sheep in the UK, of which around half are breeding ewes. The population is relatively stable, having increased little recently. Animals are predominantly grazed on areas of less productive land unsuited to growing crops. It is a stratified industry, with breeds and crosses best adapted to hill, upland and lowland environments, maximising the potential to produce high quality food and generate rural incomes from otherwise unproductive land.

Vast areas of hill and upland landscapes in UK, which deliver benefits for tourism and the leisure industry, owe their character at least in part to sheep production.

Lamb production was **277 000 tonnes**, with lamb and mutton sales worth **£1.5 billion** in 2021.

The sheep sector contributes approximately **£2.3 billion** to the UK economy each year, from **38,000 sheep farms** providing **50,000 jobs** on farms and another **100,000 in associated industries**.

Impacts from agriculture are well documented with GHG emissions for sheep coming mostly from methane as a result of digesting feed. In addition, sheep farming has received criticism for overgrazing causing detrimental changes to landscape function, but sheep farming also allows animal products to be derived from marginal land and, if grazing is well managed, provides positive contributions to biodiversity and carbon sequestering.

Challenges and new innovations

A key factor influencing sheep farm incomes is exceptional price volatility, both for input costs and returns. Key pressures for sheep farming include (1) ageing demographic of lamb consumers in UK; (2) cheaper imports; (3) costs of production; and (4) supermarket prices. To face these challenges, sheep farmers are being advised to consider how they can make their businesses more resilient.

Innovations within sheep farming are often broader in nature as the farming systems are extensive. Genetic improvement is a useful tool but under-utilised in the sheep sector. Electronic ear tags enable easier capture of performance data that inform genetic improvement and benchmark key performance indicators. Farmers can make efficiency gains through multiple small gains across their whole farming system. Efficiency and sustainability of sheep farming are significantly affected by infectious and production diseases. The greatest economic losses are attributable to lameness, internal parasites and abortion, which together cost industry in excess of £140 million.

Most cases of lameness are attributable to footrot, which afflicts up to 60% of flocks. Research suggests greater adoption of the national Five-Point Plan for lameness could help to reduce lameness to 2% or less.

Abortion in ewes continues to cause significant losses and some infectious agents are zoonoses. The Schmallenerg virus, which emerged suddenly in Europe in 2011, can cause a high incidence of deformities in lambs. Vaccines are available for most common abortion pathogens.

Internal parasites are problems at all stages of sheep growth, with resistance to anthelmintics a significant long-term threat to productivity and animal welfare. Targeted parasite management, supported by the Sustainable Control of Parasites industry-led group (SCOPS), provides more effective control than whole flock routine treatment. The Smart Sheep project, led by the Moredun Research Institute and funded by UKRI, together with commercial partners, aims to promote targeted selective parasite treatment of poorly performing lambs identified through their Electronic Identification (EID) tag and an applied algorithm. There has also been success in selective breeding for parasite resistance.

Acute and chronic respiratory diseases are common. Acute disease is associated with a broad range of pathogens, many of which are viruses. Chronic and insidious diseases include Ovine Pulmonary Adenocarcinoma (OPA) and Maedi-Visna. Control of these requires identification and removal of carrier animals in a flock; this can be achieved for OPA using thoracic ultrasound.

Clostridial diseases continue to be a problem. Although vaccines are readily available usage is not high. A vaccine rate of 63% was achieved in 2021, the highest level since records began in 2012. Flock health schemes are promoted by groups including the Sheep Veterinary Society, the National Sheep Association (NSA) and Scotland's Rural College (SRUC).

Pressure points and opportunities for innovation

- Monitoring sheep health and disease on extensive grazing is challenging; this may be improved through cost-effective tracking devices
- Some available technologies are under-utilised and initiatives aimed at improving access to these would yield benefits
- Improved point of care diagnostics for common infectious diseases

Focus on livestock type

Pig

There were **4.1 million pigs in the UK in 2022, of which 261,000 were breeding females**. These numbers revealed a marked decline compared to previous years.

Most of the pig population is kept on approximately 3000 commercial holdings, 40% of which are feeder-only farms where pigs are raised to slaughter weight.

Large, vertically integrated companies such as Pilgrim's UK, Karro and Cranswick PLC control a substantial part of UK pork production, often delivering under contract to major retails chains.

Pig farmers operate on very slim margins, susceptible to shocks to input prices including energy and feed. Consequently, the opportunity for investment in innovation may be constrained. Unusually, more than 40% of the breeding herd is kept outdoors, benefitting the land through weed and pest control as well as improving soil fertility. Improved breeding and selection for outdoor pigs assures performance that is similar to indoor systems. Analysis of demographic data suggests there were approximately 100 nucleus-multiplier holdings, producing replacement gilts. Genetic selection has increased the average litter size of sows which can lead to increased pre-weaning mortality of smaller piglets without careful management.

In the year to April 2023, 765,000 pigs were slaughtered delivering 71,000 tonnes of pigmeat. Whilst some of this production was exported, the UK imports about 60% of the pork it consumes, principally from Denmark and other EU countries. The total value of the pigmeat trade in the UK in 2023 was estimated as £1.4 billion. Almost 70% of the costs of production are associated with feed, and about 7,800 people are employed on specialist pigs farms.

Although the UK has a good reputation for pig health and welfare, the cost of disease remains significant, with a recent study suggesting a loss of up to £858 million compared to a utopian and unattainable situation of no disease. The greatest cost is from reduced feed conversion efficiency, which may arise from reduced appetite and growth, even in pigs with relatively minor clinical signs. Enzootic pneumonia, caused by M. hyopneumoniae, is present in approximately 80% of pig farms and the clinical impact can be exacerbated by co-infections, including Actinobacillosis and porcine circovirus-2. Vaccines are available that reduce disease impact, and innovations such as needle-free devices minimise pain and simplify administration. The pig sector is also threatened by the incursion of exotic diseases, such as African Swine Fever (ASF), and early detection through effective surveillance is crucial to minimise the potentially catastrophic impact of an epidemic. The pig sector has reduced the use of antibiotics by more than 60% since 2015, mitigating the risk of contributing to the global burden of resistance to antibiotics.

Within intensive systems, thousands of pigs may be the responsibility of a small number of stockpersons, with limited capacity for careful observation of individual animals to detect early signs of disease. However, innovative technologies, including the use of video, environmental sensors, automated weighing and monitoring of drinking and feeding behaviours, promise to enable automated and dynamic early warning systems through 24/7 monitoring. A disease alert could then trigger the use of rapid on-farm diagnostic testing to identify causal agents and inform effective intervention. Not all the components of such systems exist, but innovations are appearing in this space in parallel with, and using technology from, other livestock species or non-agricultural fields.

Pressure points and opportunities for innovation

- Enhanced surveillance systems for new diseases
- Integrated on-farm monitoring for productivity and early disease detection
- Innovative diagnostic testing for on-farm use
- Genetic improvement and selection for health-related characteristics

Focus on livestock type

Poultry

The poultry industry has a significant impact on the UK economy, with **poultry-related exports valued at £192 million (2020), making it the 5th largest exporter in the world**.

Over 70% of poultry consumed globally is derived from UK genetics stock.

Since Brexit and the Avian Influenza epidemic, the value of **trade has fallen dramatically from £180 milion to £50 million**.

~ 38 million laying hens in UK produce 10 billion eggs under one of 4 systems:
Free range (~61%);
Enriched colony cages (~28%);
Barns (~7%); and Organic (~4%).

The UK is more than 90% self-sufficient for eggs, with over 60% sold through major supermarkets with total sales of approximately £1.3 billion.

The UK poultry industry produces eggs and meat, principally from chickens but also from ducks, turkeys, geese and more minor species e.g., quail and guinea fowl, and backyard production is increasingly popular.

The Welfare of Laying Hens Directive stipulates farm system requirements, and the British Lion Code of Practice sets higher standards for their eggs. Intensive poultry production is audited to meet Red Tractor standards including bird health and welfare. The Better Chicken Commitment is an industry initiative to further improve standards by 2026.

Globally, poultry production is expected to increase 17% by 2030. More than half of meat eaten by UK consumers is poultry, with an upward trend. Production is dominated by large, vertically-integrated companies such as Moy Park, 2 Sisters Food Group, Avara Foods, Bernard Matthews (Turkey) and Cherry Valley Farms (ducks). Approximately 1 billion broiler chickens are reared every year, contributing £4.6 billion to the economy. Almost all broilers are raised indoors with free range accounting for only 3.5% of production, and organic systems less than 1%. The UK's four largest poultry farms each house more than 1 million birds. Although the number of people directly employed on poultry farms is relatively small, more than 37,000 people work in the integrated food chain. Breeding stock production is highly specialised and dominated by just a few companies. For example, Aviagen supplies the UK and also the rest of Europe, North and South America, the Middle East, Africa and Asia.

Intensive poultry production depends on external inputs, dominated by those related to feed – often primarily monoculturally produced feed ingredients such as maize and soybean. These feed ingredients have been associated with serious environmental impact issues, contributing to climate change, deforestation, and loss of biodiversity. Feed production, energy use and manure management are the three main causes of environmental effects connected to poultry farms. Poultry production has a high energy demand to control housing environments and deliver feed. Consequently, energy cost rises can greatly affect profitability and hence supply.

The 2022 Highly Pathogenic Avian Influenza (HPAI) H5N1 outbreak in the UK has resulted in birds being housed indoors for extended periods, compromising free range and organic systems. Outbreaks persisted over many months and Avian Influenza is at risk of becoming endemic. Transmission from wild birds is a crucial risk and thus research into the global epidemiology of Avian Influenza viruses, accompanied by effective international surveillance, is essential. Affected flocks suffer from high mortality and must be slaughtered to control spread. Although no vaccines are currently licenced for UK use, overseas vaccination is under immediate consideration. France has invited two animal health companies to produce 80 million vaccine doses for use in ducks in Autumn 2023. CIEL's report **'Living with the Risk of Bird Flu'**, published in April 2023, recognises the need to explore mitigation strategies and actions to reduce the impact of Avian Influenza.

Very large poultry flocks are at great risk from ingress of infectious disease, so biosecurity practices are crucial to mitigate risk. Vaccination provides a highly cost-effective solution to control common infectious endemic diseases, reducing demand for interventions including antibiotics. Early detection of disease within a flock is essential and can be enhanced by automated monitoring, including sound and video, of feeding and drinking behaviours as well as environmental conditions. New approaches include sensor detection of specific volatile organic compounds indicative of infectious agents in the air in poultry houses. Together with rapid farm-based diagnostic testing, this trend to precision poultry production provides an opportunity to enhance vigilance for health.

Poultry may also be a source of human food-borne infection, especially campylobacteriosis and salmonellosis. Thus, consideration of hygiene through the food chain is essential as part of One Health. As in other parts of the agrifood industry, labour can be a limiting factor and automation in production and in abattoirs and food processing can mitigate this threat through increasing efficiency.

Coccidiosis is a common disease contracted by ingestion of oocysts found in feed, dust and other materials. Control is usually using ionophores, anti-parasiticides that reduce multiplication and allow natural resistance to be established. Vaccines are available, which are especially valuable for laying hens and breeding birds when ionophores cannot be used.

CIEL collaborates with SRUC in delivering research and innovation including nutrition and welfare through the Allermuir Avian Innovation and Skills Centre (AISC), the Centre for Digital Innovation Applied to Livestock (C-DIAL) at Newcastle University and the University of Bristol Poultry Research Farm, where research topics include laying hen and broiler health, welfare and behaviour.

Pressure points and opportunities for innovation

- Vaccine delivery systems, to make administration easier by reducing labour costs and, potentially, stress to birds
- Genetic improvement focussed on health, e.g., for leg weakness
- Automated health monitoring systems for large numbers of birds under the care of small numbers of staff
- Promotion of gut health, including use of pre- and probiotics, antioxidants etc.

Overview of the UK Aquaculture Sector

Aquaculture has boomed since the 1980s and most of the products we eat will be farmed in the coming decade.

In 2020, **the UK produced approximately 217,000 tonnes of farmed fish and shellfish, worth approximately £1 billion** – 90% of which was salmon, of which **UK is one of the top five producers globally**.

The aquaculture industry also produces **fishmeal and oils** as ingredients for animal feeds.

The sector enjoys a **Compound Annual Growth Rate (CAGR) of over 9%**, with more than **400 companies employing almost 3,000 people**.

In the UK, the main aquaculture species are salmon, rainbow trout, mussels and oysters. Other species include sea bass, clams and freshwater shrimp. Trout and shellfish production is frequently undertaken by smaller, family-owned businesses. These may have niche importance, for example in Northern Ireland's sea loughs. Salmon farming is based in Scotland, where sheltered sea lochs provide suitable locations for pen rearing. Eleven companies farmed 232 active sites in 2020; the largest are MOWI Scotland, Scottish Sea Farms, and Cooke Aquaculture Scotland.

Salmon production cycle begins in freshwater hatcheries, where small parr are produced. These are supplied to freshwater smolt-rearing facilities, which typically use recirculating aquaculture systems (RAS). These enable a highly controlled environment and effective management and control of wastes. Cooke Aquaculture Scotland supplied more than 8.5 million of the 52 million smolt put to sea in 2020.

Feed represents 50 – 60% of the cost of producing salmon and includes fishmeal and fish oils. Substitutes for marine ingredients are being actively sought, not least because of the increasing cost of fishmeal. For example, Cargill have reduced these components from 55% to 27% over ten years. In common with other livestock species, there is significant opportunity for genetic selection and application of breeding tools and technologies to improve the productivity and sustainability of aquaculture.

Salmon production may be threatened by three important notifiable viral diseases – Infectious Salmon Anaemia (ISA), Infectious Haemopoietic Necrosis (IHN) and Viral Haemorrhagic Septicaemia (VHS). Outbreaks can only be controlled by slaughter, so effective surveillance for early detection is essential.

Effective vaccines are available for two further viral diseases – Pancreas Disease (PD) and Infectious Pancreatic Necrosis (IPN) and three bacterial infections – Furunculosis (Aeromonas salmoncida), Enteric redmouth (Yersinia ruckeri) and vibriosis (Vibrio anguillarum). However, control of other conditions, including Cardiomyopathy Syndrome (CMS), which is believed to be caused by Piscine Myocarditis Virus, Proliferative Kidney Disease (PKD), caused by Tetracapsula bryoslamonae – a myxozoan parasite, and complex gill disease (CGD), which has a complex aetiology, rely on hygiene, biosecurity and treatment as necessary. Vaccine delivery is often by intraperitoneal injection, which involves handling and is stressful for fish. Recently, oral delivery systems using nanoparticles in feed promise easier administration for furunculosis and pancreas disease; this technology may be adaptable for other infections.

Salmon health and welfare is fundamental to efficient production. Sea lice are a serious problem and treatments include emamectin benzoate with azamethiphos. However, concerns about resistance and pollution have encouraged other approaches. These include the use of cleaner fish, such as ballan wrasse and lumpfish, which physically remove lice. A Sustainable Aquaculture Innovation Centre (SAIC) project is studying fish behaviour, using machine vision devices developed by Visifish to capture data for artificial intelligence (AI) modelling. Another approach is inclusion of β -glucan, a sugar molecule, to feed, which can reduce the burden by around 20%.

Innovation in diagnostics promises to enable early detection of infectious diseases. For example, SAIC and partners are developing a biomarker test for CMS, which could replace current post-mortem and PCR tests. Others are investigating use of the WellFish Diagnostics platform for PD, CGD and CMS. There are important opportunities for further improvements in fish health, since access to a broad range of affordable diagnostics is limited and treatment or control for CGD and PKD is limited. Enhanced sector-level surveillance to enable real-time response would mitigate threats to the industry from epidemic diseases such as ISA, IHN or VHS.

The Ace Aquatec Multibeam sonar enables remote measurement of fish health and detection and deterrence for predators e.g., seals. Artificial intelligence (AI) is applied to signalling to enable these multiple outcomes to be determined. Environmental conditions, including salinity, pollution, oxygenation and temperature may have a profound effect on salmon disease and environmental monitoring has a crucial role in early warning of disease risk. Stress is also an issue, which may be indicated by fin integrity, feed intake and survival. The Scottish salmon industry is a world leader in welfare, abiding, for example, to standards set by the RSPCA Freedom Food initiative which considers the production phase, handling, transport and slaughter. Other welfare standards include Label Rouge, BRCGS, the Best Aquaculture Practices (BAP) scheme and Aquaculture Stewardship Council (ASC).

Animal health and welfare, food safety and feed ingredient supply are amongst factors that could limit future growth. There are also public concerns, e.g, pollution, risk to wild species from escapes, exchange of genetic material and impacts on the coastal environment. Approaches that mitigate some of these issues include the use of multi-species systems, enabling nutrient recycling and reducing effluent burdens. An integrated One Health approach to risk management is therefore needed that accounts for animal, human and environmental health. In the longer term, threats to aquaculture include consequences of climate change, such as warming and acidification of the oceans, extreme storms and flooding that damages infrastructure.

Pressure points and opportunities for innovation

- Control of health and disease – novel non-invasive diagnostics; non-chemical control of sea lice; control of complex gill disease; improved delivery of treatments and vaccines; reducing stress
- Remote monitoring of environment and fish for early disease detection; improved surveillance

Overview of the

UK Equine Sector

Sport, leisure and working

The horse has been domesticated for 6000 years and used for transportation, traction, meat, hair, and leather production.

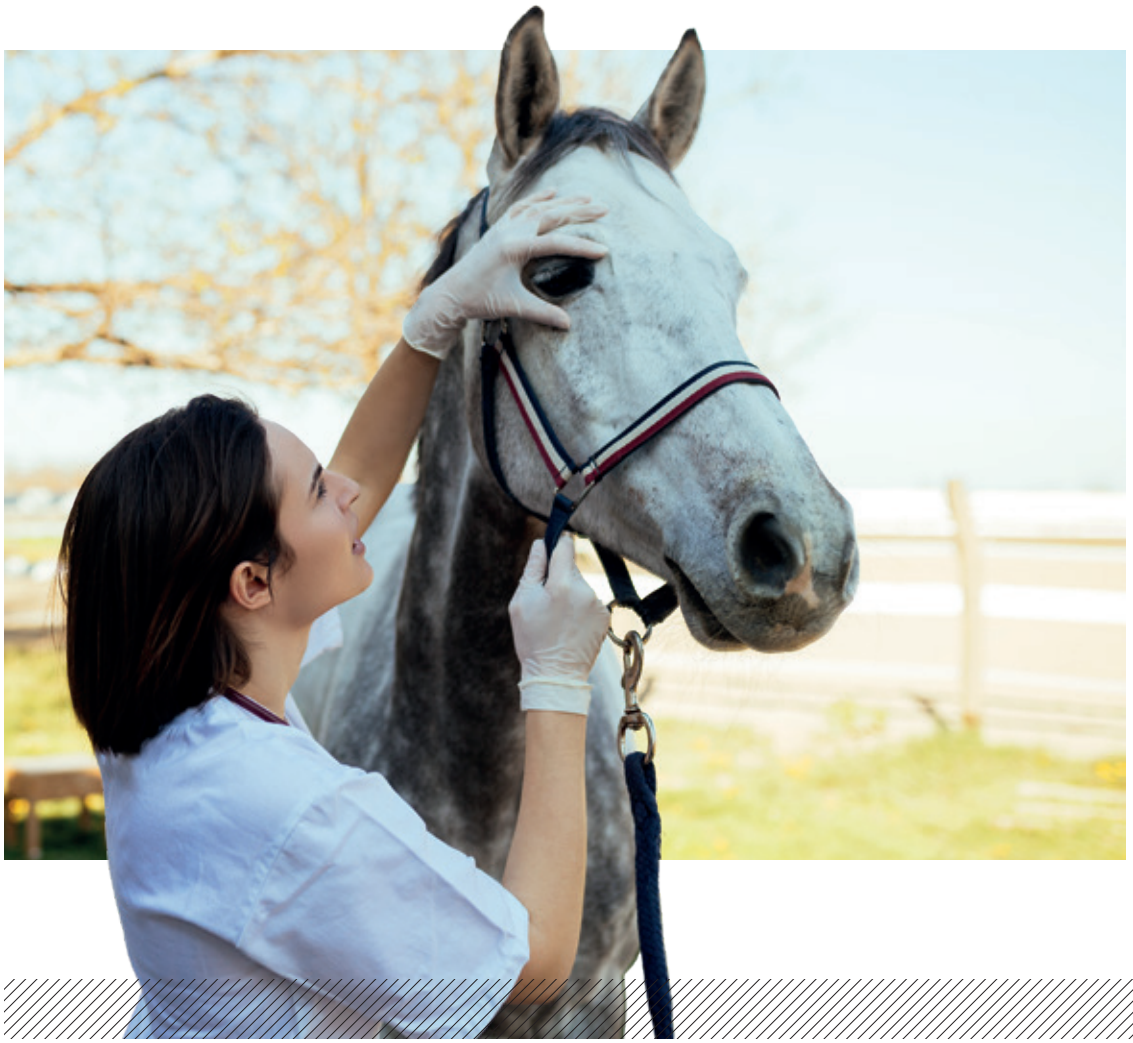
While powered machinery has replaced use of horses in modern agriculture, **up to 100 million are still used for agricultural worldwide**.

Since the 1960s, equine sports have grown in popularity, putting horses back into an important economic position, **valued at around £240 billion**.

The associated animal health market is predicted to reach ~**£695 million by 2025, with annual growth of 4.2%**.

The UK equine industry is highly regarded, contributing £8 billion annually to the economy and directly employing over 85,000 people, the second-largest rural employer. Horse racing and breeding alone generated £3.45 billion in expenditure in 2012. Sporting events attract 7 million spectators a year, generating ~£4 billion in profits. It is the second most popular spectator sport, after football.

The UK population had ~850,000 horses with an estimated number of nearly 374,000 horse owning households in a 2019 survey. Horse riding delivers benefits to ~3.5 million people in physical and mental health and equine therapy provides significant benefits to people with physical and emotional disabilities.



Common health problems include lameness, with a multitude of causes, and colic, which can be acute and catastrophic. Up to a third of horses reportedly suffered from at least one chronic health condition and these may be unnoticed in older horses, limiting quality of life.

Important infectious diseases include strangles (equine distemper), that often manifests as outbreaks in stables, and equine influenza, which is readily transmitted where horses congregate, such as sales and sports events. For the latter, effective vaccines are available and up to date vaccination may be a prerequisite of participation. Prompt diagnosis by pen-side tests in stables facilitate isolation of affected animals in the face of an outbreak and identify individuals for early treatment.

The Horse Trust, Horserace Betting Levy Board (HBLB), the Racing Foundation and the Sport Horse Research Foundation all fund research, as do charities such as World Horse Welfare and Brooke. Surveillance insights are available from sources including Equine Veterinary Surveillance Network (EVSNET) for the UK Equine Population, Equine Infectious Disease Surveillance (EIDS), Equine VetCompass and Animal and Plant Health Agency (APHA).

The complex interaction between performance, environment and health in horses make innovation in sensing and monitoring an exciting new field. Companies and devices such as Estride, Horsepal, EquinITy and Smarthalter fit to horse tack to provide information on gait, activity, heart rate in real-time or provide 24/7 alerts to unexpected change and can also inform training.

Gut health is closely linked to risk of some types of colic, amongst other conditions, so promoting a healthy gut through use of prebiotic and probiotic supplements as part of a healthy diet can be valuable. A health and well-being system could improve health and quality of life for geriatric horses and those with chronic conditions through reminders of routine procedures and early detection/warning systems for signs of disease. Figure 1 highlights further pressure points and technology applications. New innovations include automated control and intervention to detect and resolve air pollution in stables, and recording data on feeding and management strategies to prevent diseases associated with inappropriate nutrition and diet.

Increased participation in riding, the growth in value of the equine sector and the innovation landscape with new products and services show that the sector is thriving. Key areas where research and innovation are required include addressing lameness, gut health and prevention of infectious disease. In both leisure and professional sports, equine health and welfare is crucial to growth of the sector. The UK provides a fertile network of research excellence, proactive business and innovation to yield excellent returns on investment in equine health and welfare.

In determining the opportunities for launching new products or services, an appreciation of the structure of the sector is important (Figure 1). Highly specialised areas, such as racing, have professional staff and dedicated businesses, whilst the leisure sector is more disseminated. Family owners may use livery stables and informal shared grazing; riding schools, trekking centres etc. are usually small family-run businesses. Leisure riders may compete to high standards in equine sports as amateurs before some progress to become professional. Nevertheless, a range of services, including veterinary care, farriery, insurance, feed supply and equipment are shared across these sectors, which are also differentiated by the sums that can be spent on these goods.

Pressure points and opportunities for innovation

- Control of air quality in housing – intelligent mechanical ventilation systems
- Technology to monitor diet and nutrition – application for mobile device of horse's owner
- Fitness assessment to aid training and competition of sport horses – rider/horse interaction analysis, ECG, Respiratory Rate (RR), Heart Rate (HR) and Temperature (T), blood snap test & other biomarkers, as feedback to rider & trainer
- Detecting early signs of pain and stress – camera systems, algorithms and wearables for face & posture pain or stress recognition using artificial intelligence and machine learning for owners and vets
- Motion asymmetry measurement systems to aid lameness diagnosis – inertial motion sensor units (IMUs) & wearables for veterinary use
- Measuring information on health, and Quality of Life parameters for geriatric horses and those with chronic conditions – application for mobile device of horse's owner; smart wearables

Figure 1: Overview of the equine sector

Goods and Services:

- Veterinary
- Technicians
- Farriers & saddlers
- Equine dental
- Chiropractors
- Feed & equipment supply
- Chartered physiotherapists
- Osteopaths

Professional horses & riders

- Breeding
- Affiliated competition
- Horse and rider training
- Horse racing
- Horse shows
- Police and army

Semi-professional horses & riders

- Semi-professional breeders
- Semi-professional competition

Leisure horses & riders

- Breeding
- Unaffiliated competition
- Riding schools
- Trekking
- Hunting

Overview of the

UK Companion Animal Sector

Expenditure on pets in the UK was almost £10 billion in 2021, of which 38% was spent on veterinary and other services and 40% on pet food and associated products.

There was a boom in pet ownership during the Covid-19 pandemic and the sector continues to show strong growth, with a compound annual growth rate (CAGR) of 9%.

Almost **60% of households in the UK keep a pet**, including ~12 million dogs and 11 million cats. These are acquired from breeders, but also from a substantial rehoming sector. A diverse population of some **5 million other small pets** includes rabbits, guinea pigs, gerbils, hamsters, rats, birds, tortoises, turtles, lizards, snakes and indoor fish.

A higher probability of genetic problems accompanies several of the most popular breeds, leading to health and welfare issues. **Insurance is popular and had a market value of £1.4bn in 2021**, with a CAGR of more than 6%.

The value from keeping pets lies in the emotional and physical benefits that they deliver. This includes impact on important public health concerns, for example obesity, mental health and dementia. The UK has around 7,000 assistance dogs including guide dogs for the blind. Pets share their environment with their owners, which has important One Health considerations. Given the public health benefits from keeping pets, equity of access is important.

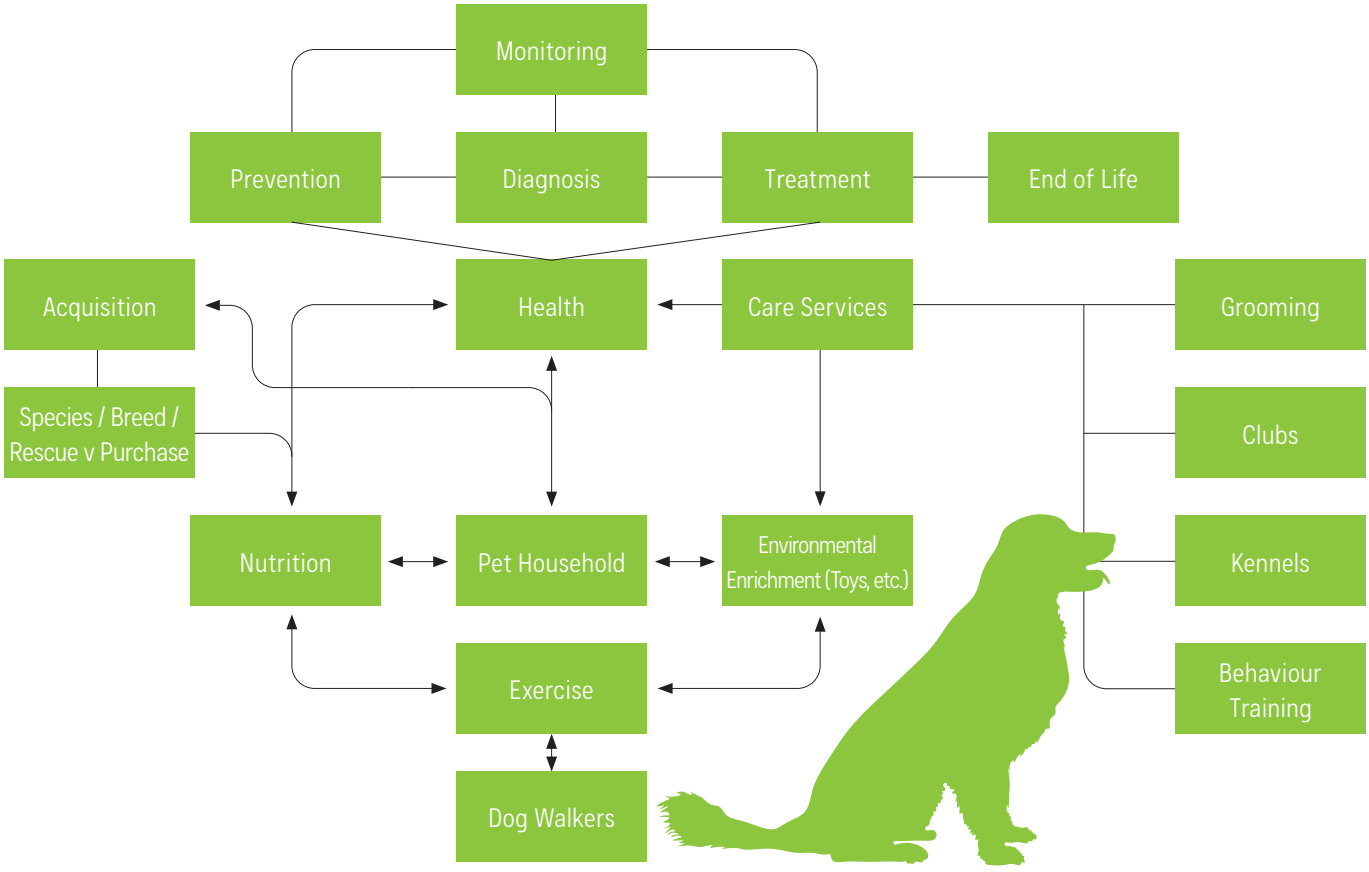
Companion animal research may provide insights into factors related to cancer or chronic disease, that could be relevant to human health. They also share microbial populations; for example, bacteria with antimicrobial resistance (AMR) and gut and skin microbiomes may share characteristics, as well as the risks from zoonotic disease.

Pet owners engage with a virtual ecosystem to source products and services, encouraging a proliferation of Business-to-Business as well as Business-to-Consumer activities which are increasingly connected. Innovation seeks to deliver value within and across this ecosystem. There has been a significant increase in digital technology in the companion animal sector, including a plethora of apps and wearables with an estimated 7% CAGR in this sector to 2028. Amongst the latter, use of activity and GPS trackers is popular. In future, it is possible to imagine an 'internet of pet things', where data from a diverse range of internet-enabled devices and monitors are integrated to provide dynamic insights into pet behaviour and quality of life.

Pressure points and opportunities for innovation

- Access to valid and reliable information, as pet owners turn to the internet for advice
- Enhancing quality of life by addressing issues such as chronic disease, obesity and unwanted behaviours
- Improving preventive medicine as only 40% of dogs and cats maintain routine vaccination schedules and control of internal and external parasites is also poor
- The advent of precision veterinary medicine promises improvements in diagnosis, treatment and control of disease

Figure 2: The Petcare Ecosystem



2 Overview of the UK Animal Health Sector

The UK animal health market, including innovative therapeutics and diagnostics, was valued at £1.2 billion in 2020 and is predicted to grow at a compound annual growth rate (CAGR) of up to **9.5% to 2028**.

Growth is driven by several factors, including pet ownership, with owners investing in products and services such as preventive care, nutrition, grooming, and insurance.

Livestock play a vital role in supplying high quality protein food products, and require effective health management to support productivity, efficiency, welfare, and sustainability.

There is rising awareness about threats that zoonotic diseases and antimicrobial resistance (AMR) pose to public health and the economy, such as Covid-19, Avian Influenza, bovine tuberculosis, and salmonellosis. The animal health sector plays a crucial role in preventing and controlling these risks through innovation, surveillance, stewardship, and collaboration. This presents attractive investment opportunities for investors looking to generate returns by investing in active companies within these areas.

Research and innovation

The UK has a diverse and well-balanced animal health ecosystem of universities, institutions, and companies that support a culture of innovation, with initiatives and resources for startups to thrive, driving growth and advancement of animal health solutions. This covers the full range of the Technology Readiness Level (TLR) scale (see Figure 3), which is used to measure maturity of an invention or innovation from 1, representing the ideation stage of a potential solution such as a vaccine, to 9, indicating proven effectiveness and widespread use. Intermediate stages encompass the development, testing, and validation of these technologies in both laboratory and real-world settings and different sources of funding support transition through these stages.

Animal health is a highly regulated sector. The Veterinary Medicines Directorate (VMD) is the UK regulator for veterinary medicines, assessing and authorising new medicines and monitoring their safety. As the pace of innovation in animal health accelerates, new demands are placed on the regulatory system. The VMD Regulatory Science Strategy 2021 – 2026 aims to anticipate future technological advances and novel approaches, addressing scientific and regulatory challenges, whilst the European Medicines Agency (EMA) European Veterinary Big Data Strategy seeks to converge traditional regulatory practice with innovative digital solutions.

The UK Agri-Tech Centres, supported by Innovate UK, the UK's innovation agency, join up excellence and invest in pioneering resources and research, unlocking opportunities for transformational change across the agricultural industries. As the UK Agri-Tech Centre established to drive innovation within livestock and aquatic food production, CIEL has led the investment of ~£70 million in UK livestock research capability. This includes a multi-million-pound development in the ground-breaking Large Animal Research and Imaging Facility (LARIF) at the University of Edinburgh's Roslin Institute, enabling unprecedented insights into the health and well-being of livestock and the prevention of human diseases.

Investment opportunities

The global animal health sector is undergoing transformation driven by consolidation of companies and diversification of portfolios aiming to achieve economies of scale, expand market presence, enhance product portfolios, or gain competitive advantage. Innovation and digitalisation are major drivers reshaping the health industry. Biotechnology, nanotechnology, genomics, artificial intelligence (AI), big data analytics, and blockchain are among the technologies leveraged to develop novel solutions that address unmet needs, improve performance and efficiency, enhanced customer experience, and create new business models.

The UK offers attractive investment opportunities for existing players and new entrants seeking to capitalise on its growth potential and competitive edge. With careful assessment and management to identify and overcome industry challenges or uncertainties, adopting a collaborative and sustainable approach is necessary to meet the evolving needs and expectations of different stakeholders.

Figure 3: The Technology Readiness Level (TRL) in animal health measures the maturity of technologies in veterinary medicine

Disruptive Research

1. Idea Stage
Basic Technology Research
> Basic principles observed and reported

2. Market Research
Research to prove feasibility
> Technology concept and/or application formulated

Applied Research

3. MVP
Technology Development
> Analytical and experimental critical function and/or characteristic proof-of-concept

4. Seed Funding
Technology Development
> Component and/or validation in laboratory environment

Pilot Product

5. Incubators / Accelerators
Technology Demonstration
> Component and/or validation in relevant environment

6. Series A Funding
System Development
> System model or prototype demonstration in a relevant environment

7. Product Development
System Development
> System prototype demonstration in an operational environment

Manufacturing

8. Series B, C, D etc
System Launch & Operation
> Actual system completed and qualified through test and demonstration

9. IPO or Acquisition
System Launch & Operation
> Actual system proven in operational environment

Market for animal health products and services

The value of the UK animal medicine market is approximately £745 million, approximately 62% of the total value of the sector. It includes vaccines, ectoparasiticides, endoparasiticides, endectocides, antimicrobials, reproductive management treatments, anti-inflammatories, and other therapeutic medicines for livestock, aquaculture, equine and companion animals. Notably, the relative value of medicines to prevent disease, such as vaccines, is increasing compared to antibiotics, reflecting the sustained efforts of the UK livestock sector in responsible antibiotic use. Several global and innovative corporations are active in the UK, providing opportunities for start-ups to extend their impact and reach, with increasing focus on the responsible use of all medicines, embracing sustainability and One Health.

Animal health products and services include training, diagnostics, technical support and an expanding interest in data and digital innovation.

Whilst the therapeutics sector reportedly shows a compound annual growth rate (CAGR) of around 4%, the data and digital area is forecast to grow at 10% or more. In the therapeutics area, innovative treatments based on monoclonal antibodies and stem cell therapy, antivirals (e.g., for canine parvovirus), treatments for cancer and addressing chronic conditions in companion animals such as osteoarthritis, diabetes and kidney disease demonstrate the breadth of opportunity for improving animal health. Development of novel therapies is a global endeavour and advances are exchanged between human and veterinary medicine. The Royal Veterinary College undertook early research in stem cell therapy for equine tendon injuries and now offers a stem cell clinic. The AURA Veterinary oncology centre treats cancers and has an active research and innovation programme.

Globally the diagnostics market is valued at £2.6 – 5.7 billion and is forecast to grow at around 11% to 2030. Diagnostics encompasses physiological measurements, imaging, pathology and diagnostic tests for infectious and non-infectious diseases. The increasing sophistication of these tests, combined with reducing costs and the ability to deliver them at the point of care – in the veterinary clinic, stable or farm – enhances the development of precision veterinary medicine. This is based on increased volumes of information, creating a demand for information management systems designed for the vet and stock managers on farm. The role of artificial intelligence (AI) including, for example, ChatGPT and large language models (LLM) in synthesising big data and presenting easily assimilated insights for the animal health community, will undoubtedly increase and necessitate oversight to manage potential risks with respect to bias and validity.

Supply chain

The UK has a mature and evolving ecosystem of animal health services available, including veterinary services, animal feed manufacturers and suppliers, animal health laboratories, animal welfare organisations, government agencies, agricultural suppliers, and research institutions.

Extensive veterinary services are provided across the UK, offering healthcare and treatment. Animal health laboratories provide testing services, including disease diagnosis and monitoring, nutritional analysis, and genetic testing. Animal welfare organisations offer a variety of services related to animal health and well-being, such as rescue, rehabilitation, and rehoming of animals in need. Animal feed manufacturers and suppliers offer a wide range of feed options, from standard commercial feeds to custom formulations for specific animals and conditions that may include specific mineral supplements or therapeutics. There has been a significant growth in the market for nutraceuticals, prebiotics and probiotics. The present global value is £2.6 billion with a CAGR of 7.9%.

Access to animal health and veterinary services may be made more affordable through insurance, and the UK market was valued at more than £1 billion in 2021, with an anticipated growth of 11%. Opportunities exist for insurance companies to add other services to their products for client benefits, e.g., provision of veterinary advice or access to apps and wearables to monitor health.

At a Glance: The UK Animal Health Sector

- With proactive, collaborative, and sustainable approaches, the UK's animal health sector is well-positioned to meet the needs of animals, humans, and the environment. It is experiencing significant growth with key drivers such as the increasing rate of pet ownership, demand for animal protein, and concerns regarding zoonotic diseases and antimicrobial resistance
- Major companies are actively involved in research and development to meet the evolving needs of animals and people. Many start-ups are working in the space of health diagnosis and hygiene management for livestock and companion animals. Some industry players are focussing on consolidation, innovation, and digitalisation to gain a competitive edge
- Industry is supported by a comprehensive network of animal health services, including veterinary services, animal feed manufacturers and suppliers, animal health laboratories, animal welfare organisations, government agencies, agricultural suppliers, and research institutions
- The breadth and depth of animal health activity, span of the health market, and excellence in science make present an attractive investment opportunity in the UK, for globally relevant research and innovation

3 Grand Challenges and Animal Health Solutions

Farming faces many challenges in a changing world, with some specific to livestock and aquatic food production. These overlap with those for other animals in our care as well as wildlife.

Food security is a major issue in countries faced with challenging environments, poverty or man-made conflicts. Modern trade introduces distortions to food security internationally, and paradoxically it is argued that it underpins excessive consumption of animal-sourced foods in developed countries. Added pressure comes from projected increases in the human population, exaggerated further by expected increases in standard of living leading to greater demand for protein from some large cohorts in this population.

Where food security is focussed on receiving adequate nutrition, animal-sourced foods are key to the nutritional well-being of most people. Even in well-developed economies, they are considered essential by many for infants, growing children, reproductive age women and the elderly. There has been a degree of polarisation in debate of these issues, but increasingly evidence is being published on this important role animal-sourced foods have in human diets. Since the efficiency of animal production impacts on food security, animal health impacts on food security.

Antimicrobial resistance

When first discovered, antibiotics were a gamechanger for human and animal health. Within the livestock sector, this meant a greater focus could be put on production and efficiency. It was found that animals fed low levels of antibiotics had higher feed conversion efficiency, so their use became common place. Misuse of antibiotics in people and animals leads to the development of antimicrobial resistance (AMR) and loss of antibiotic efficacy, with challenges in controlling infections. Following considerable reductions in antibiotic use across the UK livestock sector, the focus now includes looking at ways to reduce the need to use antibiotics in the first place. Simple, rapid pen-side tests for pathogens are needed for early disease detection and appropriate treatment. Data will be a key tool in managing disease and treatments in future, while nanotechnologies, and pre- and pro-biotics offer scope for managing the microbiomes of the gut in new ways. AMR is a challenge to production efficiency, animal health and welfare.

Environmental impact

Climate change is another challenge, with livestock involved in two different ways:

Firstly, they are implicated with global warming because they contribute greenhouse gas (GHG) emissions directly from their own biological processes, and indirectly from the systems used to feed and manage them. For ruminants, the main focus is methane, a potent GHG, produced when microbes in the rumen digest fibre in the diet. This constitutes the largest part of their carbon footprint and much of the direct emissions from agriculture overall. However, there are other GHGs associated with livestock, and significant emissions associated with production and use of artificial fertilisers and feed production overall. This is where the largest proportion of the carbon footprint is for modern, high-productivity pig and poultry systems. These are simplistic portrayals and a series of CIEL reports explore this challenge in greater detail, to include helping farmers minimise emissions from different livestock types. Good animal health improves production efficiency, which is a key factor affecting emissions intensity.

The other challenge related to climate change is the direct impact that it has on animals themselves. It is likely to alter the incidence of different diseases as temperatures rise while increases in volatility of weather will also impose drought or flooding more often, affecting animal access to food and water. This will place extra or new stresses on livestock, impacting health and welfare and reducing their efficiency. Rising environmental temperatures will likely increase energy needed for maintaining control of housed livestock environments, with associated increases in indirect emissions.

Environmental impacts of agriculture are receiving greater scrutiny than ever before. Making the most efficient use of our natural resources is needed to reverse degradation of these resources in some areas, and to reduce competition for resources e.g., the food vs feed (human vs animal nutrition) debate about use of good agricultural land. This underpins the concept of circular food systems and relegates some classes of livestock to the role of turning low grade feed material, of limited value to human nutrition, into high quality animal-sourced foods, ideal for human nutrition. Such systems may mean animals have different needs in regard to optimising animal health and welfare.

These effects are tied up in the issues addressed by the United Nations (UN) Sustainability Development Goals (SDG), all of which have a livestock dimension (Figure 4). These also highlight the lower access to good animal health care in low- and middle-income countries (LMIC), compared to more developed countries, limiting the gains provided by improved animal health. The UK has a good record in working in this specific area, with work funded through the Bill & Melinda Gates Foundation to benefit animal health in LMICs being carried out by UK researchers working with international health providers. The UK is also involved in initiatives such as the One Health Poultry Hub, led by the Royal Veterinary College (RVC) and working in Asia with global partners, and GALVMed to develop and provide medications, vaccines and diagnostics for livestock keepers in LMICs.

The key thread linking these impacts to solutions is the effect animal health has on efficient production of high quality, animal-sourced foods. Programmes wishing to address these grand challenges must consider animal health as a key route for delivering significant improvement.

Figure 4: The UN Sustainable Development Goals

4 UK Animal Health Capability

Education, Research and Development

The UK is a global leader in education, research and development (R&D) for the animal health market, with a strong track record of innovation and excellence in animal disease prevention, diagnosis, and treatment.

Universities and further education colleges provide a wide range of courses related to animal health, including animal and biological sciences, animal nutrition, veterinary nursing, farriery, engineering and animal handling, ensuring a pipeline of talent across the breadth of job opportunities. Significantly, five of UK's veterinary schools are ranked in the top 20 globally. Increasing demands for vets in the UK has seen seven new veterinary schools established since 2000, and efforts are being made to increase the participation of under-represented groups, particularly candidates from ethnic minority backgrounds. The quality of UK veterinary education attracts students from around the world. Research and innovation in animal health increasingly requires multi-disciplinary approaches engaging, for example, genetics, social science, engineering, mathematics, computing and data science, which are also UK research strengths.

A host of UK institutions, which illustrate this expertise and their contribution to national and international animal health management, include the **Pirbright Institute**, an internationally recognised centre for research on exotic viral diseases of farm animals and zoonotic organisms and host institution for the **BBSRC National Vaccinology Centre**. The **Animal and Plant Health Agency (APHA)** undertakes animal health research and surveillance, focussing on diseases of livestock. In 2020, the Agency announced a £1.4 billion investment to redevelop and future-proof its world-leading Weybridge facility. The **Centre for Environment, Fisheries and Aquaculture Science (CEFAS)** safeguards aquatic health. APHA, CEFAS and the Pirbright Institute host national and international reference laboratories for a wide range of animal diseases.

The University of Edinburgh's **Roslin Institute** is a world-leading centre for animal science research, with renowned expertise in genetics and hosts the **National Avian Research Facility (NARF)**, providing resources, collaborative expertise and advice for avian biology research. The CIEL-supported **Large Animal Research and Imaging Facility (LARIF)**, highlighted earlier in this report, is co-located with the Roslin Institute on the University of Edinburgh Easter Bush Campus. The Campus is home to further CIEL-supported livestock research capability covering all livestock species developed in partnership with Scotland's Rural College (SRUC). Facilities include the **Allermuir Avian Innovation and Skills Centre (AISC)**, which is the UK's largest facility to improve avian nutrition, health and welfare. Collectively, the Easter Bush Campus represents the largest concentration of animal science-related expertise in Europe. Close by, the **Moredun Research Institute** delivers world-class scientific research to improve animal health and welfare through the prevention and control of infectious diseases of livestock.

The **UK Surveillance Forum (UKSF)** ensures that intelligence regarding animal health across the devolved administrations is coordinated. The **Wales Veterinary Science Centre**, **APHA's veterinary surveillance centres**, the **Agri-Food and Biosciences Institute (AFBI)** in Northern Ireland and SRUC's disease surveillance centres provide diagnostic testing, disease control programmes and research to support animal health.

Spotlight

Large Animal Research and Imaging Facility (LARIF)

Developed in partnership

THE UNIVERSITY of EDINBURGH · ROSLIN · CIEL

With the support of

UKRI Innovate UK

Enabling unprecedented insights into the health and well-being of animals and the prevention of human diseases – a One Health approach

Overview

LARIF allows users to benefit from unparalleled facilities alongside a wide range of expertise in farm animal production and animal health & welfare.

Research within LARIF supports the One Health framework, recognising the link between human, animal and environmental health. Specialist facilities available for in-depth studies include: containment areas for work involving infectious pathogens; facilities for advanced gene technologies; environmentally controlled units suitable for behaviour and welfare studies; imaging, surgical and critical care facilities for large animal models of disease; and development of medical technology that will benefit both humans and animals.

Key research expertise

Users benefit from a wide range of expertise in farm animal production, health and welfare including:

- Infectious diseases and zoonoses
- Vaccines
- Genetics and genome editing
- Imaging
- Radiology
- Medicine
- Surgery and critical care

Welfare

A Culture of Care is central to the function of LARIF and animal welfare is of utmost priority. All work is undertaken in line with UK Home Office Guidelines and licencing requirements and is overseen by a team of dedicated, independent Named Veterinary Surgeons.

Impact

- Linking One Health initiatives with animal health and disease epidemiology through advancing study of the physiological state of animals and gene expression
- Supporting research in animal health and veterinary therapies
- Enabling advances in immunology and host defence, neuroscience and developmental biology across multiple livestock species

Email: larif@ed.ac.uk
www.ed.ac.uk/roslin/facilities-resources/larif

CIEL (Centre for Innovation Excellence in Livestock)

CIEL is one of the world's foremost farm animal research alliances and a leading membership organisation which brings together an active network of industry members spanning the food supply chain, including producers, processors, retailers, veterinary health, feed companies and SME innovators, all with an interest in R&D and improving UK food systems. CIEL's reach also extends across government, providing a voice to ensure important industry issues are addressed, championing new ideas, and providing our members with unparalleled opportunities to partner in projects.

CIEL's membership includes many of the leading UK animal science institutions as partners, connecting with more than 20 animal health-related research facilities. In addition to LARIF and the Allermuir AISC, the research capability developed in partnership between CIEL and its academic members includes the Centre of Digital Innovation Applied to Livestock (C-DIAL) at Newcastle University; the Centre for Dairy Science Innovation (CDSI) at the University of Nottingham; and the National Pig Centre at the University of Leeds.

Comprehensive information on all CIEL-supported research facilities, to include a number of virtual walkthroughs, is available from the CIEL website.

UK animal health policy

The animal health sector is impacted by government policies and strategies in several areas including food and agriculture, environment and climate change, public health, including antimicrobial resistance (AMR) and innovation and industrial strategy. UK animal health and welfare policy is mostly devolved in legislative terms to the governments of Scotland, Wales and Northern Ireland.

The UK is undergoing a seven-year transition, which began in 2021, towards payment for environmental goods and services alongside food production. The Green Future 25 Year Environment Plan introduced this strategy, which includes incentivising farmers to adopt nature friendly practices. Alongside this, the UK Government Food Strategy aims to ensure a prosperous agrifood sector, securing food supply and ensuring that employment opportunities are available across the UK. Choice in high-quality, locally produced food should be available for healthier diets, whilst international trade should offer opportunities for export as well as imports to supplement UK produce.

UK policy has had a positive impact on animal welfare with the Action Plan for Animal Welfare addressing all domestic animals, including pets. The implementation of strict animal welfare standards, the reduction in disease outbreaks, improved access to veterinary care, and the reduction in antibiotic use have all helped to improve the health and welfare of animals.

The Department for Environment, Food and Rural Affairs (Defra) Animal Health and Welfare Pathway involves three mutually reinforcing strands: financially rewarding farmers who deliver public goods; stimulating market demand for higher welfare products; and improving animal health and welfare outcomes. There are also plans to eradicate bovine tuberculosis (bTB) by 2038, continue to prioritise tackling AMR, and support the Net Zero strategy for climate change. The Livestock Information Service, a joint venture between government and industry, supports livestock traceability for disease control and food safety.

The UK Innovation Strategy envisages that the UK will be a "global hub for innovation" by 2035, as a component of the agrifood industry as well as life sciences. The projected £22 billion public investment should extend to appropriate animal health-related opportunities. The UK Digital Strategy and National AI (artificial Intelligence) Strategy also offer opportunities for businesses to apply artificial intelligence and digital solutions within animal health.

Funding for UK animal health

In 2020 the UK Government announced a £1.2 billion APHA investment in the Science Capability in Animal Health (SCAH) programme. This development of APHA's facilities is designed to support world-class research, surveillance and testing capability to protect animal health. A joint initiative between the Biotechnology and Biological Sciences Research Council (BBSRC), the Foreign, Commonwealth & Development Office (FCDO) and the Bill & Melinda Gates Foundation, have jointly funded up to £40 million for the new Centre for Veterinary Vaccine Innovation and Manufacturing (CVIM) at the Pirbright Institute to help accelerate the development of animal vaccines to combat emerging and urgent infectious diseases. The CVIM aims to strengthen UK's own emergency response capacity and capability, focussing on the diseases most prevalent.

The Scottish Government have funded animal health start-ups through incubators and accelerators, such as the Roslin Innovation Centre, part of the University of Edinburgh, with £58 million in phase one and £20 million in phase two contributing towards new animal facilities. The Centre of Expertise on Animal Disease Outbreaks (EPIC), which is funded by the Scottish Government, provides risk-based evidence through: (1) rapid access to emergence advice and analyses; (2) estimating disease risks and improving disease detection; (3) assessing different disease control options; and (4) improving future risk resilience.

In Northern Ireland, the Agri-Food and Biosciences Institute (AFBI) provides research and scientific services to a wide range of organisations. AFBI has a range of innovative projects, including consideration of climate change and nutrition for farm animals, application of virtual fencing, dairy farming systems and sustainability. Queen's University Belfast (QUB) hosts the Institute for Global Food Security where their Agriculture and Environment Resilience programme encompasses animal production, health, welfare and behaviour.

In Wales, the Animal Health and Welfare Framework and implementation plan sets out the roadmap for improvements in standards of animal health and welfare for kept animals, including funding support for disease eradication programmes and the control of AMR in animals and the environment.

Perhaps the most notable difference between livestock, including poultry and aquaculture, and the equine and companion animal sectors, is the lower investment in research and innovation by government for equine and companion animals. For these sectors, commercial industry provides the greatest investment. Animal welfare research is supported by government to a degree, with charities providing a significant source of funding, reflecting public interest in animal welfare in the UK.

CIEL Commentary

By Dr Grace O'Gorman and Dr Mark Young, CIEL

There is a clear and multi-faceted opportunity for investment in animal health based on challenges across the livestock, aquaculture, equine and companion animal sectors. The UK has a collaborative and innovative ecosystem that can deliver the solutions needed to address these challenges.

Those solutions should consider the complex interactions between health, nutrition, welfare, genetics and environment in the management and care of animals.

Common challenges for livestock include sustainability, farm profitability and environmental impact. Health management through prevention, early detection and timely treatment is central to many One Health issues, such as AMR, where vaccines and responsible antibiotic use are becoming established norms throughout the UK. Despite progress in some areas, we need to focus efforts on endemic disease challenges and ever present zoonotic and exotic disease threats.

A step change through greater use of objective monitoring systems could catalyse widespread and more rapid progress. These can integrate housing parameters, such as ventilation, air and water quality with living space, environmental enrichment, productivity metrics and expression of behaviours to monitor and manage, health and welfare.

Collaboration is the key to drive data sharing, enabling integration and interoperability with analytics and good accessibility, promoting adoption and safeguarding security whilst recognising data ownership. Benchmarking as a function of these innovations can incentivise uptake, monitor progress and drive improvements in outcomes.

Companion animals and horses sit at the heart of UK society, with challenges focussed on nutritional problems such as obesity, genetics and the effects of conformational deformities on health and welfare arising from some pedigree breeding in dogs and cats, along with the control of infectious disease.

All regulatory environments need to keep pace with science and innovation, where the challenge is allowing innovation to flourish while reducing the time to end-user adoption. In animal health, this is the case for veterinary medicines, provision of world leading veterinary care and empowering a science-based research and development environment that attracts global talent and investment.

The animal health investment proposition in the UK is attractive based on market potential, access to world class research capability and facilities, and the growing need for solutions that sustainably improve food security and safety, whilst providing services to companion animals valued by society and for our wellbeing.

CIEL is in the ideal position to connect these strengths and capitalise on opportunities. Contact us to find out more.

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