Healthy livestock produce sustainable food

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TIME TO VACCINATE

MSD Animal Health

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Content

Foreword

Mandy Nevel, Senior Veterinary Manager, AHDB

British farmers and growers produce food of exceptional quality. AHDB has long recognised the importance of animal health in efficient production and hence the sustainability of our livestock production.

The world is rapidly changing; farmers and growers need to be resilient to these changes and to continue to produce food that is trusted and produced sustainably. Our strategy aims to help our farmers and growers to understand and deliver what consumers want and buy and at the same time accelerating innovation and productivity growth. Sustainable production must consider the needs of humans, animals and our ecosystems – often called a 'One Health Approach'.

At the heart of sustainability is good animal health and welfare. Healthy animals can realise their genetic potential thereby optimising the efficiency of production and reducing both cost of production and environmental impact. Healthy animals have higher welfare and use fewer antibiotics. These factors all contribute to, and are increasingly important to, the sustainability of farming.

AHDB encourages a collaborative approach to sustainability ensuring experts from different disciplines are working together to achieve a truly world-class industry.

AHDB

Gwyn Howells, CEO, Hybu Cig Cymru-Meat Promotion Wales

Sustainable agriculture is vital for our world-class industry to thrive, and we're pleased to see the crucial role of animal health in this highlighted by the report. Proactive and co-ordinated management of animal health is at the core of our mission as the levy body responsible for lamb, beef and pork in Wales.

Our farmers already have a good reputation for high standards of husbandry, animal welfare and sustainability.

The benefits of the industry taking a proactive approach to flock and herd health are numerous. Consumers will be reassured that all measures are being taken to ensure the UK is at the forefront of animal health and welfare, and the effective, judicious and sustainable use of antibiotics, anthelmintics and other treatments. Farmers will see a benefit to their bottom line in terms of greater productivity and profitability. This approach will also help agriculture to meet its objectives in terms of mitigating greenhouse gas emissions.

Focusing on healthy livestock and sustainability is a win-win for all involved in our industry.

HYBU CIG CYMRU
MEAT PROMOTION WALES

Kate Rowell, Chair, Quality Meat Scotland

QMS's strategy is to support the development of a sustainable, professional, resilient and profitable red meat industry which makes an important contribution to Scotland Food & Drink's target of £30 billion turnover by 2030.

This paper highlights the importance of animal health and welfare in achieving our target. As an industry, we already know the adage, 'a healthy animal is a productive animal', and I'm pleased to see the link between this and sustainability made clear.

Red meat production in Scotland is very different to other parts of the world. The geography our country means that over 80% of Scottish farmland is comprised of grass and rough grazing which is not suitable for growing fruit, cereals and vegetables but ideal for producing top quality beef and lamb using one of our country's greatest natural assets – grass. Livestock production also makes a valuable contribution to soil health with animal manure providing a natural fertiliser in crop rotations.

I am hugely proud of the beef, lamb and pork produced in Scotland. As well as earning a global reputation for its outstanding taste, our quality assured Scotch Beef PGI, Scotch Lamb PGI and Specially Selected Pork has an exceptionally strong story to tell in terms of sustainability and animal health and welfare.

QMS

TIME TO VACCINATE

Executive summary

Livestock farming today is expected to produce more food than ever before, from fewer resources and with the smallest possible impact on our environment. It must do so in order to help feed and nourish a growing world population, which is predicted to reach 9.8 billion by 2050 (United Nations, 2017) and require 70% more animal protein (OIE, 2015).

This report explains how productive, sustainable livestock farming can be achieved by balancing three necessary components – **economic viability, environmental responsibility, and social acceptability** (Pope, et al., 2004) – and understanding the vital role healthy livestock play in delivering on all three aspects.

1. **Healthy livestock are the most productive and economically viable, achieving increased growth rates, milk yields or egg production from each unit of input alongside improved fertility, longer lifespans and better-quality carcases**

2. **Healthy animals create a smaller carbon footprint – they produce more food from fewer resources, with the emissions of fewer greenhouse gases – resulting in environmentally-responsible protein production**

Using specific diseases and costs, this report shows how significant improvements in health can have a profound effect on productivity and animal welfare, and ultimately the sustainability of livestock production. The table below is an example of the diseases analysed in this paper.

Disease	Economic cost	Performance impacts	Environmental impacts
Infectious bovine rhinotracheitis (IBR) – cattle	£200 per subclinically infected cow[1]	• Reduced milk yield • Abortion • Reduced growth rates • Increased mortality in calves and fattening cattle	• Increased greenhouse gas emissions per kg of energy corrected milk by 8%[4]
Porcine respiratory and reproductive syndrome (PRRS) – pigs	12-74% decrease in gross margin[2], £111 cost per sow per outbreak[3]	• Reduced fertility • Reduced growth rates • Increased mortality	• 15% reduction in annual output = increased resource use per unit produced[5]

[1] Statham et al. (2015)
[2] Difficult to calculate per head as a direct cost as net margins for UK pork production have varied from -£10 to +£23 per head over past five years (AHDB Pork, 2018)
[3] Nieuwehhuis et al. (2012)
[4] Chatterton et al. (2014)
[5] Holtkamp et al. (2013)

For further information on these and more specific disease examples and references, see page 18 onwards.

3. **Healthy animals are fundamental for social acceptability of livestock production systems – health and welfare is identified as the most significant issue affecting consumer trust and perception of animal-based diets**

> "94% of surveyed consumers believe it is important to protect the welfare of farmed animals."
>
> (Eurobarometer, 2015)

Farming practices focused on disease prevention, which could be benchmarked and incentivised under stewardship schemes to improve animal health include:

- Using vaccination to protect animals against future infection
- High standards of biosecurity to protect farms against the entry and spread of pests and diseases
- High standards of stockmanship, housing, health, hygiene and animal welfare
- Breeding animals which have improved disease resistance

The UK has one of the most advanced farming industries in the world and, with the right frameworks in place which put best-in-class practices at the top of the agenda, it can continue to meet the ongoing challenge of improving livestock health and productivity in a sustainable way.

The rewards for doing so will be felt far beyond the farm gate.

Healthy livestock require fewer antimicrobials (including antibiotics) to treat disease – one of the most urgent cross-industry challenges of our generation – which was described in the publication 'Looking beyond antibiotics', published by MSD Animal Health in November 2017.

Healthy livestock also provide a cost-effective source of safe and nutritious food and protein sources for the UK population and export market – of growing importance at a time of global uncertainty, where food security isn't guaranteed.

> "Healthy livestock also provide a cost-effective source of safe and nutritious food and protein sources for the UK population and export market."

In short, if the industry fosters good animal health, healthy livestock will cultivate a thriving and sustainable food and farming sector, allowing the UK to continue to hold its competitive advantage in the global market.

The challenge of feeding the world – what is sustainable food?

Agriculture faces greater challenges today than at any time since man first cultivated crops and domesticated livestock. For, not only is the farming industry charged with feeding a rapidly growing world population, but it must do so with a diminishing supply of resources and the least possible damage to our fragile environment. In other words, in a sustainable way.

Population gains, which are predicted to reach 9.8 billion in 2050 (United Nations, 2017), will intensify competition for the world's finite resources – in particular for land, water and energy. Meanwhile, with most population growth projected to take place in the developing world, going hand-in-hand with a rising per capita income, much of the extra demand will be for high-quality, animal-sourced protein. The World Organisation for Animal Health (OIE) projects demand for animal protein will increase by 70% over the next thirty years (OIE, 2015).

This reflects the fact that demand for animal-sourced food (such as milk, meat and eggs) is known to increase linearly as household income rises (Delgado, 2003). Furthermore, protein of animal origin is generally of a higher quality for humans due to its amino acid pattern and good digestibility (Elmadfa and Meyer, 2017) – important in both the developing and the developed world.

The challenge this places on the livestock industry is expected to surpass any it has experienced before, as the demand for increased production runs concurrently with the need to reduce environmental impact (Buller et al., 2018). Never before has there been so great a need for productive, sustainable farming. At the root of meeting this challenge are healthy livestock.

“At the root of meeting this challenge are healthy livestock.”

Quite simply, healthy animals are more productive – they produce more food from fewer resources and with the emission of fewer greenhouse gasses. Put another way, fewer livestock are needed to produce the same amount of food, and they will do so with minimal requirement for veterinary intervention and without the need for treatment with antibiotics.

But sustainability in agriculture extends far beyond the responsible use of the world's finite resources. It also encompasses economic viability and social acceptability, both of which are essential for the continuation of a thriving farming industry.

In fact, countless definitions of sustainable food have been proposed over the years, but perhaps the most useful is that which simply encompasses the three components of (De Wit et al., 1995; United Nations, 2005):

- Environmental responsibility
- Economic viability
- Social acceptability

Long-term sustainability is said to require all three components to come into balance (Pope et al., 2004).

Healthy livestock are an essential component in achieving this balance. They have the potential to fulfil all three requirements, not only minimising the environmental impact of a livestock production enterprise, but also providing the basis for the economic viability of a farming business. And while the requirements for social acceptability may be harder to define and address – being subject to personal opinion and media campaigns, and sometimes lacking a scientific base – healthy, efficient livestock experiencing high standards of animal welfare have every reason to be acceptable to the vast majority of consumers.

Healthy livestock are best placed to supply a cost-effective source of safe and nutritious food for the UK population and export market. And at a time when much of the world faces a turbulent and uncertain future – where imports of agricultural products are no longer assured and the need for food security gains political traction – the requirement for UK farmers to produce this nutrition at home becomes ever more important.

Keeping animals healthy is therefore at the heart of every progressive farmer's business policy. It is increasingly encouraged by buyers of agricultural produce and should be central to the UK's farming strategy, with practices such as preventative vaccination and biosecurity part of every responsible farming system.

Agriculture and food policy should encourage productivity and sustainability in the livestock sector through a focus on disease reduction and preventative health practices, including vaccination.

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A framework which encourages this will extend its reach beyond the farm gate. It will not only help address animal welfare and ethical concerns around animal production, but it will feed through to consumer health and confidence, buoy the health of the UK economy, potentially enhance its balance of payments, and provide the basis for the food and livestock industry's long-term efficiency and sustainability.

Improving animal health

- The industry should aspire to move all animal keepers towards the health status of the best practice farmers (FAWC, 2012)
- Vaccination helps animals resist infection from a particular disease by mimicking infection and providing immunity
- High standards of welfare and the avoidance of stress can also help improve an animal's immune response and resistance to disease
- Farm biosecurity provides measures designed to protect a property from the entry and spread of pests and diseases, including wildlife and vermin
- High standards of stockmanship, housing and hygiene play an important role in the prevention of disease
- Disease challenges exist for all types of farming system, such as through a higher stocking density in indoor systems, while some outdoor systems have seen the re-emergence of diseases which had been eliminated in more bio-secure indoor systems (FAWC, 2012)
- All livestock farms should have a dynamic Farm Health Plan, reviewed regularly, to document key procedures and policies undertaken to maintain animal health and welfare

Why do healthy livestock produce sustainable food?

Sustainable food has been defined as being produced in a manner which is both environmentally responsible and acceptable to society, while producing economic returns for the farmer.

Both environmental responsibility and economic viability are highly inter-dependent, each relying, in the first instance, on the most efficient use of resources. Social acceptability can also be closely linked. It is dependent on public approval, itself linked to responsible resource use, environmental protection and optimal animal health and care.

However, in almost all cases, the primary reason healthy livestock produce sustainable food comes down to the level of production they achieve, whether of milk, meat or eggs. When production is not compromised by poor animal health, it is maximised in relation to the inputs and resources the animal receives.

This is a fact which is independent of farming system. For whatever the farming system, healthy livestock will achieve better performance and have the potential to achieve higher standards of welfare.

Vaccines are vital components in preventing a wide variety of diseases and a key tool in reducing antibiotic use (Small et al., 2017), alongside biosecurity, good stockmanship, hygiene and effective monitoring and benchmarking.

One Health

The concept of One Health – a term used to describe how multiple disciplines can work together locally, nationally and globally to strive for optimal health for people, animals and the environment – helps explain the intrinsic relationships which exist between health in these different sectors and how this is related to sustainable livestock farming.

One Health is a relatively new phrase, first used in 2003 (Woods et al., 2018), and today, this holistic concept has facilitated global action on the management of a number of zoonotic diseases – those which can be spread from animals to humans. This includes the pandemic H1N1 avian influenza, endemic zoonoses in developing countries and global rabies control (Gibbs, 2014).

The potential value of this concept in tackling both diseases and issues which have health impacts across multiple species and sectors (livestock, companion animals, wildlife and humans), such as tuberculosis or antimicrobial resistance, should not be underestimated. Animal health, as a component of One Health, also contributes to sustainable development by significantly improving livelihoods and household resilience in low-income countries (Stringer, 2014) and can thus be directly linked to sustainability.

Healthy livestock and economic viability

A key method of improving economic viability is to reduce the input cost for each unit of output, whether that be meat, milk or eggs. In the livestock industry, every animal has a maintenance cost – similar to a fixed cost in a manufacturing industry. This is the cost of maintaining the animal's bodily functions, its baseline health and activity, before its production (pregnancy, lactation or growth) are taken into account.

It stands to reason that if this maintenance cost can be diluted over a higher level of production (say, more meat or milk) then each unit will be cheaper to produce.

This dilution of maintenance with increasing production has been widely demonstrated (Capper et al., 2008; Capper et al., 2009; Capper 2011) and explains why a cow whose milk production rises from 15 litres to 45 litres of milk/ day increases her total energy requirement from 140 mega joules (MJ)/day to 282 MJ/day, yet the energy needed per unit of milk production effectively decreases from 9.4 MJ/litre to 6.3 MJ/litre. So, the 15-litre cow uses 50% of her energy intake for maintenance, whereas the cow giving 45 litres per day will use only 25% of her intake for the same level of maintenance (Capper, 2018a). In other words, all else being equal, both cows need the same level of feed for their own maintenance, irrespective of their production.

If everything else remains the same, (for example, there is no price premium for meat or milk produced in a more extensive, possibly lower yielding system) then feed cost per unit of output is a good indicator of economic viability and therefore, an enterprise's sustainability.

However, in any system – whether an extensive grazing-based system or one which is dependent on housing and cereal feeds – production per unit of input can be seriously reduced as a result of poor animal health. It is estimated that 20% of animal production worldwide is lost as a result of disease (OIE, 2015).

Of course, the impact of different diseases varies, but in most cases, sick animals perform less well than their healthy cohorts. This drop in performance may not simply be seen in lower milk yields or animal growth rates. There's also the possibility of reduced fertility, abortions, stillbirths, rejected carcases or milk, and increased mortality, all of which can damage a business's economic viability (Husu-Kallio, 2008; Cervantes, 2015). Add to this the cost of veterinary treatments and medicines – which may include antibiotics and therefore have the potential to exacerbate the worldwide problem of antimicrobial resistance (Small et al., 2017) – and the economic losses are compounded.
In contrast, achieving an excellent health status can have an important positive impact on economic sustainability and should be an aspiration of every livestock farming business.

Poor animal health may affect economic viability by:

- Reducing yields of meat, milk or eggs
- Slowing growth rates
- Creating lower value carcases with poorer grades
- Creating poorer quality milk or eggs with a lower value
- Reducing fertility
- Increasing mortality
- Increasing veterinary costs

Healthy livestock and environmental responsibility

The environmental responsibility of livestock production is a focus for the industry and consumers since wider coverage of climate change and its causes has brought it firmly under the public's eye. Its impact continues to be the source of debate and dispute. Even a report from the Food and Agriculture Organisation (FAO, 2006) claiming that livestock production accounts for 18% of human-related greenhouse gas (GHG) emissions was later acknowledged by its authors to have been inaccurate (Black, 2010).

Grazing and carbon

Pasture-fed livestock may make use of land which cannot be cropped, often turning the lowest-quality feed which cannot be digested by non-ruminant species into the highest quality protein. At the same time and in the right conditions, grazing livestock can potentially sequester carbon into the soil, in other words, removing it from the atmosphere and storing it in a stable form (Garnett et al., 2017). Good grazing practices can encourage this process, while also keeping the soil covered with vegetation, improving water storage, preventing erosion and nutrient migration, and maintaining water quality – all vital ecosystem services (Voth and Gilker, 2017).

The relative merits of each farming system are beyond the scope of this publication, which seeks only to make the link between animal health and sustainability. Suffice to say that irrespective of production system, the positive relationship which has been described between animal health, productivity and economic viability, applies in just the same way to environmental responsibility. In other words, the 'dilution of maintenance' which goes with higher individual animal production, confers environmental as well as economic benefits. In livestock systems, this primarily means that higher-producing or faster-growing animals require less land, water and fossil fuel for each unit of output. This is demonstrated clearly by FAO (2010) data, which shows that on a global basis, there is a negative relationship between dairy cow milk yields and carbon footprint for each kilogram of milk. In other words, as milk yields per cow go down, carbon footprint per kilogram of milk produced goes up (Capper, 2018b).

In this instance, the carbon footprint comprises the sum of carbon dioxide, methane and nitrous oxide emissions (broadly defined as GHGs), weighted for their relative global warming potential.

In livestock production systems, these GHGs primarily result from the digestion of feed, but there are also emissions from manure management and storage, crop production (including fertiliser use) and transport. Emissions from processing are not normally included.

As demonstrated in the case made for economic viability, healthy animals will achieve better levels of performance per unit of resource input, thereby positively impacting on environmental sustainability. This is a factor which should become increasingly important as the Agriculture Bill 2017-2019 comes into effect. The bill will see the replacement of direct payments for agricultural production with payment for 'public goods'. This includes better air and water quality, improved soil health and higher animal welfare standards, all of which healthy livestock are better placed to deliver.

Poor animal health may affect environmental sustainability by:

- Increasing resource use for the same level of output
- Increasing antibiotic use and adding antimicrobial load to the environment, thereby negatively impacting microbial ecosystems
- Requiring more animals to be kept per unit of production and therefore creating more GHGs and environmental contamination

Healthy livestock and social acceptability

Social acceptability is a major determinant of a livestock production system's sustainability, irrespective of whether that acceptability is based on well-informed science or unsubstantiated perception.

If the weight of public opinion within a society disapproves of a practice – seen for example in battery egg or crate veal production – then it is unlikely to have a sustainable future, at least within that society.

If livestock systems contain components that are likely to be morally unacceptable to a substantial proportion of the population either now or in the future, the system's sustainability can be questioned (Broom, 2010). The issue is compounded by stark differences of opinion, demonstrated, for instance, in gestation stalls for sows (Fraser, 2008). One group of scientists has concluded that sow stalls, even under excellent management, compromise animal welfare and has recommended their prohibition. Another group concluded that the same practice could meet the welfare requirements of pigs, and noted that animal welfare should not be confounded by public perception.

However, animal welfare is undoubtedly one of the most significant issues affecting the public's perception of livestock farming, with 94% of surveyed consumers believing that it should be protected (Eurobarometer, 2015).

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The livestock industry now widely recognises that social acceptability, although only one component of sustainability, may be the most important. This has been intensified by the speed of knowledge transfer across the globe via social media, whereby information can be spread throughout populations in seconds (Capper and Yancey, 2015; Stevens et al., 2016).

Although welfare is often grouped with animal health as a single construct, the two are in fact quite differently defined. Animal health has been described as a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity (WHO, 1948). In contrast, animal welfare has been said, in its simplest definition, to be 'what the animal needs and what the animal wants' (Dawkins, 2012) or, when framed within the welfare quality of a specific system or environment, is the ability of an animal to express its natural behaviour or express its innate 'animalness' within that situation (Goldberg, 2016).

So, although a healthy animal is not necessarily in a good state of welfare, an unhealthy animal cannot, by definition, have good welfare.

This, once again, underlines the importance of good animal health as a basic requirement for achieving the societal acceptability required for sustainable farming systems.

A conflict appears to exist within current production systems in attempting to achieve simultaneous perfection in animal health and welfare. It is possible to produce livestock which are immunologically naïve – kept in a controlled, disease-free environment and isolated from sources of infection, and yet therefore by definition unable to interact with other animals and express natural social behaviours. Similarly, keeping livestock in conditions that are as 'natural' as possible (eg free-range poultry) exposes them to external diseases, parasites and hazards, potentially affecting their health (Wathes et al., 2013; Goldberg, 2016).

Aside from the ethical requirement to maintain good animal health, there are also practical considerations linked with societal acceptance.

The farming and veterinary professions have a duty to ensure that food produced from livestock does not cause public health issues such as zoonoses, as well as unacceptable contamination. To this end, farm assurance schemes in the UK carry out audits and make recommendations on the basis of animal health and welfare.

The use of antimicrobial medication such as antibiotics in livestock production is a further area of public concern. With a growing awareness of antimicrobial resistance – which occurs when microorganisms acquire the ability to survive in the presence of an antimicrobial agent, which is usually sufficient to inhibit or kill that species of microorganism (Patrick and Hutchinson, 2009; Small et al., 2017) – the concern has a legitimate basis.

The problem has been estimated to currently cause 50,000 human deaths a year across Europe (Barber and Swaden-Lewis, 2017). However, it has been projected that by 2050, 10 million people per year may die worldwide because of antimicrobial resistance (HM Government, 2014).

Although this resistance can occur naturally, there is evidence that the inappropriate or excessive use of antimicrobial drugs increases the rate at which it occurs (Jansen et al., 2018). However, the relative contributions and impacts of human, companion animal and livestock usage on this process have yet to be quantified (Scott et al., 2018) although each sector has a responsibility to reduce its use.

The livestock farming, veterinary and pharmaceutical industries are therefore committed to reducing the on-farm use of antibiotics, and are doing so in a cross-sector, target-setting process, which involves government officials, is co-ordinated by RUMA (Responsible Use of Medicines in Agriculture Alliance) and is underpinned by the UK Government's action plan for antimicrobial resistance 2019-2024.

The livestock industry has already taken great strides in this process by adopting better animal husbandry, housing, hygiene and biosecurity practices, breeding more disease-resistant animals, and – most effective and immediate of all – by vaccinating animals to protect them against future disease. This results in animals being healthier and requiring less antibiotic treatment, so benefitting the animal, the farmer, the consumer and society as a whole.

And by building consumer trust – also enhanced by education, product labelling, clear and transparent auditing, and a proactive communication strategy (Verbeke, 2009) – social acceptance and the long-term sustainability of livestock farming will continue to improve.

Poor animal health may affect social sustainability by:

- Negatively affecting animal welfare – a major concern to the public
- Increasing the risk of zoonotic diseases passing to the human population
- Increasing antibiotic use, exacerbating antimicrobial resistance and compromising human health
- Increasing resource use for the same level of output – an increasing concern to the consumer
- Creating more GHGs – a contributor to climate change

Impacts of poor animal health on sustainable food

The production losses incurred through poor animal health have been identified as having a major impact on the sustainability of any livestock farming business. But a closer scrutiny of individual endemic diseases shows specific circumstances in which their influence can be felt.

Cattle

Bovine viral diarrhoea (BVD)

BVD is estimated to cost up to £252 per cow, with an average cost per cow of £46.50 (Yarnell and Thrusfield, 2017). Because the disease is so prevalent (possibly present in over 98% of non-vaccinated UK dairy and beef herds) (Cowley et al., 2014), this multiplies up to cost the UK cattle industry £162 million each year. These losses are caused directly through lost production and indirectly through reduced fertility, early embryonic death, congenital deformities and suppression of the immune system.

This immunosuppression itself means the cost of BVD may be far higher than estimated, because of the secondary effects of the disease (Stott et al., 2010).

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Furthermore, these cost estimates take no account of GHG emissions which have since been gauged for the beef sector. Chatterton et al., (2014) calculated that BVD could increase GHG emissions by 113%, based on a 2.2kg increase for every carcase (Capper, 2018e), over a baseline 17.1kg in a healthy animal.

Countries which have assessed the economic impact of BVD have been found to be 10 times more likely to implement eradication programmes (Pinior and Firth, 2017) and Belgium, Germany, Ireland, Northern Ireland and Scotland are among those which have put control schemes in place.

Mastitis

Mastitis takes a similar toll on the dairy cow industry, with estimated costs ranging from £125 to £384 million (Capper, 2018c). This colossal burden for the industry to bear is brought about by reductions in milk yield, discarded milk and veterinary costs, while the environmental cost of this has to be borne by all. Resource use and GHG emissions per unit of output will inevitably rise in infected animals, while antimicrobial use to treat the disease adds to its ecosystem impact (Hospido and Sonesson, 2005). However, reducing the incidence of clinical mastitis from 25% to 18% and reducing sub-clinical mastitis incidence from 33% to 18%, was modelled by Hospido and Sonesson (2005), revealing a 2.5% decrease in GHG emissions.

Respiratory disease and scouring

Both bovine respiratory disease (BRD) and diarrhoea (scouring) in youngstock also come with a high economic cost to a farm and the industry, with each disease occurring in almost half (45.9 and 48.2% respectively) of all dairy heifers (Johnson et al., 2017). The most recent industry estimates have assigned a cost of £60 million (calculated from data published by Statham (2018)) and £11 million (Bennett, 2003) to these diseases respectively, although the harm they cause can persist, through longer-term damage to animals' gut (Ohnstad, 2016) and lungs.

Impacts of infectious cattle diseases on key performance indicators and environmental impacts

Disease	Prevalence	Economic cost	Milk yield	Fertility	Growth rate	Mortality	Vaccine available?*	Environmental impacts
Bovine viral diarrhoea virus (BVD)	Up to 98.5% in non-vaccinated dairy herds and 98.3% in non-vaccinated beef herds[1]	£162 million to the UK cattle industry[2], £46.50 per infected cow[3]	Reduced	Reduced fertility, abortion, congenital deformities	Reduced	Increased in young calves	Yes	Moderate
Bovine respiratory disease (BRD)	45.9% in dairy heifers[4]	£60 million to the industry[5], £31.50 per infected calf[6]	N/A	N/A	Reduced	Increased in young calves	Yes	Low (milk), moderate (beef)
Scour (diarrhoea)	48.2% in dairy heifers[4]	£11 million to the industry, £58 per infected calf[7]	N/A	N/A	Reduced	Increased in young calves	Yes (agent specific)	Low (milk), moderate (beef)
Mastitis	100% of herds affected, 59.5 cases per 100 cows[8]	£125-384 million to the industry, £111 to £341 per clinical case[9]	Reduced	Reduced	N/A	Rare death, major cause of culling	Yes (strain specific)	Moderate
Sub-clinical ketosis (SCK)	1-49%[10]	£48-212 million to the industry[11], £229 per infected cow[10]	Reduced	Reduced	N/A	Rare	No	Moderate
Infectious bovine rhinotracheitis (IBR)	Up to 74.7% in non-vaccinated dairy herds and 86.5% in non-vaccinated beef herds[1]	£200 per subclinically infected cow[10]	Reduced	Abortion	Reduced	Increased in youngstock with some instances seen in adult cattle	Yes	High
Johne's disease	Thought to be present in 65% of English dairy herds, with 2.5% of cattle clinically-infected[11]	£2.8 million to the industry[12], £38 per infected dairy cow, £25 per infected beef cow[13]	Reduced	Reduced	Reduced	Rare death, major cause of culling	Yes	High

*More information on specific vaccines and their effectiveness in reducing antimicrobial use is available in Time To Vaccinate Looking Beyond Antibiotics (Small et al. 2017)

[1]Cowley et al. (2014); [2]Calculated from data published by Yarnall and Thrusfield (2017) and AHDB (2018); [3]Yarnall and Thrusfield (2017); [4]Johnson et al. (2017); [5]Calculated from data published by Statham (2018); [6]Statham (2018); [7]Bennett (2003); [8]Down et al. (2016); [9]Calculated from data published by Down et al. (2013); [10]Statham et al. (2015); [11] Vidal-Diez et al. (2009); [12]Calculated from data published by Gunn et al. (2004) adjusted for prevalence and increase in inflation over time; [13]Calculated from data published by Gunn et al. (2004) adjusted for increase in inflation over time.

Sheep

Research into the economic, performance-related and environmental impact of sheep disease is sparse, and not sufficient to present the same overview as with cattle and pigs.

Diseases of sheep may have been measured less closely than those for cattle, but they have the same potential to reduce productivity and compromise sustainable farming. With slim margins in the industry, their economic impact can be devastating for a business, so farm health planning should be geared towards preventative solutions.

Footrot

Footrot is one of the most significant sheep diseases in terms of lost productivity and economic impact, while lame animals have an impact on social acceptability. The principal effects of footrot are reductions in general wellbeing and performance, with a reduction in bodyweight of 0.5 to 2.5 kg (2 to 8% of liveweight) reported in infected lambs (Nieuwhof et al., 2008). However, this weight was regained after effective vaccination.

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The effective treatment of a whole flock has also been reported to improve performance, increasing gross margin by £6.30 per ewe (including the £1.50 cost of treatment) (Wassink et al., 2010).

Foetal losses

Two serious causes of foetal loss, toxoplasmosis and enzootic abortion, could be protected against by vaccination yet the adoption rates are low, at 22 and 36% respectively (Small et al., 2017). However, reducing the impact of these two diseases may reduce the carbon footprint for each kilogram of lamb by 0.55kg (toxoplasmosis) and 0.71kg (enzootic abortion) carbon dioxide equivalent per kg lamb (Capper, 2018d).

However, an altered mindset appears to be needed to change the fortunes of the sheep industry.

Pigs

The pig industry is different in many ways from those of the ruminant species in that it is more integrated, with well-established communication throughout the production chain. A keen focus on economic margins reflects the cyclical nature of profitability, seen in margins ranging from a loss of £10 to a gain of £23 per pig over the past five years (AHDB Pork, 2018).

There appear to have been no published studies evaluating the impact of porcine disease on environmental sustainability. This may be partly due to ruminant production systems bearing the brunt of public attention regarding climate change, because of their contribution to methane emissions through enteric fermentation. In contrast, the bulk of emissions from the pig industry are from feed production and manure storage (Basset-Mens and van der Werf, 2005; Jones and Cherruault, 2011; BPEX, 2014), explaining why reducing feed use has the greatest potential for cutting the GHG emissions associated with pig farming (Nguyen et al., 2010).

One US study found feed efficiency to be a major driver of environmental impacts per unit of pork, with systems which require more feed to produce the same quantity of meat having greater energy use, GHG emissions, ecological impacts and potential to pollute water courses with excessive nutrient run-off (Pelletier et al., 2010).

Porcine reproductive and respiratory syndrome (PRRS)

In quantifying the cost of specific porcine diseases it has been suggested that the highest impact on the industry is associated with porcine reproductive and respiratory syndrome (PRRS) (Davies, 2012). Estimated to cause around a 15% reduction in annual output (Holtkamp et al., 2013), this would be expected to have significant negative environmental impacts, particularly due to the increase in resource use resulting from reduced productivity. The environmental impact and economic cost add weight to the argument for effective PRRS control, which can be achieved with a vaccination strategy together with high levels of on-farm hygiene and biosecurity (Rathkjen and Dall, 2017).

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(Rathkjen and Dall, 2017)

Glässer's disease

Glässer's disease is caused by the bacterium, *Haemophilus parasuis*, which is endemic in the majority of pig herds and frequently isolated from healthy pigs. However, stress or trigger factors such as early weaning or temperature fluctuations can lead to disease, as can the introduction of a new strain of the bacterium, particularly to a naïve herd.

H. parasuis can also be an important component of porcine respiratory disease complex (PRDC) which has significant economic consequences for the pig industry (White, 2012). UK-based diagnoses of Glässer's disease have varied year-on-year, from 22 diagnoses in 2015, to 11 diagnoses in 2017 (Animal and Plant Health Inspection Service, 2018). The National Animal Disease Information Service (White, 2012) reported an acute outbreak of Glässer's disease as resulting in 6% pig mortality, with a combination of pig losses, medication and subsequent vaccination equal to £8,000 (£27 per sow), plus an ongoing vaccination cost of £6,000/year (£20 per sow).

If seen as a component of porcine respiratory disease complex (PDRC), Glässer's disease was reported to add £7 per pig as a consequence of reduced growth rate, mortality and veterinary costs, although ProHealth (2015) cited the cost as £3.70 per affected pig.

Pleuropneumonia

Pleuropneumonia (*Actinobacillus pleuropneumoniae*) can also hit the industry hard from an economic perspective, estimated to cost £5.64 per infected pig (ProHealth, 2015) or up to £3.4 million to the UK industry (calculated from data published by ProHealth (2015) and Eze et al. (2015).

Vaccination would be expected to have a positive economic and environmental impact through a reduction in feed use and GHG emissions.

Streptococcus suis

Some pig diseases present a zoonotic risk including *Streptococcus suis*, which can cause meningitis and septicaemia in humans. The fact that some *S. suis* isolates have shown resistance to several antibiotics (Williamson, 2018), emphasises the importance of disease prevention or alternative methods of control.

Enteric disease

Enteric disease in pigs should not be overlooked given the vast toll it takes on feed conversion efficiency and liveweight gain. Ileitis (a group of conditions associated with *Lawsonia intracellularis*) can reduce both by up to 50% (Gogolowski et al., 1991) and 17 to 84% respectively in clinical cases, leading to significant economic losses and expected environmental cost. Vaccination has been shown to protect pigs from clinical disease (Collins, 2013) which would reduce reliance on antibiotics and improve sustainability.

A range of further livestock diseases imposes damage on the industry, some affecting fertility, some reducing a breeding animal's lifespan, but all impinging on farming efficiency and causing both financial and environmental damage. The welfare cost of some diseases is a further concern, adding a moral case for prevention strategies, which have the bonus of improving public perception and the sustainability of farming.

Leptospirosis

When leptospirosis first enters a susceptible (naïve) sow herd, it causes an abortion storm. Chronic leptospirosis causes losses in total pigs born, pigs born alive, and pigs weaned. It increases stillbirths and pre-weaning mortality by increasing the number of live, but weak, low-viability pigs.

However, it is the uncontrolled, endemic (chronic, sub-clinical) leptospirosis infection in sow herds that causes the highest economic losses, due to its ongoing, hidden effects on sow productivity. The disease reduces farrowing rate, average birth weight, and may increase the wean-to-first service interval.

An analysis done in America found that uncontrolled chronic leptospirosis increased the cost to produce a weaned pig by over $8.00 per pig. Ultimately, the system in control of leptospirosis produces weaned pigs at a cost of $29.07 per pig, compared to $37.35 per pig in the uncontrolled system (Stein, 2017).

Impacts of pig diseases on key performance indicators and environmental impacts

Disease	Economic cost	Fertility	Growth rate	Mortality	Vaccine available?	Predicted environmental impacts
Porcine pleuropneumonia	£5.64 per infected pig[1], estimated at £453,000-£3.4 million cost to the UK industry[2]	Abortion	Reduced	Increased	Yes	High
Porcine respiratory and reproductive syndrome (PRRS)	12-74% decrease in gross margin[3], £111 cost per sow per outbreak[4]	Reduced	Reduced	Increased	Yes	High
Glässer's disease	£27 per sow in affected herds, plus £20 per sow for ongoing vaccination[5]	N/A	Reduced	Increased	Yes	Moderate
Leptospirosis	Uncontrolled chronic leptospirosis can increase the cost of producing a weaned pig by over $8.00 per pig[6]	Abortion and reduced fertility	Reduced	Reduced	Yes	Moderate
Streptococcus suis	Not known	N/A	Reduced	Increased	Yes – strain-specific	Moderate
Porcine Enteropathy (ileitis)	£3.7-7.4 million cost to the UK industry[7]	N/A	Reduced	Increased	Yes	Moderate

[1]ProHealth (2015); [2]Calculated from data published by ProHealth (2015) and Eze et al. (2015); [3]Difficult to calculate per head as a direct cost as net margins for UK pork production have varied from -£10 to +£23 per head over the past five years (AHDB Pork, 2018); [4]Nieuwehhuis et al. (2012); [5]White (2012); [6]Stein, (2017). Leptospira production and economic effects. International Pig Topics. Volume 31, Number 7. [7]Calculated from data published by McOrist et al. (1997) adjusted for increase in inflation over time.

Conclusion

The need for farming to be both sustainable and productive has never been greater.

The world population is predicted to reach 9.8 billion by 2050 (United Nations, 2017), increasing demand for animal protein by over 70% (OIE, 2015). Meanwhile, competition for the world's finite resources – particularly land, water and energy – continues to intensify and the farming industry will be expected to produce more from less. It must also do so with the smallest possible carbon footprint and the lowest environmental impact. At the same time, livestock must continue to experience rising standards of welfare in adherence to moral codes and societal expectations.

The farming industry has to rise to this challenge by producing meat, milk and eggs in a more efficient and sustainable way than ever before.

Healthy livestock are key to this process. Whatever the system of farming, they produce more meat, milk or eggs per unit of input; they have a smaller carbon footprint; they present a reduced risk of passing zoonoses to man and they have no need to experience the compromised welfare which can accompany disease.

Livestock can experience optimal health when they are farmed with high standards of biosecurity, hygiene and husbandry, fed appropriately, bred for long-term disease resistance and vaccinated to provide immediate protection against infection.

The challenge to the UK livestock industry is to continue the long-held tradition of excellence in animal husbandry and to enhance animal health through the adoption of both traditional best-practice and new technologies. This must be achieved using a One Health approach involving all stakeholders, assessing systems and management practices with a view to improving animal, human and ecosystem health.

As every industry evaluates its position in the wake of the EU referendum, a new opportunity arises for the livestock sector to prioritise disease prevention and bring it to the forefront of policy and industry initiatives.

This includes a joined up process to stewardship schemes and rewarding preventative disease practices. Collaboration with assurance schemes and species-specific benchmarks can measure success and ensure the UK continues to produce a competitive animal health ecosystem.

The adoption of this approach must be communicated to all food stakeholders, to ensure widespread social acceptance of UK livestock systems. If the industry fosters good animal health, healthy livestock will cultivate a thriving UK food and farming sector which offers better food security, increasing export opportunities and a growing contribution – through high quality, home-produced food – to the UK economy.

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TIME TO VACCINATE

Time to vaccinate is an initiative from MSD Animal Health to provide information and share experiences about vaccination as a preventative tool for livestock.

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