

**What will the Scottish
cattle industry look like in 2040
and how resilient will it be to
livestock disease?**







EPIC, Scotland's Centre of Expertise on Animal Disease Outbreaks, has been established with the overarching purpose of providing expert advice on animal health and disease outbreaks to policy-makers from the Animal Health and Welfare Division at Scottish Government.

For further information please go to: www.epicscotland.org and http://epicscotland.org/epic_new/info/3/epic_research/16/module_4_forecasting_and_horizon_scanning#.UnpGZvmuRll



Contents

Title	Page
1. Foreword	2
2. Introduction	3
3. Scenario Planning Process	4
4. Scenarios	5
5. Opportunities and Threats	10
6. Developing Strategies	11
7. Adding Value	12
8. Disease Resilience in the Future	13
9. Future Work	14

Foreword

Key Messages

- EPIC scenario planning workshops have created a new space for dialogue amongst a diverse group of cattle industry participants. These include representatives from the Scottish cattle retail sector, farming and forestry sectors, veterinarians, epidemiologists, social scientists and Scottish Government policy makers.
- This exercise enabled stakeholders to build strategic partnerships by sharing experiences, understanding one another's constraints and exchanging knowledge.
- Information-rich narratives based on important drivers of change (regulation, technological innovation and Government prioritisation) for the Scottish cattle industry have been developed.
- Key questions for policy makers have been framed which encompass issues such as farm biosecurity and farmer-led surveillance initiatives, farmer education, industry insurance and the potential for a 'license to farm'.
- EPIC is using these scenarios to determine how drivers of change will have an impact on industry demographics and the risks of disease introduction and disease spread as well as disease control strategies. Modelling disease incursion will help EPIC scientists understand how the risks of exotic pathogens are altered in different futures. This will improve future tools for disease outbreak prevention and management.
- Scenario planning contributes to EPIC goals of improved epidemiological outcomes for Scotland both at the policy level where stakeholder buy-in and input are advantageous, and at the local level where innovation and good practice will be encouraged.

Introduction

The Scottish livestock industry and the disease challenges it faces are continually evolving. The wider environment in which this evolution occurs is inherently uncertain. The shape of the future environment will be determined by different drivers of change – developments and influences that will act internally and externally to influence the nature and structure of the cattle industry including its exposure to disease and the impacts of disease. Exploring potential future possibilities empowers today's decision makers to develop and evaluate current contingency plans to ensure the resiliency of the Scottish livestock industry.

EPIC, in collaboration with Scottish Government and industry stakeholders, has undertaken an exercise called “scenario planning” to think strategically about future disease management in the Scottish cattle industry. By looking at the potential impact of different drivers on the cattle industry in Scotland and considering the threats and opportunities that might be presented by different narratives, strategies to optimize disease management can be developed. EPIC's aim is to create future narratives for specific livestock sectors. The first of these narratives, undertaken in 2013, addresses the cattle industry. The second, undertaken in 2014, focuses on the sheep industry. We hope that the publication of this report will further facilitate knowledge exchange between EPIC scientists and Scottish Government as well as with interested members of the public.

Scotland's Cattle Industry

Scotland's beef and dairy cattle industry is the largest agricultural activity within Scotland¹. The export of livestock and meat to the rest of the UK and to Europe is a significant part of the economic activity of the livestock supply chain. Over the last three decades, globalisation, increasing trade of live animals and animal products, and new risks of animal diseases have had a major impact on the industry (e.g. the Bovine Spongiform Encephalopathy (BSE) crisis leading to a ban on British beef from 1996 to 2006 and the UK Foot and Mouth Disease (FMD) crisis in 2001). The BSE crisis exposed weaknesses in the European Commission's ability to regulate foodstuffs and prompted the creation of the European Food Safety Authority (EFSA), the development of the British Cattle Movement Service (BCMS) and the Cattle Tracing Systems (CTS) Database (1998) in response to European Union (EU) legislation. The FMD crisis cost Scottish agriculture approximately £231m, with the additional loss of gross revenue to tourism estimated to be between £200–250m². It also resulted in the creation of the post of Chief Veterinary Officer for Scotland. These shocks to the industry alongside the pressure to supply cheap food for a growing population have resulted in a decline in numbers of livestock farmers (further exacerbating the ageing demographic), accompanied by the creep of ‘industrial agriculture’ and proposals for ‘super-farms’³ for sustainable intensification. Despite minor trends for consumers to buy locally and ethically, consumer preferences remain predominantly based on price.

In line with the rest of the UK, the Scottish dairy herd has been decreasing in size for a number of years. Retail pressure, particularly from leading supermarkets has kept consumer prices low. Protests by some dairy farmers in 2012 raised the media profile on this issue but ultimately had little sustainable impact on farm gate prices. Alongside increases in key farm costs, driven predominantly by world oil and grain prices, this has created challenging times for the dairy sector. Whilst the majority of beef produced in Scotland is for the domestic market, the export market has been strong in recent years. UK exports more than doubled between 2006 and 2011 with EU countries taking the vast majority of beef exported⁴. However, financial support remains critical to the profitability of both beef and dairy producers, with producers still using CA payments to bridge the income gap, particularly in hill and upland areas.

In 2011, the Scottish Government negotiated responsibility for a devolved budget for Animal Health (£21.03 million in 2011) covering the various services provided by the Animal Health and Veterinary Laboratories Agency (AHVLA) (the executive agency responsible for animal health and welfare in GB), the British Cattle Movement Service (BCMS) and Food Standards Agency in Scotland. As a result, there has been an emphasis on disease control strategies such as maintaining Scotland's official bovine tuberculosis (TB) free status, an industry-led and government supported Bovine Viral Diarrhoea (BVD) eradication scheme and industry and Scottish Government partnerships to ensure that Scotland remains free of bluetongue and FMD. In addition, the Scottish Government has funded a Centre of Expertise in Animal Disease Outbreaks (EPIC) to provide independent scientific advice. State competency over animal health and welfare is shared with the EU and falls under the Animal Health Law, the legal framework supporting the Animal Health Strategy for the EU (2007).

Further Reading

1. Structure of the Scottish Livestock Industry. Executive Summary. Accessed online at [<http://www.scotland.gov.uk/Publications/2008/06/19154131/3>].
2. Inquiry Into Foot And Mouth Disease In Scotland (2002). Accessed online at [http://www.royalsoceid.org.uk/cms/files/advice-papers/inquiry/footmouth/fm_mw.pdf].
3. PostNote 2012. Livestock Superfarms. Accessed online at [<http://www.parliament.uk/business/publications/research/briefing-papers/POST-PN-404/livestock-super-farms>].
4. Bullish Prospects, a vision for the British beef industry, NFU, 2012. Accessed online at [<http://www.nfuonline.com/beef-vision-report>].

Scenario Planning Process

Scenario planning is a tool to enable qualitative, structured, medium to long-range strategic thinking about possible futures, and depends on strong trans-disciplinary collaboration between scientists, industry representatives, policy-makers and relevant stakeholders. The process includes the systematic examination of current trends and foreseeable developments which are played-out in plausible ways to create a road-map to different future scenarios. This process also considers potential threats and opportunities, including those at the margins of current thinking and planning. The value of scenario planning lies not just in the development of the scenarios, but in the opportunities it creates for engagement with interested and informed parties about the future of Scotland's different livestock industries. The scenario planning outputs will also be used to augment ongoing work in a range of other scientific programs within EPIC. Issues raised by the development of the scenarios will be explored in more depth by those with expertise in modelling disease transmission, formulating control strategies, and performing risk assessments, in order to better inform disease contingency planning for the livestock industry. Specifically, EPIC will use information from the scenarios to explore the impact of different drivers of change on disease risk and management and evaluate the robustness of potential strategies that could be implemented in the present day to account for future industry challenges. This highlights why foresighting exercises such as these are important and useful tools to enhance the timely delivery of robust long-term scientific advice in the context of the quickly evolving, current political landscape. In this report, EPIC presents a summary of the scenario planning work examining the future of the cattle industry in Scotland with a time horizon of 2040. This work was the result of a two day workshop held in April and May 2013. Participants included representatives from the Scottish cattle retail sector, farming, forestry, veterinarians, epidemiologists, EPIC scientists and Scottish Government. Participants were given the role of scenario planners, tasked with engaging in strategic thinking through a series of carefully crafted exercises that resulted in the creation of four scenarios set in 2040. The focal question addressed was:

What will the Scottish cattle industry look like in 2040 and how resilient will it be to livestock disease?

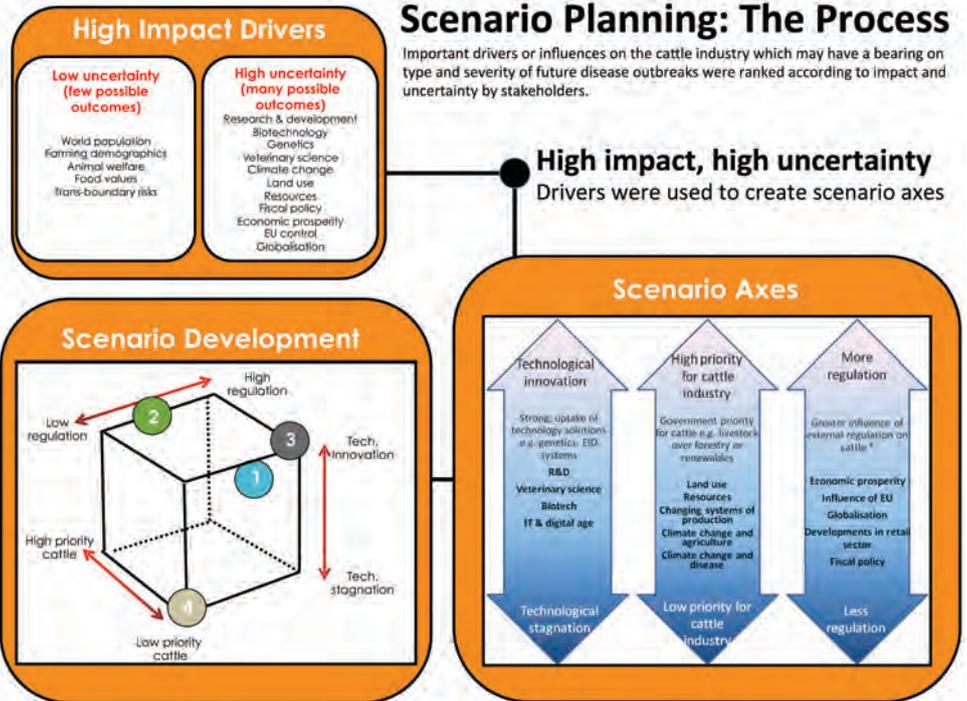
Drivers of Change for the Scottish Cattle Industry					
Population/ Demographics	Technology	Economy	Society	Environment	Politics
World population	Biotechnology	Globalisation	Education	Climate change and disease	Scottish independence
UK population	Information technology/ Digital age	Localisation	Health and wellbeing	Climate change and agriculture	Influence of European Union
Farming demographics	Changing systems of production	Trans-boundary risk	Food values	Future land use	Governance
	Influence of renewables	Developments in retail sector	Animal welfare values		Food sovereignty
	Veterinary science	Economic prosperity			Fiscal policy
	Research and development	Trade			

Drivers of Change

In the first stage of the process, 'driving forces' which shape the environment for cattle diseases in Scotland were considered by workshop participants. The list was derived from expert opinion. Participants ranked these drivers for their relative impact and then uncertainty following discussion in plenary. In this instance, uncertainty does not refer to the likelihood that an event will occur, but refers to the range of outcomes that can result from a driver. High numbers of outcomes means high uncertainty. When there was substantially polarised discussion over uncertainty of a driver, that driver was subsequently and implicitly considered to result in high uncertainty.

Scenarios

In stage two, the high impact, high uncertainty drivers prioritised by participants were used to construct three axes along which a logical and systematic grouping or cluster of drivers of change could be represented. These axes were plotted on a cube. Four scenarios were constructed to represent potential futures at different points along the axes. Best and worst-case scenarios were avoided in order to ensure that the identified scenarios contained a realistic mixture of threats and opportunities. Once scenarios were characterised, a 'back-casting' exercise was undertaken to identify specific events along the time-line and determine whether events unfold in a plausible manner, consistent with each scenario.

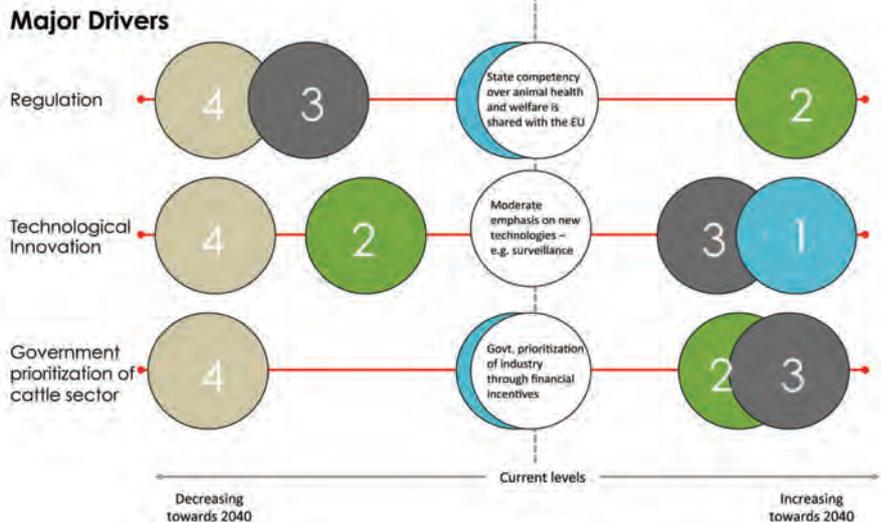


Axes were plotted on a cube as a three dimensional scenario space. Four scenarios were constructed to represent potential futures at different points along the axes. Best and worst case scenarios were avoided. Scenarios were a plausible mixture of threats and opportunities.

*The future fiscal environment will almost certainly be an important driver in the cattle sector. However, it proved complex to incorporate possible interactions between regulation and funding within a single trajectory. Funding was considered within each scenario rather than exclusively as part of the regulation axis.

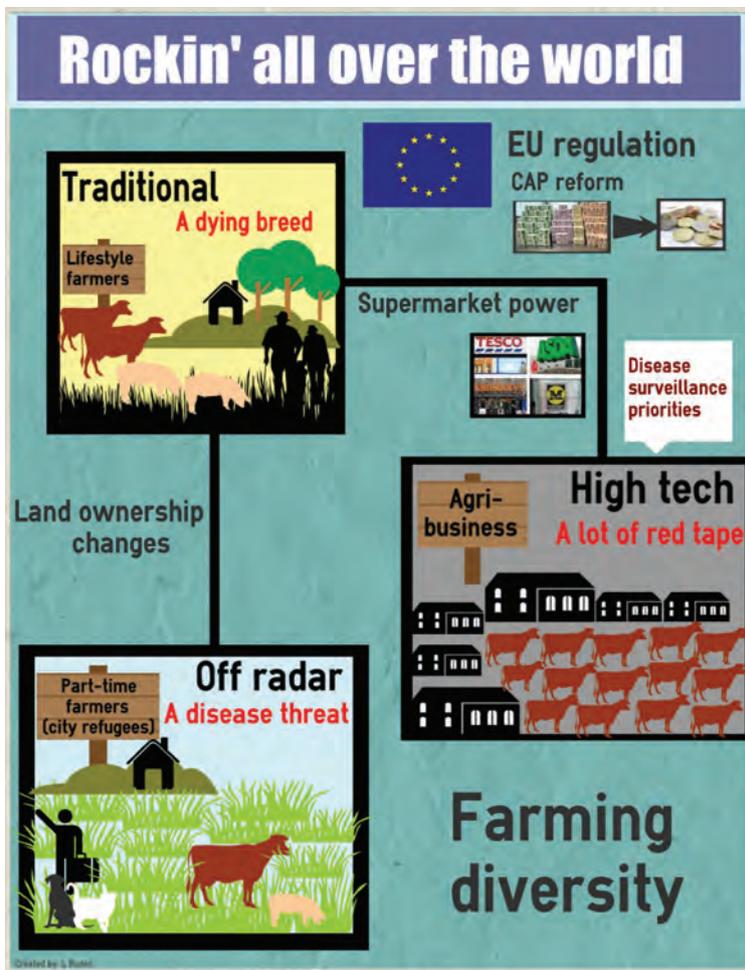
In stage three, participants were invited to devise a set of strategies that aimed to exploit the opportunities and counter the threats within a particular scenario.

In stage four, a **windtunnelling exercise**, was conducted, in which each strategy was individually assessed by the other groups to evaluate its likely effects under the different set of conditions within each future. This process allowed strategies to be ranked in terms of their perceived robustness.



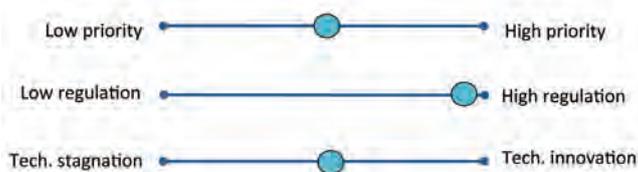
Scenario 1

The cattle sector is divided into three major groups: hobby farmers, lifestyle farmers, and agri-businesses. This has resulted in a mixed distribution of uptake of technology and innovation. Hobby farmers comprise many 'city refugees', the majority of whom embrace technology, ethical practices and animal welfare. Other "hobbyists" form small enclaves where animal movements are difficult to trace, and it is difficult to control or prevent disease. Lifestyle farmers are those that embody traditional farming practices, may have other sources of income through spouses and have traditional means of buying and selling through auction houses. This group sell animals to agribusiness and as such they are inter-dependent on agri-business for survival. This relationship is complex as paradoxically, as agri-business grows, adjacent land is bought up and lifestyle farmers are diminishing in number. Technology is willingly embraced by some; others use it only when enforced. Agribusiness is characterised by the scale and size of the operation and as such dictates that this is the entire source of income for families/participants. Growth of agribusiness is dependent on longstanding contracts with retail industry. Large scale enterprises favour high uptake of innovation and technology to ensure efficient performance including good disease control and biosecurity.



How could this scenario happen?

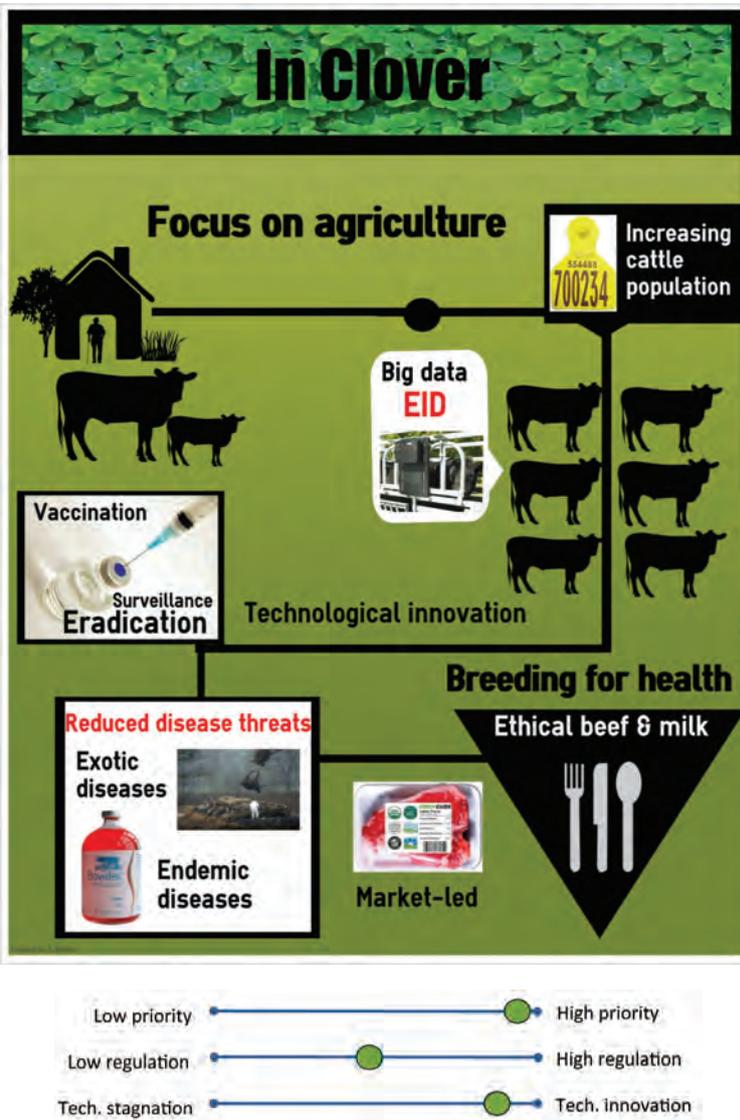
This begins with the development, sustainability and adoption of high technology solutions to improve farm biosecurity and disease surveillance. Visual technologies to assess carcasses are introduced into all abattoirs; there is wide acceptance of technology for traceability and the development of movement databases. The EU is strong, CAP subsidies are reformed and sources of financial support dwindle. Disease regulation and surveillance will remain dependent on funding and external enforcement and will be targeted or risk-based; animals will be tested for disease before export. In general there will be more obligatory checks and surveillance for public health risks. Hobby farmers may remain exempt from some of these checks based on farm size or number of animals on farm. There will be both more direct (money/cow) and indirect support to boost production. Development and sustainability of contracts with supermarkets will benefit large agri-business over the next 25 years. World population and food security may decline but as long as economic prosperity remains good, there will be demand for British products. An ageing farming population will result in a dearth of farmers by 2025 which will lead to issues regarding land ownership versus land occupation and use. This may drive



changes in the distribution of numbers of lifestyle versus agri-business farmers. Education for farming is prioritised early on, resulting in farming careers with a clear trajectory into agri-business. In the meantime, hobby and some lifestyle farmers tend to stay under the radar. Some will embrace technology, others will not. This will depend on provenance of farming habits (i.e. the transfer of agricultural knowledge between generations). Some farm businesses will fail. These will largely come out of the hobby and lifestyle farming sector.

Scenario 2

The cattle industry is enjoying a rosy future in terms of reduced endemic and exotic disease levels, and high-health production systems. Cattle have been given priority over trees in Scotland in a departure from earlier less flexible green policies and heterogeneous forms of cattle farming are prospering, although large units have enjoyed the greatest boost. This has been achieved with minimal state-driven regulation. Supermarkets are playing a positive role in a 'light-touch', lower state-subsidy, regulatory future, supporting a sustainable cattle sector through market-led provenance and quality control schemes. They are acting as an effective bridge between consumer demands for ethically-produced, traceable and high quality produce, and farming needs in terms of running sustainable, profitable enterprises. Technology up-take has resulted in disease prevalence reduction on a number of fronts including genetics, vaccines and surveillance systems (e.g. cattle Electronic Identification (EID)).



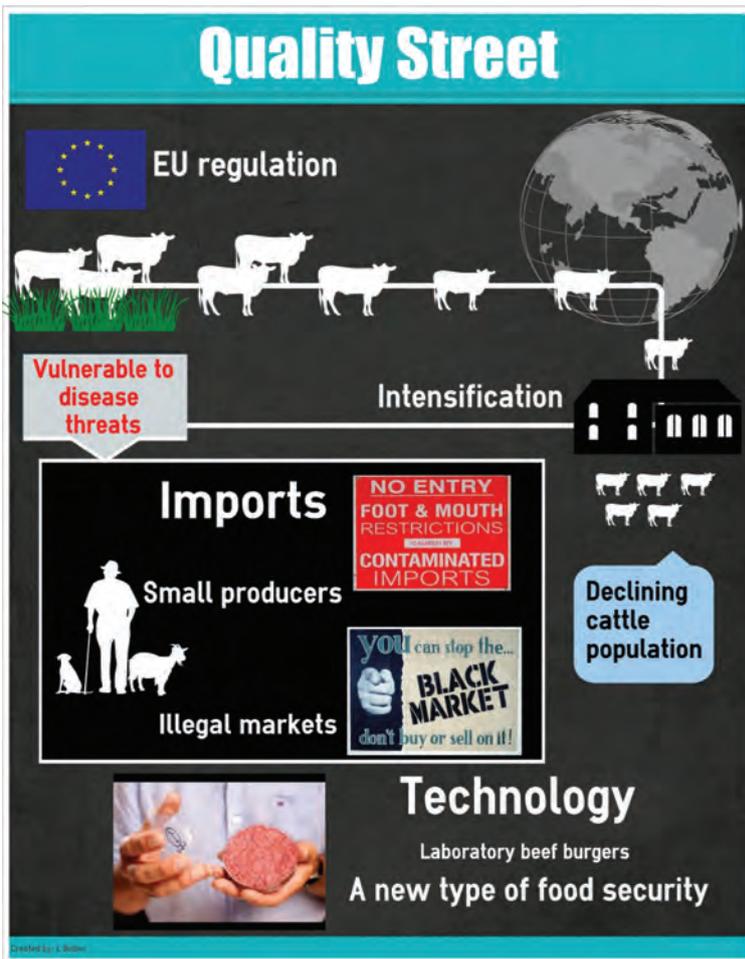
How could this scenario happen?

In the years leading up to 2040, warmer, wetter weather saw steady increases in vector-borne diseases including liver fluke and exotic incursions. Disease control efforts were characterised by government sponsored, scientific collaborations with pharmaceutical companies heralding new veterinary solutions notably in parasite control and genetics. The new partnerships were associated with a 'green light' for genetically modified (GM) crops. Production shifted towards zero-grazing and indoor rearing, a trend that was further driven by more extreme weather. Low carbon farming began to receive state support in 2020 leading to carbon efficient beef farming with new hybrids replacing traditional breeds. Breed societies declined with many of them disbanding. Negative effects included increases in diseases of production following a pattern that had been seen decades earlier in the pig and poultry sectors. In 2024 another game-changing event was a significant cut in EU agricultural aid. This stimulated supermarkets to manipulate supply in order to leverage consumer preferences for sustainable and ethically responsible livestock products. This coincided with a consumer backlash against perceived

factory farming, creating a U-turn with 'breeding for health' emerging as a priority and a 'Zero-Grazing Prohibition Act' that was passed in 2036. Expansion of animal surveillance gained momentum over this period and included compulsory cattle electronic identification (EID). Following the success of the Scottish Bovine Viral Diarrhoea (BVD) eradication programme, farmers' attitudes to disease control and strong emphasis on disease surveillance resulted in significant improvements in John's control. New environmental policy flexibility began to emerge; forestry was reprioritised, as food production gained ascendancy. Stability gradually returned to the subsidy arrangements with no further cuts seen. Live auctions all but disappeared by 2035, replaced by information-rich eBay-style auctions thereby eliminating much nose-to-nose contact. The ageing farmer issue was actively tackled by the promotion of farmer training in the 2030s.

Scenario 3

High regulation and a lack of support for the cattle industry has led to a greater number of large and intensive commercial farms. Some hobby farms and crofts remain but most small units struggle with the red tape and low support environment. High regulation means decisions are made at a European level, with Scotland having little autonomy. However, the combination of large commercial units, the degree of regulation and improved technology means that endemic diseases are much easier to control. This has created a bimodal consumer market with large farms producing a relatively top end product whilst a significant import market for beef and dairy products provides produce for the cheaper end of the market. Laboratory-produced beef is also filling this gap. The homogeneous nature of the big farms to some extent resembles today's poultry industry. This lack of diversity makes the industry vulnerable to new disease threats.



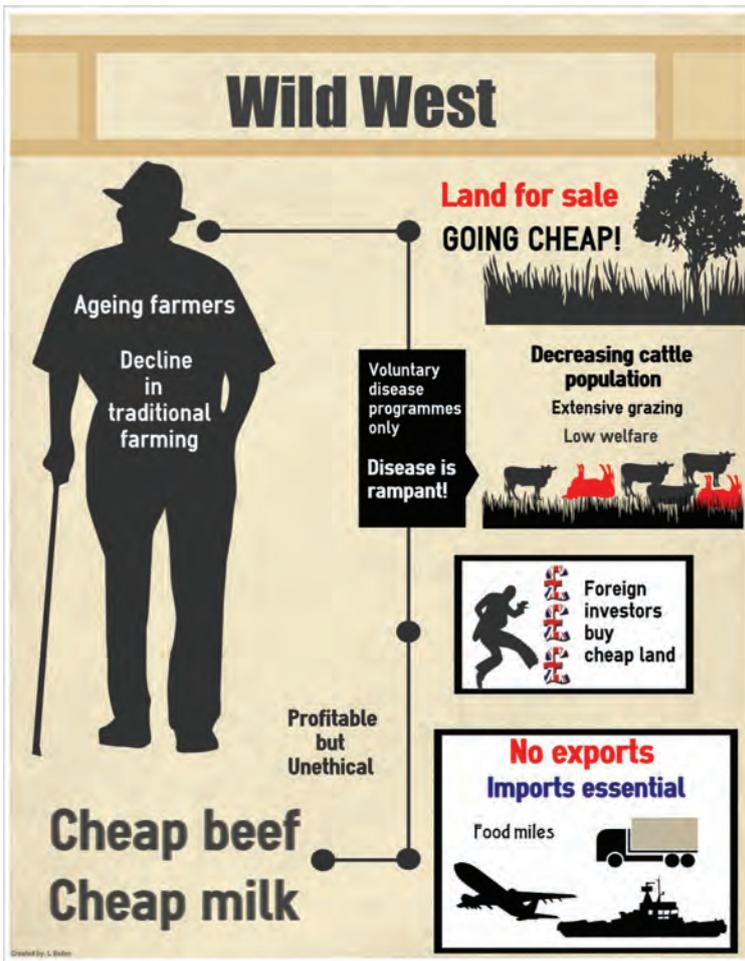
How could this scenario happen?

With increasing European regulation, Animal Health Veterinary Laboratories Agency (AHVLA) closes and is replaced by a new European Union Veterinary Laboratories Agency (EUVLA) based in Romania. The European focus on disease management means that Scotland cannot make unilateral decisions, and much regulation becomes inflexible and unwieldy. All information is collected and stored in one central system. Technological progress such as EID systems make this feasible but wide-scale reliance on technology makes the system vulnerable to failure. Although there are technological solutions available, the regulatory process to promote uptake is slow. The subsidy system changes to put more emphasis on forestry and climate targets. Farmers focus more on on-farm energy generation as energy prices increase. The degree of regulation and lack of support makes it difficult for small producers to keep going, and most of the surviving farms are large commercial units with intensive production. There is some public backlash to intensification, with demand for free range cows. In response to the increased regulation, illegal or black market products increase. This, along-

side the few remaining hobby or small-scale farms, presents a disease risk to the large units. Imports of beef and milk products also present a risk of disease incursion, along-side the overall increase in global trade. In general biosecurity is good on the large units, but if a disease incursion does occur, the potential consequences are severe. The focus on intensification leads to genetic selection for production and endemic disease management but may leave the herd genetically homogeneous and immunologically vulnerable to exotic or new diseases. The changing industry does not require private veterinary practices, as large units do more health management in-house. This leads to an increase in pen-side diagnostics and farmer-led disease management. However, Scotland no longer has a sufficient veterinary taskforce to deal with disease outbreaks.

Scenario 4

By 2040, there are considerably fewer cattle in Scotland. Beef cattle are on large, low-tech extensive rearing systems where animals are largely untended. Minimal regulation has made the use of substances, such as growth hormones, common. Animal welfare is a low priority and veterinary services are purchased based solely upon economic rather than welfare considerations. Serious problems are dealt with by on-farm culling and burial. Many large farms are foreign-owned by large organisations. Meat is very cheap but of poor quality and endemic disease is rife, usually controlled at a local scale and only when economically necessary – firefighting rather than strategic control. Hobby farms occupy a niche, some of them breeding pedigree animals for the export market. Replacement animals for the large farms are imported in significant numbers; imports come from far and wide. Lots of beef is imported, particularly from South America.



How could this scenario happen?

The ageing farmer population is not adequately replaced by family succession and many farms cease trading. The importance of the livestock sector to the Scottish people correspondingly declines, leading to a relaxation in regulations. This is matched by a gradual reduction and eventual end to the Common Agricultural Policy (CAP) support and a decline in research and development. Foreign investors see an opportunity given the low regulatory environment and availability of land and buy up large amounts of land for cattle grazing. This is very profitable but volatile. The poor quality beef satisfies cheap domestic production, but the premium quality meat comes from overseas. The hobby farmers that remain from traditional systems are still farming some pedigree breeds but their ability to export animals is limited by endemic disease and countries are reluctant to import Scottish cattle. An improvement in Ultra-High-Temperature (UHT) treatment of milk reduces the need for domestic dairy production.



Opportunities and Threats

Realistic scenarios contain both **opportunities and threats**. A strategic approach requires exploiting opportunities and counteracting threats through the development of long-term thinking which can be set in motion in the present day. However, the robustness of these strategies needs to be critically considered. Strategies considered desirable and effective in one scenario, can be irrelevant or even counterproductive under a different set of conceivable circumstances.

	Opportunities	Threats
Scenario 1	<ul style="list-style-type: none"> • Big high technology businesses develop. • Loss of lifestyle farmers. 	<ul style="list-style-type: none"> • Impact on rural economies, job losses. • Big businesses associated with big bureaucracy; red tape. High incentives to comply but more likely to be penalised. • Lack of consumer support; longing for countryside of old.
Scenario 2	<ul style="list-style-type: none"> • Technology for rapid disease detection. 	<ul style="list-style-type: none"> • Large companies are vulnerable to disease. • Limited compensation available.
Scenario 3	<ul style="list-style-type: none"> • Opportunities to control or eradicate more endemic diseases. • Opportunities for farmer training. • Beef/dairy products are niche high quality products that are easy to market. 	<ul style="list-style-type: none"> • European level decision making leads to loss of skills base in Scotland for disease management and control. • Industry is stagnant and difficult to grow. • Industry is susceptible and vulnerable to new threats. • Decreasing government interest.
Scenario 4	<ul style="list-style-type: none"> • Disease control from other sectors – “shoot the cattle to protect the deer”. • Development of cross-sector collaboration – “peer pressure”. 	<ul style="list-style-type: none"> • No future for farmers exporting pedigree breeds. • Damage to dependent sectors e.g. deer hunting.

The identified scenarios yielded a number of options for improving Scotland’s ability to respond to future industry trends.

There was general consensus from stakeholders that ‘farmer empowerment’ for endemic, but not exotic diseases, has the potential to be useful in all future scenarios. The most controversial strategy was the ‘disease-free mark’ which was perceived to be completely unnecessary in scenarios 2 and 3, but highly applicable in scenario 4. Other strategies such as ‘industry insurance’, a ‘licence to farm’, and ‘import control strategies’, were perceived to be highly variable in terms of their potential success across all scenarios. Exploring the reasons for this variability across strategies is a useful focal concept for future discussions between EPIC disease modellers and Scottish Government policy makers.

Developing Strategies

Scenario 1

Biosecurity initiative: This would include a move towards closed herds, in-house diagnostics, risk management consultants and regionalisation to allow trading in disease outbreaks. Enforcement of this strategy was perceived to be a big challenge.

Licence to farm: This would include an education initiative promoting a professional career path towards positions in high technology farming businesses. This was seen by some as bureaucratic as supermarkets are already acting as de facto regulators. However, educational aspects to this strategy were welcomed.

Scenario 2

Industry insurance scheme: This would replace current compensation arrangements. This promoted discussion on whether it should be compulsory, how it might be audited, how premiums might be determined and whether these premiums might be disease-dependent.

Farmer empowerment: This would include self-administered controls and diagnostic tests for disease. In discussions, this was subsequently considered separately for exotic and endemic diseases. For exotic disease, there was concern over self-diagnostics. Unregulated testing is considered too high a risk when the industry is so susceptible to exotic disease threats.

Scenario 3

Import control strategy: This would include on-farm strategies such as breeding own replacements and increased regulation. This was perceived to be heavily contingent on whether the control is based on animals or animal products/meat. High technology, high regulatory environments may result in greater numbers of trade disputes due to SPSS agreement.

Specialised education: This would include the use of farmer-led health management strategies and high use of technology will require specialised training. This would augment farmer empowerment but sufficient investment is essential.

Scenario 4

Countryside alliance: This would incorporate a strategy focussing on the dissemination of impartial information and advice through a network of farmers. It was suggested that supermarkets are de facto performing much of this function therefore impartiality is not paramount.

Disease-free mark: This would promote quality assurance. Similar to the 'Red Tractor' concept, this would provide assurance that products were disease free (after leaving the farm). This would need to be a farmer- rather than consumer-led initiative. It was seen by some as unnecessary and a 'last line of defence' in circumstances where other up-stream mechanisms effectively guarantee disease free produce.

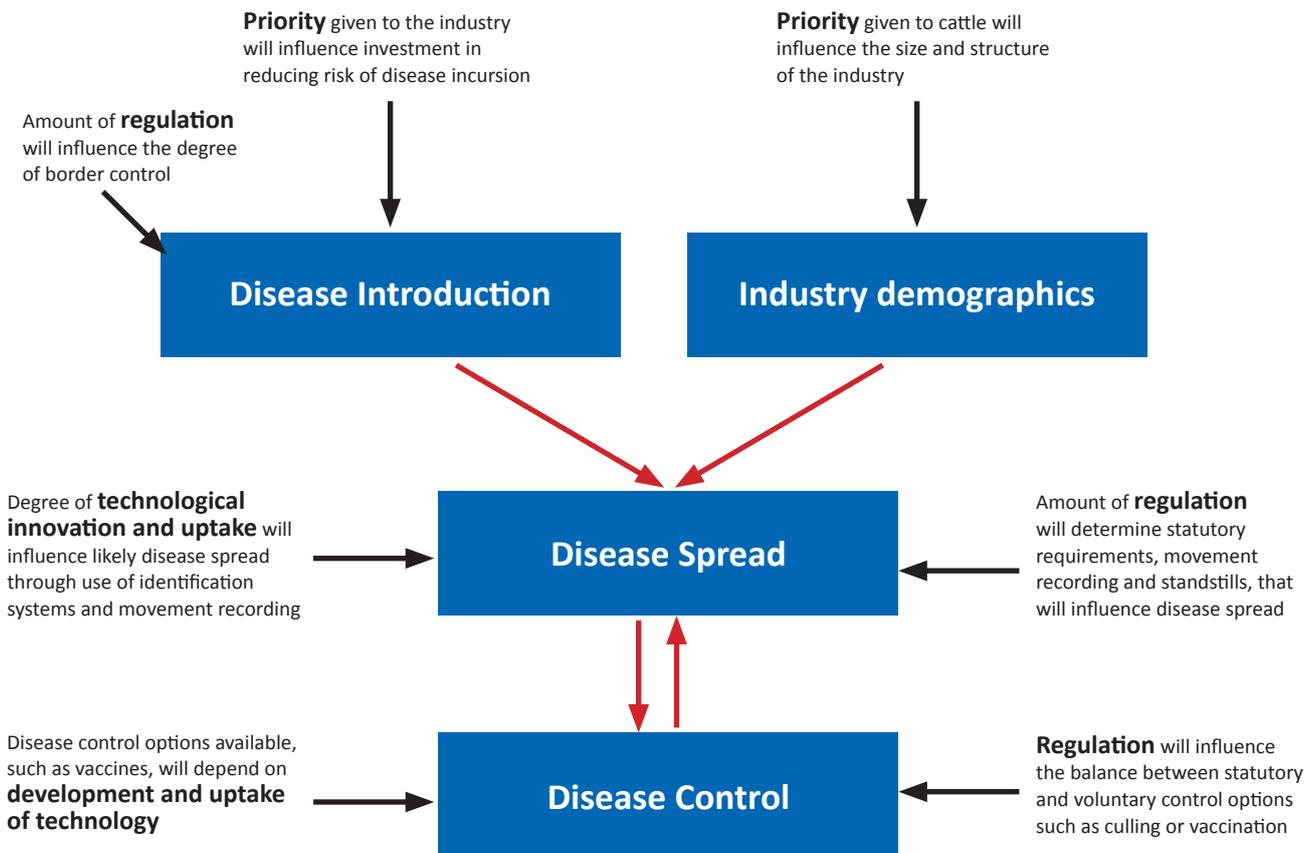
Key Questions for Policy-makers

- Does the current Animal Health Law allow scope for **increased farmer empowerment**? Is this too high a risk when the industry is so susceptible to exotic disease threats?
- Will the new Animal Health Legislation proposed by the EC for 2015 formally address **biosecurity initiatives**? Will national surveillance programmes remain a high priority?
- Would a '**licence to farm**' augment the impact of other initiatives (including specialised education schemes) to encourage young new farmers into the industry or would the perception of increased regulation and bureaucracy have the opposite effect? Might this have a positive impact on compliance with biosecurity initiatives?
- Who should provide **impartial advice** and lead farmer education initiatives on biosecurity and disease prevention (supermarkets, industry, government, private veterinarians)?
- In the context of animal disease outbreaks is an **industry insurance scheme** a feasible and useful mechanism to cater for the diversity of the cattle sector: agribusinesses, lifestyle farmers and 'hobby' farmers?
- Do current or proposed regulations inhibit or enhance Scotland's access to or development of new technologies for detection and elimination of disease?
- Are there sufficient upstream mechanisms to guarantee disease-free produce or would a '**disease-free mark**' enhance industry-led control of endemic diseases?

Adding Value

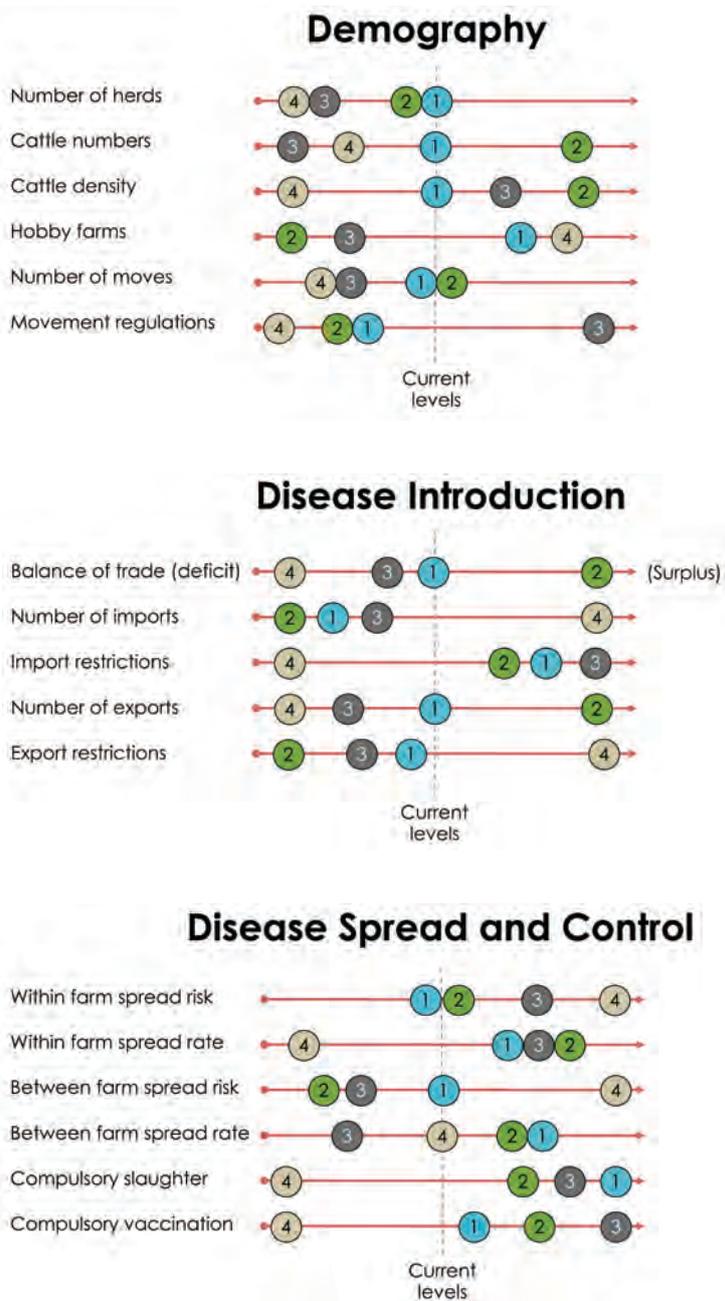
EPIC's aim in developing these scenarios is to be able to look at how disease incursions and disease spread may be different in the future, and how our control strategies may need to adapt, should the industry and risk profile look quite different to now. Data from the four scenarios have been analysed to extract disease-relevant components based upon how the drivers will impact upon the **risk of introduction**, the **industry demographics** and the **disease spread** and **disease control** opportunities.

The participants were specifically asked to consider diseases whilst developing their scenarios. From analysis of the discussions and the narratives it was possible to extract information on how the axes would impact on different components of disease spread. Not all of the axes have influence on all the components of disease spread, as shown below.



Disease Resilience In The Future

Each component of disease spread can be broken down to a number of parameters that will be used to inform mathematical models to explore future disease resilience in terms of the potential for spread and efficacy of controls. Each parameter listed below was estimated through analysis of the narratives for each scenario. For instance, scenario 4 describes high volumes of meat and live animal imports in an unregulated system, which has the potential to increase the risk of disease introduction.



Demographics

The shape and size of the industry varies dramatically in the different scenarios. Any changes in cattle numbers, farm size, production type and movements influence disease spread. For example in scenario 3, the cattle sector is diversifying into a more heterogeneous group comprising lifestyle farmers, agri-businesses and hobby farmers. Although many will embrace technology, and ethical practices, some “hobbyists” may form small enclaves where animal movements are difficult to trace, inadvertently increasing the difficulty of disease control and prevention.

These differences in industry demographics, along with cattle movements, influence the ease with which diseases can spread between animals and between farms. Control options vary with technology available and the degree of statutory control. For example in scenario 4, disease is likely to spread easily, but control can be enforced and technological advancements provide more control options.

Disease Introduction

The opportunities for the introduction of a new disease to the national herd would be quite different in each of the four scenarios. This would be particularly influenced by the import/export market, and any restrictions put in place. For example in scenario 1, increased imports in the absence of high regulation make disease incursions very likely.

Disease Spread and Control

These differences in industry demographics, along with cattle movements, influence the ease with which diseases can spread between animals and between farms. Control options vary with technology available and the degree of statutory control. For example in scenario four, disease is likely to spread easily, but control can be enforced and technological advancements provide more control options.

Future Work

The scenario planning workshops explore the future of the Scottish cattle industry, and are the first in a series of similar workshops which will look at specific sectors of the Scottish livestock industry. Within these workshops, EPIC will build new scenarios and develop these existing scenarios to provide comprehensive coverage of livestock disease challenges in Scotland towards 2040. The next topic, 'The future of the Scottish sheep industry' has been selected as the follow-on study due to the areas of similarity between the cattle and sheep sectors. This will allow EPIC scientists to further explore some of the themes that have emerged from the cattle workshops.

It is important to recognise that scenarios are not predictions of the future. They are based on a fixed number of assumptions and drivers. The challenge is to find a balance between the numbers of fixed assumptions that go into a scenario, in order to balance the complexity of the resultant scenarios against the plausibility of their occurrence. In the scenarios presented here, we have opted to address two or three primary drivers per scenario, recognising that in future, an unknown number of drivers will interact.

The scenario building process is a useful social learning tool that enables scientists, policy makers and industry stakeholders to identify and discuss the future of the livestock industries. Workshops already completed for the cattle sector have also produced a large amount of valuable data that will be disseminated throughout EPIC. The data of particular value are the scenario narratives (described above), the relative impacts of the drivers and axes on animal demography, disease introduction and spread, and the intervention strategies. These data will both be incorporated into existing work and used as the basis of new disease modelling and economic modelling work. Specific examples of the uses of the scenario planning work by EPIC are:

1. Use of EPIC's existing disease models with the parameters specific to each scenario to understand how disease might be best controlled in each proposed future.
2. Modelling disease incursion risks in each scenario to understand how the risks of different pathogens may differ in different scenarios.
3. Further assessment *in silico* and through collection of survey data of the potential effectiveness of the strategies from the windtunnelling exercise both under present farming circumstances and proposed future scenarios.
4. Grounding EPIC's scientific program in 'real-world' knowledge by developing and maintaining stakeholder forums rich in practical expertise.

This will greatly enhance EPIC's preparedness for future major disease epidemics. Data will also be combined with the outputs from future scenario planning meetings on other livestock sectors to give a holistic vision of the future of the Scottish livestock industry.

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The views expressed in this report are those of participants in the workshops held by EPIC in its capacity as a Centre of Expertise on Animal Disease Outbreaks. These views are not necessarily endorsed by EPIC scientists. They do not represent Scottish Government policy.





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