Feasibility of Introducing Methods in the UK for Reducing Shedding of *E. coli* O157 in Cattle

Final Report
November 2011

SAC[1] contributors: **J.C. Low[*], B. Vosough Ahmadi, L. Toma and A.W. Stott**

University of Glasgow[2] contributors: **L. Matthews and D. Mellor**

[1] Research Division
Scottish Agricultural College
West Mains Road
Edinburgh
EH9 3JG, UK
Tel: 0131 535 3150
E-mail: Alistair.Stott@sac.ac.uk

[2] College of Medical, Veterinary and Life Sciences
University of Glasgow
Bearsden Road
G61 1QH, UK
Tel: 0141 330 8175
E-mail: Louise.Matthews@glasgow.ac.uk

[*] Current address: R(D)SVS, Easter Bush, E-mail: Chris.Low@ed.ac.uk

Contents

List of Tables

Cost benefit analysis

List of Figures

Cost benefit analysis

Executive Summary

The aim of this study was to consider on-farm measures that have been investigated for control of *E. coli* O157 in cattle, and to assess the costs, benefits and barriers associated with using these strategies, in full or in part, in the UK.

A literature review on the efficacy of control measures for reducing *E. coli* O157 shedding in livestock identified a total of 221 relevant scientific publications dating from 1990 to 2011. It was noted that the majority of peer reviewed work on this subject was dominated by publications from North America. From the published research papers the methods identified for the control of *E. coli* O157 in farm livestock were categorised as: i) drinking water treatments, ii) dietary manipulations, iii) provision of probiotics or other feed additives, iv) the improvement of farm bio-security, v) use of bacteriophages or vi) vaccines. Out of the 221 publications studied, few practical and economical treatments were identified that demonstrated a reduction in *E. coli* O157 prevalence and shedding. Probiotic treatments and vaccine approaches were described in the literature review with data on the possible levels of reduction in *E. coli* O157 shedding that could be expected through their application. However, information was limited on the duration of effect and impact on the numbers of *E. coli* O157 that would be found in the faeces of treated animals. The literature review also identified no work comparing the efficacy of these products, and little published research on their application in European farming systems.

Analyses were carried out; based on eight publications from the literature review that most clearly quantified the reduction in prevalence or bacterial shedding that may be achieved through the application of a control measure. The selected publications provided sufficient quantitative data on two vaccine approaches and one probiotic treatment to include in the benefit-cost analyses. The impact of bio-security was also assessed, although evidence for its efficacy was less clear, and quantitative data was only available on the effect of applying a combined package of eight bio-security measures on *E. coli* O157 prevalence in cattle. For each of the selected control options mathematical models were used to predict the reduction in human infections that may be expected following their application and the financial benefit that may be gained through prevention of human illness was calculated.

The total costs of applying the control measures in the UK and its four regions were determined. Two options were considered for estimating the cost of each control measure: *1)* applying the control measure to all animals on each farm and *2)* targeting the control measure at young animals (defined in this study as animals under 25 months of age). The benefit-cost ratios were the total benefits of each control measure from the illness prevented divided by the total costs of applying the measure in either option 1 or 2. The benefit-cost ratios showed how much benefit was generated, if any, by spending one pound on each control measure. The results suggested that using vaccines or probiotics to control *E. coli* O157 could, in some circumstances payback the costs. However, this outcome is heavily dependent on the preventable human losses, especially the severity of human illnesses and not just the number of cases prevented. The results of the analyses also suggested that application of the package of bio-security measures which was demonstrated in the literature to reduce *E. coli* O157 prevalence in cattle would not be cost-effective due to the costs of implementation. It is important to note that there was insufficient published evidence regarding the efficacy of individual biosecurity measures to allow possibly cheaper approaches to be

considered. Furthermore, the benefit-cost analysis did not take into account the potential benefits of biosecurity on other pathogens which impact on human and animal health.

The study also examined the views of UK farmers on the adoption of *E. coli* O157 control measures. A telephone survey of 405 cattle farmers and an online survey of 91 farmers that deliberately open their farms to the public in the UK were carried out. The survey findings indicated that the majority of farmers in both groups were aware that *E. coli* O157 causes disease in humans, that livestock are an important source, that people may become ill through contact with calves/cows and that the pathogen may be present on raw meat. There were lower levels of awareness that *E. coli* O157 could be present in raw milk and could contaminate produce (such as lettuce, apples and spinach) and drinking water supplies. Overall, open farmers showed a greater awareness of the human health risks of *E. coli* O157 and potential pathways for transmission to humans. The identification of respondents in both groups lacking an understanding of the potential sources of *E. coli* O157 and the risks to human health suggested that not all farmers recognise drivers for controlling this pathogen.

In both groups of farmers a minority stated that they would be unwilling to pay for, or to spend time administering an effective treatment for *E. coli* O157. However, analyses of their responses showed that farmers were more likely to be willing to pay or to spend time in controlling *E. coli* O157 on their farms if they belonged to one of the following groups: 1) they thought that the control measure would be effective; 2) a higher proportion of their income was dependent on them opening their farm to the public; 3) they had been affected by *E. coli* O157 outbreaks or incidents in the past; 4) their farm type was dairy rather than beef; 5) they had more frequent access to information and stronger attitudes towards the need for *E. coli* O157 control. The findings suggested that increasing all farmers' access to information, and specifically targeting: dairy farmers, those who open their farms to the public, and those affected by past outbreaks would help to improve levels of awareness and change attitudes with regard to the control of *E. coli* O157. It is worth noting that there were no differences in the attitudes of farmers in different regions of the UK; though the smaller sample sizes mean the findings for individual countries should be interpreted with caution.

To assess the legal barriers to implementing on-farm treatments for *E. coli* O157 in livestock, contact was made with the Veterinary Medicines Directorate (VMD) and it was confirmed that no licensed medicinal product was available in the UK with a recognised claim to control *E. coli* O157. In the European Union it is possible to register medicinal products in individual member states and the VMD only hold information on those products subject to a harmonisation process, but our contacts with experts in European countries failed to identify any existing products available for use in the UK.

Though no product is currently licensed for controlling the carriage of *E. coli* O157 in animals in UK the VMD is able to assist in the importation of medicines where a practising veterinary surgeon wishes to import a product in accord with the prescription cascade. Application must be made through a Special Treatment Certificate (STC) for non-European or human medicinal products or a Special Import Certificate (SIC) for a European medical product. Written advice was obtained from the Royal College of Veterinary Surgeons (RCVS) legal team that interpretation of the phrase 'to avoid causing unacceptable suffering' required in a STC application for a product to control *E. coli* O157 in livestock could be considered in a wide sense where the perceived benefits would be to public health rather than in the strict sense of the relief of animal suffering.

In summary, this research identified no practical, cost effective control measures immediately available for reducing the prevalence or shedding of *E. coli* O157 in cattle. However, the modelling suggested that, at a national level, the use of vaccines or probiotics could pay back the costs associated with administering these treatments, especially when the severity of human illness is high.

Both vaccines and probiotics have shown promise in North American studies. However, the findings from our survey of farmers showed that although there is an awareness of *E. coli* O157, and the threat that it poses to public health, there is a reluctance to adopt any control measures that they do not know to be efficacious and safe. The survey also suggested that the benefit of implementing on-farm controls for *E. coli* O157 is not obvious to farmers. However, during our engagement with relevant stakeholder groups, the open-farm sector expressed interest in the use of vaccines. It was determined that although vaccines are not currently licensed for use in the UK, there is no legal obstacle to a practising veterinary surgeon wishing to apply to VMD to import a product in accord with the prescription cascade. It is therefore feasible that open farmers may adopt such measures in the future. However, with the exception of the open-farm sector, demand for the application of on-farm controls for *E. coli* O157 is limited until there is further evidence to demonstrate their efficacy in UK farming systems and more obvious drivers for implementing such measures are identified.

Recommendations

The background to the study was to contribute data to address formal recommendations made following two enquiries into major outbreaks of *E. coli* O157 that have occurred in the UK population since 2005.

The stated aim was to consider on-farm measures for control of *E. coli* O157 in cattle, and to assess the costs, benefits and barriers associated with using these, in full or in part, in the UK. We trust that the reader will find our contributions valuable to the debate and will now allow the authors to highlight six recommendations that derive from their consideration of the findings.

Recommendation 1. We recommend that an opportunity is sought to evaluate the efficacy of probiotics and/or vaccines for on-farm *E. coli* O157 control in UK. Probiotic treatments and vaccines have been described where reduction in *E. coli* O157 shedding may be expected through their application. However, information is limited on the duration of effect and impact on the numbers of *E. coli* O157 that would be found in the faeces of treated animals. Additionally, there is little published research on the application of such controls in European farming systems. There is therefore a need to extend the general principles to examine the means of probiotic administration, or to tailor vaccination regimes to ensure maximum effectiveness in reducing the carriage of *E. coli* O157 in cattle. Development of such targeted on-farm interventions in the UK may provide important evidence of safety and efficacy for farmers.

Recommendation 2. We recommend that NFAN be encouraged in developing Codes of Practice for on-farm *E. coli* O157 control and are given assistance to engage with the open-farm sector and to publicise their experiences in the adoption and implementation of control measures. During our engagement with stakeholder groups, the open-farm sector was most concerned with the means to protect their businesses and with our assistance some individuals have imported commercially available vaccines to vaccinate their livestock. We suggest that such farmers, with a higher proportion of their income dependent on opening to the public; and that have been directly or indirectly affected by *E. coli* O157 incidents, may increasingly adopt such measures. However, since there is no official record of 'open farms' in the UK the dissemination of such information is dependent upon organisations such as NFAN to encourage farms to use codes of practice and to implement measures to protect the safety of their visitors.

Recommendation 3. We recommend that farmers may implement on-farm controls for *E. coli* O157 if they identify a clear hazard and if there is greater knowledge of the safety and efficacy of the proposed controls. Despite farmers recognising a responsibility for the potentially negative consequences that maintaining cattle and spreading this pathogen poses to the public, for the majority of farmers there is a lack of validated on-farm control options, and the lack of a clear link between human cases of infection and their own livestock. Without such evidence we do not believe that most individual farmers will take ownership of the problem. We consider that recommendations 1 and 2 may permit the demonstration of the efficacy of controls in UK farming systems and could encourage uptake.

Recommendation 4. We believe that major retailers and buyers of milk and beef could be asked to provide incentives to those farmers willing to apply proven on-farm *E. coli* O157 controls. On-farm control of the pathogen may be considered publically beneficial. However, a highly important issue with respect to controlling *E. coli* O157 is that the pathogen does not cause disease in livestock and no direct economic incentive for the farmers. We are conscious that currently the costs will be borne by the agricultural community with no immediate or direct benefit. Whilst the protection of their families might occur, we think that our work demonstrates a wider public good should arise from control of infection in cattle. Whilst retailers and buyers will be cautious in providing financial incentives for *E. coli* O157 control on-farms we believe there may be in certain circumstances an opportunity for them to encourage or demonstrate the measures as acts of public good and beneficial to their reputations.

Recommendation 5. We consider as a priority for further research activity continued interdisciplinary cooperation in the collection of information for the development of more detailed and refined disease transmission models. Our transmission models were used to translate the observed prevalence and shedding reductions in cattle into a predicted reduction in risk to humans. These models are robust representations but are determined from historic surveillance and prevalence data and require continued validation**.**

Recommendation 6. We recommend the increasing use of the media as a crucial mechanism in disseminating information relating to *E. coli* O157 control. Our findings suggested that increasing all farmers' access to information would help to improve levels of awareness and may change attitudes with regard to the control of *E. coli* O157.

1. Introduction

1.1 Background

1.1.1 Human *E. coli* O157 infections arising from agricultural sources

The number of reported human cases of *Escherichia coli* O157 infection in the UK is currently stable at just over 1,000 cases per year (Griffin, 2010; FSA, 2011a). The majority of *E. coli* O157 infections occur between July and September each year and reporting rates are highest in children under five years of age (mean incidence 6.1 per 100,000 per year, 2000 to 2008). *E. coli* O157 infection may occur after the consumption of contaminated food or drink, through direct contact with contaminated animals, or from an environment contaminated with animal faeces, and by person to person spread (Nataro and Kaper, 1998). The infectious dose is considered to be low and ingesting just a few organisms, possibly between 10 and 100, may be sufficient to cause illness (Nataro and Kaper, 1998).

Most human *E. coli* O157 infections are considered sporadic (not associated with outbreaks) where it is often difficult to confirm a source. However, there is accumulating evidence that the farm environment is an important hazard resulting in a considerable number of sporadic *E. coli* O157 infections. Three independent case-control studies in Great Britain investigated risk factors for sporadic *E. coli* O157 infection and all identified that infected people were significantly more likely to have had farm animal contact than healthy controls (Parry et al., 1998; O'Brien et al., 2001; Locking et al., 2001). Parry et al. (1998) showed that cases are significantly more likely to have visited a private farm or to have a household contact whose occupation involved contact with farm animals and through these risk factors it may be considered agricultural contacts account for around 20% of all sporadic cases.

A case-control study conducted in England (O'Brien et al., 2001) also found a significant association with contact with the farm environment, including visits to open farms, holidaying on farms and work-related visits. In Scotland, cases are more likely to report contact with animal faeces, such as may occur during visits to farms or recreational use of animal pasture (Locking et al., 2001). In a further study in South West England between November 1994 and October 1997, 23 of 69 sporadic cases noted possible recent contact with farm animals; in seven of these there was microbiological confirmation for the animal source of infection (Trevena et al., 1999). Additional evidence comes from a Scottish study correlating cattle and sheep densities with rates of sporadic human infections (Strachan et al., 2006). In Grampian Region, after correcting for population differences, 63% of *E. coli* O157 cases occur in rural area postcodes compared to 37% in urban areas. The study concludes that 26% of Scottish cases may originate from animals or from the rural environment.

In addition to association with sporadic infections, in Scotland animal contact accounts for the largest single category of *E. coli* O157 outbreaks from 1996 to 2008. In total, these affected 220 people; the largest outbreak involving 22 people. Outbreaks have occurred on private farms, in visitors to holiday accommodation, at campsites, through contamination of private water supplies,

and from visits to open farms[1]. Suspected sources included direct animal contact as well as contact with livestock faeces, environmental exposures and contamination of water by animal faeces. Companion animal exposure has not been implicated. The higher number of outbreaks attributed to farm animal contact in Scotland than in England and Wales may be due to differences in classification or more accurate attribution of outbreaks in Scotland as a result of the enhanced surveillance scheme (Griffin, 2010). In the United States, between 1996 and 2002 animal contact is considered responsible for 11 outbreaks: five on-farms, two at county fairs, two at petting zoos, one at a barn dance and one at a camp (Rangel et al., 2005) and in England 93 children were infected with *E. coli* O157 after visiting an open farm in South East England (Griffin, 2010).

In conclusion since the late 1990's, there have been increasing number of outbreaks of *E. coli* O157 (and other gastrointestinal infections) linked with animals in public settings such as open farms and fairs (Steinmuller et al., 2006; Griffin, 2010). There is also considerable evidence that exposure in the farm environment results in a significant number of sporadic *E. coli* O157 infections. In addition, it is feasible that human foodstuffs may become contaminated as a consequence of the carriage of the organism by livestock.

1.1.2 Animal carriage

E. coli O157 present in animal manure can lead to contamination of soil and grass, farm buildings, fences, machinery and water-courses, and the organism may survive for months in animal faeces and soil. Cattle, sheep, goats and other ruminants are considered important reservoirs of *E. coli* O157 although the organism may be found in the gut flora of other species including pigs, cats, dogs, rabbits, chickens and other birds (Nataro and Kaper, 1998; Naylor et al., 2005). Young cattle between two and 18 months of age are most likely to be excreting the organism but importantly, animals that are shedding *E. coli* O157 in faeces show no clinical signs, and owners cannot identify affected animals.

Cattle vary considerably in the numbers of *E. coli* O157 that they shed. Possible factors that affect shedding include: age, diet, previous exposures and, probably, the time of year. However, the major factor is whether the animal is colonised by the bacterium. Colonisation particularly occurs at the rectum and colonised cattle are sometimes referred to as 'supershedders' since they may shed up to 10^6 c.f.u/gram faeces though this level of shedding is not persistent (Naylor et al., 2003; Chase-Topping et al., 2008). The organism is unequally distributed in the dung of colonised animals with most bacteria being found on the surface of the stool. These colonised animals greatly increase the potential for spread of *E. coli* O157 (Chase-Topping et al., 2008). The number of farms with positive cattle has been estimated to be in the order of 20% in Scotland but importantly the status of individual farms, as positive or negative, changes (Naylor et al., 2005; Chase-Topping et al., 2008) and the frequency of carriage fluctuates with time. Though shedding in an animal or group may be intermittent; as there are no clinical signs of infection it is important that all ruminants are regarded as potentially infected.

[1] Open farms are understood to mean those premises that as a business are operating as an attraction and opening to the public allowing deliberate access to the livestock.

1.1.3 Control

From the early 1990s, there has been a move towards a goal-based, self-regulatory approach in the UK for safe food production, with implementation of the Meat Products (Hygiene) regulations (S.I. 1994 No. 3082), the Food Safety (General Food Hygiene) Regulations (S.I. 1995 No. 1763) and superseded more recently by the European Union (EU) Regulations EC 178/2002, EC 852/2004; EC 853/2004 and EC 854/2004. Food businesses operators (FBOs) are obliged by regulators to devise and implement individual safety management strategies to ensure food placed on the market is safe for human consumption. Implicit in the demands for self-regulation is the assumption that businesses have a thorough understanding of the risks produced in their own particular operation and of the measures necessary to control those risks. Taking into account the complexities of food supply, these EU regulations introduce consistency and clarity throughout the food production chain from 'farm to fork' (i.e. from the production to the consumption point).

With regard to the control of *E. coli* O157 in the food chain, there has been considerable effort to implement Hazard Analysis and Critical Control Point (HACCP) control measures at abattoir, catering establishments and retailers, and to promote food hygiene advice to consumers in order to minimise risks in the domestic kitchen. However, in addition to food chain risks, the farm environment is a major source of *E. coli* O157 infections for humans, as described through: direct animal contact, by environmental contamination and pollution of water supplies. In relation to measures for the control of *E. coli* O157 on-farm, EU food regulations recognise that 'The application of HACCP principles to primary production is not yet generally feasible. However, guides to good practice should encourage the use of appropriate hygiene practices at farm level'.

Though there has been significant effort in the past 10 years to understand the carriage of *E. coli* O157 by cattle and to a lesser extent by other ruminants, and a large number of prevalence studies have been conducted, there remains a lack of knowledge of transmission events both on and between farms. There is also limited understanding of what can be understood as good practice for on-farm control. Super-shedding presents an important theoretical aspect for the control of *E. coli* O157 on-farms and, indirectly, in reducing the risk of human infection (Chase-Topping et al., 2008) but animals show no signs of infection by *E. coli* O157 and the organism may be commonly found in the environment of infected animals. Additionally, no production losses are associated with infection and controls are therefore necessary only to prevent human infection.

1.2 Remit of the study

This report was to examine the public health burden attributed by *E. coli* O157 infection, to appraise published evidence on the efficacy of measures for controlling this pathogen at the farm level, and to describe the costs, benefits and barriers associated with implementing these measures in the UK. The main objective of the research was to contribute data to address recommendations made after 2 major *E. coli* O157 outbreaks that occurred in the UK over the past 10 years. Namely, the recommendation made in the public report of the foodborne outbreak which occurred in South Wales in 2005 (Pennington, 2009) that: 'the feasibility of identifying 'supershedder' cattle on farms should be explored as a potential means of reducing the likelihood of spreading *E. coli* O157 to other cattle'. Additionally, one of the recommendations from the public report of the 2009 outbreak involving an open farm in South East England (Griffin, 2010) was to 'Study the feasibility of vaccine

control of *E. coli* O157 in ruminant animals in the UK, and identify the obstacles to its implementation'.

The outputs of this research were based on the findings of three areas of work described below:

1. An evidence review to establish the cost, practicality, evidence for adoption and efficacy and cost-effectiveness of control options.
2. Behavioural analysis to understand the drivers and barriers of adoption of control options
3. Stakeholder engagement to share the intelligence through consultation with both observers and stakeholders.

2. Evidence Review

2.1 Review to establish the cost, practicality, evidence for adoption and efficacy of control options

2.1.1 Methodology

The literature review was conducted using mainly the following databases: ScienceDirect, SpringerLink, PubMed, Web of Knowledge, Cambridge Journals Online, CAB Direct, Google Scholar, Blackwell, JSTOR, Oxford Journals, and PLoS. We searched a few of the top medical, veterinary and animal science journals for publications focused on on-farm control measures. Specifically, we searched *Journal of Preventive Veterinary Medicine, Food Protection*, *Foodborne Pathogens and Disease, Vaccine, Food Control, Applied and Environmental Microbiology, Animal* and *Veterinary Research*. In addition, we used GooglePatents and FreePatentsOnline to search for products that have been patented in the Europe and in the US for an on-farm control of *E. coli* O157. The main search keywords were a combination of the name of the pathogen (i.e. *E. coli* O157*, E.coli* O157:H7, *VTEC* O157*, STEC* O157) with a range of related keywords that included: on-*farm control measure, interventions, feed additives, vaccination, bio-security, treatments, probiotics, bacteriophage, effectiveness, epidemiology, economics, cost, outbreaks* and *human case.* In the mentioned databases and journals, we found a total of 221 relevant scientific publications from 1990 to 2011.

An examination of the literature on possible means to reduce the faecal shedding of *E. coli* O157 by livestock identified a large number of peer-reviewed publications that examine *E. coli* O157 controls in challenge experiments, in field cohort studies, and randomised control trials. The results presented below are derived primarily through a collation of the findings presented in the large number of recently published reviews (Synge, 2000; Stevens et al., 2002; Callaway et al., 2003; Callaway, et al., 2004; Brashears et al., 2005; Hussein and Sakuma, 2005; Lejeune and Wetzel, 2007; Sargeant, et al., 2007; Callaway et al., 2009; Jacob, et al., 2009; Oliver, et al., 2009; Berry and Wells, 2010; Duffy, 2010; USDA, 2010; Doyle and Erickson, 2011) with additional evidence derived from individual peer-reviewed articles.

An important observation to a study examining the feasibility of farm level controls in UK is that published reviews are dominated by publications from North America. Indeed only three of the reviews are from Europe and in these the vast majority of papers cited are sourced from North America. The work did not seek out reports or reviews in non-English language journals but we did contact veterinarians studying the control of *E. coli* O157 in Netherlands, Sweden and Germany and identified no alternative control measures that are not described in this report.

Possible strategies for the on-farm control of *E. coli* O157 include the detection and removal of super-shedding cattle, or testing before movement of individual animals (Naylor et al., 2005; Chase-Topping et al., 2008). However, these are theoretical approaches that have yet to be proven or implemented in a commercial environment. Therefore this report has focused on the evidence for on-farm controls that involve treatment or management strategies to reduce the burden of *E. coli* O157. Such methods that may be used for the control of *E. coli* O157 include treatment of drinking water, dietary manipulations and feeding additives, or using packages of controls that are here referred to as bio-security measures. An alternative approach is to restrict the likelihood of animal

colonisation by vaccination. From the reviews and cited papers these potential methods to control the carriage and shedding of *E. coli* O157 on-farm may be considered as:

2.1.1.1 Drinking water treatments

E. coli O157 is excreted in faeces and may cause considerable environmental contamination and pollute water troughs. In field conditions, chlorine has no measurable effect on the prevalence of *E. coli* O157 (USDA, 2010), though the addition of chlorine to water at 2-5 parts per million significantly reduces total *E. coli* concentrations. Zhao et al. (2006) determined that treatment of water with combinations of 0.1% lactic acid, 0.9% acidic calcium sulphate, and 0.05% caprylic acid was effective *in vitro* but found that it had major impacts on water consumption by cattle and thus is unlikely to be practicable. A review of pre-harvest controls (Lejeune and Wetzel, 2007) states that eliminating *E. coli* O157 from drinking water for cattle may be a meritorious goal, but that practical, economical, and effective water treatments have not been demonstrated to significantly affect *E. coli* O157 epidemiology.

2.1.1.2 Dietary manipulations

Modifications of the cattle diet are a preferred method in the feedlot systems that are common in USA to alter pathogen shedding but to be successful such diets should not compromise animal productivity and must be practical to implement. In UK beef production systems the cattle are grazing open pastures for long periods and in such systems any alterations to diet are impracticable. However, for open farms and in dairy production in UK control by dietary manipulation may be applicable.

There are numerous studies of the effects of diet on *E. coli* O157 shedding but the results are conflicting (Stevens et al., 2002; Hussein and Sakuma, 2005; Jacob et al., 2009; Lejeune and Wetzel, 2007; USDA, 2010; Doyle and Erickson, 2011). Some reviews (Callaway et al., 2003; Callaway et al., 2004; Callaway et al., 2009) suggest an abrupt shift to forage feeding may decrease general *E. coli* populations, but the effect is inconsistent and of course is likely to adversely impact on carcass quality with a significant negative effect on finishing cattle performance (Callaway et al., 2009; USDA 2010). In an extensive review (Jacob et al., 2009) the inconsistencies of dietary influences on *E. coli* O157 carriage are described and the authors highlight the problems of: variability in nutrient composition, animal utilisation, and feed processing methods that challenge the repeatability of results. In addition, the impacts are more complex than dietary influences alone where the response of the intestinal microbial flora and consequential influences on foodborne pathogens is not known (Jacob et al., 2009). The only consistent finding from the reviewed studies is that dietary manipulation is not a reliable means for on-farm control of *E. coli* O157. Though contradictory results have been seen when studying effects of diets on *E. coli* O157 shedding there are possible benefits (Callaway et al., 2004) as the effect of the diet may alter the nature and consistency of faeces and though it is unproven drier faeces may assist in reducing transmission of the pathogen.

One important observation with regard to diet is that research in North America has shown that feeding cattle distillers' grain increases *E. coli* O157 shedding (Callaway et al., 2009; USDA, 2010; Doyle and Erickson, 2011). In USA, distillers' grains are increasingly available as a by-product after the distillation of cereals for bio-ethanol production (Doyle and Erickson, 2011) and recently, (Jacob et al., 2010) confirmed earlier studies that feeding cattle 40% wet or dried distillers' grains was

associated with an increased *E. coli* O157 prevalence, whereas at lower inclusion levels (20%), there was no significant increase.

In Scotland, distillers' grains are a traditional animal feedstuff sourced from the whisky industry. One Scottish epidemiological study has shown feeding of distillers' grains is significantly associated with the shedding of *E. coli* O157 by housed-cattle, and all those farms using distillers' grains, as a feedstuff for housed cattle, were identified as positive for *E. coli* O157 (Synge et al., 2003).

2.1.1.3 Probiotics (Direct Fed Microbials) or other feed additives

The U.S. Food and Drug Administration (FDA) defines direct fed microbials as "...products that are purported to contain live (viable) microorganisms (bacteria and/or yeast)."

The microbial flora is an important component of the gastrointestinal tract, and certain bacteria have beneficial properties preventing harmful bacterial colonisation by competitive exclusion, producing antibacterial compounds, and/or promoting healthy immune function (Berry and Wells, 2010).

Probiotics or direct fed microbials are live bacteria given to a host and are typically, but not exclusively limited to, *Lactobacillus* spp. The cattle industry has used probiotics for many years to increase growth rate, milk production, and production efficiency (Oliver et al., 2009). In cattle, numerous probiotics have been identified and tested for efficacy in controlling *E. coli* O157 in cattle (Berry and Wells, 2010). As a direct fed microbial, selected *L. acidophilus* strains, alone or in combination with *Propionibacterium freundenreichii*, have been the most thoroughly studied and are often effective at reducing the prevalence of faecal shedding of *E. coli* O157 when dosed at 10^9 cells per animal daily (Berry and Wells, 2010). Feeding lactobacillus based direct fed microbials have also reduced the prevalence of *E. coli* O157 on cattle hides (USDA, 2010).

The USDA states that several probiotic preparations are effective in reducing *E. coli* O157 shedding in cattle (USDA, 2010). A product Bovamine® is commercially available in North America and contains *Lactobacillus acidophilus* NP51 which is used in the American feedlot system prior to slaughter (Callaway et al., 2004; Peterson et al., 2007a; USDA, 2010). Sargeant et al. (2007) reported a lower prevalence of *E. coli* O157 in cattle treated with this probiotic, with no negative effects on performance and a single instance of a beneficial effect on average daily gain and gain to feed ratio. However, it is not clear whether the inclusion rates of the products that are routinely used in the USA achieve the levels required for *E. coli* O157 control.

Commensal *E. coli*, including colicinogenic strains, have been tested for their potential against *E. coli* O157 in inoculated calves, but without definite results (Berry and Wells, 2011). In addition, *E. coli* O157 may become resistant to individual colicins, so effective treatments would require a cocktail of strains that could be more difficult to license. Competitive exclusion products that contain undefined microbes are not approved for use in livestock in the USA because of concerns regarding the potential for transfer or exchange of virulence or antibiotic resistance genes (Doyle and Erickson, 2011).

Tasco-14 is an extract from the brown seaweed *Ascophyllum nodosum,* and may be effective in reducing *E. coli* O157 shedding in cattle. Several studies have shown that supplementing cattle diets with Tasco-14 for two weeks prior to slaughter resulted in a significantly lower percentage of animals with naturally occurring *E. coli* O157 in the faeces and on the hides compared to control

cattle (USDA, 2010; Berry and Wells, 2011). The product also increased carcass marbling scores (Berry and Wells 2011).

Chlorate that is reduced by the bacterial respiratory enzyme nitrate reductase appears to act as a selective toxic agent to many enteric pathogens. Whereas most beneficial bacteria in the gut do not produce nitrate reductase the members of the family *Enterobacteriaceae*, including *Salmonella* and *E. coli* O157, reduce chlorate to a lethal chlorite at the intracellular level (Doyle and Erickson, 2011). Sargeant et al. (2007) describe studies on research farms in the USA involving chlorate treatments for cattle and sheep diets. Significant reductions of 1 to 2 $\log^{10}$ reductions in the level of faecal shedding of *E. coli* O157 were described with different doses of chlorate except where the product was used in water treatments and in one feed trial where the low dosage of the product resulted in a numeric, but not statistically significant, reduction in *E. coli* O157.

In North America, other feed additives, including antimicrobials, ionophores and ractopamine hydrochloride (a beta-adrenoceptor agonist that repartitions nutrients) have been studied for their effect on the shedding of *E. coli* O157 in cattle (Callaway et al., 2004; Sargeant et al., 2007; Doyle and Erickson, 2011; Berry and Wells, 2011). The use of these products in animals is banned in many countries, including those of the EU, and these approaches face legal barriers from European regulatory authorities so their efficacy has not been included in this review.

2.1.1.4 Bio-security/Farm management practices

Clean and dry bedding should help to prevent heavy soiling of the animal's brisket and keeping cattle clean is helpful for the control of carcass contamination at slaughter. In the UK, the 'Clean Livestock Policy' was introduced by the Meat Hygiene Service in 1997 (FSA, 2011a).

Herd and flock bio-security are perceived as offering benefits to farmers and to the wider community from greater levels of disease control, but whether bio-security/farm management practices can be altered to impact upon *E. coli* O157 is debatable. With regard to *E. coli* O157 an analysis of risk factors associated with the presence of a supershedder on a farm suggested the pathogen and individual host were more important to transmission than the farm environment (Chase-Topping et al., 2007). One of the few pieces of work that has examined the impact of bio-security on *E. coli* O157 was conducted in the UK, where a randomized control trial was carried out to examine the impacts on *E. coli* O157 prevalence of applying different management packages in groups of calves aged 3 to 18 months old (Ellis-Iversen et al., 2008). The results suggest that keeping young cattle in the same group throughout rearing, without introducing new animals, and ensuring bedding is dry are important to *E. coli* O157 control. However, there are difficulties in attributing statistical significance to the results because of the complexity of the work, the failure to measure *E. coli* O157 bacterial numbers, the difficulties of ensuring farmer compliance and the changes that naturally occur in *E. coli* O157 shedding where the burden of *E. coli* O157 was seen to decline in all groups, including the no intervention controls.

In the USA, little evidence has been found that clean bedding or housing reduces *E. coli* O157 faecal shedding in cattle (USDA, 2010). Callaway et al. (2004) and Lejeune and Wetzel, 2007) report no management strategies with a demonstrated impact on the shedding or carriage of foodborne pathogens in cattle. Housing cattle in pens with pond ash versus pens surfaced with soil did not affect *E. coli* O157 carriage by cattle or faecal shedding (Berry and Wells, 2010). The USDA indicates that farm personnel maintaining clean clothes and equipment does not reduce *E. coli* O157 shedding

in cattle (USDA, 2010). While the exclusion of animals other than livestock from access to cattle feed and water is a best practice and may have additional benefits the effects of wildlife exclusion on *E. coli* O157 prevalence in livestock have not been documented (Lejeune and Wetzel, 2007; USDA, 2010).

Despite the difficulties of interpretation, the results of Ellis-Iversen et al. (2008) are helpful in identifying those farm management, bio-security practices, that may be useful supplements to the on-farm control of *E. coli* O157. Weaned calves are known to excrete *E. coli* O157 more frequently and in greater numbers than adult animals. Therefore separating calves from adults and maintaining them in stable groups, with clean bedding may have some effect in reducing prevalence and shedding of *E. coli* O157. Housing calves away from other livestock may also provide a mechanism to reduce the spread of *E. coli* O157 in a dairy operation.

There are suggestions in the published literature that stress of animals increases the likelihood of *E. coli* O157 shedding and Chase-Topping et al. (2007) associated the 'stressors' of movement and weaning as risk factors for high level shedding on Scottish farms. However, there may be confounding with factors such as mixing of animals and establishment of new groupings that allow alternative explanations for their association with *E. coli* O157 shedding. A specific study of stress responses over a 2-year period was conducted in feedlot cattle and correlations were performed to test individual animal heat and handling stress levels on the concentrations of generic *E. coli* and *E. coli* O157 in faeces (Brown-Brandl et al., 2009). No evidence was found to suggest a relationship between either handling or heat stress with generic *E. coli* concentrations or *E. coli* O157 concentrations and prevalence in cattle faeces (Brown-Brandl et al., 2009).

2.1.1.5 Bacteriophages

Bacteriophages have FDA approval for use on the hides of live cattle for control of *E. coli* O157 (USDA, 2010). At this time, companies producing bacteriophages consider post-harvest applications (involving application to the finished carcase) to be more effective and cost beneficial than pre-harvest application and are concentrating marketing strategies on treating finished products (USDA, 2010). In 2011 the USA Food and Drug Administration (FDA) announced approval for a post-harvest bacteriophage-based preparation. Intralytix considers the use of EcoShield™ on raw red meat as effective against *E. coli* O157 and the product highly effective in reducing *E. coli* O157 contamination of various foods (Anon 2011).

2.1.1.6 Vaccines

Vaccination reduces the colonisation of cattle by *E. coli* O157 (McNeilly et al., 2008). In Canada the vaccine Econiche™ has been licensed to Bioniche to reduce shedding by cattle of *E. coli* O157. It received full approval from the Canadian Food Inspection Agency in October 2008 and the company is in the process of obtaining a conditional licence from USDA (USDA, 2010). In large-scale clinical trials of Econiche™ the vaccinated cattle were 92% less likely to be colonised with *E. coli* O157 than non-vaccinated cattle (Smith et al., 2009a) and in a second study the vaccine's efficacy was reported at 63% (Smith et al., 2009b).

The technical information link for Econiche™ includes information regarding the effectiveness of the vaccine when administered as a 2-dose treatment. One trial compared effects of two- and three-dose regimens on the probability of detecting *E. coli* O157 in faeces and colonisation of the terminal

rectum. Vaccine was used across all animals in feedlot groups and compared to placebo treated animals. The prevalence of *E. coli* O157 in faeces at group level was 65% lower in vaccinated compared to placebo treated cattle. However in this study bacterial enumeration gave an indication that the bacterial numbers were not reduced in vaccinates (Moxley et al., 2009). In a separate report the efficacy of one, two, and three doses of vaccine was 68, 66, and 73%, respectively, when compared with cattle in pens not receiving vaccine. Cattle receiving three doses of vaccine were significantly less likely to shed *E. coli* O157 than unvaccinated cattle in the same pen and unvaccinated cattle housed together with vaccinated cattle were 59% less likely to shed *E. coli* O157 than cattle in pens not receiving any vaccine (Peterson et al., 2007b).

The USDA has awarded conditional marketing approval to Pfizer for their Epitopix™ product, a siderophore receptor protein (SRP) vaccine technology, to reduce *E. coli* O157 shedding. A conditional licence means a company can market the product, but that the USDA still requires additional safety and efficacy tests. The vaccine must be used under the direction of a veterinarian and is marketed as a three-dose vaccine. The Epitopix SRP vaccine targets the iron requirement of pathogenic Gram-negative bacteria, such as *E. coli* O157, causing disruption of bacterial iron transport, and death of the organism. Initial reports are from challenge studies (Thornton et al., 2009) and subsequently the vaccine efficacy has been examined with cattle naturally shedding *E. coli* O157 that were either vaccinated or left as unvaccinated controls. After vaccination a 3 ml dose significantly reduced the prevalence of *E. coli* O157 compared to controls, reduced the number of days cattle were positive for *E. coli* O157 and the number of days cattle were identified as high-shedders compared to controls (Fox et al., 2009).

In general, the efficacy of vaccinating cattle for *E. coli* O157 with these products is established in North America though research is on going to develop the vaccine compositions, to determine the duration of immunity and number of doses necessary to ensure maximum effectiveness in reducing the *E. coli* O157 in cattle.

2.2 Cost benefit analysis

Cost-benefit and cost-effectiveness analyses are a set of tools to determine whether implementing risk mitigation measures is in the public interest (Gray et al., 2011). In this study epidemiological and economic information were used to evaluate the costs and benefits of the selected potential on-farm control measures to reduce the annual number of human infections with *E. coli* O157 in the UK.

2.2.1 Methodology

First, eight publications that most clearly quantified the reduction in prevalence or bacterial shedding were selected based on the literature review (for details of selection process see section 2.1). Second, the effectiveness of the selected control measures in terms of reducing risk to humans (i.e. reduction in number of annual human cases) were determined by using published figures in conjunction with simple epidemiological models of cross-species transmission. Third, the financial benefits of implementing on-farm control measures in terms of reduction in human cases were estimated by using published data on the number of cases and associated costs of illness. Fourth, the costs of the selected control measures were estimated under a range of implementation scenarios. Fifth, benefit-cost ratios were calculated and the selected control measures were ranked based on economic criteria, and finally the robustness of our conclusions were assessed using a sensitivity analysis.

2.2.1.1 Selected control measures

Initially, 221 relevant scientific publications including papers, reports, patents and internet publications published in the period 1995-2011 were selected by the project team for detailed review and identification of the data required in these analyses (Figure 1). Based on the criterion that the papers should provide quantitative evaluation of the efficacy of the on-farm control measures this number was reduced to 158 in the second round. A large number of remaining papers were eliminated at this stage as most did not quantify the actual reduction in bacterial load (i.e. provided no data on bacterial counts but reported reduction in prevalence of infected animals). The other shortcoming in some of the selected papers was that the reported results were confounded as the intervention was applied where controls and experimental animals comingled and the efficacy of the experimental intervention could not be assessed. Therefore, reporting of quantitative figures for the reduction in prevalence and/or shedding rate as well as clearly defined and implemented experimental/epidemiological procedures were the two strict criteria applied to select the final publications. Ultimately, eight publications that mostly clearly quantified the reduction in prevalence or shedding were selected for this portion of the study. Note that, even amongst these studies direct comparisons are difficult to make as some studies applied the interventions in groups where controls and experimental animals comingled. In such cases, the reported efficacy could be a conservative estimate of true efficacy if applied to all individuals in a group. The selected control measures were: vaccination (two types of vaccine; six publications), probiotics (one publication) and bio-security (one publication).

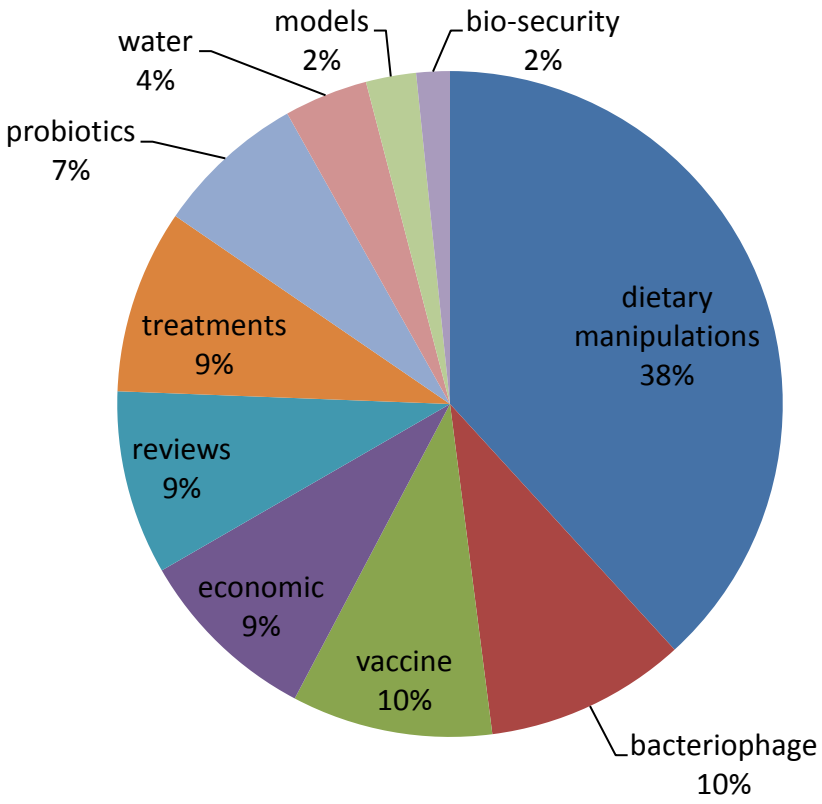

Figure 1. The main focus and frequencies of the 221 reviewed scientific publications in each category.

2.2.1.2 Effectiveness

For the three selected control measures, reported information on both prevalence reduction and shedding reduction in cattle were collated. Cross-species transmission models (Matthews et al., *submitted manuscript*) were used to translate the observed prevalence and shedding reductions in cattle into a predicted reduction in risk to humans (further information on the modelling approaches is available from the report authors upon request).

Briefly, we used veterinary, human surveillance and molecular data to reveal the key features of *E. coli* O157 strains that pose the greatest risk to humans. The mathematical models were developed to quantify the relationship between bacterial shedding distribution in cattle and the relative risk posed to humans by different shedding densities. The models are based on a comparative analysis of the distribution of supershedder and non-supershedder strains of *E. coli* O157 in the cattle and human population. The observed excess of supershedder cases in the human population relative to the cattle population allows models relating shedding density and human risk to be developed, compared and parameterised. We identified two models which both provided a good fit to the data: (i) a threshold model, which predicted that all human risk arose from shedding by cattle above a threshold of approximately 10^3 cfu/g, and (ii) a log-linear model, which uses a power relationship to link shedding density in cattle with relative risk to humans. These models predict the decline in risk to humans as cattle prevalence falls and high shedding densities are eliminated. Eliminating fewer than 10% of the highest shedding densities could produce a 40% drop in cattle prevalence (Figure 2, black line) but a 70-75% drop in human cases (Figure 2, dashed and red lines).

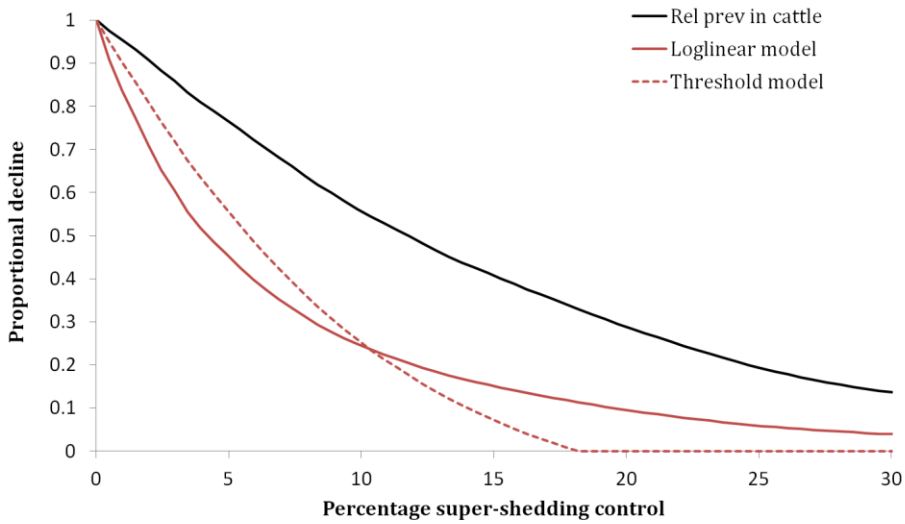

Figure 2. Targeting supershedding amplifies the reduction in human risk (red and dashed lines for log-linear and threshold models respectively) relative to the reduction in cattle prevalence (black line), (adapted from Matthews et al., *submitted*).

Which mathematical model was used depended on the form of the published data on control measure efficacy e.g. change in number of days as a 'high-shedder' (i.e. shedding > 10^3 cfu/g) versus a reduction in log bacterial counts. If no suitable data was available on shedding reduction, the reduction in human risk was assumed to be proportional to the reported reduction in prevalence in cattle. Table 1 summarises these two estimates for each type of control measure, for two types of commercially available vaccines (vaccine A and vaccine B), bio-security, and probiotics, with the references and country where the studies were conducted. These data suggest that probiotic usage was the most effective control measure when considering both prevalence based and shedding based relative risk to humans of 0.12 (efficacy of 88%) and 0.04 (efficacy of 96%) respectively. Data also showed that the siderophore based vaccine (A1) was the least effective measure from both prevalence based and shedding based perspectives with relative risk remaining to humans of 0.54 and 0.15 respectively.

Table 1. The relative risk of infection to humans as a consequence of control, based on threshold model and loglinear model of risk.

Control measure*	Type	Relative risk to humans**		Reference	Country
		Prevalence based	Shedding based		
A1 (1, 2)	Vaccine Siderophore	0.542	0.153	(Fox et al., 2009)	USA
A2 (1, 2)		0.148	0.193	(Thomson et al., 2009)	USA
B1 (1, 2)		0.210	0.070	(Allen et al., 2011)	Canada
B2	Vaccine	0.270	N/A	(Peterson et al., 2007b)	Canada
B3	Type III	0.370	N/A	(Smith et al., 2009b)	Canada
B4		0.350	N/A	(Moxley et al., 2009)	Canada
BS	*Package A****	0.140	N/A	(Ellis-Iversen et al., 2008)	UK
PR (1, 2)	*CE E. coli probiotics*	0.120	0.040	(Tkalcic et al., 2003)	USA

* Numbers in parentheses (1 and 2) indicate prevalence based and shedding based effectiveness considered for the control measures respectively (e.g. A1,1 refers to siderophore vaccine with a prevalence based relative risk to humans of 0.542 reported by Fox et al., 2009).

** Relative risk to humans: total human risks were expressed as relative human risks with values between 0 (no risk) and 1 (highest level of risk).

*** See Table 7 For details of included interventions in package A.

2.2.1.3 Estimation of the benefits

To evaluate the economic case for implementing an on-farm control measure, incremental benefits and costs of the measure were quantified. The decline in relative risk to humans was quantified in terms of the human illnesses prevented and viewed as the incremental benefit of the adopted control policy. This was done by multiplying the relative risk to human figures, as efficacy of each control measure which are mentioned in Table 1 by the losses incurred from human infections. Potential prevented economic burden of *E. coli* O157 outbreaks on the agricultural sector and wider economy (e.g. negative impact on farmers via reduced demand and hence prices) were not included in this calculation. Therefore benefits presented in this analysis are conservatively confined to human losses avoided. The simplifying assumptions are necessary given the scope of our analysis though it is possible that the calculated benefits (i.e. avoided human cases) may not be fully realized in practice, but on the other hand the full (direct and indirect) costs may be greater.

The first step in calculating the benefits of control measures was to establish the annual number of human cases of infection confirmed by medical authorities in UK (Table 2).

Table 2. Epidemiological data (2000–2009) showing number of laboratory confirmed human cases caused by *E. coli* O157 in the UK and broken down by its four countries. Figures in parentheses represent rates per 100,000 population of laboratory-confirmed culture-positive *E. coli* O157 cases.

Year	Number of confirmed human cases (rates per 100,000 population)				
	Scotland[1]	England[2]	Wales[3]	NI[4]	UK[5]
2000	197 (3.8)	738 (1.5)	46 (1.6)	54 (3.1)	1035 (1.7)
2001	235 (4.6)	725 (1.4)	43 (1.4)	46 (2.6)	916 (1.5)
2002	229 (4.5)	559 (1.1)	36 (1.2)	27 (1.6)	748 (1.2)
2003	148 (2.9)	656 (1.3)	19 (0.6)	53 (3.0)	777 (1.3)
2004	209 (4.1)	678 (1.3)	21 (0.7)	19 (1.1)	819 (1.4)
2005	172 (3.4)	770 (1.5)	180 (6.1)	49 (2.8)	1029 (1.7)
2006	243 (4.7)	945 (1.9)	56 (1.9)	47 (2.7)	1146 (1.9)
2007	243 (4.7)	793 (1.6)	35 (1.2)	54 (3.1)	974 (1.6)
2008	241 (4.7)	895 (1.8)	55 (1.9)	59 (3.4)	1096 (1.8)
2009	237 (4.6)	957 (1.9)	77 (2.6)	48 (2.8)	1160 (1.9)

[1](Health Protection Scotland, 2011), [2] (Money et al., 2010), [3](Public Health Wales, 2010), [4](PHA, 2009), [5](FSA, 2011b).

The distribution of cases by severity of illness is an important factor to consider when establishing the total cost of illness due to *E. coli* O157. In the absence of relevant data for all countries examined in this study, the average figures for the distribution of cases by severity in 2007 and 2008 in Scotland (Pollock, 2010) were used and totals calculated (Table 3).

Table 3. Distribution of severity of cases estimated based on the average prevalence of severities observed in Scotland in 2007 and 2008 (Pollock, 2010).

	The total number of cases and total percent distribution based on severity							
	Didn't visit physician; survived	Visited physician; survived	Didn't have HUS[1]; survived	Had HUS but not ESRD[2]; survived	Had HUS and ESRD; survived	Didn't have HUS; died	Had HUS; died	Total
2007	125	40	59	14	2	0	3	243
2008	125	42	62	16	0	1	0	246
Mean prevalence (%)	51.11	16.27	24.90	6.17	0.41	0.21	0.62	100

[1] HUS: haemolytic uraemic syndrome

[2] ESRD: end-stage renal disease

To estimate the annual economic cost of illness caused by *E. coli* O157 in the UK, an online foodborne illness cost calculator[1] developed by Economic Research Service (ERS) of the United States Department of Agriculture (USDA) was used (Frenzen, 2007). This calculator estimates the total costs of illness (COI) for any specified year for all cases of *E. coli* O157. The COI method estimates the costs incurred through the incidence of an illness in a population by taking the sum of total medical costs, loss of productivity and loss of life. The COI methodology used in the cost calculator developed and explained by Frenzen (2007), have been previously used in economic evaluation of *E. coli* O157 infections in the UK and elsewhere (e.g. Tariq et al., 2011; Pollock et al.,

[1] Available on: http://www.ers.usda.gov/Data/FoodBorneIllness/

2010). The cost calculator categorises the estimated annual *E. coli* O157 cases into seven severity bands ranging from cases who did not visit a physician to cases who died (Table 3). It includes costs arising from the acute illness associated with haemorrhagic colitis (HC) and haemolytic uraemic syndrome (HUS), two complications that can arise from *E. coli* O157 disease, as well as chronic illness costs arising from HUS that may develop end-stage renal disease (ESRD), a condition that results in reduced life expectancy. The estimate includes medical costs due to illness, kidney dialysis and transplant costs, and the cost (value) of time lost from work due to non-fatal illness, and the cost (value) of premature death. Earlier studies have demonstrated that hospitalised HUS and, HUS plus ESRD cases accounts for the vast majority of the estimated costs (Pollock et al., 2010; Frenzen, 2007). Although only a small share of cases develop HUS, the results are severe, long-lasting, and with higher per capita costs than those with milder illnesses (Buzby and Roberts, 2009). Possible costs and expenses imposed on the parents of affected children as a result of long term emotional distress and substantive disruption to family and daily life (Pollock et al., 2009) were not included in this calculation. Using the data collated in Tables 2 and 3, the total cost of human illnesses and the average cost per human case for the UK and its four countries were then calculated. An exchange rate of 0.64317[1] was used to convert the estimated values from US$ to GBP. Results are presented in Table 4.

It must be noted that the ERS's calculator uses the US figures and assumptions for the 'average cost per unit' and it provides users a chance to change these figures and assumptions to reflect country specific conditions. In this report we used data on the distribution of severity of cases from a study in Scotland (Table 3). The funding of the health systems are clearly different in the UK and the US and this may well affect the costing for diseases. It would have been ideal to adjust the 'average cost per unit' data for the different severity categories (which have been used in the calculator) based on UK data to have a better cost estimation. However, in the absence of these data and given the scope of the current research we have not changed the 'average cost per unit' data used in the cost calculator. Buzby et al. (1998) compared the cost of *E. coli* O157 in the US and Scotland and found that for non-HUS cases, per case medical costs do not vary between the two countries while per case productivity losses are 2 to 5 times higher in the US, where the difference in valuation of a premature death in the two countries contributed to the differences in costs (Buzby et al., 1998). The same authors concluded that the US and Scottish estimates are similar in that the overwhelming share of *E. coli* O157 disease costs are allocated to HUS and in that productivity costs outweigh medical costs.

Using the ERS calculator, the estimated annual total cost of illness due to *E. coli* O157 infection in Scotland was £17,279,709 in 2007 and £9,512,566 in 2008. In an earlier study the annual total cost of illness in Scotland was estimated at £16,296,168 in 2007 and £3,928,140 in 2008 (Pollock et al., 2010). Thus the estimated cost using ERS calculator for 2007 is close to the figure reported by Pollock et al. (2010) but the estimated cost of illness for 2008 was considerably higher using the ERS calculator. The estimates differ because there were differences in assumptions and methods between the ERS cost calculator and the study carried out by Pollock, et al. (2010). In a recent study, the total annual undiscounted and discounted costs of illness due to *E. coli* O157 infection for the Dutch society were estimated at €9.1 million and €4.5 million, respectively (Tariq et al., 2011). In the

[1] http://www.xe.com/ucc/convert/?Amount=1&From=USD&To=GBP on 27 Sept 2011

Netherlands annually approximately 2100 human cases experience symptoms of gastroenteritis, leading to 22 cases of HUS and 3 cases of ESRD (Tariq et al, 2011).

Table 4. Estimated total cost of human illness by ERS online calculator[1] using the total number of cases presented in Table 2 and distribution of severity presented in Table 3.

Year	Estimated total cost of illness (m£)				
	Scotland	England	Wales	NI	UK
2000	9.36	44.12	0.15	0.16	53.81
2001	9.51	36.31	0.15	0.15	53.85
2002	9.47	27.05	0.11	0.10	48.50
2003	9.20	36.06	0.06	0.16	48.56
2004	9.41	36.15	0.06	0.06	53.44
2005	9.29	44.23	9.31	0.16	62.96
2006	17.28	53.50	0.17	0.16	71.13
2007	17.28	44.29	0.11	0.16	62.80
2008	9.51	53.34	0.17	0.21	70.99
2009	9.51	53.54	0.26	0.16	71.19
Mean (±SE)	10.98 (1.05)	42.86 (2.48)	1.06 (0.92)	0.15 (0.01)	59.72 (2.92)

The estimated average costs per human cases by the ERS calculator for 2000-2009 are summarised in Table 5. These estimated costs are considerably higher in Scotland and England than Wales and Northern Ireland. The estimates differ primarily because in England and Scotland the higher numbers of human cases translate into a higher number of hospitalisations and severe cases using the distribution of severity of cases in Table 3, thereby resulting in higher costs for these countries.

Table 5. Estimated average cost per human case by ERS online calculator using the total number of cases presented in Table 2 and distribution of severity presented in Table 3.

Year	Estimated average cost per case (£)				
	Scotland	England	Wales	NI	UK
2000	47,509	59,789	3,333	3,053	51,987
2001	40,454	50,083	3,564	3,333	51,339
2002	41,333	48,393	3,103	3,709	56,987
2003	62,164	54,965	3,081	3,110	55,435
2004	45,008	53,320	2,790	3,081	57,651
2005	54,040	57,442	51,701	3,247	53,766
2006	71,110	56,609	3,040	3,384	55,100
2007	71,110	55,850	3,191	3,053	55,823
2008	39,471	59,594	3,096	3,498	56,789
2009	40,115	55,948	3,371	3,314	54,387
Mean (±SE)	51,231 (4,009)	55,199 (1,176)	8,027 (4,853)	3,278 (68)	54,927 (661)

[1] Costs were calculated based on 2010 estimations in online calculator.

2.2.1.4 Cost calculations of the control measures

The total incremental cost of an on-farm control policy may include implementation costs and compliance and regulatory costs incurred by producers, consumers and Government. Direct purchase and overhead costs (including logistics, labour and administration) were used to calculate the implementation cost. Following Velthuis et al. (2011), who performed a financial evaluation of controlling strategies for Bluetongue in The Netherlands, the total costs of the selected control measures were calculated using the following equation:

$$C = \sum_j n_j \cdot d \cdot (Vet_1 + h_j \cdot Vet_2 + na_j (M + V + R))$$

where n_j represents the number of farms in each country j, d_k the number of doses (for vaccines and probiotics) that an animal needs, Vet_1 the standard call out charge and Vet_2 the hourly rate of a veterinarian. The assumption was that vaccines are administered by a veterinarian and therefore cost of veterinary (labour) was included in the calculation and no opportunity cost of labour for farmers was included. However if these products are licensed in the UK then they could be given by the farmers which would incur lower labour and administration costs. In this equation, h_j represents the number of hours in country j needed to apply interventions to all animals on a single farm, na_j the average number of animals per farm that need to be covered, M, the costs of any materials per animal used for particular measures, V the purchase costs of the measures per unit and R, the registration and administration costs.

Table 6. Input for the cost calculations of vaccination and probiotics strategies to control *E. coli* O157 in cattle.

		Input parameters					
Var.	**Description**	**Farms**	**Scotland**	**England**	**Wales**	**NI**	**UK**
n_j	Number of farms		13,146	51,663	12,903	21,468	99,180
D	Doses per animal/year for						
	vaccines A & B		2	2	2	2	2
	Probiotics		365	365	365	365	365
Vet_1	Call out charge £/visit	32.00					
h_j	Hours to vaccinate a farm		1	1	1	1	1
Vet_2	Hourly rate £/hour	72.53					
na_j	Animals to be vaccinated per farm						
	all animals (mean)		147	107	91	77	106
	Only young (mean)		76	55	44	42	52
M	Materials costs £/head	0.02					
V	Price s						
	A (£/dose)	1.86					
	B (£/dose)	1.50					
	Probiotics (£/dose)	0.01					
R	Vaccine Registration costs £/head	0.05					
R	Probiotics Regis. costs £/head	0.01					

The inputs for the calculations are listed in Table 6. The demographic input of number of farms, average number of animals per farm and the proportion of adult and young animals in each country were obtained from the official publications (DEFRA, 2008), and dardni.gov.uk.

For the bio-security measures, estimated costs were based on the efficacy of a package of measures reported earlier (Ellis-Iversen et al., 2008). Table 7 summarises the assumptions and figures used in calculating the costs of the bio-security package and its components. For all the components, except 'no new animals brought in' and 'keep bedding dry', costs were estimated/updated based on the results of a survey carried out under Defra project OZ0144 (Defra, 2003). Figures in Table 7 represent average cost figures of 20 cattle farms studied in the mentioned survey with a population ranging from 45 to 240 cattle per farm. To estimate the cost of maintain a closed herd or 'no new animal bought in' it was assumed farms are raising all replacements internally with no outside purchases (Chi et al., 2002). To estimate the average annual cost of double fencing, a fence lifetime of 10 years was assumed and the annual payment on capital cost of double fencing for a 10 year period was based on periodic, constant payments and a constant interest rate of 10%. The 2007 figures of capital cost of double fencing were multiplied by a compound factor of 1.21 ((1+0.05)^4) to adjust them to represent values in year 2011. The average annual cost of double fencing for 19 surveyed farms is presented in Table 7. The minimum estimated cost was £1.3/head/y (for a herd size of 210) and the maximum was £249/head/y (for a herd size 125). The same approach was used in estimating the costs of providing fresh water to farms and avoiding shared water sources (data for only 12 surveyed farms were available). The cost of keeping bedding dry was adapted from estimated published figures by Lyons *et al.* (2012). These authors mentioned that the use of extra bedding is considered negligible because when bedding is applied less frequently, relatively more is applied and therefore the cost is assumed to be only depend upon extra labour which itself is dependent on the number of young stock present (Lyons, et al., 2012). For 'keeping animals clean' it was assumed it takes 30 minutes/day which is equal to 156 hours/yr (i.e. 6 working days/week). Labour costs were considered at 7.5 £/hour. The average per head figure was estimated based on number of cows in 19 surveyed farms (DEFRA, 2003). The costs of maintaining closed groups, use of boot-dip and over coat data were estimated by using the data from 19 surveyed farms and assumptions presented in Table 7.

It should be noted that Ellis-Iversen et al. (2008) suggested that the studied combined intervention package may significantly reduce the level of pathogen in a group of animals. However, it is impossible to determine whether individual control measures included in the package would provide control. Although application of the individual bio-security measures have been examined for their cost and reducing risk of infection (see Lyons et al., 2012; Vosough Ahmadi *et al.,* 2007) because of an absence of evidence for their efficacy we have estimated and considered the total cost of the package as the cost of bio-security measure in this report.

Table 7. Bio-security package and estimated costs of individual measures and the total costs

#	Type	Average cost (±SE) £/head/y	Assumptions
1	No new animals brought in	30.98	Raising heifer 1100; calf value 413; purchase heifer price: 1100; replacement rate: 0.15; raising all replacements internally with no outside purchases (Chi et al., 2002).
2	No contact with other cattle (double fencing)	34.20 (13.87)	Average cost of double fencing estimated for 19 surveyed farms (DEFRA, 2003).
3	No shared water sources	8.17 (2.24)	Average cost of access to clean water source estimated for 12 surveyed farms (DEFRA, 2003).
4	Keep bedding dry	4.18	Assumed no extra bedding is required and cost only depends on extra labour (from Lyons et al., 2012).
5	Keep animals clean	12.45	The average per head figure was estimated based on number of cows in 19 surveyed farms (DEFRA, 2003).
6	Maintain closed group	3.00	Based on one entry in Defra project OZ0144 (DEFRA, 2003).
7	Use boot-dip	0.48 (0.03)	£50/boot-dip with a 3 years life
8	Use overcoat	0.30 (0.05)	£74 average price of overcoat with life time of 3 years
Total		**93.76**	

2.2.1.5 Scenarios

Two scenarios were considered for each control measure: *1)* applying the control measure to all animals on each farm and *2)* targeting the control measures at young animals (under 25 months of age)[1] on each farm. Table 8 and 9 summarise these estimated costs.

Table 8. Estimated cost of control measures in the UK and its four countries based on data presented in Table 6 and Table 7.

Control measure	Estimated cost of control measure (£/head/year)				
	Scotland	England	Wales	NI	UK
Vaccine A	5.27	5.81	6.15	6.57	5.83
Vaccine B	4.57	5.10	5.44	5.86	5.13
Probiotics (PR)	5.91	5.91	5.91	5.91	5.91
Bio-security (BS)	93.76	93.76	93.76	93.76	93.76

[1] For the purposes of this study young cattle were classed as animals <25 months old based on categories defined in the Defra Cattle Book (2008) which provides descriptive statistics of cattle numbers in Great Britain for 1 June 2008. http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/documents/cattlebook-2008.pdf

Table 9. Estimated total annual cost (m£) of the selected on-farm control measures for the UK and its four countries under two scenarios: i) applying control measures to all animals within herds and ii) applying control measures only to young animals (<25months).

Control measure	**Cost of control measures (m£/year)**				
	Scotland	England	Wales	Northern Ireland	UK
Vaccine A					
All animals	10.19	32.09	7.22	10.85	61.03
Only young	6.62	21.66	4.87	7.92	42.27
Vaccine B					
All animals	8.83	28.09	6.39	9.69	53.66
Only young	5.91	19.67	4.47	7.29	38.32
Probiotics					
All animals	11.42	32.66	6.94	9.77	61.82
Only young		21.66	4.87	7.92	42.27
Bio-security					
All animals	181.17	518.26	110.08	154.98	980.98
Only young	94.21	264.31	52.84	83.43	524.13

2.2.2 Economic criteria and sensitivity analysis

Benefit-cost ratios were calculated for each of the control measures described in Table 1 by dividing the total benefits of a given control measure by the total costs. These ratios represent how much benefit is generated, if any, by spending one pound on control measures. If these ratios exceed one, the control measure is considered to be economically justified and the higher the ratio the greater the value created from the control measures. The net return equals the total benefits of the measure minus the total costs. A sensitivity analysis was performed to assess the impacts of benefits and costs on net returns of the control measures. Both the benefits and the costs of measures estimated in the previous sections were changed by ±10% and the total net returns recalculated.

2.2.3 Results

Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) under scenario 1 and scenario 2 in Scotland, England, Wales, Northern Ireland and the UK are presented in Figure 3, Figure 4, Figure 5, Figure 6, and Figure 7 respectively. The estimated benefit-cost ratios (including bio-security) are presented separately in Table 10.

In Scotland under scenario 1 (Figure 3), the benefit of a group of control measures, namely A1,2; A2,1; A2,2 and B1,2 exceed or is equal to the cost for control measures. Hence, these measures have benefit-cost-ratios greater or equal to one (Table 10). In scenario 2 all the examined control measures had greater benefits than the costs and therefore benefit-cost ratios of greater than one, except A1,1 and bio-security.

In England under scenario 1 (Figure 4), in addition to the group of measures in Scotland that have higher benefits than costs, there were other control measures that achieve a benefit-cost ratio great than one. These were B1,1; PR1 and PR2. In general the benefit-cost ratios of these measures in England were higher than in Scotland (Table 10). For England, all the benefits of all the measures exceeded or equalled the costs under scenario 2 except for bio-security.

In both Wales and Northern Ireland the costs of the control measures were far higher than the benefits and therefore generated below one benefit-cost ratios under both scenario 1 and 2 (Figure 5 and Figure 6). This is due to the high number of cattle in both countries (1.2 and 1.6 million head in Wales and NI respectively) and the relatively lower number of recorded human cases (77 and 48 cases in 2009 in Wales and NI) compared to Scotland, England. In 2009, there were 1.8 and 5.5 million head of cattle in Scotland and England with respective total numbers of confirmed human cases of 237 and 957.

For the UK as a whole, under scenario 1, although the benefits of some of the interventions including A1,2; A2,1; A2,2 B1,2 and PR2 were very close to their estimated costs none of the measures had a benefit-cost ratio exceeding 1. In scenario 2, A1,1; B3, B4 and BS were the only measures with higher costs than benefits and hence benefit-cost ratios <1.

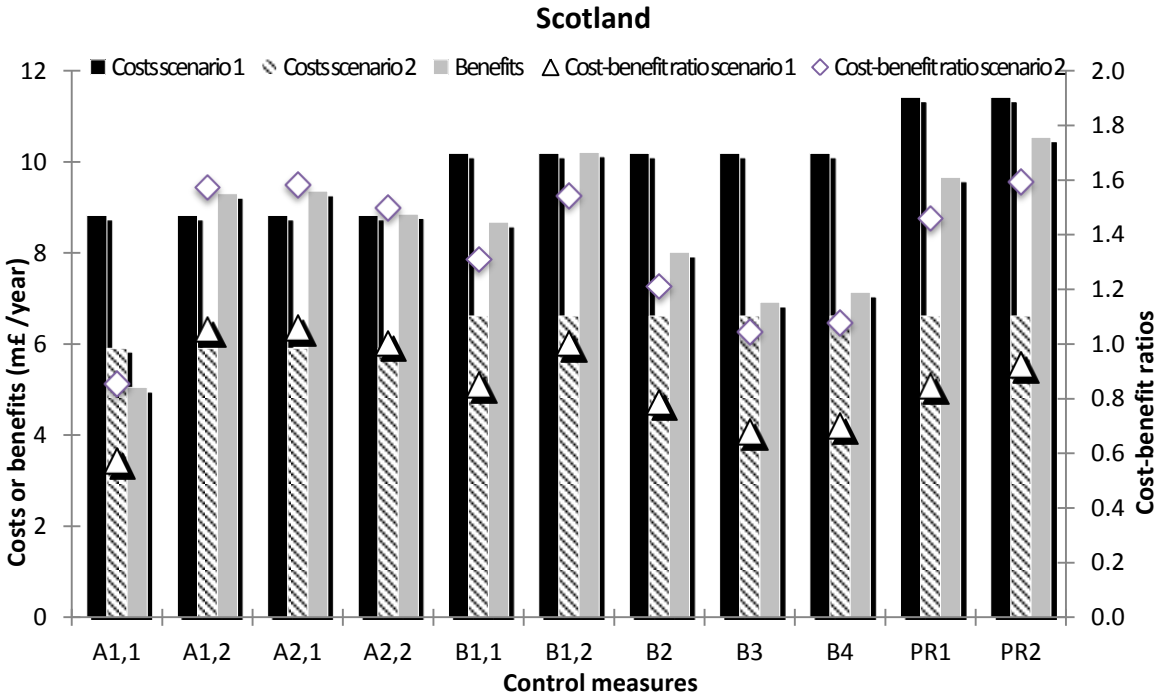

Figure 3. Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) for the two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in Scotland.

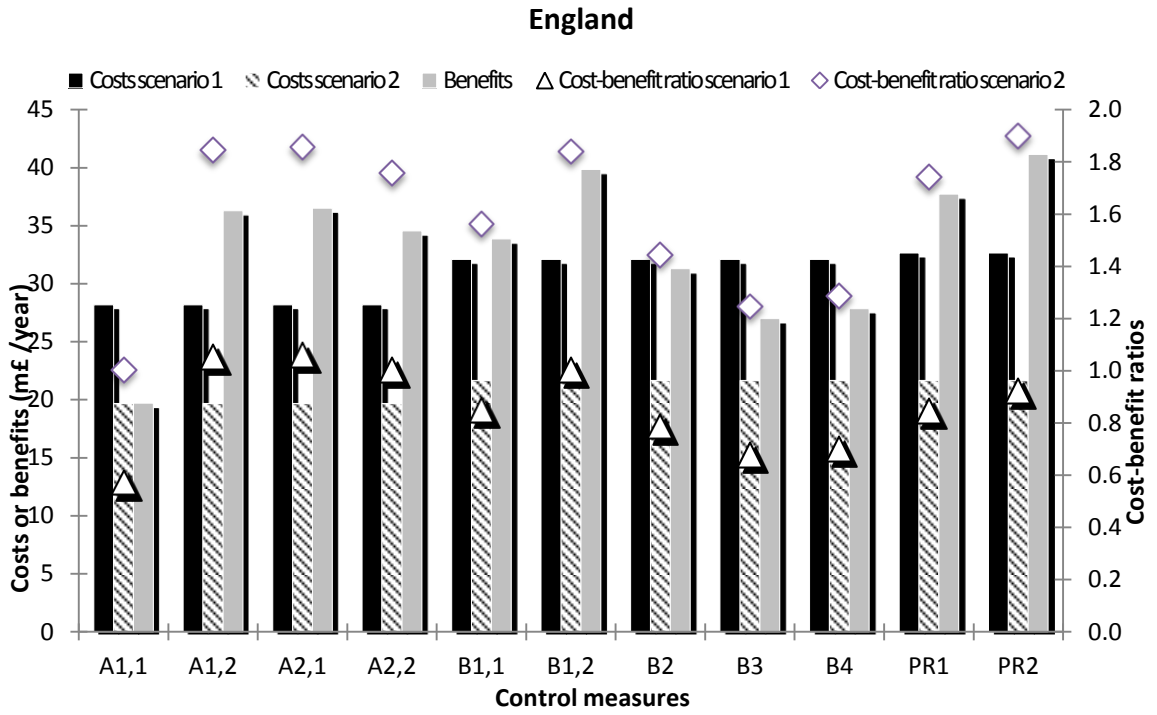

Figure 4. Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) for the two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in England.

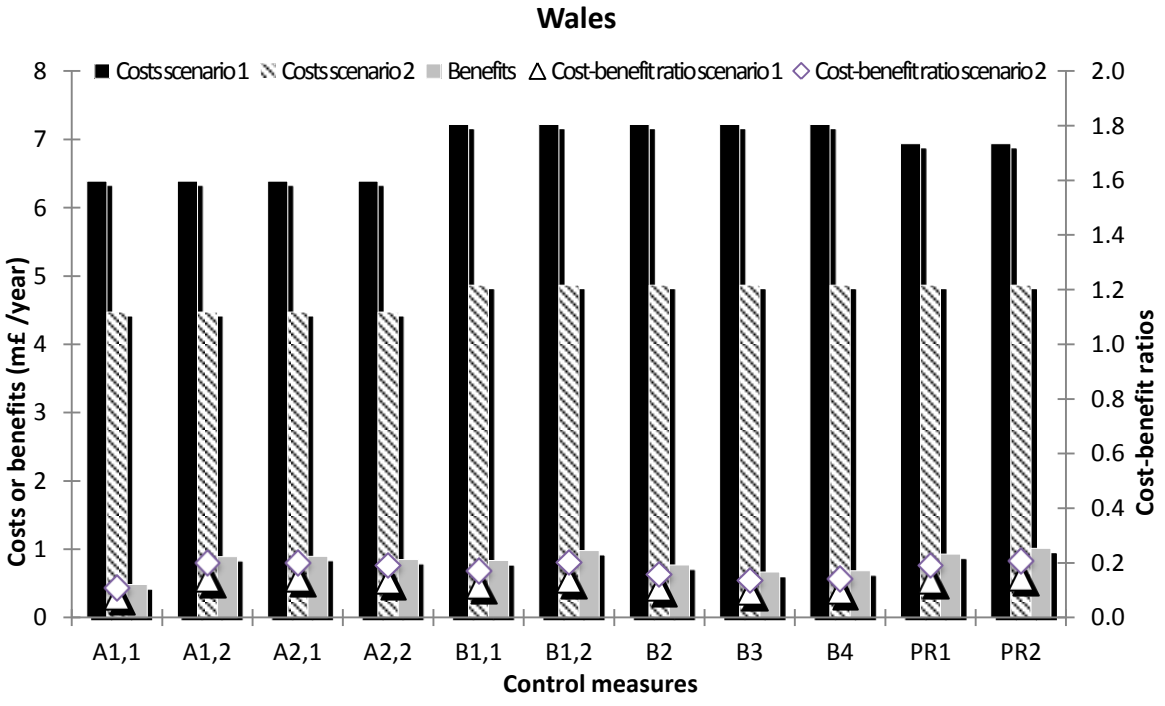

Figure 5. Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) for the two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in Wales.

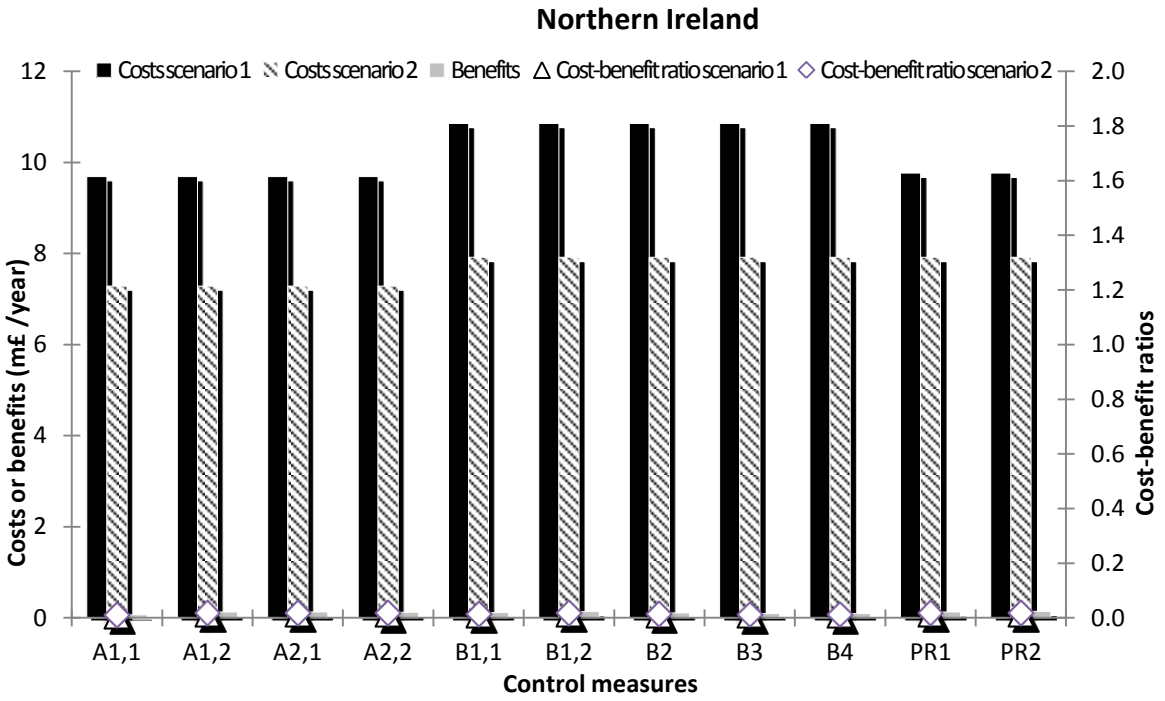

Figure 6. Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) for the two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in Northern Ireland.

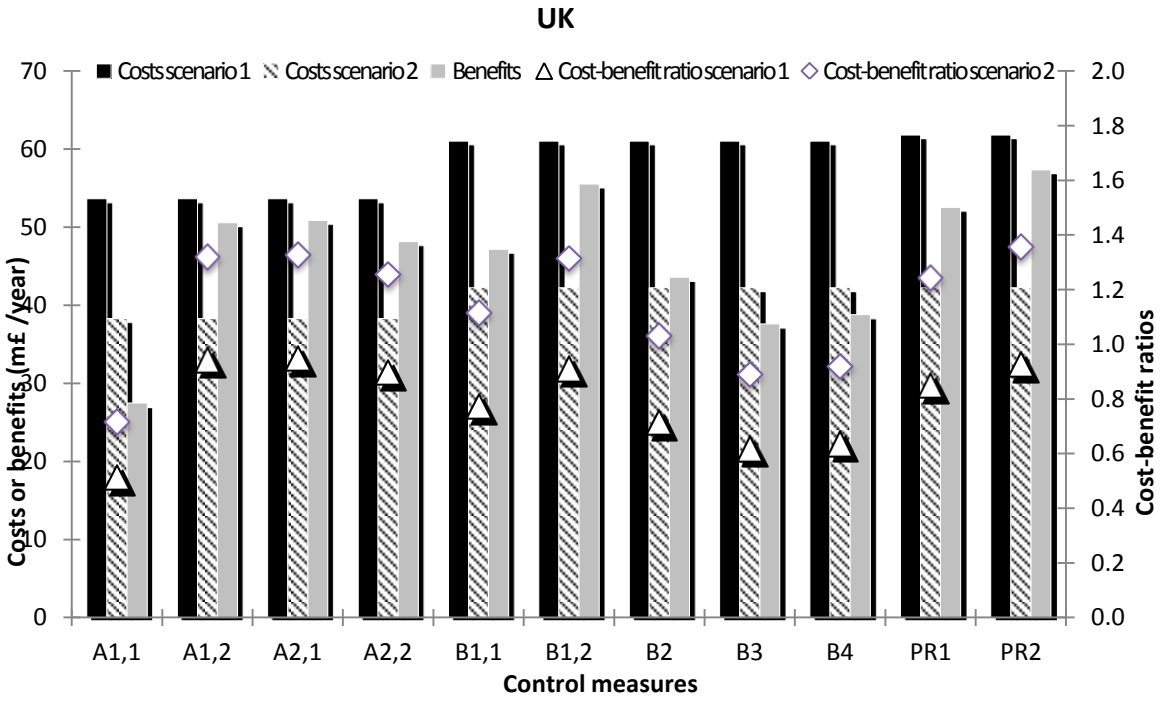

Figure 7. Benefits, costs and benefit-cost ratios of the studied control measures (excluding bio-security) for the two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in the UK.

Table 10. Estimated benefit-cost ratios of the studied control measures in the UK and its four countries under two scenarios: scenario 1 applying measures to all animals and scenario 2 applying interventions only to young animals in the UK.

	Benefit-cost ratios of control measures											
	A1,1	**A1,2**	**A2,1**	**A2,2**	**B1,1**	**B1,2**	**B2**	**B3**	**B4**	**BS**	**PR1**	**PR2**
Scenario 1												
Scotland	0.57	1.05	1.06	1.00	0.85	1.00	0.79	0.68	0.70	0.05	0.85	0.92
England	0.70	1.29	1.30	1.23	1.06	1.24	0.97	0.84	0.87	0.07	1.15	1.26
Wales	0.08	0.14	0.14	0.13	0.12	0.14	0.11	0.09	0.10	0.01	0.13	0.15
NI	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
UK	0.51	0.94	0.95	0.90	0.77	0.91	0.71	0.62	0.64	0.05	0.85	0.93
Scenario 2												
Scotland	0.85	1.57	1.58	1.50	1.31	1.54	1.21	1.05	1.08	0.10	1.46	1.59
England	1.00	1.85	1.86	1.76	1.56	1.84	1.44	1.25	1.29	0.14	1.74	1.90
Wales	0.11	0.20	0.20	0.19	0.17	0.20	0.16	0.14	0.14	0.02	0.19	0.21
NI	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.00	0.02	0.02
UK	0.72	1.32	1.33	1.26	1.12	1.31	1.03	0.89	0.92	0.10	1.24	1.36

Ranking the interventions separately in each country and UK, indicated that, for scenario 1, vaccine A2,1 achieved the first rank in Scotland, England and the UK and probiotics PR2 achieved the first rank in Wales and Northern Ireland (Table 11). In Scotland and England vaccine A1,2, for Wales vaccine A2,1 and for NI probiotics PR1 were in ranking 2. Probiotics PR2 was in ranking 3 in England whereas rank 3 in Scotland, Wales and NI belonged to vaccines A2,2, A1,2 and A2,1 respectively. A1,1; B2, B3, B4 and BS consistently ranked poorly in all the countries under both scenarios (Table 11).

Probiotics PR2, scenario 2, achieved the highest ranking for all countries with vaccine A2,1 ranked second in Scotland, England and the UK for scenario 2, and vaccine B1,2 ranked second in Wales and NI. Ranked third was vaccine A1,2 in Scotland and England and vaccine A2,1 in Wales and NI (Table 11).

When all the measures were ranked across all of the countries in a single list (Table 12), control measures achieved higher rankings in England followed by Scotland then the UK. A2,1, A1,2 and PR2 ranked 1st to 3rd in England. Bio-security, and vaccines A1,1 and B3 achieved the lowest overall rankings.

In summary, probiotics PR2 and vaccines A1,2, A2,1, A2,2 and B1,2 were ranked higher than other control measures in terms of benefit-cost ratios.

Table 11. Ranking of control measures based on the estimated benefit-cost ratios for each country and the UK under scenarios 1 and 2.

	Benefit-cost ratios of control measures											
	A1,1	**A1,2**	**A2,1**	**A2,2**	**B1,1**	**B1,2**	**B2**	**B3**	**B4**	**BS**	**PR1**	**PR2**
Scenario 1												
Scotland	11	2	1	3	6	4	8	10	9	12	7	5
England	11	2	1	5	7	4	8	10	9	12	6	3
Wales	11	3	2	6	7	4	8	10	9	12	5	1
NI	11	4	3	6	7	5	8	10	9	12	2	1
UK	11	2	1	5	7	4	8	10	9	12	6	3
Scenario 2												
Scotland	11	3	2	5	7	4	8	10	9	12	6	1
England	11	3	2	5	7	4	8	10	9	12	6	1
Wales	11	4	3	6	7	2	8	10	9	12	5	1
NI	11	4	3	6	7	2	8	10	9	12	5	1
UK	11	3	2	5	7	4	8	10	9	12	6	1

Table 12. Overall ranking of the studied control measures based on the estimated benefit-cost ratios under scenario 1 and 2.

	Benefit-cost ratios of control measures											
	A1,1	**A1,2**	**A2,1**	**A2,2**	**B1,1**	**B1,2**	**B2**	**B3**	**B4**	**BS**	**PR1**	**PR2**
Scenario 1												
Scotland	32	9	7	10	20	11	24	29	27	47	22	16
England	28	2	1	5	8	4	12	23	19	45	6	3
Wales	44	36	35	39	40	37	41	43	42	59	38	34
NI	58	51	50	53	54	52	55	57	56	60	49	48
UK	33	14	13	18	25	17	26	31	30	46	21	15
Scenario 2												
Scotland	32	9	8	12	19	11	24	27	26	46	13	7
England	29	3	2	5	10	4	14	22	20	45	6	1
Wales	44	37	36	39	40	35	41	43	42	58	38	34
NI	59	51	50	53	54	49	55	57	56	60	52	48
UK	33	17	16	21	25	18	28	31	30	47	23	15

The effect of increasing and decreasing the benefits and the costs by ±10% on net return of the control measures varied in different countries and for different measures. The minimum effect was observed in Wales and Northern Ireland where the reported occurrence of *E. coli* O157 was considerably lower in the human population and the changes had little impact on the net returns. In general, a 10% increase or decrease of the costs had a greater impact on the net return in all the countries. The net return for B1,2 and A2,2 in Scotland and B2 and B1,1 in England under scenario 1 were very sensitive to these changes and could change the outcome of the analysis. In the UK a 10% decrease in costs or 10% increase in benefits of PR2, A2,1 and A1,2 could change net return from negative to positive figures.

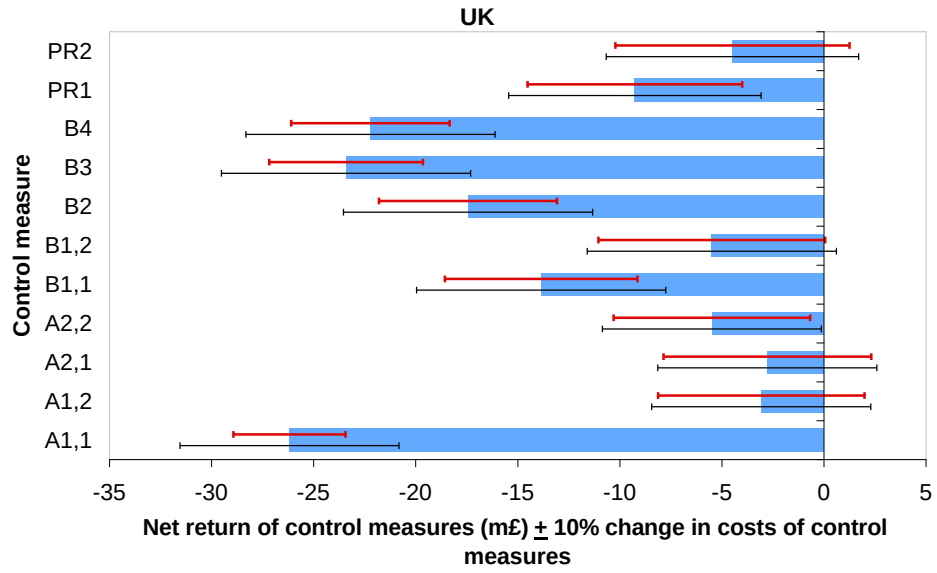

Figure 8. The difference in net return (blue bars) in scenario 1 caused by changing the costs (black error bars) and benefits (red error bars) by ±10%.

2.2.4 Summary

The results show that administration of vaccines and probiotics as on-farm control measures for *E. coli* O157 in young animals and in some cases for all cattle in the studied countries and in the UK may payback their costs. The outcome is dependent on the fraction of the cattle population that are vaccinated and its associated costs, but primarily on the preventable human losses that combines the quantity of annual human cases and the severity of illnesses.

A range of efficacy levels for the two types of commercially available vaccines have been reported in the reviewed papers and as a consequence these approaches achieved both high (e.g. A2,1 and B1,2) and low (e.g. A1,1 and B3) benefit-cost ratios (Table 10, Table 11 and Table 12). However the results show greater difference within the calculated cost-effectiveness than between the calculated cost-effectiveness of the two types of vaccine. The efficacy of probiotic was based on one study in which it was found to be highly effective. PR2 (reduction in shedding levels achieved) in particular achieved a benefit-cost ratio greater than one in England and close to one in Scotland and the UK. This indicates that the possibility of usage of probiotics as an on-farm control measure should not be ignored, though the feasibility of in-feed administration to grazing cattle is questionable. In contrast to probiotics, the considered bio-security package achieved benefit-cost ratios that were consistently below one. This was due to the high estimated implementation costs – in line with those of previous estimates (e.g. Defra, 2003). This result indicates that, based on the evidence which is currently available, bio-security alone does not appear to provide a viable control option for *E. coli* O157 due to the costs associated with its implementation and uncertainty over its efficacy. However, it must be considered that increased bio-security may have additional benefits for the producer through the control of other diseases though these benefits have not been quantified and the measures cannot be considered as routine to UK production systems.

It is concluded that given the assumptions used, the models show that implementing vaccination and probiotics for all the cattle population in Scotland and England gives rise to benefits that cover costs whereas this is not the case in Wales and Northern Ireland. When targeting only young cattle,

assuming the same efficacy levels, both the studied vaccines and probiotics gave benefits greater than costs in Scotland, England and the UK. Implementing this approach in Wales and Northern Ireland in isolation led to costs that did not cover the benefits. However, for all comparisons, the benefits i.e. human losses avoided are extremely uncertain, likely to be variable (Roberts et al, 2000; Havelaar, et al., 2004; Frenzen et al., 2005; Frenzen, 2007; Pollock, 2010; Tariq et al., 2011) and give rise to high publicity with attendant anxiety, unpredictable direct and indirect losses and very severe consequences (Griffin, 2010). The costs of control measures on the other hand are likely to be more certain and have minimal impact beyond the direct costs imposed on farming businesses and those elsewhere in the food marketing chain likely to absorb them. In this situation the precautionary principle could be justified i.e. benefit-cost ratios less than 1 may not rule out control actions if risk aversive behaviour was adopted by decision makers concerned.

3. Drivers and barriers of adoption of control options: Behavioural analysis

3.1 Introduction

The study analyses the impact of *a priori* determinants of adoption of *E. coli* O157 control measures by cattle farmers in the UK. We used two datasets collected through a stratified telephone survey of 405 cattle farmers (split 147 England, 123 Wales, 101 Scotland and 34 Northern Ireland) and an online survey of 91 farmers that deliberately open their farms to the public (mostly LEAF farm members) in the UK.

The surveys' results give an insight into the cattle farmers' and 'open' farmers' attitudes and behavioural intentions towards *E. coli* O157 control. Applying *E. coli* O157 control measures on-farm is assumed to decrease the risk of transmission of *E. coli* O157 disease from livestock to humans and, implicitly, reduce the risks posed by *E. coli* O157 to human health. Understanding which determinants influence farmers' behavioural intentions and, potentially, behaviour, would assist an ambition of behavioural change.

3.2 Literature review

There is an increasing amount of literature looking at farmers' attitudes and behaviour towards livestock disease control. Most studies acknowledge the impact of socio-demographic and economic factors, and access to information on attitudes and behaviour towards animal disease control. Most studies reviewed in this section were undertaken in the UK, however many of their findings were similar to some of studies done in other European countries, the United States of America, Australia and New Zealand, some of which are also mentioned in this section.

Farmers' socio-demographics and attitudes towards animal health/bio-security measures have an important role in farm decision-making processes. Farmer's age, education, experience, household status have all been shown to have an effect on behaviour (Ellis-Iversen et al., 2010; Fairweather and Keating, 1994; Gasson, 1973). While younger farmers with larger herds and dependents are more likely to engage with an eradication programme, older farmers with no successors are less likely to implement changes in their management systems (BVA 2005; Tuyttens et al., 2007). Education and training have been shown to enhance and influence farmers' willingness to implement a change in management practices (Austin et al., 2001; Gasson, 1998). This, together with farmers' ability to understand the problems, risks and potential impacts will influence farmers' behaviour and attitudes to animal health and animal disease control/bio-security (Chilonda and Van Huylenbroeck, 2001). Farmers' ability to understand information on bio-security issues and other aspects of disease control will influence their perceived risk of a disease outbreak. For instance, exotic diseases which have not been present in a system for a prolonged time are considered to be low risk and farmers are more likely to behave in a 'risky' manner. Conversely, in an outbreak situation the perceived and potential risks are elevated and the likelihood of farmers' implementing bio-security measures increases significantly (Coleman et al., 1998; Delabbio, 2004; Ekboir, 1999; Lindberg et al., 2006).

A farm's physical attributes will influence what bio-security measures are required and the level of investment (financial or labour) needed. Farmers perceive the level of investment needed to implement bio-security measures to be expensive, involving either an increase in management effort with a higher demand on labour and time (Dwyer et al., 2007; Gunn et al., 2008; Hubbard et al.,

2007; Morgan-Davies et al., 2006) or requiring changes such as building improvements or maintenance of boundaries (Bewsell and Monaghan, 2007; Brennan et al., 2008). The financial circumstances of the farm will contribute largely to the type of measures farmers can afford to implement (Chilonda and Van Huylenbroeck, 2001; Stott et al., 2003; Tuyttens et al., 2007).

Another factor influencing farmer behaviour is the access to information on disease control/bio-security measures and animal health issues. The source of the information is key as some studies found that farmers tend to distrust governmental or scientific bodies while placing more reliance on other farmers and veterinarians (Bingham et al., 2008; Heffernan et al., 2008; Olmstead and Rhode, 2007; Palmer et al., 2009). This means that farmers are more likely to act on the information given to them by their veterinarians or by someone with whom they have built up a trusting relationship (Lindberg et al., 2006; Marshall et al., 2006; Mills et al., 2006).

Some studies found that farmers might perceive the requirements of regulation to be confusing or less appropriate to the needs of their farm, which might have a negative impact on their uptake of disease control/bio-security measures (Gunn et al., 2005; Moore and Payne, 2007). Demonstrations of successful implementation of bio-security measures and their benefits will increase the level of uptake (Braun et al., 2006).

3.3 Data

3.3.1 Telephone survey

The sampling frame was derived from the June 2010 Survey of Agriculture and Horticulture for England, Wales, Scotland and from the Public Health Information System data for Northern Ireland and included all holdings with cattle. The criteria for inclusion in the study were as follows:

1. main farm type (classification derived from the June 2010 survey information as the standard measure of farm activity and type; to be classed in a particular area, a holding must have at least two-thirds of its activity in one particular area, otherwise it is deemed to be of mixed type);

2. farm size (using only holdings which have a standard labour requirement (SLR) greater than 0.25 FTE (Full Time Equivalent) to avoid inclusion of hobby farmers);

3. stocking density or LFA marker (used in place of stocking density when data not available);

4. livestock groups (holdings can either have dairy and/or beef - any one activity or all);

5. region (England, Wales, Scotland and Northern Ireland).

A stratified sample was drawn from this population in which the sample had the same proportionate split of holdings according to farm type (309 beef and 96 dairy cattle farms). Farmers were removed from the sample if they met any of the following criteria: they were no longer active on the register (ceased farming); they were listed as a ‘stop’ (people to whom no correspondence was sent, e.g., recent bereavements).

During the three weeks prior to the survey (April 2011), 1420 opt-out letters were sent to farmers in England, Scotland, Wales and Northern Ireland. The opt-out letter stated the aim of the survey, approximate duration of the interview, underlined that the survey was voluntary and that it ensured respondent anonymity. The letters sent to the Welsh farmers were written in English and Welsh. Farmers who did not wish to participate were asked to return an enclosed form in a reply paid

envelope provided, within one week. Two to three weeks were allowed for opt-out letters to be returned by farmers before the survey started, and 81% of the farmers contacted by postal mail (opt-out letters stage) did not return their opt-out letters and implicitly agreed to participate in the telephone interview.

A pilot survey of 10 farmers from England, Scotland, Wales and Northern Ireland was conducted to identify any changes needed to the questionnaire before administration.

The telephone survey took place during May-June 2011. Overall, 405 farmers were contacted by telephone for the interview and 405 completed questionnaires were obtained forming a representative sample at the UK level (147 England, 123 Wales, 101 Scotland and 34 Northern Ireland).

The average duration of the interview was 17 minutes. The interviews were not audio-recorded but notes were taken by the interviewer and answers compiled in an SPSS database. Farmers were reassured that all information provided would be completely anonymous in any subsequent reports or publications and that they and their farms would never be individually identifiable. Any farmers wishing to opt out after the data was collected were able to do so.

The questionnaire included questions on:

- socio-demographic information about the farmer (gender, age, education)
- farm economic information (status with respect to the farm holding, total farm land area, number of livestock, full-time and part-time labour, share of income from livestock production, organic certification, open farm characteristics, proportion of farm income dependent on opening to the public)
- access to information sources
- knowledge about *E. coli* O157
- attitudes as regards the use of control measures for *E. coli* O157
- perceived benefits of controlling *E. coli* O157
- perceived responsibility in controlling *E. coli* O157
- influence on business of factors such as regulations and *E. coli* O157 outbreaks
- perceived practicality of bio-security measures
- intentions to change farm size
- intentions to change public access to the farm
- intentions to change *E. coli* O157 control measures on-farm
- willingness to use *E. coli* O157 control measures.

The complete questionnaire used in the telephone survey is presented in Appendix B1. Before the analysis, all the variables in the dataset were checked and corrected for errors, particularly out-of-range values.

3.3.2 Online survey

The online survey took place after the telephone survey, during August-September 2011, and 91 completed questionnaires were obtained.

Communication with statisticians from Defra, Scottish Government, Welsh Government, DARDNI and FSAS, confirmed there is no Government-held list of open farms and, consequently the number or the types of open farms that exist cannot be estimated. A number of farm networks exist, such as Linking Environment And Farming (LEAF) and the National Farm Attractions Network (NFAN) that record open farms. However there are believed to be open farms that are not part of any networks

and the LEAF database includes amongst these open farms those that only allow public access for "Open Farm Sunday" and who may not consider themselves as open farm attractions. Thus, it was not possible during this study to find reliable information as regards the total number of farm attractions open to the public in the UK. Therefore, we cannot confirm that this is a representative sample for open farm attractions and the results of the analysis of the online survey data should be interpreted with caution. The online survey was directed to the cattle farmers who were members of LEAF and recorded by LEAF as opening to the public. LEAF circulated our invitation to their members to participate in the survey (which was only open to LEAF members) and 91 responses were received.

The questionnaire was built based on the telephone survey questionnaire, however it included more questions specifically directed to farms that open to the public. In addition to the questions included in the telephone survey questionnaire, the online questionnaire included questions on ways in which livestock were accessible to the public, number of public visitors (including children younger than 10 years old) to the farm per year and some open-ended questions on attitudes and perceptions of *E. coli* O157 control measures. The complete questionnaire used in the online survey is presented in Appendix B2.

3.4 Methodology

We used structural equation models (SEM) with observed and latent variables to test the influence of *a priori* identified determinants on behavioural intentions towards *E. coli* O157 control. SEM is a statistical technique for testing and estimating causal relationships amongst variables, some of which may be latent, based on a combination of statistical data and qualitative causal assumptions. Latent variables are not directly observed but inferred from other variables that are observed and directly measurable (Bollen, 1989). Examples of latent variables are constructs like extraversion, spatial ability, self-efficacy, and attitudes (Borsboom, 2003).

While the idea of causality may be controversial (Mueller, 1996), SEM is not intended to discover causes but to assess the soundness of the causal relationships *a priori* identified in the scientific literature. Hence it is mostly used as a confirmatory analysis/theory testing tool.

The basic SEM consists of two parts, namely the measurement model (which specifies the relationships between the latent variables and their constituent indicators), and the structural model (which designates the causal relationships between the latent variables). The measurement model is similar to factor analysis, where latent variables represent 'shared' variance, or the degree to which indicators 'move' together. The structural model is similar to a system of simultaneous regressions, with the difference that in SEM some variables can be dependent in some equations and independent in others.

The model is defined by the following system of three equations in matrix terms (Jöreskog and Sörbom, 2007):

The structural equation model: $\eta = B\eta + \Gamma\xi + \zeta$

The measurement model for y: $y = \Lambda_y \eta + \varepsilon$

The measurement model for x: $x = \Lambda_x \xi + \delta$

Where: η is an m*1 random vector of endogenous latent variables; ξ is an n*1 random vector of exogenous latent variables; B is an m*m matrix of coefficients of the η variables in the structural model; Γ is an m*n matrix of coefficients of the ξ variables in the structural model; ζ is an m*1 vector of equation errors (random disturbances) in the structural model; y is a p*1 vector of endogenous variables; x is a q*1 vector of predictors or exogenous variables; Λ_y is a p*m matrix of coefficients of the regression of y on η ; Λ_x is a q*n matrix of coefficients of the regression of x on ξ ; ε is a p*1 vector of measurement errors in y; δ is a q*1 vector of measurement errors in x.

This study estimates SEM with the normal-theory maximum likelihood (MLE) method using the statistical package Lisrel 8.80 (Jöreskog and Sörbom, 2007).

Additionally, we used multiple logistic regression (*e.g.*, for the smaller samples at regional level, where SEM could not be applied). Logistic regression is useful for situations in which one wants to be able to predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables. It is similar to linear regression but is suited to models where the dependent variable is dichotomous. Logistic regression coefficients can be used to estimate odds ratios for each of the independent variables in the model. The interpretation of the results of logistic regression analysis is done using statistical tests, *e.g.*, Wald statistic (which is used to provide the statistical significance for each coefficient estimated, with the significance coefficient indicating the significance level of the Wald statistic) and Nagelkerke R-square (which measures the overall significance of the regression).

3.5 Results

3.5.1 Statistical analysis of data collected through the telephone survey

3.5.1.1 Demographics

Detailed results of the statistical analysis are presented in Appendix A1. Here we briefly present some statistics for the total sample. Namely, as regards gender distribution, the sample consisted of 85% male farmers and 15% female farmers. Age distribution showed 38% of farmers under 50 years old, 40% between 51-65 years old and 22% over 65 years old. As regards educational level, 45% of farmers finished school, 42% finished college and 12% finished university.

With respect to farm holding, most farmers (61%) owned their farms, 25% were partly tenants/partly owners and 12% are tenants. There was a high variation between the countries as regards farm ownership, from 50% in England, 64% (each) in Scotland and Wales, to 88% in Northern Ireland, however this variation was not representative as the Northern Ireland sample size was very low.

As regards labour, 90% of farmers (85% of dairy farmers and 91% of beef farmers) had up to 3 full time people working on the farm, with 6% of farmers (12% of dairy farmers and 4% of beef farmers) having between 4-10 full time people working on the farm. While the majority (65%) of farmers did not hire part time labour, a third (33%) of farmers (39% of dairy farmers and 31% of beef farmers) hired up to three part time workers and 2% of farmers (2% of dairy farmers and 2% of beef farmers) hired more than three part time workers.

As regards the number of cattle on beef cattle farms, 27% of beef farms had up to 100 beef cattle; 50% had between 100-200 beef cattle; and 23% had more than 200 beef cattle. As regards the

number of cattle on dairy cattle farms, 14% of dairy farms had up to 50 dairy cattle; 25% had between 50-100 dairy cattle; 27% had between 100-200 dairy cattle; and 34% had more than 200 dairy cattle.

About two thirds of farmers (63%) used an animal health plan to manage the health of their livestock.

About 5% of farmers surveyed had organic certification.

As regards income (Figure 9a,b), 75% of farmers had half or more of their income coming from livestock production and only about 5% of farmers had more than 5% of their income dependent on opening to the public.

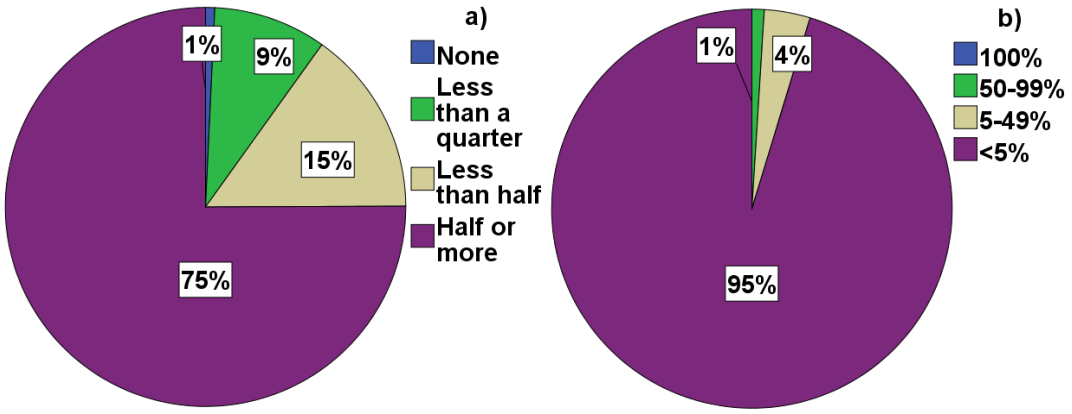

Figure 9 a). Proportion of income from livestock production (i.e. direct sales plus subsidy support) in total farm income; b). Proportion of income from opening to the public in total farm income

3.5.1.2 Knowledge

As regards *E. coli* O157 awareness, 27% of farmers had not heard of *E. coli* O157 before they were contacted through the telephone survey. This might be reflected in the fact that just under a fifth (18%) of farmers were either unaware or did not agree that *E. coli* O157 causes disease in people and that some respondents demonstrated a lack of understanding with regard to the different potential means of *E. coli* O157 transmission (Figure 10a-g). Namely, more than a third (38%) of farmers either did not agree or did not know that livestock were an important source from which *E. coli* O157 spreads, about a quarter (26%) did not agree/did not know that people touching calves/cows could potentially become infected with *E. coli* O157, and almost half (48% and, respectively 46%) did not agree/did not know that *E. coli* O157 could contaminate produce such as lettuce, apples, spinach or rural drinking water. Additionally, 19% of farmers did not agree and a further 33% did not know that *E. coli* O157 could be present in raw milk. It was also interesting that 14% of farmers did not know that *E. coli* O157 could be present on raw meat. This raises concern over a lack of awareness with regard to the risks associated with *E. coli* O157 and might imply that not all farmers recognise the importance of controls to prevent cross-contamination.

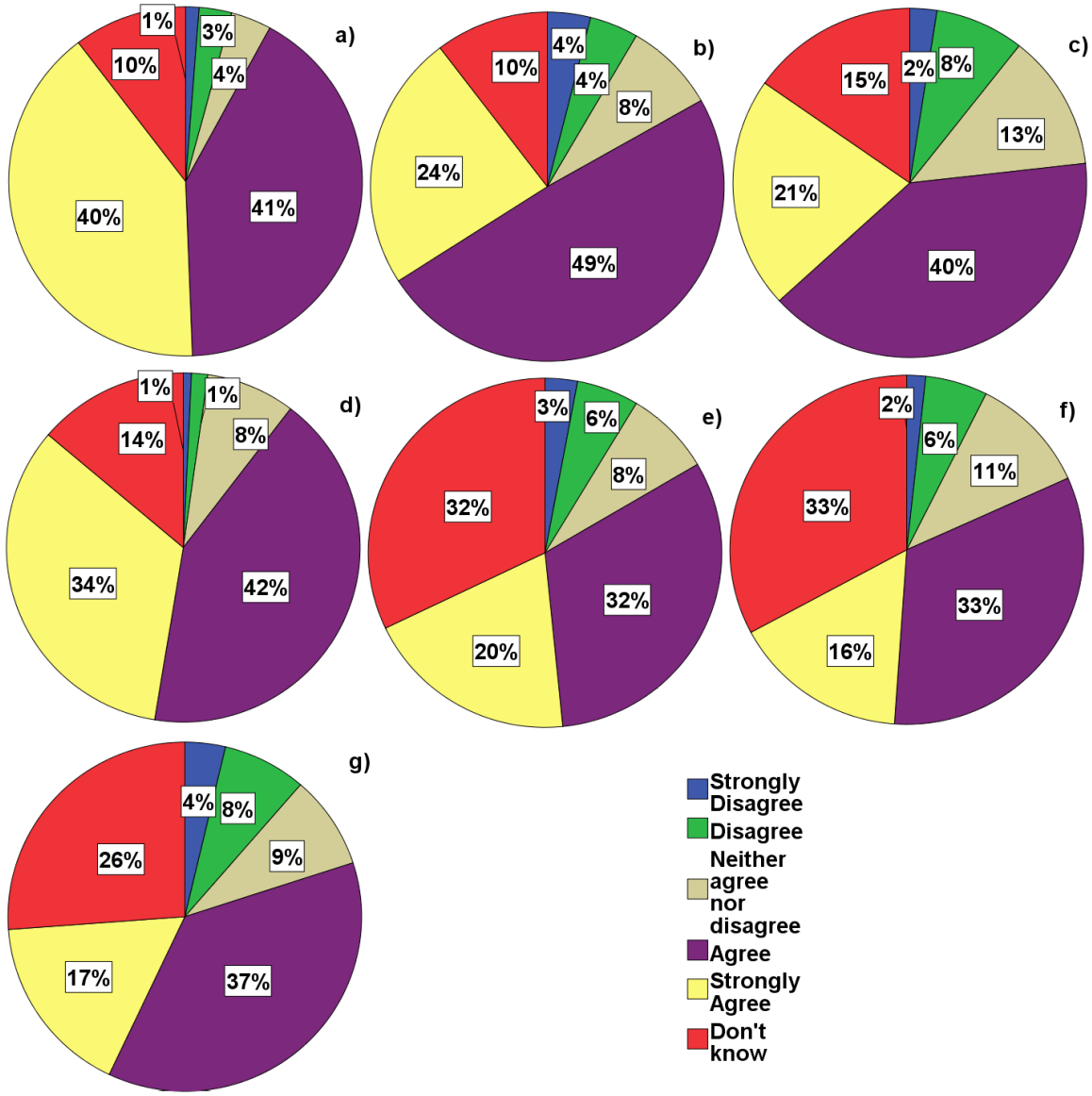

Figure 10 Knowledge about *E. coli* O157. a). E. coli O157 causes disease in people; b). People touching calves/cows may become infected with *E. coli* O157; c). Livestock are an important source from which *E. coli* O157 spreads; d). *E. coli* O157 can be present on raw meat; e). *E. coli* O157 may contaminate produce such as lettuce, apples, spinach; f). *E. coli* O157 can be present in raw milk; g). E. coli O157 may contaminate rural drinking water. Note that charts may not add up to 100% due to rounding of figures.

3.5.1.3 Benefits of and responsibility for controlling *E. coli* O157 on-farms

As regards perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle, the majority of farmers (75%)[7] thought that either all (farmers, processors, retailers, public and government) or specifically farmers (14%) would benefit (Figure 11).

[7] Some farmers answered 'yes' to more than one option.

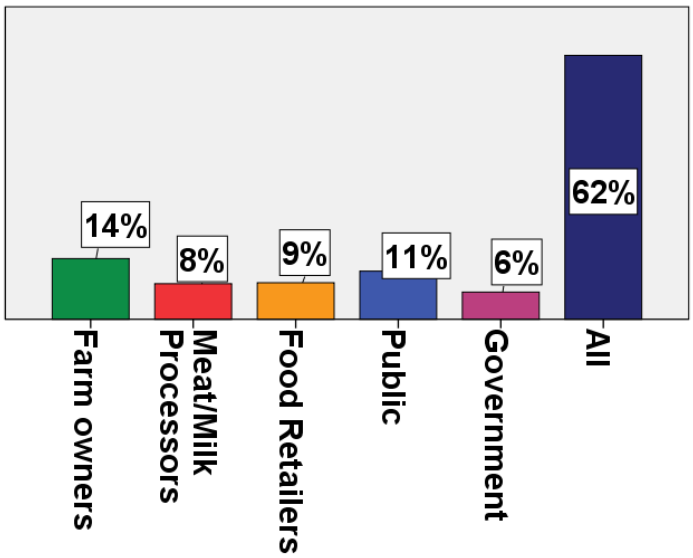

Figure 11. Perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle

There was a significant correlation between farmers' perceptions about who benefits from on-farm controls to reduce *E. coli* O157 in cattle and their attitudes towards potential benefits/losses due to the use/lack of *E. coli* O157 control. This might imply that farmers who perceive themselves (together with all others involved) as beneficiaries of *E. coli* O157 control are more likely to have stronger attitudes towards *E. coli* O157 control.

A high majority (93%) of farmers agreed/strongly agreed that for them it is very important that they, together with other UK livestock owners, take action to control the infections in animals that may affect humans. About a third (31%) of farmers agreed/strongly agreed that using control measures for *E. coli* O157 in cattle on-farm would lead to an increase in the price for their produce. More than half (53%) of farmers agreed/strongly agreed that using control measures for *E. coli* O157 in cattle on-farm would enhance their reputation with consumers/customers.

A high majority (83%) of farmers agreed/strongly agreed that their business would be adversely affected if *E. coli* O157 infection in a person was linked to their farm. Half (50%) of farmers agreed/strongly agreed that if they did not use control measures for *E. coli* O157 in cattle on-farm, they might get sued in the courts. More than a third (39%) of farmers agreed/strongly agreed that if they did not use control measures for *E. coli* O157 in cattle on-farm, they might lose the single farm payment.

Only around 19% of farmers agreed that *E. coli* O157 might be present in cattle on their farm, including 3% who strongly agreed with this statement.

As regards perceived responsibility for controlling *E. coli* O157 on farms, the majority of farmers (86%)[8] stated that responsibility either remains with them or it is to be shared equally between farmers and all others involved (processors, retailers, public and government) (Figure 12).

[8] Some farmers answered 'yes' to more than one option.

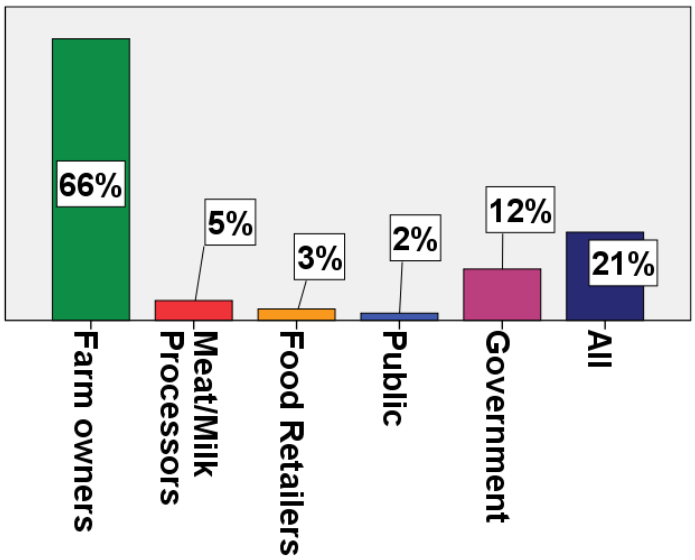

Figure 12. Perceived responsibility for controlling *E. coli* O157 on-farms

3.5.1.4 Sources of information on *E. coli* O157

As regards sources of useful information on *E. coli* O157, most farmers[9] (79%) stated media, followed by veterinary surgeons (44%), government (*e.g.* FSA, DEFRA, RERAD, DARDNI, Welsh Government) (33%), other farmers (23%), and industry organisations (19%). The other sources (open days/farm demonstrations, internet, agricultural consultants and sales people) were found useful by a lower proportion of farmers (7-11%) (Figure 13).

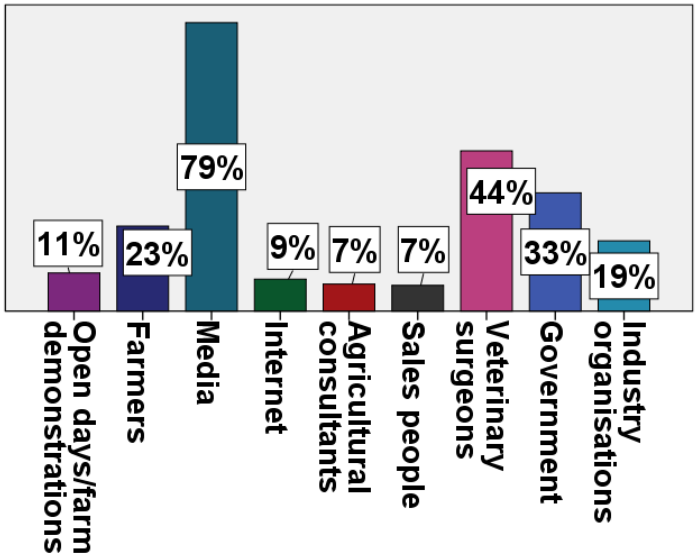

Figure 13. Sources of useful information on *E. coli* O157

3.5.1.5 *E. coli* O157 control

This section relates to farmers' willingness/ability to implement a control on farm. Based on the review of scientific literature, three main types of *E. coli* O157 control have been identified, namely

[9] The percentages relate only to those farmers who had heard of *E. coli* O157 prior to the survey (73% of the total sample).

vaccination, additives in feed or water, and more general biosecurity measures. Farmers were asked whether they were willing to use vaccination and additives and about the practicality of applying biosecurity measures to control *E. coli* O157 on their farms.

a) Vaccination

Whilst nearly 60% of farmers said they would be willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to 3-18 months old cattle, about 41% would currently be unwilling to use a vaccine treatment. For the majority of these farmers (91%) one of the reasons was lack of information about vaccination, for two thirds of them (69%) the cost was too expensive, whilst around half of them (49%) said that it would take too much time to administer. However, 61% of them said that they would be encouraged to use vaccination if it was part of a national program to benefit the reputation of the industry, while 44% of them said that they would be encouraged to use vaccination if it was used by other farmers (Figure 14).

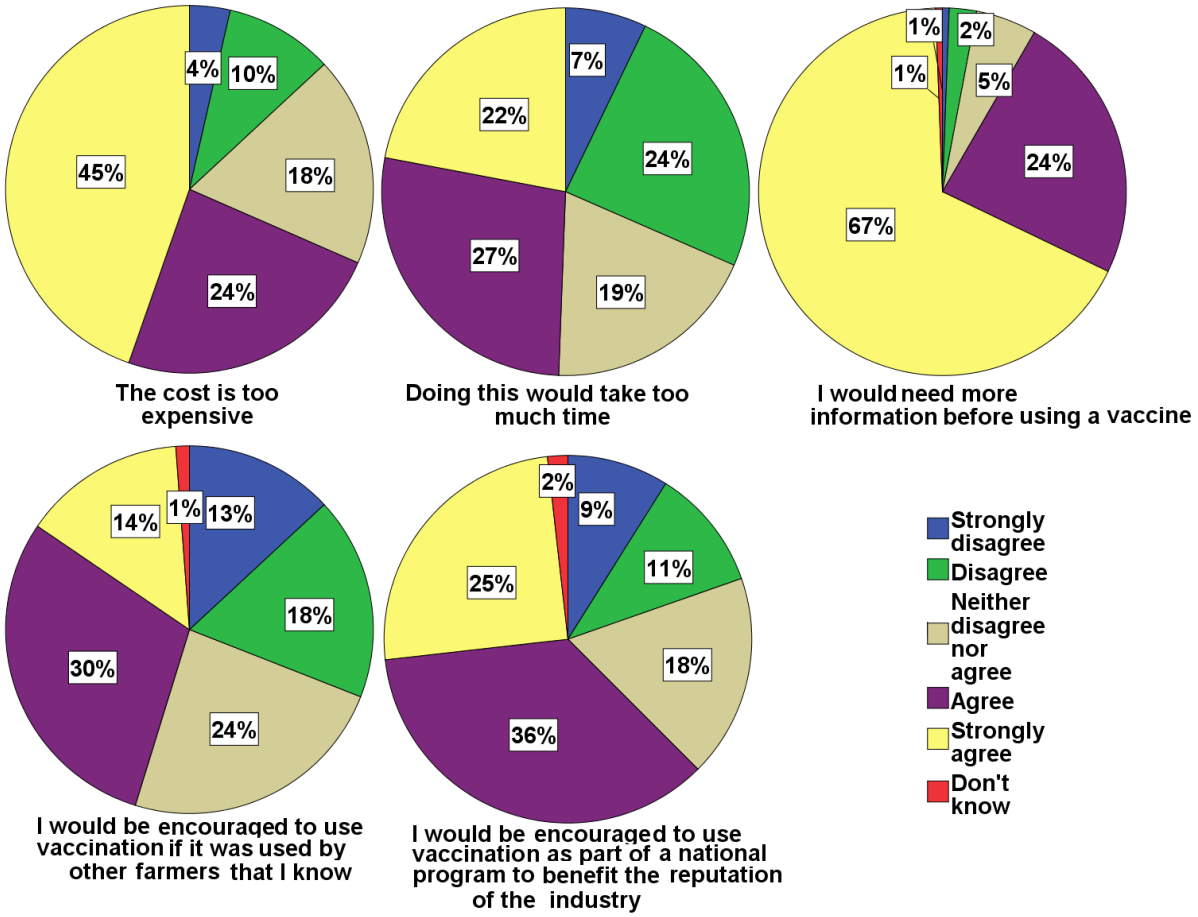

Figure 14. Reasons for not being willing/incentives to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle

There were no significant differences between dairy and beef farmers as regards their willingness to use vaccination - 60% of dairy farmers and 58% of beef farmers answered positively. There were no significant differences between dairy and beef farmers as regards their reasons for lack of willingness (money, time, information). As regards incentives to use vaccination, a slightly higher proportion of dairy farmers (50%) as compared to beef farmers (42%) stated that they would be encouraged to use vaccination if it was used by other farmers. The opposite situation was shown as regards use of vaccination if it was part of a national program to benefit the reputation of the industry (62% of beef farmers answered positively as compared to 58% of dairy farmers).

Farmers were given the opportunity to state other reasons for not being willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to cattle aged 3-18 months old.

Many comments were information/advice related, such as 'if the vet agreed it was a good idea', 'if I was 100% convinced of the safety', 'I would like to see a lot more research into the effects the vaccine might cause in the cattle', 'if there was a test that showed background levels and I was found to be at risk', 'vaccination would only keep the animal free of any effects of the bacteria and not the people who it seems are more affected by it', 'if you give a vaccine the beasts might lose their immunity'.

Many farmers stated they would be willing to vaccinate only where there was clear evidence of disease, such as 'if I had a problem on my farm or it was in the area I would use it', 'evidence that it's causing a problem further down the food chain', 'I don't like giving vaccines for no reason, only if we have a problem', 'I don't think the problem is serious enough', 'I don't like blanket vaccinations', 'it depends on the risk factors as to what we do. We have been down that route with Bluetongue and it was a big job to do. Few other farmers in the area vaccinated and then we were declared a low risk area, so we felt we had wasted time and money'.

Some comments were regulation related, such as 'if it was obligatory'.

Many farmers stated that it would need to be done in coordination with other vaccines, 'it conflicts with other vaccinations', 'need to do at the same time as TB tests if possible', 'it would cause excessive stress to the animals, they go through enough already with tagging etc.', 'depends if it could cover other illnesses'.

Others were farm type related comments, such as 'I'm an organic farmer so vaccines are really difficult to implement'.

Others were responsibility driven answers, such as 'I think there is another part of the food industry which should be dealing with *E. coli*, somewhere which is more sterile, like the slaughterhouse' or 'it isn't just the farms that should be doing something about it'.

Some gave cost benefit related answers, such as 'need to know the benefits', 'the government would have to pay', 'should be funded by others, we cannot afford it', 'if it was subsidised, cheaper and proven to be necessary we would use it', 'it would need to be a significant advantage to us before we could afford it, we vaccinate a lot as it is'.

Some farmers mention this in relation to their customers, namely 'if it was specified by our customers' or 'if I could pass the cost on to our customers'. One farmer said he does not think 'vaccination is the correct control method to use'.

b) Additives

Whilst about 40% of farmers said they would be willing to use a treatment such as additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal, about 60% would currently be unwilling to use additives. For the majority of these farmers (88%) one of the reasons was lack of information about this measure, 79% of them mentioned cost (too expensive) and half of them (53%) said that it would take too much time. However, 58% of them said that they would be encouraged to use additives if this was part of a national program to benefit the

reputation of the industry, while 43% of them said that they would be encouraged to use additives if they were used by other farmers (Figure 15).

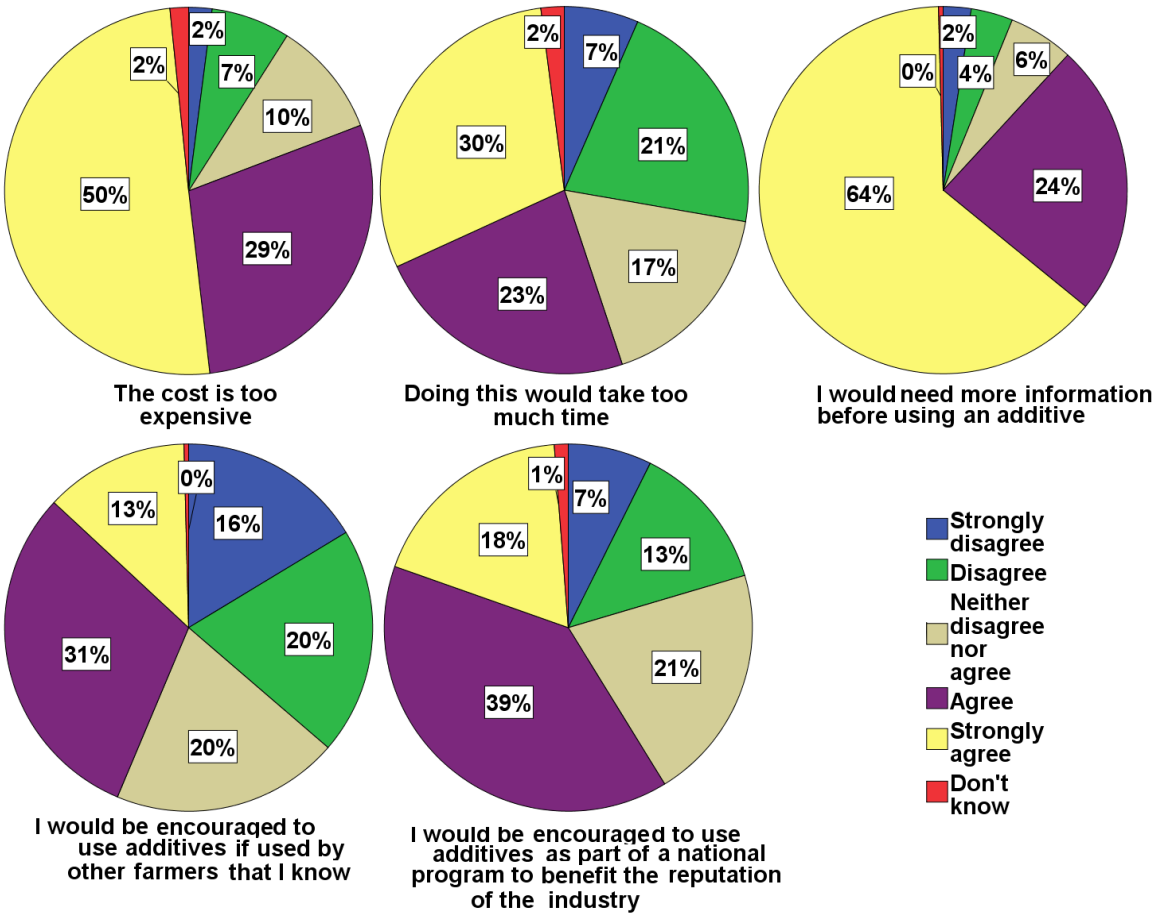

Figure 15. Reasons for not being willing/incentives to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal

There were no significant differences between dairy and beef farmers as regards their willingness to use additives - 41% of dairy farmers and 39% of beef farmers answered positively. As regards their reasons for lack of willingness, a slightly higher proportion of beef farmers (81%) strongly agreed/agreed that the cost was too expensive as compared to dairy farmers (74%). Similarly, 89% of beef farmers strongly agreed/agreed that they would need more information as compared to dairy farmers (81%). As regards incentives to use vaccination, a slightly higher proportion of dairy farmers (49%) as compared to beef farmers (42%) stated that they would be encouraged to use additives if used by other farmers. The opposite situation was shown as regards use of additives if it was part of a national program to benefit the reputation of the industry (58% of beef farmers answered positively as compared to 53% of dairy farmers).

Farmers were given the opportunity to state other reasons for not being willing to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal.

Most farmers mentioned implementation difficulties, 'it is difficult to monitor because they are outside part of the year' or 'I would be concerned about getting the right dose down them given that they are outside mainly', 'I would not be that sure that every animal would get the benefit of the additive', 'you don't know that every animal is getting a proper dose', 'not all the animals would get a dose when they're feeding on grass. Some animals drink from the ditches in some of the fields so

they wouldn't get it there either', 'we don't use feeding or water troughs often enough for it to be a viable option if needed', 'it wouldn't be practical as we have watering holes in the fields'.

Many comments were information/advice related, such as 'I would worry that it wasn't safe for humans and animals', or 'if it wouldn't have any long term effect', 'if our vet recommended it', 'make sure they don't have any side effects'.

Many farmers stated they would be willing to use additives only when there was clear evidence of disease, such as 'I don't think such measures are needed as the problem is so low that it isn't a problem that has affected anyone I know and feel it is something more for those farms which are open to the public', 'if we had outbreak on the farm I would be encouraged to use it', 'if there was a test that showed background levels and I was found to be at risk'.

Some comments were regulation related, such as 'if it was compulsory we'd do it' or 'I would only use this if I was forced to'. One farmer said he would use additives 'as part of an accreditation scheme'. Another farmer said that 'you have to have a licence to mix minerals so more people would have to be licensed'.

Some farmers stated that it would need to be done in coordination with other measures, 'would be good if it had other benefits, such as preventing other illnesses', 'I would rather vaccinate than medicate', 'I prefer a vaccine, the problem with additives is you don't know if all animals have had some or not'. .

Others were farm type related comments, such as 'I would be concerned about our organic status'.

Others were responsibility driven answers, such as 'it isn't just the farms that should be doing something about it'.

Some gave cost benefit related answers, such as 'if it was funded by the government', 'if there was a government subsidy I would be more likely to consider it', 'it's a good idea, but expensive'.

Some farmers mention this in relation to their customers, namely 'if it was specified by our customers' or 'once people start hearing that farmers are feeding additives to livestock, they are unlikely to want to eat meat from such farms who carry out such a thing'.

c) Biosecurity

In addition to the two aforementioned specific treatment measures (vaccine and additives), farmers were asked to state their willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 was not present on own farm.

While almost half of the farmers (47%) indicated that they would be willing to pay £1 to £5 and a seventh of farmers (14%) more than £5 per animal per year to ensure that *E. coli* O157 was not present on own farm, almost a sixth (17%) of farmers answered that they would not be willing to spend any money. A tenth (11%) of farmers would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth (18%) would not spend more than one day per year and about an eighth (12%) of farmers would not be willing to spend any time at all (Figure 16).

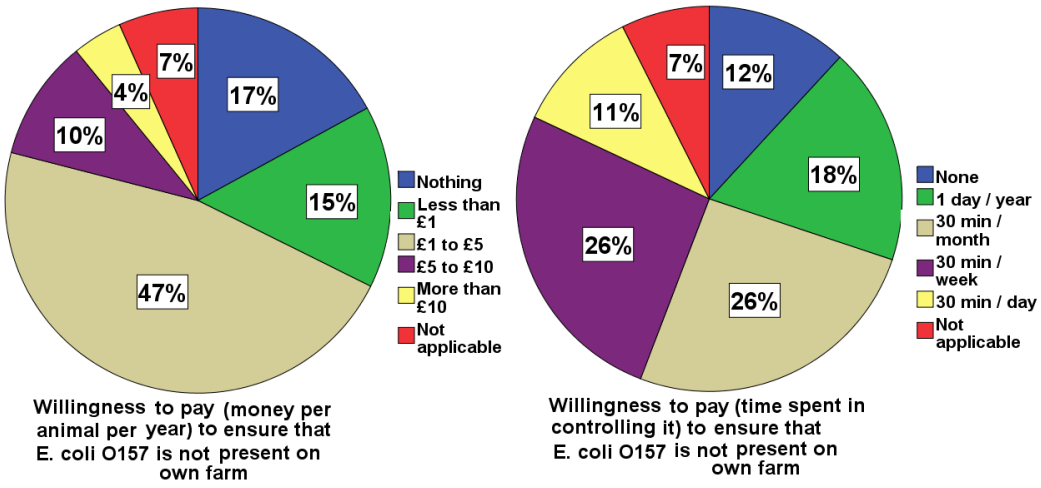

Figure 16. Willingness to pay (money or time per animal per year) to ensure that E. coli O157 is not present on own farm

As regards their willingness to pay money per animal per year to ensure that *E. coli* O157 was not present on own farm, a higher proportion (52%) of dairy farmers were willing to pay £1 to £5 as compared to beef farmers (45%), while a lower proportion (13%) of dairy farmers were not willing to pay any money as compared to beef farmers (18%). In terms of time spent to control *E. coli* O157, dairy farmers showed slightly higher willingness, especially as regards weekly commitment (32% dairy farmers as compared to 24% beef farmers would be willing to spend 30 minutes per week).

Additionally, farmers were asked about the practicality of specific biosecurity measures (Figure 17). The majority of farmers found as practical/very practical the following measures: separating animals into different age groups for the majority of the time (74%), keeping bedding dry and replacing contaminated/wet bedding on a daily basis (65%), quarantine and testing of livestock brought to the farm (57%) and cleaning feed troughs daily (54%). Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were found to be not at all practical by 44% and, respectively, 40% of farmers.

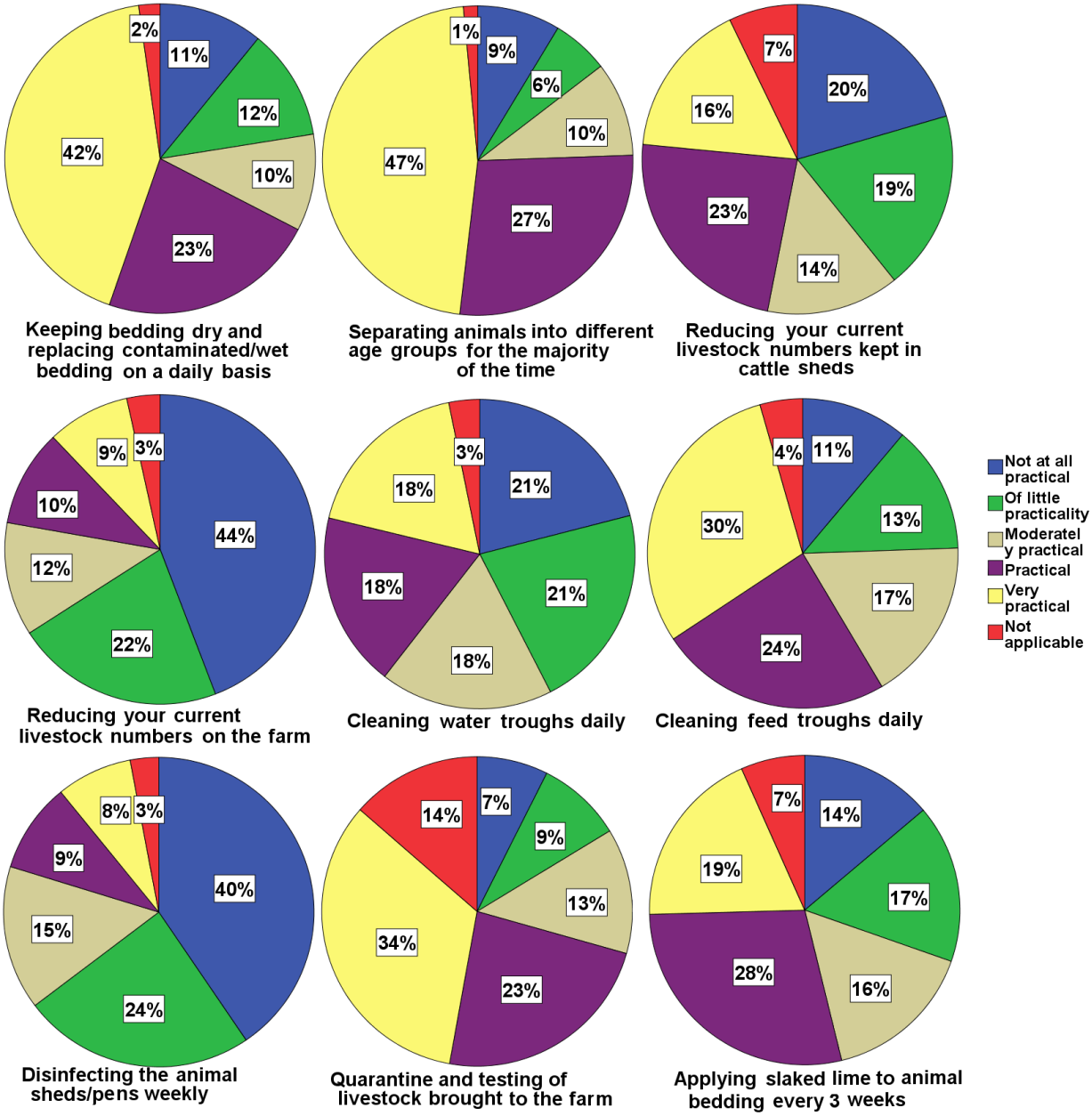

Figure 17. Farmers' perceptions about the practicality of specific biosecurity measures

3.5.2 Econometric analysis of data collected through the telephone survey

3.5.2.1 Structural equation model results

Based on a review of the scientific literature and expert opinion, main behavioural determinants were identified and subsequently translated in a number of categories of questions incorporated in the questionnaire. Factor analysis was used to group the different questions (indicators) and build eight factors/latent variables, each of them based on a number of indicators, which loaded significantly on the same factors. These are:

- willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 is not present on own farm;

and its underlying determining factors:

- farm type – dairy or beef;
- use of a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock;
- proportion of farm income dependent on opening to the public;
- source of general information for managing the farm, such as other farmers, media, consultants, sales people, veterinary surgeons and the government;
- perceived effect of reports/ experience/ incidents of *E. coli* O157 outbreaks or incidents on the way of managing business during the past five years;
- perceived practicality of specific bio-security measures on-farm;
- attitudes towards use of control measures for *E. coli* O157 in cattle on-farm.

The structural equation model was built to reflect the potential relationships between the latent variables based on empirical evidence (literature and expert opinion) and assess the strength of these relationships, *i.e.*, how much these variables influence one another and primarily the behavioural willingness. For instance, the literature has consistently confirmed that more informed farmers are more likely to implement animal disease control on their farms; that attitudes towards disease control will influence intentions to control and actual behaviour; that perceived effect of outbreaks will lead to stronger willingness to control disease; that financial issues will always affect behaviour and/or behavioural intentions (in this case, proportion of farm income dependent on opening to the public is expected to influence farmers' willingness to control disease); that farmers will adopt control measures if these measures are perceived practical/suitable for their farms.

The structural equation model is able to assess the individual effects between variables and the overall effect of all determinant variables mentioned above on the behavioural willingness to control *E. coli* O157 on-farm. As each variable will influence behavioural willingness both directly or indirectly (through their effect on other variables in the model, which in turn will directly influence behavioural willingness), the variance explained by the model is higher than when other techniques, such as regression analysis, are used.

Table 13 presents a description of the latent variables and their corresponding indicators. Table 14 presents a series of descriptive statistics for the indicators of the latent variables included in the model.

Table 13. Description of latent variables and their corresponding indicators[10]. The table presents the name of the latent variables, indicators, the corresponding statements, values & labels and type of variables.

Latent variable	Indicator	Statement	Value & label	Variable type
farmtype	type	type of farm – dairy or beef	1 = dairy farm 2 = beef farm	dichotomous
hplan	healplan	Use of a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	0 = no 1 = incomplete 2 = yes	categorical
income	incomopn	proportion of farm income dependent on opening to the public	1 = <5% 2 = 5-49% 3 = 50-99% 4 = 100%	categorical
ginfo	ginfo2 ginfo3 ginfo5 ginfo6 ginfo7 ginfo8	source of general information for managing the farm: other farmers source of general information for managing the farm: media source of general information for managing the farm: consultants source of general information for managing the farm: sales people source of general information for managing the farm: veterinary surgeons source of general information for managing the farm: government	1 = never 2 = infrequently 3 = frequently	ordinal
effect	effect2 effect3 effect4	perceived effect of reports of E. coli O157 outbreaks or incidents on the way of managing business during the past five years perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years perceived effect of incidents of E. coli O157 that occurred on own farm on the way of managing business during the past five years	1 = not affected 2 = slightly affected 3 = much affected	ordinal

[10] Three of the eight variables are observed variables built in the model as single-indicator latent variables (as specified by the software Lisrel8.80). The other five latent variables were built based on two to six indicators.

biosec	biosec1 biosec3 biosec7 biosec9	perceived practicality of keeping bedding dry and replacing contaminated/wet bedding on a daily basis on own farm perceived practicality of reducing current livestock numbers kept in cattle sheds on own farm perceived practicality of disinfecting the animal sheds/pens weekly on own farm perceived practicality of applying slaked lime to animal bedding every 3 weeks on own farm	1 = not at all practical 2 = of little practicality 3 = moderately practical 4 = practical 5 = very practical	ordinal
attd	attd4 attd5	If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree	ordinal
wtp	wtp1 wtp2	willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	0 = not willing 1 = willing	dichotomous

Table 14. Descriptive statistics (mean and standard deviation).

Indicator	Mean	StdD
type	1.76	.426
healplan	1.27	.960
incomopn	1.06	.271
ginfo2	1.63	.554
ginfo3	1.78	.493
ginfo5	.84	.763
ginfo6	.90	.665
ginfo7	1.70	.515
ginfo8	1.15	.749
effect2	1.14	.417
effect3	1.10	.359
effect4	1.11	.389
biosec1	3.68	1.491
biosec3	2.75	1.575
biosec7	2.11	1.324
biosec9	3.02	1.536
attd4	2.56	1.418
attd5	3.16	1.481
wtp1	2.49	1.204
wtp2	2.83	1.409

We tested the model (as explained below) and the path diagram for the estimated model is presented in Figure 18.

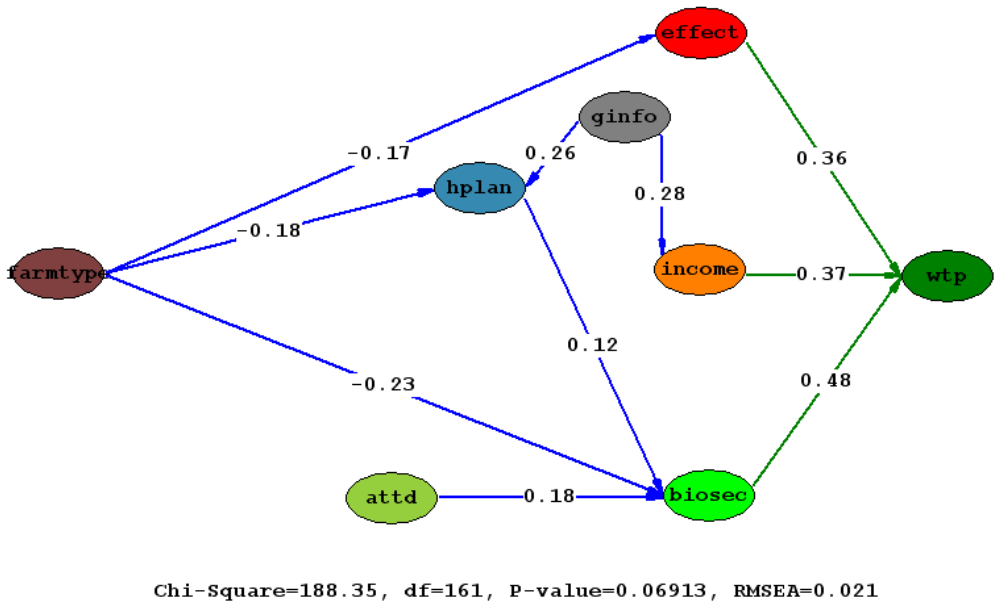

Figure 18. Path diagram for the estimated model showing the drivers of farmers' willingness to pay (wtp) to ensure that *E. coli* O157 is not present on their farm. Coefficients indicate strength of influence (*ceteris paribus*) and the arrows indicate direction of influence. Green arrows represent direct influences on wtp. Indirect influences (blue arrows) on wtp are calculated based on the other relationships in the model (details in Table 16 below).

The model reached acceptable standards in all respects. Details of the tests are as follows:

The model has a very good fit according to the measures of absolute, incremental and parsimonious fit (Hair *et al*., 2006). The main goodness of fit (GoF) indicators (estimated and recommended values) for the estimated models are presented in Table 15.

Table 15. Goodness of fit indicators. The table presents absolute, incremental and parsimonious goodness of fit indicators. The absolute fit indicators include: root mean square error of approximation & p-value test; goodness of fit index; standardised root mean square residual. Incremental fit indicators include: adjusted goodness of fit index; non-normed fit index; comparative fit index; incremental fit index. Parsimonious fit indicators include normed chi-square.

GoF indicators	Estimated value	Recommended value
Degrees of freedom	161	-
Normal Theory Weighted Least Squares Chi-Square	188.35 (P = 0.069)	low (P>=0.05)
Normed chi-square (Chi-Square / df)	1.17	[1-3]
Root Mean Square Error of Approx. (RMSEA)	0.021	0.00-0.10
P-Value Test Close Fit (RMSEA<0.05)	1.00	0.50-1.00
Non-Normed Fit Index (NNFI)	0.94	0.90-1.00
Comparative Fit Index (CFI)	0.95	0.90-1.00
Incremental Fit Index (IFI)	0.96	0.90-1.00
Critical N (CN)	438	Above sample size
Standardised Root Mean Square Residual (SRMR)	0.045	<0.08
Goodness of Fit Index (GFI)	0.96	0.90-1.00
Adjusted Goodness of Fit Index (AGFI)	0.94	0.90-1.00

Additional testing of the appropriateness of the model was achieved by comparing the estimated model with two other models that acted as alternative explanations to the proposed model, in a competing models strategy (we used a nested model approach, in which the number of constructs and indicators remained constant, but the number of estimated relationships changed). The results across all types of goodness-of-fit measures favoured the estimated model in most cases. Therefore, we confirmed the accuracy of the proposed model and discarded the competing ones.

An acceptable level of overall goodness-of-fit does not guarantee that all constructs meet the requirements for the measurement and structural models. The validity of the SEM was assessed in a two-step procedure, the measurement model and the structural model.

In the measurement model we tested the reliability of the single-indicator latent variables, namely we tested the 'theory-testing extremes' of reliability within the range of 0.7 to 1 (Ping, 2008) and determined that none of the structural coefficients became non-significant at these extremes. The reliability of the single-indicator latent variables was assumed the value of 0.99 for variables 'type', 'healplan', 'incomopn', with the corresponding loadings (square root of reliability value) of 0.99 on own indicators and standardised measurement error variance of 0.01.

After assessing the overall model and aspects of the measurement model, the standardised structural coefficients for both practical and theoretical implications were examined. Table 16

presents the standardised total effects between the latent variables in the model. All determinants, with the exception of 'hplan' were found to significantly influence 'wtp'.

Table 16. Standardised total (direct and indirect) effects (t-values in parentheses). The latent variable scores and observational residuals depend on the unit of measurement in the observed variables. As some of these units are the result of subjective scaling of the observed variables the observational residuals were standardised (rescaled such that they have zero means and unit standard deviations in the sample) (Jöreskog & Sörbom, 2007). Total effects represent how much a one unit change in an independent variable will change the expected value of a dependent variable.

Observed/ latent variables	Total effects on 'wtp' (direct and indirect effects)
type[11]	-0.18 (-2.42)
hplan	0.06 (1.29)
income	0.37 (2.55)
ginfo	0.12 (2.34)
effect	0.36 (2.14)
biosec	0.48 (2.09)
attd	0.08 (1.96)

3.5.2.2 Interpretation of SEM results

The model has a reasonably good level of prediction as it explains more than half (52%) of the variance in willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 is not present on own farm.

The highest (direct) influence is shown by the perceived practicality of specific bio-security measures on-farm (48% *ceteris paribus*). This suggests that farmers who perceive biosecurity measures to be practical/suited to the needs of their farms are more likely to show a stronger willingness to control *E. coli* O157.

The second strongest (direct) influence on behavioural willingness is the proportion of farm income dependent on opening to the public (37% *ceteris paribus*). This suggests that farmers whose income depends more on their opening their farms to the public are more likely to be willing to pay more money/time to control *E. coli* O157.

Third comes the perceived effect of reports/ experience/ incidents of *E. coli* O157 outbreaks or incidents on the way of managing business during the past five years, which influences behavioural willingness directly (36% *ceteris paribus*). This is again an expected result as farmers whose livestock

[11] The negative sign is related to the coding of the two variables, farm type (1 = dairy, 2 = beef) and wtp (0 = not willing, 1 = willing).

was affected by disease in the past or who know other farmers who were affected are more likely to do more to control disease.

Farm type has a significant influence (18% *ceteris paribus*) on behavioural willingness. This suggests that dairy farmers rather than beef farmers are more likely to show a stronger willingness to control *E. coli* O157. The influence on willingness is indirect through perceived effects on business of past *E. coli* O157 outbreaks, use of a Health Plan, and perceived practicality of biosecurity measures. This implies that dairy farmers rather than beef farmers are more likely to have perceived a stronger effect on business of *E. coli* O157 outbreaks; are more likely to use a Health Plan; and have stronger perceptions as regards practicality of biosecurity measures.

Access to information has a significant influence (12% *ceteris paribus*) on behavioural willingness indirectly through use of a Health Plan and proportion of farm income dependent on opening to the public. This suggests that more informed farmers are more likely to use of a Health Plan and have a higher proportion of their income from opening their farm to the public.

Attitudes towards use of control measures for *E. coli* O157 in cattle on-farm have a significant (8% *ceteris paribus*) indirect influence on willingness. The effect is intermediated by the perceived practicality of specific bio-security measures on-farm, which suggests that farmers with stronger attitudes as regards *E. coli* O157 control will have stronger perceptions of the practicality of biosecurity measures and, implicitly stronger willingness to control disease.

Use of a Health Plan has a lower (6% *ceteris paribus*) and not significant influence.

Besides the determinants included in this model, some other factors influence farmers' behavioural willingness and more research is needed, especially exploratory type of modelling, to identify more of these other influences.

The model suggests that farmers:

- with stronger biosecurity perceptions,
- whose income depends more on their opening their farms to the public,
- who are more likely to have been affected by past outbreaks,
- whose farms are dairy rather than beef,
- who are more informed and
- have stronger attitudes towards *E. coli* O157 control

will show a higher willingness to spend money and time to control *E. coli* O157.

This might imply that increasing access to information to all farmers and targeting more specifically dairy farmers, farmers who open their farms to public and farmers affected by past outbreaks might lead to stronger biosecurity perceptions and attitudes and, subsequently, to higher willingness to control disease. The fact that perceived practicality of biosecurity measures was found to have the strongest effect on behavioural willingness might suggest that not only increasing access to information, but providing information on control measures to suit the specific circumstances of farms is needed.

Next we present results of the regression analysis undertaken to identify factors influencing specific *E. coli* O157 control measures (*i.e.*, vaccine and additives).

3.5.2.3 Binary logistic regression results

a) Willingness to use vaccination

Binary logistic regression was undertaken to determine which factors influence willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle. The models were estimated for the total sample and for three of the regional samples[12]. The variables are described in Table 17 and regression results are presented in Table 18.

The independent variables with a significant influence in the 'total sample' model are:

- willingness to pay (money per animal per year) to ensure that *E. coli* O157 is not present on-farm;
- willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal;
- proportion of farm income dependent on opening to the public;
- frequency of access to information from government (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government);
- attitudes towards use of control measures for *E. coli* O157 in cattle on-farm.

Similar significant influences were found in the England model, while Scotland model shows a lower number of significant determinants and Wales shows the added influences of perceived practicality of biosecurity measures and perceived effect on business of past outbreaks.

The 'total sample' model predicts a third (33%) of the variance in willingness to use vaccination. The regional models explain more than a third of the variance (37% in Scotland, 38% in England and 40% in Wales).

b) Willingness to use additives

Binary logistic regression was undertaken to determine which factors influence willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal. The models were estimated for the total sample and for three of the regional samples[13]. The variables are described in Table 17 and regression results are presented in Table 18.

The independent variables with a significant influence in the 'total sample' model are:

- willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle;
- perceived practicality of disinfecting the animal sheds/pens weekly on own farm;
- frequency of access to information from agricultural consultants.

[12] The samples analysed were England, Scotland and Wales. The Northern Ireland sample size was too small. As the samples are not representative at regional level (the representativity is valid for the total sample and industry type – beef and dairy), the regression results for the regional models should be interpreted with caution.

[13] The samples analysed were England, Scotland and Wales. The Northern Ireland sample size was too small. As the samples are not representative at regional level (the representativity is valid for the total sample and industry type – beef and dairy), the regression results for the regional models should be interpreted with caution.

Similar significant influences were found in the Wales model, while Scotland model shows a lower number of significant determinants and England shows the added influence of proportion of farm income dependent on opening to the public.

The 'total sample' model predicts a quarter (26%) of the variance in willingness to use additives. The regional models explain between a quarter and half of the variance (27% in England, 38% in Scotland and 52% in Wales).

The regression models included 'dairy' and 'beef' variables (dairy cattle and, respectively, beef cattle farms by size), which were not found significant, so were excluded during previous iterations. This confirms the results of the SEM model, namely that the farm type (dairy/beef) will not directly influence farmers' willingness to pay (money/time/vaccine/additive) but indirectly (through perceived effects on business of *E. coli* O157 outbreaks and perceived practicality of biosecurity measures).

Table 17. Descriptive statistics (mean and standard deviation) for the variables included in regression models.

	Total sample		England		Wales		Scotland	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Beef cattle farm by size					3.61	2.118		
proportion of farm income dependent on opening to the public	1.06	.271	1.09	.329				
source of general information for managing the farm: other farmers					1.72	.520		
source of general information for managing the farm: government (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	1.15	.749	1.12	.717				
source of general information for managing the farm: agricultural consultants	.84	.763	.93	.764	.69	.770		
perceived effect of reports of E. coli O157 outbreaks or incidents on the way of managing business during the past five years					1.11	.334		
perceived practicality of keeping bedding dry and replacing contaminated/wet bedding on a daily basis on own farm					3.63	1.500		
perceived practicality of reducing current livestock numbers kept in cattle sheds on own farm			2.83	1.589	2.74	1.562		
perceived practicality of disinfecting the animal sheds/pens weekly on own farm	2.11	1.324			2.12	1.371		
perceived practicality of applying slaked lime to animal bedding every 3 weeks on own farm					3.13	1.584		
If you used control measures for E. coli O157 in cattle on farm the price for your produce might increase	2.56	1.418						
willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	.59	.493	.59	.494	.55	.499	.59	.494
willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	.40	.489	.36	.482	.43	.497	.39	.489
willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	2.49	1.204	2.38	1.172			2.44	1.330
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm					2.80	1.469		
Valid N (listwise)	405		147		123		101	

Table 18. Regression models results.

	Total sample			England			Wales			Scotland		
	Wald	Sig.	Exp(B)	Wald	Sig.	Exp(B)	Wald	Sig.	Exp(B)	Wald	Sig.	Exp(B)
	willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle											
proportion of farm income dependent on opening to the public	4.125	.042	.415	4.348	.037	.265						
source of general information for managing the farm: government	8.218	.004	1.572	7.284	.007	2.268						
source of general information for managing the farm: agricultural consultants				4.299	.038	.542						
perceived effect of reports of E. coli O157 outbreaks/incidents on business during past 5 years							4.807	.028	6.743			
perceived practicality of reducing current livestock numbers kept in cattle sheds on-farm							9.598	.002	1.654			
perceived practicality of applying slaked lime to animal bedding every 3 weeks on-farm							4.156	.041	.710			
If you used control measures for E. coli O157 the price for your produce might increase	3.836	.050	1.179									
willingness to use additives	51.122	.000	6.689	19.612	.000	9.061	16.214	.000	6.890	13.987	.000	9.597
willingness to pay (money per animal per year) to control E. coli O157	25.268	.000	1.695	18.813	.000	2.288				4.748	.029	1.548
willingness to pay (time spent in controlling it) to control E. coli O157							8.177	.004	1.632			
Valid N (listwise)		405			147			123			101	
Nagelkerke R Square		33%			38%			40%			37%	
	willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal											
Beef cattle farm by size							6.791	.009	.722			
proportion of farm income dependent on opening to the public				5.233	.022	4.396						
source of general information for managing the farm: other farmers							12.870	.000	.128			
source of general information for managing the farm: government				3.979	.046	.563						
source of general information for managing the farm: agricultural consultants	5.294	.021	1.414				7.889	.005	2.598			
perceived practicality of keeping bedding dry & replacing contaminated/wet bedding daily							3.828	.050	.700			
perceived practicality of reducing current livestock numbers kept in cattle sheds on-farm				5.480	.019	1.343						
perceived practicality of disinfecting the animal sheds/pens weekly on-farm	11.540	.001	1.338				13.054	.000	2.094			
willingness to use vaccine	55.770	.000	6.608	17.841	.000	6.770	17.025	.000	9.627	13.439	.000	9.260
willingness to pay (money per animal per year) to control E. coli O157										5.643	.018	1.628
Valid N (listwise)		405			147			123			101	
Nagelkerke R Square		26%			27%			52%			38%	

3.5.3 Statistical analysis of data collected through the online survey

From the 91 completed questionnaires received from farmers who open their farms to the public, two were discarded as containing a very low number of valid answers. We analysed the remaining 89 responses. Detailed results of the statistical analysis are presented in Appendix A2. Here we briefly present some statistics for the total sample.

3.5.3.1 Demographics

As regards gender distribution, the sample consisted of 58% male farmers and 42% female farmers. Age distribution showed 52% of farmers under 50 years old, 40% between 51-65 years old and 8% over 65 years old. With respect to farm holding, 57% of farmers owned their farms, 14% were partly tenants/partly owners, 13% were tenants and 16% were employees. As regards educational level, 13% of farmers finished school, 34% finished college and 53% finished university. As regards labour, 68% had up to 3 full time people working on the farm, with 21% having between 4-10 full time people working on the farm. The majority (67%) hired 1-3 part time labour, with 20% hiring more than three part time workers. About two thirds of farmers (62%) used an animal health plan. 82% of farmers had an identified person who acted as safety officer on-farm. 55% of farmers had provided training in public safety to their staff. About a quarter (27%) of farmers sold agricultural products produced to standards specified by supermarkets.

As regards income (Figure 19), 13% of farmers had half or more of their income dependent on opening to the public.

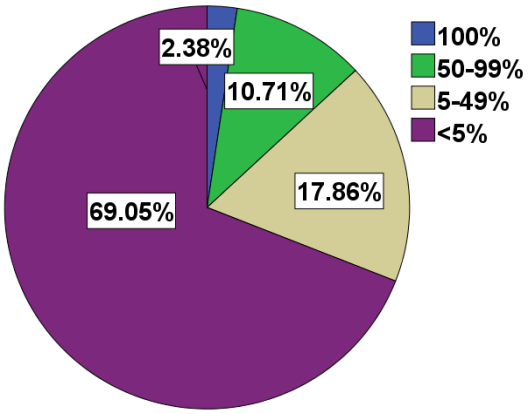

Figure 19. Proportion of income from opening to the public in total farm income

3.5.3.2 Characteristics of farms opening to the public

Farmers were asked questions about the services provided to visitors, such as access to animals, access to land, and facilities in the past 12 months[14].

[14] The average number of missing values for this group of questions was 9 (10% of the sample). The descriptive statistics (frequencies) are based on actual answers.

As regards access to land:

- 87.0% of the farmers who answered the questions opened their farm on LEAF open days;
- 75% of farmers had land which includes public footpaths;
- 17.9% of farmers had land which includes ground for camping, caravanning;
- 17.1% of farmers had land which includes fixed holiday accommodation;

As regards access to animals:

- 50.6% of farmers allowed visits by school groups of children to touch the animals;
- 81% of farmers allowed visits by school groups of children to see the animals;
- 13.3% of farmers allowed children <10 years old into the pens with ruminant animals;
- 26.9% of farmers allowed children <10 years old to bottle feed lambs;
- 66.7% of farmers ensured that public to animal contact areas were supervised continually by staff;
- 34.2% of farmers had double fencing to separate the animals from all picnic/lunch areas;

As regards facilities for visitors:

- 69.9% of farmers had signs warning visitors of health hazards from animal infections;
- 69.6% of farmers had hot water hand-washing facilities for visitors throughout the farm;
- 86.8% of farmers had cold/hot water hand-washing facilities for visitors throughout the farm;
- 28.9% of farmers had a water source(s) on own land used for private water supply to a house(s);
- 6.1% of farmers provided protective overshoes for all visitors;
- 32.1% of farmers provided disinfectant footbaths at entrances to pens;
- 36.9 of farmers ran a farm produce shop from the premises;

Additionally:

- 30.5% of farmers had a safety consultant;
- 36.6% of farmers had their premises known to the local authority as an Open Farm;
- 62.1% of farmers considered the revised AIS23 to be an improvement on the advice available in 2010.

3.5.3.3 Knowledge

As regards *E. coli* O157 awareness, 7% of the farmers who answered the question[15] had not heard of *E. coli* O157 before they took part in the survey.

Approximately an eighth (12%) of the farmers who answered the questions[16] did not agree or were unaware that *E. coli* O157 causes disease in people and some respondents demonstrated a lack of awareness with regard to the different potential means of *E. coli* O157 transmission (Figure 20a-g), although levels of awareness were higher in these respondents than those recorded for the beef and dairy farmers. A seventh (14%) of farmers either did not agree or did not know that livestock are an important source from which *E. coli* O157 spreads, and 15% did not agree/did not know that people touching calves/cows could potentially become infected with *E. coli* O157. Approximately a quarter (23%) did not agree/did not know that *E. coli* O157 could contaminate produce such as lettuce, apples, spinach and about a third (32%) did not agree/did not know that *E. coli* O157 could contaminate rural drinking water. Additionally, almost a third (30%) of farmers did not agree/did not

[15] The average number of missing values for this group of questions was 20 (22% of the sample).
[16] The average number of missing values for this group of questions was 12 (13% of the sample). The graphs show the statistics based on actual answers.

know that *E. coli* O157 can be present in raw milk. Interestingly, 8% of open farmers did not know that *E. coli* O157 could be present on raw meat, compared with 14% of the beef and dairy farmers surveyed (Figure 10).

While the level of knowledge on *E. coli* O157 is higher than that observed in the survey of beef and dairy farms, the figures still raise concern over a lack of awareness with regard to the risks associated with *E. coli* O157 and might imply that not all farmers who open their farms to the public recognise the importance of controls to prevent cross-contamination.

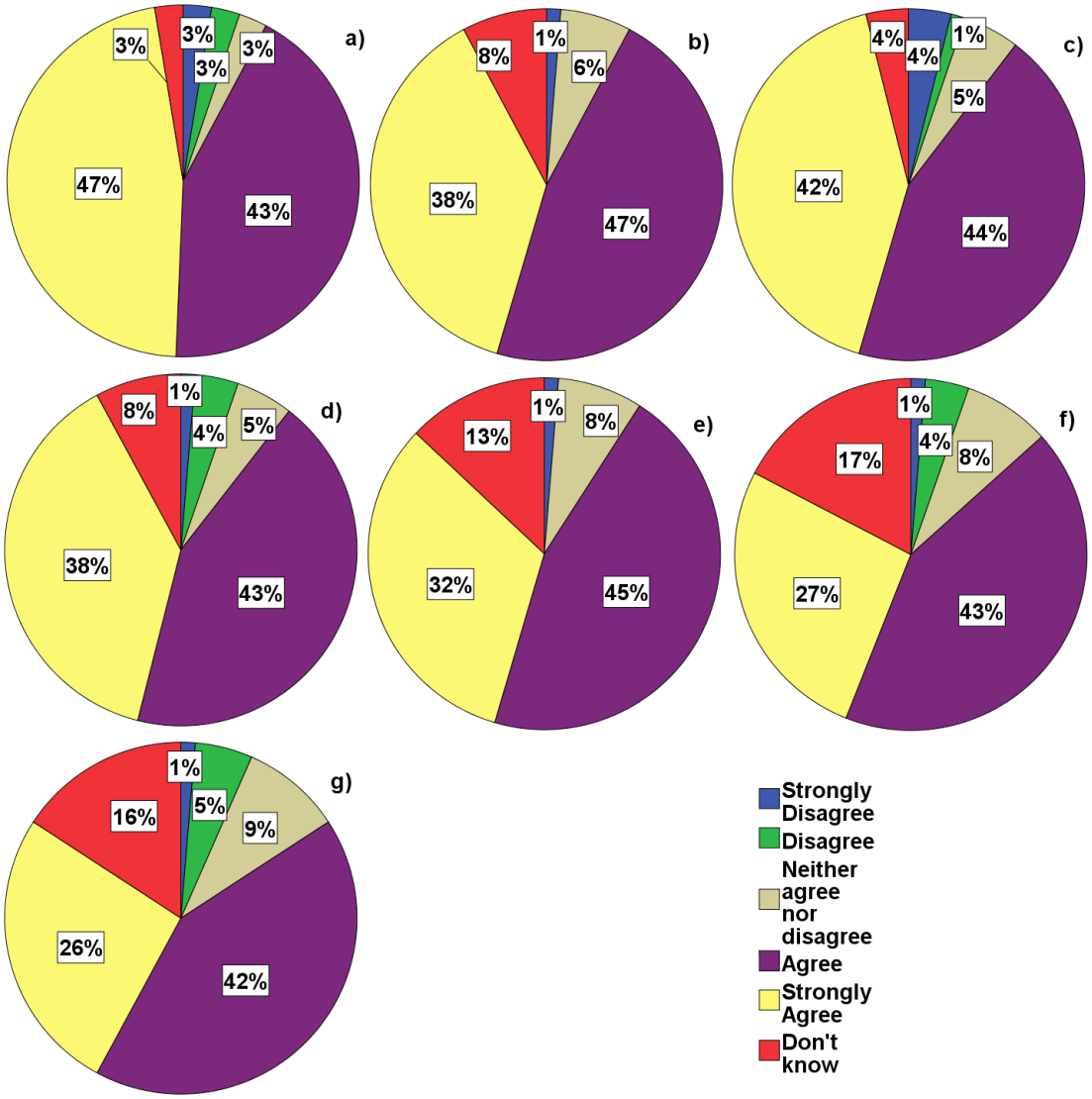

Figure 20. Knowledge about *E. coli* O157. a). E. coli O157 causes disease in people; b). People touching calves/cows may become infected with *E. coli* O157; c). Livestock are an important source from which *E. coli* O157 spreads; d). *E. coli* O157 can be present on raw meat; e). *E. coli* O157 may contaminate produce such as lettuce, apples, spinach; f). *E. coli* O157 can be present in raw milk; g). E. coli O157 may contaminate rural drinking water.

3.5.3.4 Benefits of and responsibility for controlling E. coli O157 on-farms

As regards perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle, a low majority (50%) of farmers who answered the question[17] thought that all would benefit; 44% that the public would benefit; about a third (31%) that farmers would benefit; about a fifth (21%) that food retailers would benefit; about a sixth (14%) think that meat/milk processors would benefit; and a lower proportion (7%) thought that government would benefit (Figure 21).

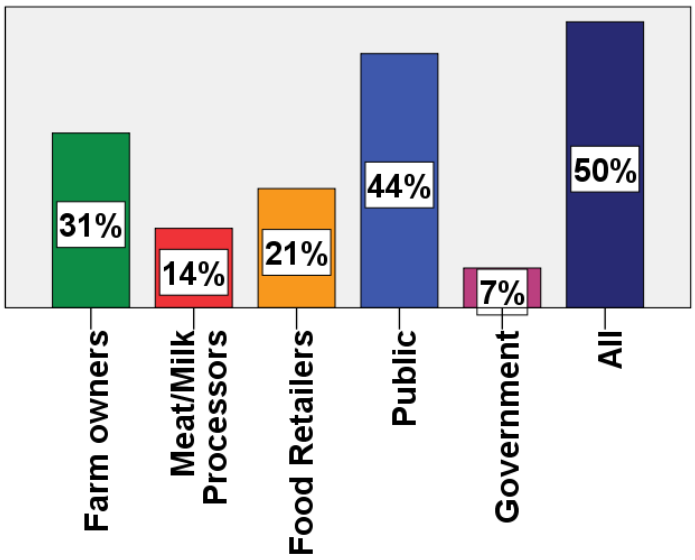

Figure 21. Perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle

There is a significant correlation between farmers' perceptions about who benefits from on-farm controls to reduce *E. coli* O157 in cattle and their attitudes towards potential benefits/losses due to the use/lack of *E. coli* O157 control. This might imply that farmers who perceive themselves (together with all others involved) as beneficiaries of *E. coli* O157 control are more likely to have stronger attitudes towards *E. coli* O157 control.

A high majority (90%) of farmers agreed/strongly agreed that for them it was very important that they, together with other UK livestock owners, take action to control the infections in animals that may affect humans. 41% of farmers agreed/strongly agreed that using control measures for *E. coli* O157 in cattle on-farm would enhance their reputation with consumers/customers. 20% of farmers agreed/strongly agreed that using control measures for *E. coli* O157 in cattle on-farm might lead to an increase in the number of visitors.

A high majority (83%) of farmers agreed/strongly agreed that their business would be adversely affected if *E. coli* O157 infection in a person was linked to their farm. 40% of farmers agreed/strongly agreed that farms open to the public posed a greater risk to human health than farms that do not welcome visitors. Half (47%) of farmers agreed/strongly agreed that if they did not use control measures for *E. coli* O157 in cattle on-farm, they might get sued in the courts.

About a quarter of farmers (26%) agreed that *E. coli* O157 might be present in cattle on their farm, with 6% of them strongly agreeing about it. This figure is higher than that observed for the dairy and

[17] The average number of missing values for this group of questions was 17 (19% of the sample). The graphs show the statistics based on actual answers.

beef farms, however the same caveat as regards the representiveness of the sample for farms open to the public applies.

As regards perceived responsibility for controlling *E. coli* O157 on farms, a high majority of the farmers who answered the question[18] state that responsibility remains with them (76%), however about a quarter of farmers (23%) state that all should share responsibility, about a fifth of farmers (18%) consider that the government is responsible, and lower proportions (9% and 4%) state that processors and, respectively, retailers are responsible for the control of *E. coli* O157 on farms (Figure 22).

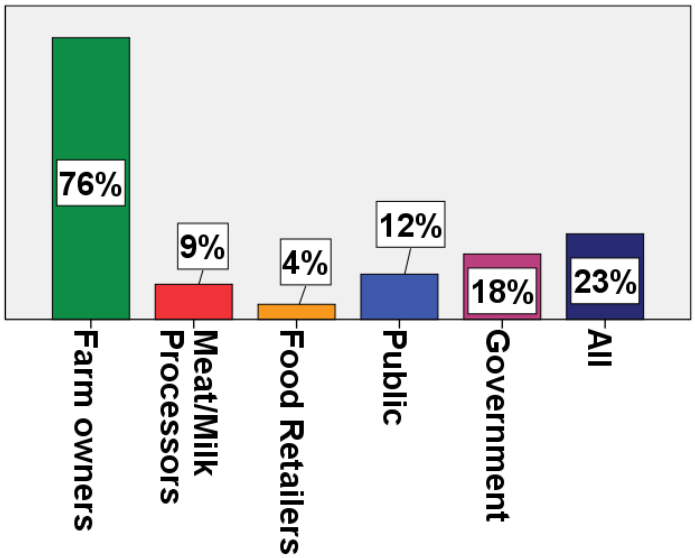

Figure 22. Perceived responsibility for controlling *E. coli* O157 on farms

3.5.3.5 Sources of information on *E. coli* O157

As regards sources of useful information on *E. coli* O157, a high majority (77%) of the farmers who answered the question[19] stated media, followed by government (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government) (59%), industry organisations (55%), veterinary surgeons (42%), and internet (42%), open days/farm demonstrations (32%), other farmers (31%) and agricultural consultants (17%) (Figure 23).

[18] The average number of missing values for this group of questions was 15 (17% of the sample). The graphs show the statistics based on actual answers.

[19] The average number of missing values for this group of questions was 18 (20% of the sample). The graphs show the statistics based on actual answers. The percentages relate only to those farmers who had heard of *E. coli* O157 prior to the survey.

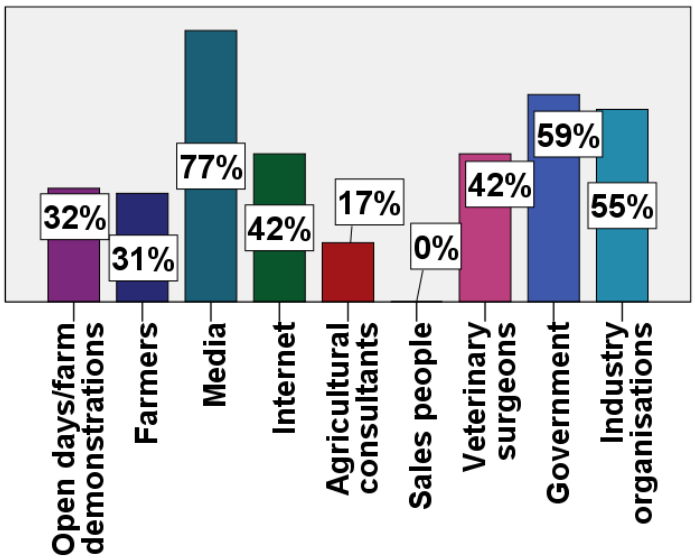

Figure 23. Sources of useful information on *E. coli* O157

3.5.3.6 E. coli O157 control

This section relates to farmers' willingness/ability to implement a control on farm. Based on the review of scientific literature, three main types of *E. coli* O157 control have been identified, namely vaccination, additives in feed or water, and more general biosecurity measures. Farmers were asked whether they were willing to use vaccination and additives and about the practicality of applying biosecurity measures to control *E. coli* O157 on their farms.

a) Vaccination

Whilst 41% of farmers said they would be willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to 3-18 months old cattle, about 59% of the farmers who answered the question[20] would currently be unwilling to use a vaccine treatment. Thus a higher percentage of these farmers surveyed on-line than observed for beef and dairy farms expressed an unwillingness to vaccinate, however, it is not clear how representative this sample is to the open farm sector in the UK.

Of the farmers who answered[21] reasons for not being willing to use a vaccine treatment included lack of information about vaccination (89%), the cost being too expensive (47%), and that it would take too much time to administer (28%). However, 75% of them said that they would be encouraged to use vaccination if it was part of a national program to benefit the reputation of the industry, while 40% of them said that they would be encouraged to use vaccination if it was used by other farmers (Figure 24).

[20] The average number of missing values for this group of questions was 21 (24% of the sample).
[21] The average number of missing values for this group of questions was 43 (48% of the sample). The graphs show the statistics based on actual answers.

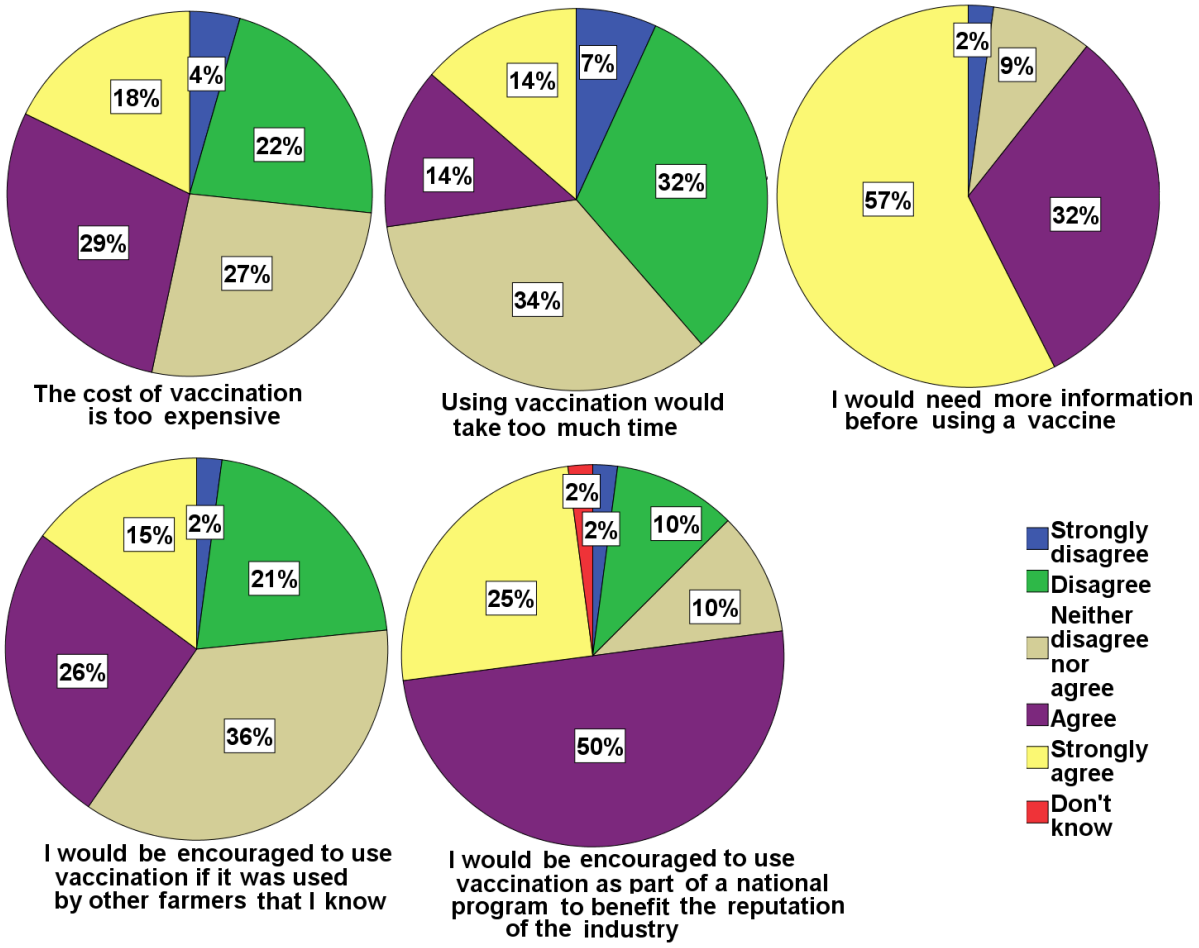

Figure 24. Reasons for not being willing/incentives to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle

Farmers were given the opportunity to state other reasons for not being willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle.

Many farmers gave cost benefit related answers, such as 'The margins in farming are so tight, for example we keep a beef animal for a year and the gross margin may only be 50-75 pounds. You're asking the farmer to give up 10% just for one vaccine. I think it will be difficult convincing any business minded farmer. Also, farmers will not see any benefit, only the retailers who will use this as a marketing tool. Sorry to put a dampener on it!' or

'We currently use over 8 vaccines at a serious cost to our business. £5 a vaccine is too much. My most expensive vaccine is £10 a head but if I don't use it, I can guarantee that a couple of my cows will die and general growth will suffer so there is a financial loss. This is not the case with *E. coli*. If I had an open farm that was open to the public all the time, maybe it is worth it, but for a farm that is a normal farm I don't see that I should have to cough up a couple of grand per year to protect the public when I open the farm for 2-3 days per year free of charge' or

'I would be willing to use on animals in contact with the visitors. All other animals would have to attract a market premium to even consider the use'.

Other farmers were not convinced that vaccination is the best control measure *'E. coli* can be picked up at any time from soil, transmitted by wild birds other animals etc. I think robust control measures all the time are better than vaccination which may cause people to assume that animals are safe and not be so good at the daily control measures needed to prevent public infection, needs to be every day not rely on just vaccination' or

'vaccines are a licence to mutation. Just as anti-bacterial washes encourage mutation of live organisms which survive. This has been shown over and over again throughout medical history in both humans and animals, hence: Measles A,B... Hepatitis A B C ..., *E. coli* xxxx, and storm outbreaks of clostridial disease in sheep given Heptavac over many years. Orf lives in the soil indeterminately as a result of fallen scabs after vaccination. Far more to the point to build flock/herd health through other means e.g. minerals, herbs, homoeopathic preparations. Finally there is recognition that prolonged use of antibiotics is counter-productive' or

'this whole thing is based on the false impression that we can kill off things that we don't like. Looking at the escalation of natural problems (resistant worms, increase in cancer, bird/pig/etc flu, general ill health, etc.) does this really sound plausible any more, or is it just better for your grants and the drug industry this way? How about promoting health rather than trying to kill off things? How much more foolish interference will it take before something really bad happens'.

Some comments were information/advice related, such as 'need more information, what about animals under 3 months not covered', 'need to know it would work and there was some benefit for my business or at least the industry as a whole'.

Some farmers stated they would be willing to vaccinate only as answer to clear evidence of disease, such as 'I would have to have some evidence to show that there was any *E. coli* on my farm'.

Some comments were regulation / responsibility driven answers related, such as 'I would consider vaccination but anyone developing *E. coli* O157 after a visit to us, may have come into contact with it from a stile or from footwear after they have left our farm. Therefore it needs to be a national scheme'.

Many farmers stated that it would need to be done in coordination with other vaccines, 'We already carry out multiple vaccinations for herd health on our dairy herd and it is already difficult to get young stock through a vaccination programme and out grazing soon enough (autumn calving herd) and every additional vaccination is additional handling and stress as many cannot be given at the same time', 'I am keen to minimise the number of unnecessary injections/treatments for my livestock'.

Some farmers mentioned implementation difficulties 'getting suckler calves in twice to be vaccinated would be tricky'.

Others were farm type related comments, such as 'I would like an affordable testing programme first to identify on-farm risk and then employ a vaccination programme tailored to the farm. As organic farmers we need to justify the use of vaccination to our certification body and would only be able to do this if there was a known or strong risk and we were advised to vaccinate by our vet' or 'I have no cattle'.

Some farmers mention this in relation to their customers, namely 'if it would make the public buy British this would be fine but in reality they will buy the cheapest meat. We have no cattle so this

doesn't apply to us - I have answered it as if we had to vaccinate the cattle we brought in for the day'.

Others were comments regarding perceived significance of disease, 'I do not accept at the moment that the scale and problem of *E. coli* O157 requires this level of intervention especially when set in the context of other recent animal disease outbreaks/issues'.

b) Additives

Approximately 25% of farmers in this group said they would be willing to use a treatment such as additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal. However, about 75% of the farmers who answered the question[22] would currently be unwilling to use additives.

For the majority of the farmers (92%) who answered[23] that they would be unwilling to use additives, one of the reasons was lack of information about this measure, 73% of them mentioned cost (too expensive) and more than a third (39%) said that it would take too much time. However, 61% of them said that they would be encouraged to use additives if this was part of a national program to benefit the reputation of the industry, while 38% of them said that they would be encouraged to use additives if they were used by other farmers (Figure 25).

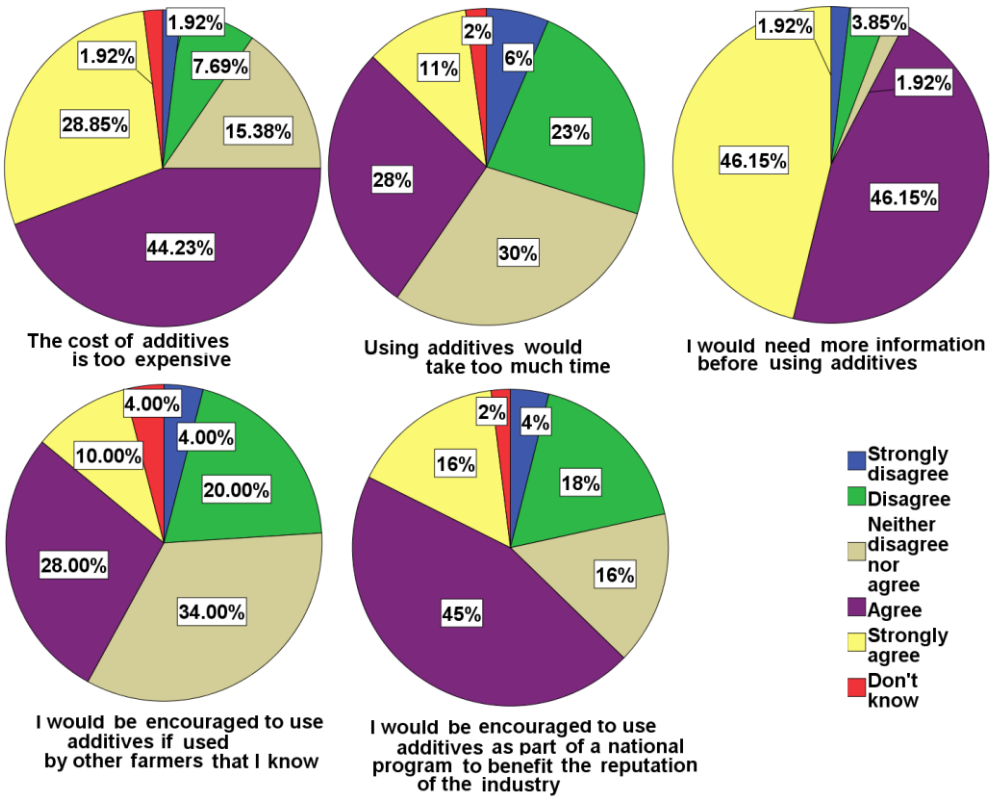

Figure 25. Reasons for not being willing/incentives to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal

[22] The average number of missing values for this group of questions was 21 (24% of the sample).
[23] The average number of missing values for this group of questions was 39 (44% of the sample). The graphs show the statistics based on actual answers.

Farmers were given the opportunity to state other reasons for not being willing to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal.

Many farmers mentioned implementation difficulties, 'this does not say if it is just for young stock, but once 18 months old, our young stock are grazing only without supplementation and they are not drinking from a trough so we would not be able to get it to them without a great deal of extra work' or 'would this work if livestock had access to streams etc.' or 'I would have problems using an additive since my cattle only eat grass and ad-lib silage' or 'impossible to do on a extensive unit with no troughs' or 'unsure if it would work on each animal the same/get correct dose'.

Some gave cost benefit related answers, such as 'for dairy farmers the cost is frightening' or 'there only is around £50 in an animal for the farmer that's 30% of the margin before fixed costs. Education and cleanliness and separation is probably the only viable way' or 'I would be willing to spend £15 per animal in cattle. Sheep though are not very valuable and £15 per animal would be too expensive' or 'I would consider using additives if there was another benefit for me. Sorry to be selfish but have to make the cows pay somehow!'.

Other farmers were not convinced that additives would be the best control measure, 'public contact is not the prime reason for us keeping animals. Just because you take steps to eliminate one disease, doesn't mean another won't then predominate. Good hygiene and awareness of infection risks are better solutions'.

Some comments were information/advice related, such as 'what do you mean by additives'.

Many farmers stated they would be willing to use additives only as answer to clear evidence of disease, such as 'must not use additives prophylactically... need to prove disease is present before undertaking such a program'.

Others were farm type related comments, such as 'as an organic farm, this would have to be cleared with the Soil Association as routine antibiotics are not allowed. I would also be very unhappy about prophylactic use of antibiotics for instance without knowing IF there was an infection on-farm due to the potential for encouraging resistance of the *E. coli*' or 'I have no cattle'.

c) Biosecurity

In addition to the two aforementioned specific control measures (vaccine and additives), farmers were asked to state their willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 was not present on own farm.

While 43% of the farmers would be willing to pay £1 to £5 and a quarter of farmers (25%) more than £5 per animal per year to ensure that *E. coli* O157 was not present on own farm, 9% of farmers would not spend any money. Only 6% of farmers answered that they would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth (18%) said they would not spend more than one day per year and about a twelfth (8%) of farmers answered that they would not be willing to spend any time at all (Figure 26).

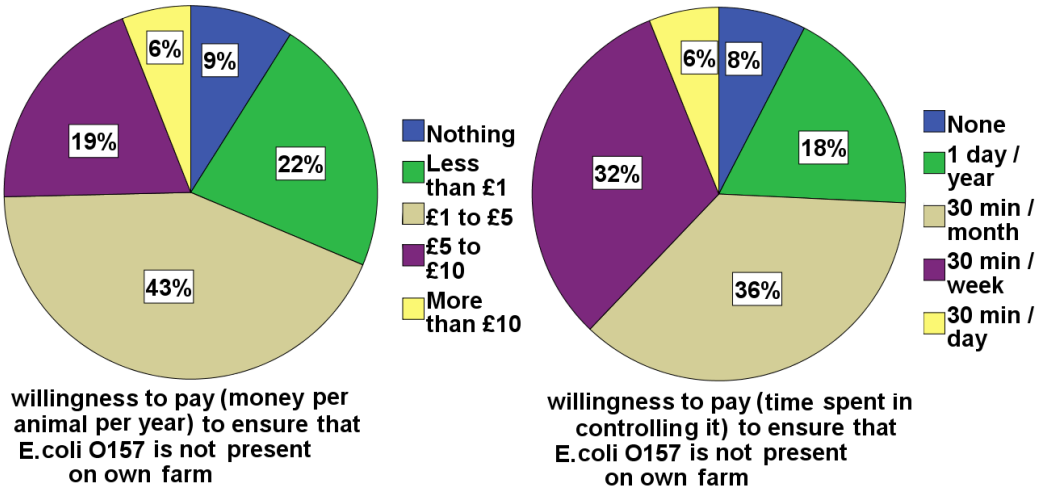

Figure 26. Willingness to pay (money or time per animal per year) to ensure that E. coli O157 is not present on own farm

Additionally, farmers were asked about the practicality of specific biosecurity measures (Figure 27). The majority of farmers who answered this group of questions[24] found as practical/very practical the following measures: quarantine and testing of livestock brought to the farm (60%) and keeping bedding dry and replacing contaminated/wet bedding on a daily basis (53%). Almost half (48%) of farmers found practical/very practical separating animals into different age groups for the majority of the time. Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were both found to be not at all practical by 52% of farmers.

[24] The average number of missing values for this group of questions was 29 (33% of the sample). The graphs show the statistics based on actual answers.

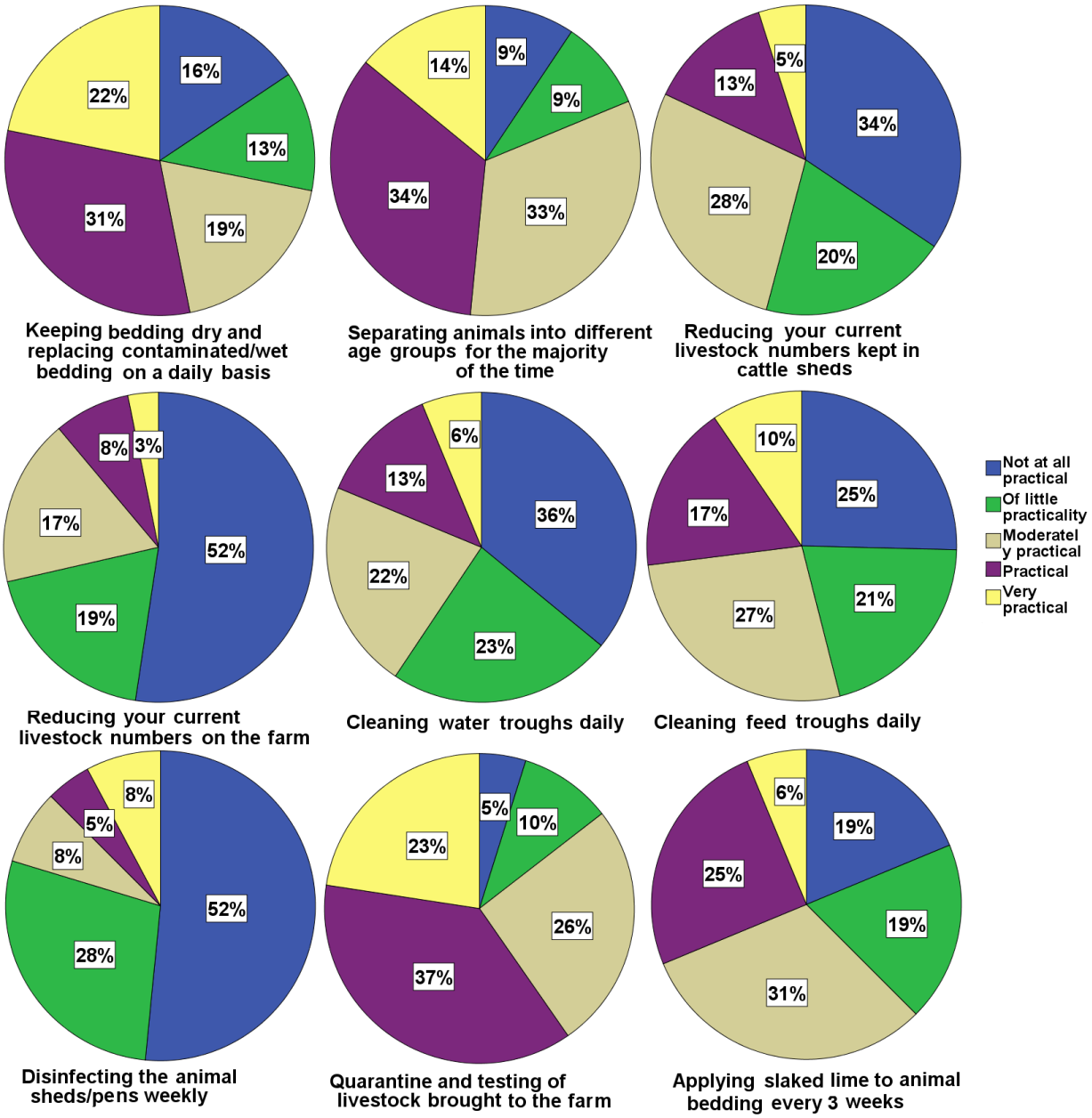

Figure 27. Farmers' perceptions about the practicality of specific biosecurity measures

3.5.4 Econometric analysis of data collected through the online survey

Due to the small sample size it was not possible to use structural equation modelling to analyse the data. Instead a regression analysis was undertaken to identify factors influencing specific *E. coli* O157 control measures (*i.e.*, vaccine and additives). As mentioned in the description of the online survey data, this is not a representative sample of farms which open to the public, and results should be interpreted with caution.

A binary logistic regression was run to determine which factors influence willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle. The independent variables with a significant influence are: farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets; source of general information for managing the farm: internet; farm livestock accessible to public in

the past 12 months; perceived effect of experience of *E. coli* O157 outbreaks or incidents on the way of managing business during the past five years. The total variance explained is 40%. The variables are described in Table 19 and regression results are presented in Table 20.

A binary logistic regression was run to determine which factors influence willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal. The independent variables with a significant influence are: farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets; source of general information for managing the farm: internet; farm livestock accessible to public in the past 12 months. The total variance explained is 39%. The variables are described in Table 19 and regression results are presented in Table 20.

Table 19. Descriptive statistics (mean and standard deviation) for the variables included in regression models.

	Mean	Std. Deviation
farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	1.73	.445
farm livestock accessible to public in the past 12 months[a]	.00	1.000
source of general information for managing the farm: internet	1.51	.611
perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years	1.25	.547
willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	1.59	.496
willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	1.76	.427
Valid N (listwise)	61	

[a] Factor built on four indicators ('visits by school groups of children to touch the animals'; 'visits by school groups of children to see the animals'; 'hot water hand-washing facilities for visitors throughout the farm'; 'proportion of farm income dependent on opening to the public').

Table 20. Regression models results.

	willingness to use vaccine		
	Wald	Sig.	Exp(B)
farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	7.3196	.0068	8.7069
farm livestock accessible to public in the past 12 months	7.1097	.0077	3.0539
source of general information for managing the farm: internet	4.8814	.0271	3.4916
perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years	3.8530	.0497	.3292
Valid N (listwise)		61	
Nagelkerke R Square		40%	
	willingness to use additives		
farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	4.2014	.0404	5.7379
farm livestock accessible to public in the past 12 months	6.3597	.0117	4.5079
source of general information for managing the farm: internet	4.8287	.0280	4.7150
perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years	1.1368	.2863	.5032
Valid N (listwise)		61	
Nagelkerke R Square		39%	

3.6 Summary and Conclusions

The study analysed the impact of *a priori* determinants of adoption of *E. coli* O157 control measures by cattle farmers in the UK. We used two datasets collected through a stratified telephone survey of 405 cattle farmers and an online survey of 91 farmers that deliberately open their farms to the public in the UK. We used a structural equation model with observed and latent variables and binary logistic regression to test the influence of *a priori* identified determinants on behavioural intentions towards *E. coli* O157 control.

The literature on farmers' attitudes and behaviour towards control measures of *E. coli* O157 is currently limited. The results of this study will contribute to the existing evidence and will potentially assist policy makers in finding means of behavioural change.

As regards knowledge about *E. coli* O157 impacts on human health, the majority of 'standard' (not open) farmers are aware of *E. coli* O157 causing disease in people, that people touching calves/cows may become infected with *E. coli* O157, that livestock are an important source from which *E. coli* O157 spreads and that *E. coli* O157 can be present on raw meat, in raw milk and can contaminate produce such as lettuce, apples, spinach or rural drinking water. The awareness is stronger in the open farms sample[25]. However, around fifth of 'standard' farmers and a tenth of farmers who open their farms to the public either do not agree or do not know that *E. coli* O157 causes disease in people. The surveys also identified a number of farmers within both groups that demonstrated a lack of awareness of the different potential means of *E. coli* O157 transmission, which might imply that not all farmers implement the necessary controls to prevent cross-contamination.

As regards perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle, the majority of 'standard' and open farmers answered that all (farmers, processors, retailers, public and government) would benefit, however the proportions vary between the two categories when it comes to the perceived benefits for the public or farmers.

As regards perceived responsibility for controlling *E. coli* O157 on farms, the majority of 'standard' and open farmers stated that responsibility remains with them (with a higher proportion amongst the latter), however a fifth and, respectively, a quarter of farmers stated that all should share responsibility and a tenth and, respectively, a fifth of farmers considered that the government should be responsible for the control of *E. coli* O157 on-farms.

As regards sources of useful information on *E. coli* O157, most 'standard' and open farmers (with a higher proportion of the latter) stated media, followed by veterinary surgeons, government, other farmers, industry organisations and internet (different proportions and ranking between 'standard' and open farmers).

Whilst nearly 60% of 'standard' farmers said they would be willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to 3-18 months old cattle, about 40% would currently be unwilling to use a vaccine treatment. For the majority of these farmers one of the reasons was lack of information about vaccination, for two thirds of them the

[25] We compare the results of the representative telephone survey with the results of the non-representative online survey, however due to non-representativity of the open farms sample, the comparisons should be treated with caution.

cost was too expensive, whilst half of them said that it would take too much time to administer. However, a low majority said that they would be encouraged to use vaccination if it was part of a national program to benefit the reputation of the industry, while less than half said that they would be encouraged to use vaccination if it was used by other farmers. Additional reasons given by farmers were the need for clear evidence of disease, regulation related ('if it was obligatory') and practical difficulties relating to the implementation of the vaccine.

Whilst 41% of open farmers said they would be willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to 3-18 months old cattle, about 59% of them would currently be unwilling to use a vaccine treatment. This means that of the farmers that are known to open their premises to the public a higher proportion would currently be unwilling to use a vaccine treatment than observed for beef and dairy farms[26]. Similar to the 'standard' farmers, the majority of open farmers stated that one of the reasons for this unwillingness was lack of information about vaccination. For almost half of them the cost was too expensive, whilst about half of them also said that it would take too much time to administer. However, three quarters of them said that they would be encouraged to use vaccination if it was part of a national program to benefit the reputation of the industry, while two fifths said that they would be encouraged to use vaccination if it was used by other farmers. Additional reasons given by farmers were need for clear evidence of disease, need to know that vaccination is the best control measure, regulation related ('if it was obligatory'), implementation practical difficulties and perceived significance of disease.

Whilst about 40% of 'standard' farmers said they would be willing to use a treatment such as additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal, about 60% would currently be unwilling to use additives. For a high majority of these farmers one of the reasons was lack of information about this measure, four fifths of them mentioned cost (too expensive) and half of them said that it would take too much time. However, three fifths said that they would be encouraged to use additives if this was part of a national program to benefit the reputation of the industry, while two fifths said that they would be encouraged to use additives if they were used by other farmers. Similar additional reasons as those given for vaccination were stated here.

Approximately 25% of open farmers said they would be willing to use a treatment such as additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal, and about 75% of farmers would currently be unwilling to use additives. This figure is higher than that observed for beef and dairy farms (same caveat applies). For a high majority of the farmers one of the reasons was lack of information about this measure, three quarters of them mentioned cost (too expensive) and more than a third said that it would take too much time. However, three fifths said that they would be encouraged to use additives if this was part of a national program to benefit the reputation of the industry, while two fifths said that they would be encouraged to use additives if they were used by other farmers. Similar additional reasons as those given for vaccination were stated here.

As regards willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 was not present on their own farm, while almost half of the 'standard' farmers would be willing to pay £1

[26] However, as previously mentioned, we do not claim representativity of the sample of farmers who open their farms to the public.

to £5 and a seventh of farmers more than £5, almost a sixth of farmers would not spend any money. A tenth of farmers would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth would not spend more than one day per year and about an eighth of farmers would not be willing to spend any time at all. As regards their willingness to pay money per animal per year to ensure that *E. coli* O157 was not present on own farm, a higher proportion (52%) of dairy farmers are willing to pay £1 to £5 as compared to beef farmers (45%), while a lower proportion (13%) of dairy farmers are not willing to pay any money as compared to beef farmers (18%). In terms of time spent to control *E. coli* O157, dairy farmers show slightly higher willingness, especially as regards weekly commitment (32% dairy farmers as compared to 24% beef farmers would be willing to spend 30 minutes per week).

While 43% of the open farmers would be willing to pay £1 to £5 and a quarter of farmers more than £5 per animal per year to ensure that *E. coli* O157 was not present on own farm (higher than the figures observed for the standard farms), an eleventh of farmers would not spend any money (lower than the figures observed for the standard farms). Only 6% of farmers would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth would not spend more than one day per year and about a twelfth of farmers would not be willing to spend any time at all (lower than the figures observed for the standard farms).

The majority of 'standard' farmers found as practical/very practical the following biosecurity measures: separating animals into different age groups for the majority of the time, keeping bedding dry and replacing contaminated/wet bedding on a daily basis, quarantine and testing of livestock brought to the farm and cleaning feed troughs daily. Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were found not at all practical by about two fifths of farmers. Similarly, the majority of open farmers found as practical/very practical the following measures: quarantine and testing of livestock brought to the farm and keeping bedding dry and replacing contaminated/wet bedding on a daily basis. Almost half of farmers found practical/very practical separating animals into different age groups for the majority of the time. Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were found not at all practical by about half of the farmers.

The results of the structural equation model for the representative telephone survey sample of 'standard' farmers confirm findings from the literature and expert opinion. The model has a reasonably good level of prediction as it explains more than half (52%) of the variance in willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 is not present on own farm. The model suggests that farmers: with stronger biosecurity perceptions; whose income depends more on their opening their farms to the public; who are more likely to have been affected by past outbreaks; whose farms are dairy rather than beef; who are more informed; and have stronger attitudes towards *E. coli* O157 control will show a higher willingness to spend money and time to control *E. coli* O157. This might imply that increasing access to information to all farmers and targeting more specifically dairy farmers, farmers who open their farms to public and farmers affected by past outbreaks might lead to stronger biosecurity perceptions and attitudes and, subsequently, to higher willingness to control disease. The fact that perceived practicality of biosecurity measures was found to have the strongest effect on behavioural willingness might suggest that not only increasing access to information, but providing information on control measures to suit the specific circumstances of farms is needed.

The results of the binary logistic regression for the representative telephone survey sample show that the factors with a significant influence on willingness to use vaccination are willingness to pay (money per animal per year) to ensure that *E. coli* O157 is not present on-farm, willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal, proportion of farm income dependent on opening to the public, frequency of access to information from government and attitudes towards use of control measures for *E. coli* O157 in cattle on-farm. The 'total sample' model predicts a third (33%) of the variance in willingness to use vaccination.

The factors with a significant influence on willingness to use additives are willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle, perceived practicality of disinfecting the animal sheds/pens weekly on own farm and frequency of access to information from agricultural consultants. The 'total sample' model predicts a quarter (26%) of the variance in willingness to use additives.

The results of the binary logistic regression for the non-representative online survey sample show that the factors with a significant influence on willingness to use vaccination are farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets; source of general information for managing the farm: internet; farm livestock accessible to public in the past 12 months; perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years. The total variance explained is 40%.

The factors with a significant influence on open farmers' willingness to use additives are farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets; source of general information for managing the farm: internet; farm livestock accessible to public in the past 12 months. The total variance explained is 39%. As mentioned above, this is not a representative sample of farms which open to the public, and results should be treated with caution.

4. Stakeholder engagement

4.1 Introduction

The intention for this objective was that it would be completed through a number of meetings to allow dissemination of the intelligence from Objectives 1 (i.e. an evidence review on the efficacy of control measures) and Objective 2 (i.e. determination of the legal, social and economic drivers and barriers to implementation of *E. coli* O157 controls by farmers in the UK) to farmers to aid their decisions on the use of on-farm controls, the provision of summary reports to the project participants including dairy, beef and open farm managers and national representative bodies such as RHET, LEAF, NFU and NFUS. The following sections describe work that has been undertaken by the project team to raise awareness of the research with the relevant interested parties, which can be used as a basis for future stakeholder engagement in this area.

4.2 Meetings and discussions with stakeholders

National Farm Attraction Network (NFAN)

Discussions were held with NFAN, which is a network of individual open farm owners, managers and related businesses. The organisation's committee stated that it was fully aware of *E. coli* O157 and its threat to human health and had already hosted presentations for its membership at its annual meeting in 2010. A visit to NFAN was made in April 2011 and the NFAN committee informed us that in 2009 at the height of the Godstone Farm outbreak their visitor numbers were considerably reduced and some of their incomes fell by 25%. Individual members had been proactive in working with the Health and Safety Executive (HSE) to consider on-farm controls for *E. coli* O157 and in 2011 they would be assisting the agricultural branch of HSE to revise the advisory leaflet AIS 23 that may be revised as a Code of Practice.

The NFAN committee are highly motivated to *E. coli* O157 control and the measures the farms currently use to prevent human infection include: signage and briefings for visitors, provision of hand washing, supervision by staff, and segregation of livestock from picnic areas with double fencing. Results from the examination of possible on-farm controls were shared with a committee member who on behalf of NFAN is interested in the feasibility of vaccinating his ruminant livestock to reduce *E. coli* O157 carriage (see VMD below).

Veterinary Medicines Directorate (VMD) of DEFRA

The VMD is responsible for: the assessment, issue and maintenance of all national Marketing Authorisations (MA) for veterinary medicines in accordance with European Community and UK legislation; controls on the manufacture and distribution of veterinary medicinal products, and the provision and implementation of policy advice on these matters to Ministers. Initial contact with VMD was by correspondence and it confirmed that no licensed medicinal product is available in UK with a recognised claim to control *E. coli* O157. In the European Union it is possible to register medicinal products in individual member states and the VMD only hold information on those products subject to a harmonisation process.

The VMD is able to assist in the importation of medicines from European members or non-EU countries if no licensed medicinal product is available in UK and where a practising veterinary

surgeon wishes to import a product in accord with the prescription cascade. Application must be made through a Special Treatment Certificate (STC) for non-European or human medical products or a Special Import Certificate (SIC) for a European medical product.

The Veterinary Medicines Regulations (VMRs) were introduced in the autumn of 2005 and set out the legal controls for veterinary medicinal products. The cascade is a legislative provision in the VMR that allows a veterinary surgeon to prescribe unauthorised medicines that would not otherwise be permitted. The principle of the cascade is that, if there is no suitable veterinary medicine authorised in the UK to treat a condition, the veterinary surgeon responsible for the animal may, to avoid causing unacceptable suffering, treat the animal in accordance with the following sequence, in descending order of priority:

- A veterinary medicine authorised in the UK for use in another animal species or for a different condition in the same species.
- If there is no such product, the next option is either –

  a medicine authorised in the UK for human use, or a veterinary medicinal product (VMP) not authorised in the UK but authorized in another member state for use in any animal species (in the case of a food-producing animal the medicine must be authorised in a food producing species).

- If there is no such product, the last option is a medicine prescribed by the veterinary surgeon responsible for treating the animal and prepared extemporaneously by a veterinary surgeon, a pharmacist or a person holding an appropriate manufacturer's authorisation.
- In exceptional circumstances, medicines may be imported from third countries through the VMD's import scheme.

At a meeting of the NFAN representative, accompanied by their veterinary surgeon, with VMD the possibility of importing a medicinal product under the cascade to control *E. coli* O157 in livestock was explored. VMD gave their opinion that no vaccine is available in UK or the rest of Europe that has data sheet recommendations for *E. coli* O157 control. VMD also stated that UK licensed pharmaceuticals are for clinical use only (note – *E. coli* O157 causes no clinical disease in ruminants). The meeting confirmed that the vaccines available in North America include Econiche™ that is fully licensed in Canada and Epitopix (Pfizer SRP®) that has a conditional licence in USA.

The HSE's legal requirements, to apply reasonable precautions to *E. coli* O157 control were discussed and it was noted that the best advice is to regard all ruminants as potentially positive. The NFAN representative is therefore interested in his veterinarian applying to VMD for a STC to make an import request so as to vaccinate ruminant species under his care in accord with the label directions and with a 60-day slaughter withdrawal notice.

VMD confirmed that a submission for an STC for Econiche™ could be made. The justification should be consistent with EU directives and should state "the use was in particular to avoid unnecessary suffering". VMD would view the application as potentially setting a precedent and would therefore ask for additional information from Bioniche and consult with the UK's Chief Veterinary Officer before making a decision. VMD's primary responsibility was to ensure the product was safe and in considering the risk benefits may require any use to be supplemented by other controls and Econiche™ usage to be limited to open farms. In accordance with the VMR's, it is a requirement that any pharmacologically active substances included in a medicinal product administered to a food-producing animal under the cascade must be listed in Table 1 in the annex to commission Regulation

(EU) No 37/2010 (on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin). If the above issues were addressed then VMD procedures were to process an STC application in 15 working days with time in addition for that required for extra information. (NB. after submission of this study report to FSAS the VMD have issued in summer 2012 an STC to allow the importation and use of Econiche™ in an open farm context).

With regard to probiotics/direct fed microbials the VMD had earlier given written correspondence that the FSA regulate feed additives and this classification refers to additives influencing the technological aspects of animal feed. These include those: to improve feed handling or hygiene characteristics, to improve palatability, to provide vitamin, amino acid or trace minerals or zootechnical additives that improve the nutrient status of the animal. An example of such an additive would be an enzyme or direct fed microbial product, to enhance the conditions of the intestinal tract. Such zootechnical food additives would have no recognised claim to control *E. coli* O157.

Royal College of Veterinary Surgeons (RCVS)

Written advice was obtained from the RCVS legal team that interpretation of the phrase 'to avoid causing unacceptable suffering' required in a STC application for a product to control *E. coli* O157 in livestock would be considered in a wide sense where the perceived benefits would be to public health rather than in the strict sense of the relief of animal suffering.

Linking Environment And Farm (LEAF)

LEAF promotes environmentally responsible farming and helps build public understanding of food and farming in a number of ways. These include Open Farm Sunday and year round farm visits to a national network of demonstration-farms. The LEAF events manager for Open Farm Sunday facilitated our on-line survey of LEAF members and will be given feedback on completion of the work.

Royal Highland Education Trust (RHET)

RHET promote and arrange school visits to farms in Scotland and after an initial contact asked for a briefing on *E. coli* O157. On 14th September 2011 the RHET forum, which includes the regional representatives responsible for the coordination and planning of 1,500 school visits annually, were given a presentation on the hazards of *E. coli* O157 and a discussion was held to consider their risk planning for school visits.

National Farmers Union of Scotland, Royal Highland and Agricultural Society of Scotland and Quality Meat Scotland.

On 12th May 2011 a meeting was held with senior representatives from all of these organisations to discuss the hazards of *E. coli* O157 and the possibility of adopting on-farm control measures in UK.

5. Final discussion and conclusions

An interesting observation of this study is that although Europe has made significant contributions to our understanding of *E. coli* O157, its significance as a bacterial pathogen, the routes for human infection, its occurrence in feedstuffs and on-farms and to our epidemiological understanding, there is little work to implement on-farm controls for the pathogen in UK and few that we have been able to identify from continental Europe.

One possible cause for this is the different perceptions and regulatory approaches that are adopted in North America and Europe. In North America there is considerable effort to protect processed meat from contamination and end product testing for *E. coli* O157 is widely used in meat processing plants. The Food Safety and Inspection Service (FSIS) within the U.S. Department of Agriculture (USDA) inspects and regulates meat, poultry and processed egg products produced in federally inspected plants. FSIS is responsible for ensuring that these products are safe, wholesome, and accurately labelled. Product recalls are common and initiated by the manufacturer or distributor of the meat or poultry, sometimes at the request of FSIS. All recalls are voluntary but if a company refuses to recall its products, then FSIS has the legal authority to detain and seize those products in commerce. The financial losses associated with such recalls are significant and provide a major financial incentive for the on-farm control of *E. coli* O157 that are absent in Europe where food producers use HACCP planning and have less reliance on end-product testing. These differences show that although in the UK the control of *E. coli* O157 on-farm may be desirable, it is in North America where greatest effort has been given to control infection in their feedlot systems. Identifying these different perceptions and drivers is an important aspect of this work.

The literature review identified a number of possible control measures for reducing the faecal shedding of *E. coli* O157 by livestock. This included commercially available products which have shown particular promise for reducing shedding levels, but which have not yet obtained regulatory approval in Europe. A further difficulty in assessing the feasibility of applying these controls in the UK was that most of the published evidence focuses on North American systems of husbandry and includes many studies completed in feedlot systems that are not directly relevant to the UK.

We did not take the issues described above into account for the purposes of this study, which was only concerned with identifying the existence of possible control methods, obtaining a general consensus of their effectiveness and examining the literature for evidence of a quantitative evaluation of their efficacy as on-farm control measures. Ultimately for evaluation in the cost-benefit analyses, quantitative data was available to demonstrate the efficacy of two vaccine products, a generic probiotic approach and application of a package of bio-security measures which could be considered as controls that are potentially applicable by UK farmers.

Whilst there is considerable published evidence for *E. coli* O157 infections in people arising from direct contact with livestock and evidence that the frequency of human cases is related to cattle density (Strachan et al., 2006) a problem is that we cannot precisely describe the reduction in the number of human cases of infection that will be the consequence of reducing *E. coli* O157 shedding by livestock. Therefore, cross-species transmission models were used to translate the observed prevalence and shedding reductions in cattle into a predicted reduction in risk to humans (section 2.2.1.2). To our knowledge, these models represent the first attempt to capture the cross-species transmission risk posed by supershedding; the development of more detailed and refined models was beyond the scope of this project, but should be a priority for further research activity.

The results of cost benefit analysis (section 2.2.3) show that the application of vaccines or probiotics as on-farm control measures for *E. coli* O157 may payback their costs in certain circumstances. However, whilst the possibility of the usage of probiotics as an on-farm control measure should not be ignored, the feasibility of in-feed administration to grazing cattle is an important consideration. In contrast to probiotics, the bio-security package achieved benefit-cost ratios that were far below one. This was due to the high estimated implementation costs – in line with those of previous estimates (e.g. Defra, 2003). Likely high levels of variability in the costs and effectiveness of biosecurity between farms is also an important consideration. This result/observation indicates that despite a reported efficacy, bio-security alone does not provide a viable control option for *E. coli* O157 due to its expense and difficulties in implementation (Kristensen and Jakobsen, 2011). However, it must be acknowledged that increased bio-security may have additional benefits for the producer through the control of other diseases though these benefits have not been quantified here and the measures cannot be considered as routine to UK production systems.

An important outcome is that none of the control methods are universally cost-beneficial. The outcome is highly dependent on the preventable human losses that combine the quantity of annual human cases and the severity of the illnesses caused. In England and Scotland where the proportion of human cases of *E. coli* O157 are higher than elsewhere in UK, the benefits of the on-farm controls in mitigating the public health burden of disease may be considered to financially outweigh their costs. Though Northern Ireland suffers a similar proportion of infections the fewer total cases and the high number of cattle means that the costs of implementation are higher and there is a considerably lower benefit as the number of severe infections (HUS), which are disproportionately financially significant, are low.

The results of the analysis (section 2.2.3) suggest that at the levels of *E. coli* O157 infection consistently occurring in Scotland and England over the past 10 years the benefit-cost ratios produce a marginal benefit to society by application of some of the control measures, especially by vaccination of animals. In these circumstances, the expense of a control measure, such as vaccination of farm livestock may offer a public good. However, a concern is that these calculations are dependent upon relatively few articles that adequately describe the reduction in *E. coli* O157 shedding after the application of a particular control and that the severity of illness suffered is extrapolated from a single two year study in Scotland. It is also worth nothing that the potential avoided economic burden of *E. coli* O157 outbreaks on agricultural sector and wider economy (e.g. negative impact on farmers via reduced demand and hence prices) were not included in this calculation. Therefore benefits were conservatively confined to human losses avoided.

Given the assumptions used we concluded from the analyses that implementing vaccination and probiotics for all the cattle population in Scotland and England are cost-effective whereas this is not a cost-effective approach in Wales and Northern Ireland. When targeting only young cattle, assuming the same efficacy levels, both the studied vaccines and probiotics are cost-effective in Scotland, England and UK but implementing this approach in Wales and Northern Ireland in isolation is not economically efficient.

Though on-farm controls may be considered publically beneficial a highly important issue with respect to controlling *E. coli* O157 on-farm is that the pathogen does not cause disease in livestock and no direct economic damage is imposed on the farmers. Currently there is no market incentive for *E. coli*-free cattle, beef or milk and therefore many farmers do not have an obvious and urgent reason for investing in control measures; especially as the maximum benefits are likely to occur where the control measures are applied to all animals and incur maximum costs. Only the private

concern of farmers in high-incidence areas for the safety of their families drives an idealistic ambition to eliminate the pathogen (Clarke and Jones, 2011).

In order to improve understanding of the feasibility of implementing control measures in practice, we sought information on the knowledge, attitudes and behaviours of farmers (section 3) towards *E. coli* O157 and its on-farm control. Our contacts in the organisations responsible for the national livestock census figures confirmed that there were no official records of 'open farms' in UK. The telephone survey was therefore sent to farm holdings randomly selected from national census data sets maintained in England, Scotland, Northern Ireland and Wales without *a priori* knowledge of the business purposes of the holdings. Overall, 405 farmers were contacted by telephone and 405 completed questionnaires were obtained. The survey was stratified by farm type (beef and dairy cattle) and analysis of the data revealed that few (5%) of the farms would be categorised as open farms (*i.e*., have more than 5% of their income dependent on opening to the public).

Additionally, an online survey of open farmers (members of LEAF and recorded by LEAF as opening to the public) was undertaken and 91 responses were received. Approximately 50% of the surveyed farmers who opened their farms to public (i.e. open farms) allowed visits by school groups of children to touch the animals; 81% allowed visits by school groups of children to see the animals; 13.3% allowed children <10 years old into the pens with ruminant animals; 26.9% allowed children <10 years old to bottle feed lambs. It is perhaps important that despite the recommendations encompassed in the HSE advice leaflet AIS23 our return from this small survey showed that not all farms had implemented measures to protect the safety of their visitors. For example 69.9% reported having signs warning visitors of health hazards from animal infections; 69.6% had hot water hand-washing facilities for visitors throughout the farm; and 86.8% had cold/hot water hand-washing facilities for visitors throughout the farm.

As regards knowledge about *E. coli* O157 impacts on human health, the majority of 'standard' (i.e. dairy and beef cattle) farmers were aware of *E. coli* O157 causing disease in people, that people touching calves/cows may become infected with *E. coli* O157, that livestock are an important source from which *E. coli* O157 spreads and that *E. coli* O157 can be present on raw meat, in raw milk and can contaminate produce such as lettuce, apples, spinach or rural drinking water. Levels of awareness of these issues were stronger in the open farms sample[27]. However, the fact that a fifth of 'standard' farmers and a tenth of farmers who open their farms to the public either did not agree or did not know that *E. coli* O157 causes disease in people and that a proportion of farmers within both groups did not agree with the different potential means of *E. coli* O157 transmission raises concern over a lack of awareness and might imply that not all farmers recognise the importance of controls to prevent cross-contamination.

As regards perceived beneficiaries of on-farm controls to reduce *E. coli* O157 in cattle, the majority of 'standard' and open farmers thought that all (farmers, processors, retailers, public and government) would benefit, however the proportions vary between the two categories when it comes to benefits for the public or farmers. As regards perceived responsibility for controlling *E. coli* O157 on farms, the majority of 'standard' and open farmers stated that responsibility remains with them (with a higher proportion of the latter), however a fifth and, respectively, a quarter of farmers

[27] We compare the results of the representative telephone survey with the results of the non-representative online survey, however due to non-representativeness of the open farms sample; the comparisons should be treated with caution.

stated that all should share responsibility and a tenth and, respectively, a fifth of farmers considered that the government is responsible for the control of *E. coli* O157 on-farms.

Whilst nearly 60% of 'standard' farmers said they would be willing to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and given to 3-18 months old cattle, about 40% would currently be unwilling to use a vaccine treatment. For the majority of these farmers one of the reasons was lack of information about vaccination, for two thirds of them the cost was too expensive, whilst half of them said that it would take too much time to administer. However, a slight majority said that they would be encouraged to use vaccination if it was part of a national program to benefit the reputation of the industry, while less than half said that they would be encouraged to use vaccination if it was used by other farmers. Many comments received indicated that farmers may implement on-farm controls for *E. coli* O157 where they could identify a clear hazard and if there was greater knowledge of the safety and efficacy of the proposed controls. Interestingly, these responses suggest the general advice that all cattle should be regarded as carriers of *E. coli* O157 has not influenced farmers' considerations and this may be explained by the number of farmers having direct experience of the infection (less than a tenth of farmers have perceived an effect on business due to incidents of *E. coli* O157 that occurred on their own farm).

The number of open farmers unwilling to use a vaccine treatment was higher than that observed for beef and dairy farmers surveyed during this study[28].

The responses revealed that 'standard' farmers were less willing to use feed additives on a daily basis in feed or water for a group of animals than a vaccine approach. Farmers raised similar concerns about the use of probiotics to those expressed over vaccination. However, whilst the cost estimations presented to the farmers put the cost of probiotics higher than for vaccination, the major concern related to the practicality of implementing an in feed or water treatment in a UK production system. The number of open farmers unwilling to use additives was also found to be higher than that observed for beef and dairy farms[29].

As regards willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 was not present on their own farm, while almost half of the 'standard' farmers would be willing to pay £1 to £5 and a seventh of farmers more than £5, almost a sixth of farmers would not be willing to spend any money. A tenth of farmers would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth would not be willing to spend more than one day per year and about an eighth of farmers would not be willing to spend any time at all.

While 43% of the open farmers would be willing to pay £1 to £5 and a quarter of farmers more than £5 per animal per year to ensure that *E. coli* O157 was not present on own farm (higher than the figures observed for the standard farms), an eleventh of farmers would not spend any money (lower than the figures observed for the standard farms). Only 6% of farmers would be willing to spend time on a daily basis (30 minutes per day) to ensure that *E. coli* O157 was not present on own farm, however about a fifth would not spend more than one day per year and about a twelfth of farmers

[28] However, as previously mentioned, we do not claim representativity of the sample of farmers who open their farms to the public.

[29] However, as previously mentioned, we do not claim representativity of the sample of farmers who open their farms to the public.

would not be willing to spend any time at all (lower than the figures observed for the standard farms).

As regards perceived practicality of biosecurity measures, the majority of 'standard' farmers preferred separating animals into different age groups for the majority of the time, keeping bedding dry and replacing contaminated/wet bedding on a daily basis, quarantine and testing of livestock brought to the farm and cleaning feed troughs daily. Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were found not at all practical by about two fifths of farmers.

The majority of open farmers prefer quarantine and testing of livestock brought to the farm and keeping bedding dry and replacing contaminated/wet bedding on a daily basis. Almost half of farmers found practical/very practical separating animals into different age groups for the majority of the time. Reducing current livestock numbers on the farm and disinfecting the animal sheds/pens weekly were found not at all practical by about half of the open farmers.

The results of the structural equation model for the representative telephone survey sample of 'standard' farmers confirm findings from the literature and expert opinion. The model has a reasonably good level of prediction as it explains more than half (52%) of the variance in willingness to pay (money or time per animal per year) to ensure that *E. coli* O157 is not present on their own farm. The model suggests that farmers: with stronger biosecurity perceptions; whose income depends more on their opening their farms to the public; who are more likely to have been affected by past outbreaks; whose farms are dairy rather than beef; who are more informed; and have stronger attitudes towards *E. coli* O157 control will show a higher willingness to spend money and time to control *E. coli* O157. This might imply that increasing access to information to all farmers and targeting more specifically dairy farmers, farmers who open their farms to public and farmers affected by past outbreaks might lead to stronger biosecurity perceptions and attitudes and, subsequently, to higher willingness to control disease. The fact that perceived practicality of biosecurity measures was found to have the strongest effect on behavioural willingness might suggest that not only increasing access to information, but providing information on control measures to suit the specific circumstances of farms is needed.

We have identified vaccines as practical *E. coli* O157 controls that could be applied in UK. The cost-benefit analyses indicate that their use could be targeted to farms in Scotland and England and potentially too in young animals at greatest likelihood of being carriers. However, we also identified reluctance amongst many farmers to implement any on-farm controls.

The Health and Safety at Work Act 1974, Food Safety Act 1990, The General Food Law Regulation 2004 and associated health and safety regulations all place duties on food-producers including farmers and others in the food chain to protect the public from hazards. Since *E. coli* O157 is a potential hazard the responsibility rests on producers to use good practice to protect the consumer and general public. The reduction in the frequency of major food-borne outbreaks in Scotland is suggestive that the application of HACCP at slaughterhouse has succeeded in reducing the risk of food-borne infection and pre-slaughter measures aimed at reducing *E. coli* O157 shedding in cattle may provide an additional level of control to reduce human cases of infection arising through food chain contamination via the slaughter process or through the faecal contamination of fresh produce. On-farm controls offer additional benefits by reducing risks to humans from environmental exposures, including those arising through direct animal contact or in the rural environment.

Despite farmers being responsible for the potentially negative consequences that maintaining cattle and spreading this pathogen poses to the public, for the majority of farmers there is a lack of validated on-farm control options, and the lack of a clear link between human cases of infection and their own livestock supports their decision to do nothing.

Our analyses are highly provisional and greater effort and coordination of medical and animal health authorities are needed (Clarke and Jones, 2011) to confirm the burden of infection that originates with the livestock populations in UK. Such evidence is crucial to the analyses. Most importantly, it is evidence that is required by farmers of the hazards that originate with their livestock. Without such evidence we do not believe that most individual farmers will take ownership of the problem.

However, it is clear that in some situations, such as open farms, farms that have direct experience of *E. coli* O157, or farms located in an area of high disease incidence there is a high common awareness and understandings of *E. coli* O157 (Jones et al., 2011) and there is a very considerable commitment to implement *E. coli* O157 on-farm controls. The social and financial consequences of human illnesses that are traced and linked to open farms can be significant and whilst advisory leaflets (HSE AIS23) are available to reduce the risk, the adoption of further controls are seen as reasonable steps necessary to reduce liability. This suggests a willingness to adopt controls that are under development and examination in North America and indeed our experience with the open farm industry suggested that the costs we quoted for vaccination were not an obstacle to implementation.

Of greater concern for these farmers was knowledge of the efficacy and safety of the control measures. Vaccines that are available in North America have gone through the regulatory authorities there and we know from our work that there is interest in bringing these vaccines to UK. The authorisation of veterinary medicines in the EU is complex. A product authorised in the US cannot automatically be authorised in the EU. Although there are means of gaining permission to use US-authorised products in the UK, these are restricted to very specific situations. It is possible for a veterinary surgeon to import an authorised product from a third country, but data must be provided to show that the product is safe and that no other options are available for treatment of individual animals. Any importation will require STC authority and the subsequent use, if permitted, would likely be confined to specific premises and under strict control of the veterinary surgeon where the animals are under their care.

An initial concern was that any justification needed to be consistent with EU directives with a requirement to confirm “the use was in particular to avoid unnecessary suffering”. However, without prejudice to any forthcoming opinion the view expressed by regulators was that a STC application could be considered for an *E. coli* O157 vaccine and their primary responsibility was to ensure the product was safe and that any pharmacologically active substances included in a medicinal product administered to a food-producing animal under the cascade are listed in Table 1 in the annex to commission Regulation (EU) No 37/2010.

Finally, it must be noted that from the seven severity categories of human illness identified, hospitalised HUS cases that die impose the major costs to society. Since the severity of human illnesses is variable and is presumably dependent upon biological/epidemiological factors an alternative conclusion is that preventing the human losses associated with HUS would offer a considerable benefit and would negate the implementation costs for on-farm controls. Since HUS is recognised as an illness that primarily affects children under 5 years of age the possible options for prevention of HUS may include: further education of children and parents about the dangers of on-farm exposure to *E. coli* O157; new methods for the early recognition, diagnosis and treatment of

affected children or the targeting of on-farm controls to those settings where large numbers of children may be exposed to farm environments such as occurs at open farms. Also efforts to reduce human infections in livestock farming areas could be improved with proximate reminders for visitors of the environmental pathway of *E. coli* O157 infection (Jones et al., 2011). It is clear from both surveys that the use of the media is a crucial mechanism in disseminating information relating to this problem.

We conclude, based on our evaluation of the evidence on current control options, and the results of our surveys of farmers' views on the issue, that in the short term targeted vaccination to open farms would have the potential to offer an advantage to public health. There may be future opportunity to extend the general principles for the efficacy of vaccinating cattle for *E. coli* O157 where the vaccine composition is developed to maximise duration of immunity and to tailor vaccination regimes to ensure maximum effectiveness in reducing the *E. coli* O157 in cattle. Such targeted on-farm interventions may provide evidence for other farmers where the direct financial benefits are not currently obvious but where implementation in young animals (under 25 months of age) may be worthwhile in Scotland and England for public health purposes.

6. Recommendations

The background to the study was to contribute data to address formal recommendations made following two enquiries into major outbreaks of *E. coli* O157 that have occurred in the UK population since 2005.

The stated aim was to consider on-farm measures for control of *E. coli* O157 in cattle, and to assess the costs, benefits and barriers associated with using these, in full or in part, in the UK. We trust that the reader will find our contributions valuable to the debate and will now allow the authors to highlight six recommendations that derive from their consideration of the findings.

Recommendation 1. We recommend that an opportunity is sought to evaluate the efficacy of probiotics and/or vaccines for on-farm *E. coli* O157 control in UK. Probiotic treatments and vaccines have been described where reduction in *E. coli* O157 shedding may be expected through their application. However, information is limited on the duration of effect and impact on the numbers of *E. coli* O157 that would be found in the faeces of treated animals. Additionally, there is little published research on the application of such controls in European farming systems. There is therefore a need to extend the general principles to examine the means of probiotic administration, or to tailor vaccination regimes to ensure maximum effectiveness in reducing the carriage of *E. coli* O157 in cattle. Development of such targeted on-farm interventions in UK may provide important evidence of safety and efficacy for farmers.

Recommendation 2. We recommend that NFAN be encouraged in developing Codes of Practice for on-farm *E. coli* O157 control and are given assistance to engage with the open-farm sector and to publicise their experiences in the adoption and implementation of control measures. During our engagement with stakeholder groups, the open-farm sector was most concerned with the means to protect their businesses and with our assistance some individuals have imported commercially available vaccines to vaccinate their livestock. We suggest that such farmers, with a higher proportion of their income dependent on opening to the public; and that have been directly or indirectly affected by *E. coli* O157 incidents, may increasingly adopt such measures. However, since there is no official record of 'open farms' in UK the dissemination of such information is dependent upon organisations such as NFAN to encourage farms to use codes of practice and to implement measures to protect the safety of their visitors.

Recommendation 3. We recommend that farmers may implement on-farm controls for E. coli O157 if they identify a clear hazard and if there is greater knowledge of the safety and efficacy of the proposed controls. Despite farmers recognising a responsibility for the potentially negative consequences that maintaining cattle and spreading this pathogen poses to the public, for the majority of farmers there is a lack of validated on-farm control options, and the lack of a clear link between human cases of infection and their own livestock. Without such evidence we do not believe that most individual farmers will take ownership of the problem. We consider that recommendations 1 and 2 may permit the demonstration of the efficacy of controls in UK farming systems and could encourage uptake.

Recommendation 4. We believe that major retailers and buyers of milk and beef could be asked to provide incentives to those farmers willing to apply proven on-farm *E. coli* O157 controls. On-farm control of the pathogen may be considered publically beneficial. However, a highly important issue with respect to controlling *E. coli* O157 is that the pathogen does not cause disease in livestock and no direct economic incentive for the farmers. We are conscious that currently the costs will be borne by the agricultural community with no immediate or direct benefit. Whilst the protection of their families might occur, we think that our work demonstrates a wider public good should arise from control of infection in cattle. Whilst retailers and buyers will be cautious in providing financial incentives for *E. coli* O157 control on-farms we believe there may be in certain circumstances an opportunity for them to encourage or demonstrate the measures as acts of public good and beneficial to their reputations.

Recommendation 5. We consider as a priority for further research activity continued interdisciplinary cooperation in the collection of information for the development of more detailed and refined disease transmission models. Our transmission models were used to translate the observed prevalence and shedding reductions in cattle into a predicted reduction in risk to humans. These models are robust representations but are determined from historic surveillance and prevalence data and require continued validation**.**

Recommendation 6. We recommend the increasing use of the media as a crucial mechanism in disseminating information relating to *E. coli* O157 control. Our findings suggested that increasing all farmers' access to information would help to improve levels of awareness and may change attitudes with regard to the control of *E. coli* O157.

Acknowledgements

We thank Food Standards Agency in Scotland and DEFRA who funded this research. We also thank the respondents to our surveys (Section 3) as well as Mr. Rick Culbert at Bioniche Life Sciences® for their contributions, time and cooperation.

References

Allen, K.J., Rogan, D., Finlay, B.B., Potter, A.A., Asper, D.J., 2011. Vaccination with type III secreted proteins leads to decreased shedding in calves after experimental infection with Escherichia coli O157. *Canadian Journal of Veterinary Research*. 75, 98.

Anon. 2011 Intralytix Completes Regulatory Clearance for Phage-Based *E. coli* Food Safety Technology. Accessed 6th November 2011 at: http://www.intralytix.com/Intral_News_PR061411.htm

Austin, E.J., I.J. Deary, and J. Willock. 2001. Personality and intelligence as predictors of economic behaviour in Scottish farmers. *European Journal of Personality.* 15, 123-137.

Berry, E.D., Wells, J.E. 2010 *Escherichia coli* O157:H7 Recent Advances in Research on Occurrence, Transmission, and Control in Cattle and the Production Environment. *Advances in Food Nutrition Research.* 60, 67-117.

Bewsell, D. and R.M. Monaghan, 2007. Adoption of Stream Fencing Among Dairy Farmers in Four New Zealand Catchments. *Journal of Environmental Management.* 40, 201-209.

Bingham, N., G. Enticott, and S. Hinchliffe, 2008. Bio-security: spaces, practices, and boundaries. *Environment and Planning. A* 40, 1528-1533.

Bollen, K.A. 1989. *Structural equations with latent variables*. New York: John Wiley and Sons.

Borsboom, D., Mellenbergh, G.J., & van Heerden, J. 2003. The Theoretical Status of Latent Variables. *Psychological Review*. 110(2), 203-219.

Braun, A.R., J. Jiggins, N. Roling, H.van den Berg, and P. Snijders, 2006. A global survey and review of farmer field school experiences. Report prepared for International Livestock Research Institute.

Brennan, M.L., R. Kemp, and R.M. Christley, 2008. Direct and indirect contacts between cattle farms in north-west England. *Preventative Veterinary Medicine.* 84, 242-260.

Brown-Brandl, T.M., Berry, E.D., Wells, J.E., Arthur, T.M. and Nienaber, J.A. 2009 Impacts of individual animal response to heat and handling stresses on *Escherichia coli* and *E. coli* O157:H7 fecal shedding by feedlot cattle. *Foodborne Pathogens and Disease*. 6, 855-864.

Brashears, M., Loneragan, G., Younts-Dahl, S. 2005 Controlling microbial contamination on the farm: an overview. In: Improving the Safety of Fresh Meat (Ed. Sofos, J. N.). Woodhead Publishing in Food Science and Technology, CRC Press, New York. Pp 156-174.

Buzby, J.C., Roberts, T., Roberts, J.A., Upton, P.A. 1998. A comparison of human illness cost estimates for e. coli 0157:h7 disease in the united states and Scotland. In proceedings of Agricultural and Applied Economics Association Annual Meeting, August 2-5, 1998, Salt Lake City, UT. Accessed on 6th November 2011 at: http://ageconsearch.umn.edu/bitstream/20792/1/spbuzb01.pdf.

Buzby, J.C., Roberts, T., 2009. The Economics of Enteric Infections: Human Foodborne Disease Costs. *Gastroenterology.* 136, 1851-1862.

BVA, 2005. Bio-security: Challenges of disease control at every level. *Veterinary Record.* 157, 461-464.

Callaway, T.R., Elder, R.O., Keen, J.E., Anderson, R.C., Nisbet, D.J., 2003. Forage feeding to reduce preharvest *Escherichia coli* populations in cattle, a review. *Journal of Dairy Science.* 86, 852-860.

Callaway, T.R., Anderson, R.C., Edrington, T.S., Genovese, K.J., Bischoff, K.M., Poole, T.L., Jung, Y.S., Harvey, R.B., Nisbet, D.J. 2004 What are we doing about *Escherichia coli* O157 in cattle? *Journal of Animal Science.* 82. supplement E93-99.

Callaway, T.R., Carr, M.A., Edrington, T.S., Anderson, R.C., Nisbet, D.J., 2009 Diet, *Escherichia coli* O157:H7, and cattle: A review after 10 years. *Current Issues in Molecular Biology.* 11: 67-80.

Chase-Topping, M.E., McKendrick, I.J., Pearce, M.C., MacDonald, P., Matthews, L., Halliday, J., Allison, L., Fenlon, D., Low, J.C., Gunn, G.J., Woolhouse, M.E., 2007 Risk factors for the presence of high-level shedders of *Escherichia coli* O157 on Scottish farms. *Journal of Clinical Microbiology*. 45, 1594-1603.

Chase-Topping, M., Gally, D., Low, C., Matthews, L., Woolhouse, M. 2008 Supershedding and the link between human infection and livestock carriage of *Escherichia coli* O157. *Nature Microbiology Reviews*. 6, 904-912.

Chi, J., Weersink, A., VanLeeuwen, J.A., Keefe, G.P. 2002. The Economics of Controlling Infectious Diseases on Dairy Farms. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie.* 50, 237-256.

Chilonda, P. and G. Van Huylenbroeck, 2001. A conceptual framework for the economic analysis of factors influencing decision-making of small-scale farmers in animal health management. *Revue scientifique et technique - Office international des épizooties*. 20, 687-700.

Clarke, K.A., Jones, C.D.R., 2011. Taking up the public health challenge. *Veterinary Record*. 169, 384-385.

Coleman, G.J., Hemsworth, P.H. and M. Hay, 1998. Predicting stockperson behaviour towards pigs from attitudinal and job-related variables and empathy. *Applied Animal Behaviour Science.* 58, 63-75.

DEFRA, 2003. Constraints to uptake of adequate biosecurity on UK cattle and sheep farms, with special reference to zoonotic diseases - OZ0144. Department for Environment, Food and Rural Affairs, London.

DEFRA, 2008. The Cattle Book 2008. Department for Environment Food and Rural Affairs, London.

Delabbio, J. 2004. An assessment of bio-security utilization in the recirculation sector of finfish aquaculture in the United States and Canada. *Aquaculture.* 242, 165-179.

Doyle, M.P., Erickson, M.C. 2011 Opportunities for mitigating pathogen contamination during on-farm food production. *International Journal of Food Microbiology.* doi: 10.1016/j.ijfoodmicro.2011.02.037

Duffy, G. 2010 Control of Verocytotoxigenic *E. coli* in ruminant animals. *Irish Veterinary Journal*. 6, 447-451.

Dwyer, J., J. Mills, J. Ingram, J. Taylor, R. Burton, K. Blackstock, B. Slee, K. Brown, G. Schwarz, K.B. Matthews, and R. Dilley, 2007. Understanding and influencing positive behaviour change in farmers and land managers. DEFRA Project report.

Ekboir, J.M. 1999. The role of the public sector in the development and implementation of animal health policies. *Preventive Veterinary Medicine.* 40, 101-115.

Ellis-Iversen, J., Smith, R., Van Winden, S., Paiba, G., Watson, E., Snow, L., Cook, A., 2008. Farm practices to control E. coli O157 in young cattle - A randomised controlled trial. *Veterinary Research.* 39, 1-3.

Ellis-Iversen, J., Cook, A.J.C., Watson, E., Nielen, M., Larkin, L., Wooldridge, M., Hogeveen, H. 2010. Perceptions, circumstances and motivators that influence implementation of zoonotic control programs on cattle farms. *Preventive Veterinary Medicine.* 93(4), 276-285.

Fairweather, J.R. and N.C. Keating, 1994. Goals and management styles of New Zealand Farmers. *Agricultural Systems.* 44, 181-200.

Fox, J.T., Thomson, D.U., Drouillard, J.S., Thornton, A.B., Burkhardt, D.T., Emery, D.A., Nagaraja, T.G., 2009. Efficacy of escherichia coli O157:H7 siderophore receptor/porin proteins-based vaccine in feedlot cattle naturally shedding E. coli O157. *Foodborne Pathogens and Disease*. 6, 893-899.

Frenzen, P.D., Drake, A., Angulo, F.J., The Emerging Infections Program Foodnet Working Group, 2005. Economic Cost of Illness Due to Escherichia coli O157 Infections in the United States. *Journal of Food Protection*. 68, 2623-30.

Frenzen, P., 2007. An online cost calculator for estimating the economic cost of illness due to Shiga toxin-producing E. coli (STEC) O157 infections. Economic Information Bulletin 28.

FSA, 2011a. Clean Livestock Policy. accessed on 6th November 2011 at: http://www.food.gov.uk/foodindustry/farmingfood/cleancattleandmeatsafety/

FSA, 2011b. Measuring foodborne illness levels. Food Standards Agency. accessed on 6th November 2011 at: http://www.food.gov.uk/safereating/microbiology/58736

Gasson, R. 1973. Goals and values of farmers. *Journal of Agricultural Economics.* 24, 521-524.

Gasson, R. 1998. Education Qualifications of UK Farmers: A review. *Journal of Rural Studies.* 14, 487-498.

Gray, A.M., Clarke, P.M., Wolstenholme, J.L., Wordsworth, S., 2011. Applied Methods of Cost-effectiveness Analysis in Health Care. Oxford University Press, New York.

Griffin, G., 2010. Review of the major outbreak of E. coli O157 in Surrey, 2009. Final Report of the Independent Investigation Committee.

Gunn, G.J., C. Heffernan, M. Hall, A. McLeod, and M. Hovi, 2008. Measuring and comparing constraints to improved bio-security amongst GB farmers, veterinarians and the auxiliary industries. *Preventative Veterinary Medicine.* 84, 310-334.

Gunn, G.J., H.W. Saatkamp, R.W. Humphry, and A.W. Stott. 2005. Assessing economic and social pressure for the control of bovine viral diarrhoea virus. *Preventative Veterinary Medicine.* 72, 149-162.

Hair, J. F., Black, W., Babin, B., Anderson, R.E., & Tatham, R.L. 2006. *Multivariate data analysis*. 6th edition, Upper Saddle River, NJ: Pearson Prentice Hall.

Havelaar AH, Van Duynhoven YT, Nauta MJ et al. Disease burden in The Netherlands due to infections with Shiga toxin-producing Escherichia coli O157. *Epidemiology and Infection*. 2004; 132(3):467-84.

Health Protection Scotland, 2011. *E. coli* O157, Scotland, Annual Totals. Health Protection Scotland. accessed on 6th November 2011 at: http://www.documents.hps.scot.nhs.uk/giz/10-year-tables/ecoli.pdf

Heffernan, C., L. Nielsen, K. Thomson, and G. Gunn. 2008. An exploration of the drivers to bio-security collective action among a sample of UK cattle and sheep farmers. *Preventative Veterinary Medicine.* 87, 358-372.

Hubbard, C., M. Bourlakis, and G. Garrod. 2007. Pig in the middle: farmers and the delivery of farm animal welfare standards. *British Food Journal.* 109, 919-930.

Hussein, S and Sakuma, T. 2005 Shiga Toxin–Producing *Escherichia coli*: Pre- and Postharvest Control Measures To Ensure Safety of Dairy Cattle Products. *Journal of Food Protection.* 68*,* 199–207.

Jacob, M.E., Callaway, T.R., and Nagaraj, T.E. 2009 Dietary Interactions and Interventions Affecting *Escherichia coli* O157 Colonization and Shedding in Cattle. *Foodborne Pathogens and Diseases.* 6, 785-792.

Jacob, M.E., Paddock, Z.D., Renter, D.G., Lechtenberg, K.F., Nagaraja, T.G., 2010. Inclusion of dried or wet distillers' grains at different levels in diets of feedlot cattle affects fecal shedding of escherichia coli O157:H7. *Applied and Environmental Microbiology*. 76, 7238-7242.

Jones, C.D.R., Hunter, C., Williams, A.P., Strachan, N.J.C., Cross, P., 2011. *Escherichia coli*O157: comparing awareness of rural residents and visitors in livestock farming areas. *Epidemiology and Infection*. 139, 1522-1530.

Jöreskog, K. G., & Sörbom, D. 2007. *LISREL8.80: structural equation modeling with the SIMPLIS command language*. Chicago, USA: IL Scientific Software International.

Kristensen, E., Jakobsen, E.B., 2011. Danish dairy farmers GÇÖ perception of biosecurity. *Preventive Veterinary Medicine*. 99, 122-129.

Lejeune, J.T., Wetzel, A.N. 2007 Preharvest control of *Escherichia coli* O157 in cattle. *Journal of Animal Science*. 85, E73- E80.

Lindberg, A., J. Brownlie, G.J. Gunn, H. Houe, V. Moennig, H.W. Saatkamp, T. Sandvik, and P.S. Valle. 2006. The control of bovine viral diarrhoea virus in Europe: today and in the future. Revue scientifique et technique - Office international des épizooties. 25, 961-979.

Locking, M.E., O'Brien, S.J., Reilly, W.J., Wright, E.M., Campbell, D.M., Coia, J.A., Browning, L.M., Ramsay, C.N. 2001 Risk factors for sporadic cases of *Escherichia coli* O157 infection: the importance of contact with animal excreta. *Epidemiology and Infection*. 127, 215-20.

Lyons, N.A., Smith, R.P., Rushton, J. 2012. Cost-effectiveness of farm interventions for reducing the prevalence of VTEC O157 on UK dairy farms. *Epidemiology and Infection* FirstView, 1-15. doi:10.1017/S0950268812002403

Marshall, M.J., J.B. Bashiruddin, and P.A. Roger. 2006. Making better use of technological advances to meet stakeholder needs. Revue scientifique et technique - Office international des épizooties. 25, 233-251.

Matthews, L., Reeve R., Haydon D.T., Gally, D.L., McAteer, S.P., Woolhouse M.E.J., Chase-Topping, M.E., Low, J.C., Locking, M.E., Mellor, D.J., Allison, L.J., Gunn, G.J., Reid, S.W.J. The public health benefit of vaccinating cattle against *Escherichia coli* O157. *Submitted 2013.*

McNeilly, T.N., Naylor, S.W., Mahajan, A., Mitchell, M.C., McAteer, S., Deane, D., Smith, D.G.E., Low, J.C., Gally, D.L., Huntley, J.F. 2008 *Escherichia coli* O157:H7 colonization in cattle following systemic and mucosal immunization with purified H7 flagellin. *Infection and Immunity.* 76: 2594-602.

Mills, J., D. Gibbon, J. Dwyer, C. Short, and J. Ingram. 2006. Identification of delivery mechanisms for Welsh top-tier agri-environment schemes. CCW Policy Research Report 06-15.

Money, P., Kelly, A.F., Gould, S.W.J., holm-Price, J., Threlfall, E.J., Fielder, M.D., 2010. Cattle, weather and water: mapping Escherichia coli O157:H7 infections in humans in England and Scotland. *Environmental Microbiology.* 12, 2633-2644.

Moore, D.A. and M. Payne. 2007. An evaluation of dairy producer emergency preparedness and farm security education. *Journal of Dairy Science.* 90, 2052-2057.

Morgan-Davies, C., A. Waterhouse, C. Milne, and A. Stott. 2006. Farmers' opinions on welfare, health and production practices in extensive hill sheep flocks in Great Britain. *Livestock Science.* 104, 268-277.

Moxley, R.A., Smith, D.R., Luebbe, M., Erickson, G.E., Klopfenstein, T.J., Rogan, D., 2009. Escherichia coli O157:H7 vaccine dose-effect in feedlot cattle. *Foodborne Pathogens and Disease.* 6, 879-884.

Mueller, R.O. 1996. *Basic principles of structural equation modeling: An introduction to LISREL and EQS*. New York: Springer-Verlag.

Nataro, J.P., Kaper, J.B. 1998 Diarrheagenic *Escherichia coli*. *Clinical Microbiology Reviews*. 11, 142-201.

Naylor, S.W., Low, J.C., Besser, T.E., Mahajan, A., Gunn, G.J., Pearce, M.C., McKendrick, I.J,. Smith, D.G.E., Gally, D.L. 2003 Lymphoid follicle dense mucosa at the terminal rectum is the principal site of colonization of enterohemorrhagic *Escherichia coli* O157:H7 in the bovine host. *Infection and Immunity*. 71, 1505-1512.

Naylor, S.W., Gally, D.L., Low, J.C. 2005 Enterohaemorrhagic *E. coli* in veterinary medicine. *International Journal of Medical Microbiology.* 295, 419-441.

O'Brien, S.J., Adak, G.K., Gilham, C. 2001 Contact with the farming environment as a major risk factor for sporadic cases of Shiga toxin-producing *Escherichia coli* O157 infection in humans. *Emerging Infectious Diseases*. 7, 1049-51.

Oliver, S.P., Patel, D.A., Callaway T.R. and Torrence M.E. 2009 ASAS Centennial Paper: Developments and future outlook for preharvest food safety. *Journal of Animal Science*. 87, 419-437.

Olmstead, A.L. and P.W. Rhode. 2007. Not on my farm!: Resistance to Bovine Tuberculosis Eradication in the United States. *The Journal of Economic History.* 67, 768-809.

Palmer, S., F. Fozdar, and M. Sully. 2009. The effect of trust on West Australian farmers' responses to infectious livestock diseases. *Sociologia Ruralis.* 49, 360-374.

Parry, S.M., Salmon, R.L., Willshaw, G.A., Cheasty T. 1998 Risk factors for and prevention of sporadic infections with verocytotoxin (shiga toxin) producing *Escherichia coli* O157. *The Lancet.* 351, 1019-22.

Pennington, H., 2009. The Public Inquiry into the September 2005 outbreak of *E. coli* O157 in South Wales. London: The Stationery Office.

Peterson, R.E., Klopfenstein, T.J., Erickson, G.E., Folmer, J., Hinkley, S., Moxley, R.A., Smith, D.R., 2007a. Effect of *Lactobacillus acidophilus* strain NP51 on *Escherichia coli* O157:H7 fecal shedding and finishing performance in beef feedlot cattle. *Journal of Food Protection*. 70, 287-291.

Peterson, R.E., Klopfenstein, T.J., Moxley, R.A., Erickson, G.E., Hinkley, S., Rogan, D., Smith, D.R., 2007b. Efficacy of dose regimen and observation of herd immunity from a vaccine against *Escherichia coli* O157:H7 for feedlot cattle. *Journal of Food Protection.* 70, 2561-2567.

PHA, 2009. Gastrointestinal infections: Laboratory reports of Escherichia coli O157. Public Health Agency of Northern Ireland. accessed on 6th November 2011 at: http://www.publichealth.hscni.net/directorate-public-health/health-protection/gastrointestinal-infections

Ping, R. A. 2008. *How does one specify and estimate latent variables with only 1 or 2 indicators*? [on-line paper]. http://home.att.net/~rpingjr/Under_Det.doc.

Pollock, K.G.J., Duncan, E., Cowden, J.M., 2009. Emotional and Behavioral Changes in Parents of Children Affected by Hemolytic-Uremic Syndrome Associated With Verocytotoxin-Producing Escherichia Coli: A Qualitative Analysis. *Psychosomatics* 50, 263-269.

Pollock, K.G.J., Beattie, T.J., Mackinnon, I., Tarr, P.I., 2010 Relative nephroprotection during *E. coli O157* infection: costs associated with intravenous volume expansion.. Health Protection Scotland. Accessed on 6th November 2011 at: http://www.knowledge.scot.nhs.uk/media/CLT/ResourceUploads/21475/CE22.pdf

Public Health Wales, 2010. Vero cytotoxin-producing *Escherichia coli* (VTEC) O157. Public Health Wales. accessed on 6th November 2011 at:
http://www.wales.nhs.uk/sites3/page.cfm?orgid=457&pid=50499

Rangel, J.M., Sparling, P.H., Crowe, C., Griffin, P.M., Swerdlow, D.L. 2005 Epidemiology of *Escherichia coli* O157:H7 outbreaks, United States, 1982-2002. *Emerging Infectious Diseases.* 11, 603-609.

Roberts, J.A., Upton, P.A., Azene, G., 2000. Escherichia coli O157:H7; an economic assessment of an outbreak. *Journal of Public Health* 22, 99-107.

Sargeant, J.M., Amezcua, M.R., Rajic, A., Waddell, L. 2007 Pre-harvest interventions to reduce the shedding of *E. coli* O157 in the faeces of weaned domestic ruminants: a systematic review. *Zoonoses Public Health* 54, 260-277.

Smith, D.R., Moxley, R.A., Peterson, R.E., Klopfenstein, T.J., Erickson, G.E., Bretschneider, G., Berberov, E.M., Clowser, S., 2009a A two-dose regimen of a vaccine against type III secreted proteins reduced Escherichia coli O157:H7 colonization of the terminal rectum in beef cattle in commercial feedlots. *Foodborne Pathogens and Disease*. 6, 155-161.

Smith, D.R., Moxley, R.A., Klopfenstein, T.J., Erickson, G.E., 2009b A randomized longitudinal trial to test the effect of regional vaccination within a cattle feedyard on *Escherichia coli* O157:H7 rectal colonization, fecal shedding, and hide contamination. *Foodborne Pathogens and Disease.* 6, 885-892.

Steinmuller, N., Demma, L., Bender, J.B., Eidson, M., Angulo, F.J. 2006 Outbreaks of enteric disease: not just a foodborne problem anymore. *Clinical Infectious Diseases*. 43, 1596-602.

Stevens, M.P., van Diemen, P.M., Dziva, F., Jones, P.W., and Wallis, T. S. 2002 Options for the control of enterohaemorragic *Escherichia coli* in ruminants. *Microbiology.* 148, 3767-3778.

Stott, A.W., J. Lloyd, R.W. Humphry, and G.J. Gunn. 2003. A linear programming approach to estimate the economic impact of bovine viral diarrhoea (BVD) at the whole-farm level in Scotland. *Preventative Veterinary Medicine.* 59, 51-66.

Strachan, N.J.C., Dunn, G.M., Locking, M.E., Reid, T.M.S., Ogden, I.D. 2006 *Escherichia coli* O157: burger bug or environmental pathogen? *International Journal of Food Microbiology*. 112, 129-137.

Synge, B. 2000 Veterinary significance of verocytotoxin-producing *Escherichia coli* O157. *World Journal of Microbiology and Biotechnology.* 16: 725-732.

Synge, B.A., Chase-Topping, M.E., Hopkins, G.F., McKendrick, I.J., Thomson-Carter, F., Gray, D., Rusbridge, S.M., Munro, F.I., Foster, G., Gunn, G.J., 2003. Factors Influencing the Shedding of Verocytotoxin-Producing *Escherichia coli* O157 by Beef Suckler Cows. Epidemiology and Infection 130, 301-312.

Tariq, L., Haagsma, J., Havelaar, A., 2011. Cost of Illness and Disease Burden in The Netherlands Due to Infections with Shiga Toxin Producing *Escherichia coli O157*. *Journal of Food Protection*. 74, 545-552.

Thomson, D.U., Loneragan, G.H., Thornton, A.B., Lechtenberg, K.F., Emery, D.A., Burkhardt, D.T., Nagaraja, T.G., 2009. Use of a siderophore receptor and porin proteins-based vaccine to control the burden of escherichia coli O157:H7 in feedlot cattle. *Foodborne Pathogens and Disease.* 6, 871-877.

Thornton, A.B., Thomson, D.U., Loneragan, G.H., Fox, J.T., Burkhardt, D.T., Emery, D.A., Nagaraja, T.G., 2009 Effects of a siderophore receptor and porin proteins-based vaccination on fecal shedding of *Escherichia coli* O157:H7 in experimentally inoculated cattle. *Journal of Food Protection.* 72, 866-869.

Tkalcic, S., Zhao, T., Harmon, B.G., Doyle, M.P., Brown, C.A., Zhao, P., 2003. Fecal shedding of enterohemorrhagic Escherichia coli in weaned calves following treatment with probiotic Escherichia coli. *Journal of Food Protection.* 66, 1184-1189.

Trevena, W.B., Willshaw, G.A., Cheasty, T., Domingue, G., Wray, C. 1999 Transmission of Vero cytotoxin-producing *Escherichia coli* O157 infection from farm animals to humans in Cornwall and West Devon. *Communicable Disease and Public Health.* 2, 263-8.

Tuyttens, F.M., E. Struelens, S. van Gansbeke, and B. Ampe. 2007. Factors influencing farmers' responses to welfare legislation: A case study of gestation sow housing in Flanders (Belgium). *Livestock Science.* 116, 289-299.

USDA, 2010 Pre-harvest management controls and intervention options for reducing *Escherichia coli* O157:H7 shedding in cattle. Fact sheet. Accessed at: http://www.fsis.usda.gov/PDF/Reducing_Ecoli_Shedding_In_Cattle_0510.pdf

Velthuis, A.G.J., Mourits, M.C.M., Saatkamp, H.W., de Koeijer, A.A., Elbers, A.R.W., 2011. Financial Evaluation of Different Vaccination Strategies for Controlling the Bluetongue Virus Serotype 8 Epidemic in the Netherlands in 2008. *PLoS ONE*. 6, e19612.

Vosough Ahmadi, B., Frankena, K., Turner, J., Velthuis, A.G.J., Hogeveen, H., Huirne, R.B.M., 2007. Effectiveness of simulated interventions in reducing the estimated prevalence of E. coli O157:H7 in lactating cows in dairy herds. *Veterinary Research.* 38, 755-771.

Zhao, T., Zhao, P., West, J.W., Bernard, J.K., Cross, H.G., Doyle, M.P., 2006. Inactivation of enterohemorrhagic *Escherichia coli* in rumen content- or feces-contaminated drinking water for cattle. *Applied and Environmental Microbiology*. 72. 3268-3273.

Appendices

A.1 *E. coli* O157 telephone survey. Basic statistics

Table 21. All variables - frequencies (region)

		Location				
		England	Scotland	Wales	Northern Ireland	Total
		Column N %	Column N %	Column N %	Column N %	Column N %
Gender	Male	83.0%	84.2%	86.2%	94.1%	85.2%
	Female	17.0%	15.8%	13.8%	5.9%	14.8%
Which age group are you in?	18-35	5.4%	5.0%	5.7%	8.8%	5.7%
	36-50	30.6%	34.7%	30.1%	38.2%	32.1%
	51-65	40.8%	43.6%	39.0%	32.4%	40.2%
	Over 65	23.1%	16.8%	25.2%	20.6%	22.0%
What is your status with respect to the farm holding?	Tenanted	14.3%	15.8%	9.8%	2.9%	12.3%
	Owned	50.3%	64.4%	64.2%	88.2%	61.2%
	Tenanted & owned	34.0%	18.8%	25.2%	5.9%	25.2%
	Employee	1.4%	1.0%	.8%	2.9%	1.2%
Educational background (highest degree)	School	39.5%	48.5%	42.3%	73.5%	45.4%
	College	49.0%	36.6%	44.7%	20.6%	42.2%
	University	11.6%	14.9%	13.0%	5.9%	12.3%
Please give an estimate of the total farm land area (in hectares)	less than 10	2.7%	1.0%	.8%	8.8%	2.2%
	10.01-50	23.1%	13.9%	13.8%	58.8%	21.0%
	50.01-100	28.6%	23.8%	26.0%	23.5%	26.2%
	100.01-150	13.6%	17.8%	20.3%	2.9%	15.8%
	150.01-200	14.3%	12.9%	17.1%	5.9%	14.1%
	200.01-250	5.4%	7.9%	4.9%	.0%	5.4%
	250.01-500	10.2%	17.8%	13.0%	.0%	12.1%
	over 500	2.0%	5.0%	4.1%	.0%	3.2%

Dairy cattle	none	75.5%	81.2%	78.0%	58.8%	76.3%
	0.01-10	.7%	.0%	.0%	.0%	.2%
	10.01-50	2.0%	.0%	5.7%	5.9%	3.0%
	50.01-100	7.5%	4.0%	3.3%	14.7%	5.9%
	100.01-200	8.2%	5.0%	5.7%	5.9%	6.4%
	over 200	6.1%	9.9%	7.3%	14.7%	8.1%
Beef cattle	none	7.5%	8.9%	8.1%	26.5%	9.6%
	0.01-10	6.1%	3.0%	4.1%	5.9%	4.7%
	10.01-50	25.9%	20.8%	22.0%	41.2%	24.7%
	50.01-100	21.1%	22.8%	15.4%	17.6%	19.5%
	100.01-150	12.2%	12.9%	22.0%	2.9%	14.6%
	150.01-200	9.5%	7.9%	10.6%	2.9%	8.9%
	200.01-250	6.8%	3.0%	6.5%	.0%	5.2%
	250.01-300	3.4%	5.9%	4.1%	.0%	4.0%
	over 300	7.5%	14.9%	7.3%	2.9%	8.9%
Sheep	none	50.3%	41.6%	26.0%	73.5%	42.7%
	0.01-100	10.2%	15.8%	7.3%	20.6%	11.6%
	100.01-500	21.8%	21.8%	18.7%	5.9%	19.5%
	500.01-1000	6.1%	12.9%	16.3%	.0%	10.4%
	1000.01-1500	5.4%	4.0%	13.0%	.0%	6.9%
	over 1500	6.1%	4.0%	18.7%	.0%	8.9%
Pigs	none	88.4%	98.0%	91.9%	100.0%	92.8%
	0.01-100	9.5%	2.0%	8.1%	.0%	6.4%
	over 100	2.0%	.0%	.0%	.0%	.7%
Goats	none	98.0%	99.0%	100.0%	100.0%	99.0%
	0.01-2	2.0%	1.0%	.0%	.0%	1.0%
How many people work on the farm full time?	0	6.8%	2.0%	.8%	5.9%	3.7%
	1-3	87.8%	91.1%	91.1%	91.2%	89.9%
	4-10	5.4%	5.9%	7.3%	2.9%	5.9%
	more than 10	.0%	1.0%	.8%	.0%	.5%

How many people work on the farm part time?	none	57.8%	62.4%	74.0%	76.5%	65.4%
	1-3	40.1%	36.6%	23.6%	23.5%	32.8%
	more than 3	2.0%	1.0%	2.4%	.0%	1.7%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	1.4%	1.0%	.0%	.0%	.7%
	Less than a quarter	18.4%	2.0%	1.6%	17.6%	9.1%
	Less than half	17.0%	18.8%	10.6%	11.8%	15.1%
	Half or more	63.3%	78.2%	87.8%	70.6%	75.1%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	54.4%	61.4%	74.8%	64.7%	63.2%
	No	44.9%	38.6%	23.6%	35.3%	36.0%
	Incomplete	.7%	.0%	1.6%	.0%	.7%
Are you certified organic?	Yes	4.8%	2.0%	8.1%	2.9%	4.9%
	No	94.6%	98.0%	91.1%	97.1%	94.6%
	In conversion period	.7%	.0%	.8%	.0%	.5%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	22.4%	20.8%	23.6%	8.8%	21.2%
	No	77.6%	79.2%	76.4%	91.2%	78.8%
Do you charge an entrance fee for petting the animals	Yes	1.4%	2.0%	.0%	.0%	1.0%
	No	98.6%	98.0%	100.0%	100.0%	99.0%
Do you allow visits by school-age children to touch the animals	Yes	4.1%	4.0%	3.3%	2.9%	3.7%
	No	95.9%	96.0%	96.7%	97.1%	96.3%
Do you allow visits by school-age children to see the animals	Yes	7.5%	6.9%	5.7%	5.9%	6.7%
	No	92.5%	93.1%	94.3%	94.1%	93.3%
Do you have any hand-washing facilities for visitors on-farm	Yes	59.9%	51.5%	56.1%	64.7%	57.0%
	No	40.1%	48.5%	43.9%	35.3%	43.0%
Do you open the farm on LEAF open days	Yes	2.0%	1.0%	.0%	.0%	1.0%
	No	98.0%	99.0%	100.0%	100.0%	99.0%
Do you run a farm produce shop from the premises	Yes	4.1%	.0%	.8%	2.9%	2.0%
	No	95.9%	100.0%	99.2%	97.1%	98.0%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	23.1%	43.6%	44.7%	26.5%	35.1%
	No	76.9%	56.4%	55.3%	73.5%	64.9%
Does your land includes public footpaths	Yes	75.5%	41.6%	83.7%	.0%	63.2%
	No	24.5%	58.4%	16.3%	100.0%	36.8%

Does your land includes ground for camping, caravanning	Yes	4.8%	4.0%	6.5%	.0%	4.7%
	No	95.2%	96.0%	93.5%	100.0%	95.3%
Does your land includes fixed holiday accommodation	Yes	4.1%	6.9%	4.9%	.0%	4.7%
	No	95.9%	93.1%	95.1%	100.0%	95.3%
Other	Yes	5.3%	1.6%	4.5%	.0%	3.7%
	No	94.7%	98.4%	95.5%	100.0%	96.3%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%	.0%
	50-99%	1.4%	1.0%	.8%	.0%	1.0%
	5-49%	6.1%	2.0%	3.3%	.0%	3.7%
	<5%	92.5%	97.0%	95.9%	100.0%	95.3%
Would you be willing to participate in a workshop on E. coli O157	Yes	33.3%	35.0%	31.6%	.0%	32.6%
	No	66.7%	65.0%	68.4%	100.0%	67.4%
Attending open days, or farm demonstrations	Frequently	19.7%	27.7%	35.8%	29.4%	27.4%
	Infrequently	57.8%	47.5%	46.3%	44.1%	50.6%
	Never	22.4%	24.8%	17.9%	26.5%	22.0%
Meeting with other farmers	Frequently	61.9%	62.4%	74.8%	73.5%	66.9%
	Infrequently	35.4%	31.7%	22.0%	23.5%	29.4%
	Never	2.7%	5.9%	3.3%	2.9%	3.7%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	78.9%	81.2%	83.7%	82.4%	81.2%
	Infrequently	17.0%	15.8%	13.0%	14.7%	15.3%
	Never	4.1%	3.0%	3.3%	2.9%	3.5%
Searching the internet	Frequently	35.4%	34.7%	29.3%	14.7%	31.6%
	Infrequently	30.6%	27.7%	28.5%	23.5%	28.6%
	Never	34.0%	37.6%	42.3%	61.8%	39.8%
By asking agricultural consultants	Frequently	25.9%	24.8%	18.7%	14.7%	22.5%
	Infrequently	41.5%	46.5%	31.7%	38.2%	39.5%
	Never	32.7%	28.7%	49.6%	47.1%	38.0%
By asking sales people	Frequently	17.7%	23.8%	14.6%	8.8%	17.5%
	Infrequently	57.1%	56.4%	56.1%	35.3%	54.8%
	Never	25.2%	19.8%	29.3%	55.9%	27.7%

By asking a veterinary surgeon	Frequently	68.0%	78.2%	78.0%	55.9%	72.6%
	Infrequently	27.9%	19.8%	19.5%	44.1%	24.7%
	Never	4.1%	2.0%	2.4%	.0%	2.7%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government.)	Frequently	32.0%	38.6%	38.2%	41.2%	36.3%
	Infrequently	47.6%	43.6%	39.0%	23.5%	42.0%
	Never	20.4%	17.8%	22.8%	35.3%	21.7%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	29.3%	26.7%	39.0%	29.4%	31.6%
	Infrequently	47.6%	43.6%	35.8%	29.4%	41.5%
	Never	23.1%	29.7%	25.2%	41.2%	26.9%
Other	Frequently	4.3%	3.3%	3.4%	3.3%	3.7%
	Infrequently	1.1%	.0%	1.1%	3.3%	1.1%
	Never	94.6%	96.7%	95.5%	93.3%	95.2%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	.7%	2.0%	.8%	2.9%	1.2%
	Disagree	5.4%	5.0%	1.6%	2.9%	4.0%
	Neither agree nor disagree	8.8%	4.0%	4.9%	2.9%	5.9%
	Agree	45.6%	35.6%	38.2%	47.1%	41.0%
	Strongly Agree	21.8%	29.7%	31.7%	35.3%	27.9%
	Don't know	17.7%	23.8%	22.8%	8.8%	20.0%
E. coli O157 causes mastitis in cattle	Strongly Disagree	6.1%	4.0%	6.5%	14.7%	6.4%
	Disagree	6.1%	14.9%	8.9%	14.7%	9.9%
	Neither agree nor disagree	11.6%	8.9%	7.3%	2.9%	8.9%
	Agree	25.2%	20.8%	27.6%	26.5%	24.9%
	Strongly Agree	17.0%	7.9%	15.4%	11.8%	13.8%
	Don't know	34.0%	43.6%	34.1%	29.4%	36.0%

E. coli O157 causes disease in cattle	Strongly Disagree	2.7%	3.0%	2.4%	8.8%	3.2%
	Disagree	16.3%	7.9%	11.4%	11.8%	12.3%
	Neither agree nor disagree	8.8%	5.9%	8.1%	2.9%	7.4%
	Agree	35.4%	33.7%	45.5%	29.4%	37.5%
	Strongly Agree	18.4%	19.8%	13.8%	32.4%	18.5%
	Don't know	18.4%	29.7%	18.7%	14.7%	21.0%
E. coli O157 causes disease in people	Strongly Disagree	2.7%	.0%	.0%	2.9%	1.2%
	Disagree	4.1%	.0%	2.4%	8.8%	3.0%
	Neither agree nor disagree	4.1%	2.0%	4.1%	5.9%	3.7%
	Agree	41.5%	39.6%	48.8%	20.6%	41.5%
	Strongly Agree	36.7%	52.5%	32.5%	47.1%	40.2%
	Don't know	10.9%	5.9%	12.2%	14.7%	10.4%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	3.4%	2.0%	2.4%	.0%	2.5%
	Disagree	8.8%	4.0%	8.1%	17.6%	8.1%
	Neither agree nor disagree	16.3%	9.9%	12.2%	5.9%	12.6%
	Agree	40.8%	43.6%	39.0%	29.4%	40.0%
	Strongly Agree	18.4%	24.8%	20.3%	29.4%	21.5%
	Don't know	12.2%	15.8%	17.9%	17.6%	15.3%
E. coli O157 can be present on raw meat	Strongly Disagree	1.4%	.0%	.8%	.0%	.7%
	Disagree	2.0%	.0%	2.4%	.0%	1.5%
	Neither agree nor disagree	8.8%	5.9%	8.9%	8.8%	8.1%
	Agree	41.5%	47.5%	39.8%	38.2%	42.2%
	Strongly Agree	28.6%	41.6%	33.3%	32.4%	33.6%
	Don't know	17.7%	5.0%	14.6%	20.6%	13.8%

E. coli O157 can be present in raw milk	Strongly Disagree	2.0%	2.0%	.8%	2.9%	1.7%
	Disagree	5.4%	7.9%	4.9%	2.9%	5.7%
	Neither agree nor disagree	12.9%	8.9%	12.2%	2.9%	10.9%
	Agree	31.3%	33.7%	34.1%	32.4%	32.8%
	Strongly Agree	20.4%	15.8%	9.8%	20.6%	16.0%
	Don't know	27.9%	31.7%	38.2%	38.2%	32.8%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	4.1%	1.0%	3.3%	11.8%	3.7%
	Disagree	6.1%	5.0%	13.8%	.0%	7.7%
	Neither agree nor disagree	8.8%	11.9%	5.7%	8.8%	8.6%
	Agree	38.8%	39.6%	35.0%	29.4%	37.0%
	Strongly Agree	13.6%	21.8%	14.6%	23.5%	16.8%
	Don't know	28.6%	20.8%	27.6%	26.5%	26.2%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	3.4%	2.0%	2.4%	5.9%	3.0%
	Disagree	4.1%	2.0%	9.8%	8.8%	5.7%
	Neither agree nor disagree	8.8%	9.9%	3.3%	14.7%	7.9%
	Agree	34.7%	37.6%	26.0%	23.5%	31.9%
	Strongly Agree	13.6%	27.7%	22.0%	11.8%	19.5%
	Don't know	35.4%	20.8%	36.6%	35.3%	32.1%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	1.4%	2.0%	8.1%	5.9%	4.0%
	Disagree	4.8%	3.0%	4.9%	5.9%	4.4%
	Neither agree nor disagree	8.2%	8.9%	6.5%	14.7%	8.4%
	Agree	53.1%	52.5%	46.3%	32.4%	49.1%
	Strongly Agree	22.4%	27.7%	22.0%	23.5%	23.7%
	Don't know	10.2%	5.9%	12.2%	17.6%	10.4%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	1.4%	2.0%	1.6%	5.9%	2.0%
	Disagree	4.1%	5.0%	5.7%	2.9%	4.7%
	Neither agree nor disagree	9.5%	1.0%	1.6%	2.9%	4.4%
	Agree	35.4%	34.7%	35.8%	35.3%	35.3%
	Strongly Agree	43.5%	52.5%	50.4%	44.1%	47.9%
	Don't know	4.8%	3.0%	2.4%	5.9%	3.7%
	Not applicable	1.4%	2.0%	2.4%	2.9%	2.0%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	23.8%	27.7%	20.3%	32.4%	24.4%
	Disagree	23.8%	32.7%	31.7%	35.3%	29.4%
	Neither agree nor disagree	17.0%	10.9%	8.1%	14.7%	12.6%
	Agree	17.7%	12.9%	16.3%	14.7%	15.8%
	Strongly Agree	2.7%	3.0%	4.1%	.0%	3.0%
	Don't know	14.3%	11.9%	17.1%	2.9%	13.6%
	Not applicable	.7%	1.0%	2.4%	.0%	1.2%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	1.4%	.0%	.8%	2.9%	1.0%
	Disagree	1.4%	.0%	2.4%	.0%	1.2%
	Neither agree nor disagree	4.8%	1.0%	2.4%	5.9%	3.2%
	Agree	32.7%	34.7%	34.1%	29.4%	33.3%
	Strongly Agree	58.5%	64.4%	58.5%	58.8%	60.0%
	Don't know	1.4%	.0%	1.6%	2.9%	1.2%
	Not applicable	.0%	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	19.7%	13.9%	12.2%	2.9%	14.6%
	Disagree	30.6%	23.8%	31.7%	32.4%	29.4%
	Neither agree nor disagree	15.6%	17.8%	17.9%	8.8%	16.3%
	Agree	21.1%	22.8%	20.3%	41.2%	23.0%
	Strongly Agree	6.1%	10.9%	8.1%	11.8%	8.4%
	Don't know	4.8%	8.9%	8.1%	2.9%	6.7%
	Not applicable	2.0%	2.0%	1.6%	.0%	1.7%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	8.8%	10.9%	6.5%	2.9%	8.1%
	Disagree	21.1%	10.9%	15.4%	14.7%	16.3%
	Neither agree nor disagree	19.0%	19.8%	8.9%	2.9%	14.8%
	Agree	27.9%	37.6%	40.7%	47.1%	35.8%
	Strongly Agree	13.6%	13.9%	22.8%	26.5%	17.5%
	Don't know	6.1%	5.9%	3.3%	5.9%	5.2%
	Not applicable	3.4%	1.0%	2.4%	.0%	2.2%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	15.0%	7.9%	3.3%	5.9%	8.9%
	Disagree	13.6%	5.9%	11.4%	5.9%	10.4%
	Neither agree nor disagree	2.7%	8.9%	6.5%	8.8%	5.9%
	Agree	7.5%	3.0%	7.3%	5.9%	6.2%
	Strongly Agree	2.0%	5.0%	4.1%	.0%	3.2%
	Don't know	5.4%	3.0%	3.3%	5.9%	4.2%
	Not applicable	53.7%	66.3%	64.2%	67.6%	61.2%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	6.8%	3.0%	1.6%	8.8%	4.4%
	Disagree	13.6%	6.9%	14.6%	8.8%	11.9%
	Neither agree nor disagree	17.0%	9.9%	13.0%	8.8%	13.3%
	Agree	39.5%	38.6%	33.3%	26.5%	36.3%
	Strongly Agree	8.8%	17.8%	16.3%	17.6%	14.1%
	Don't know	11.6%	15.8%	13.0%	20.6%	13.8%
	Not applicable	2.7%	7.9%	8.1%	8.8%	6.2%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	8.8%	3.0%	6.5%	11.8%	6.9%
	Disagree	18.4%	8.9%	15.4%	14.7%	14.8%
	Neither agree nor disagree	8.2%	14.9%	13.0%	8.8%	11.4%
	Agree	27.9%	24.8%	26.0%	29.4%	26.7%
	Strongly Agree	10.9%	17.8%	10.6%	8.8%	12.3%
	Don't know	20.4%	17.8%	21.1%	23.5%	20.2%
	Not applicable	5.4%	12.9%	7.3%	2.9%	7.7%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	85.7%	92.1%	83.7%	73.5%	85.7%
	Farm owners	14.3%	7.9%	16.3%	26.5%	14.3%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	88.4%	95.0%	91.1%	97.1%	91.6%
	Meat/Milk Processors	11.6%	5.0%	8.9%	2.9%	8.4%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	89.1%	89.1%	94.3%	97.1%	91.4%
	Food Retailers	10.9%	10.9%	5.7%	2.9%	8.6%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	90.5%	84.2%	88.6%	94.1%	88.6%
	Public	9.5%	15.8%	11.4%	5.9%	11.4%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	90.5%	96.0%	93.5%	100.0%	93.6%
	Government	9.5%	4.0%	6.5%	.0%	6.4%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	40.8%	33.7%	36.6%	41.2%	37.8%
	All	59.2%	66.3%	63.4%	58.8%	62.2%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	94.6%	93.1%	96.7%	94.1%	94.8%
	Don't know	5.4%	6.9%	3.3%	5.9%	5.2%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	32.7%	33.7%	32.5%	44.1%	33.8%
	Farm owners	67.3%	66.3%	67.5%	55.9%	66.2%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	97.3%	95.0%	92.7%	97.1%	95.3%
	Meat/Milk Processors	2.7%	5.0%	7.3%	2.9%	4.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	97.3%	98.0%	95.9%	100.0%	97.3%
	Food Retailers	2.7%	2.0%	4.1%	.0%	2.7%
Who do you think is responsible for controlling E. coli O157 on-farms – Public	0	98.6%	99.0%	97.6%	97.1%	98.3%
	Public	1.4%	1.0%	2.4%	2.9%	1.7%
Who do you think is responsible for controlling E. coli O157 on-farms – Government	0	91.2%	87.1%	85.4%	85.3%	87.9%
	Government	8.8%	12.9%	14.6%	14.7%	12.1%
Who do you think is responsible for controlling E. coli O157 on-farms – All	0	76.9%	78.2%	84.6%	73.5%	79.3%
	All	23.1%	21.8%	15.4%	26.5%	20.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	95.2%	94.1%	92.7%	94.1%	94.1%
	Don't know	4.8%	5.9%	7.3%	5.9%	5.9%
Government or European animal health regulations	Not affected	36.1%	45.5%	40.7%	41.2%	40.2%
	Slightly affected	32.0%	27.7%	30.1%	26.5%	29.9%
	Much affected	32.0%	26.7%	29.3%	32.4%	29.9%

Reports of E. coli O157 outbreaks or incidents	Not affected	89.1%	86.1%	90.2%	91.2%	88.9%
	Slightly affected	8.2%	8.9%	8.9%	5.9%	8.4%
	Much affected	2.7%	5.0%	.8%	2.9%	2.7%
Experience of E. coli O157 outbreaks or incidents	Not affected	91.8%	93.1%	92.7%	88.2%	92.1%
	Slightly affected	6.8%	4.0%	4.9%	11.8%	5.9%
	Much affected	1.4%	3.0%	2.4%	.0%	2.0%
Incidents of E. coli O157 that occurred on your farm	Not affected	89.8%	96.0%	91.9%	88.2%	91.9%
	Slightly affected	8.2%	1.0%	4.9%	8.8%	5.4%
	Much affected	2.0%	3.0%	3.3%	2.9%	2.7%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	58.5%	59.4%	55.3%	67.6%	58.5%
	Not willing to use this	41.5%	40.6%	44.7%	32.4%	41.5%
The cost is too expensive	Strongly disagree	4.9%	4.9%	1.8%	.0%	3.6%
	Disagree	16.4%	.0%	9.1%	9.1%	9.5%
	Neither disagree nor agree	14.8%	34.1%	9.1%	27.3%	18.5%
	Agree	23.0%	9.8%	34.5%	27.3%	23.8%
	Strongly agree	41.0%	51.2%	45.5%	36.4%	44.6%
	Don't know	.0%	.0%	.0%	.0%	.0%
Doing this would take too much time	Strongly disagree	8.2%	7.3%	3.6%	18.2%	7.1%
	Disagree	24.6%	22.0%	25.5%	27.3%	24.4%
	Neither disagree nor agree	29.5%	19.5%	10.9%	.0%	19.0%
	Agree	19.7%	34.1%	29.1%	36.4%	27.4%
	Strongly agree	18.0%	17.1%	30.9%	18.2%	22.0%
	Don't know	.0%	.0%	.0%	.0%	.0%
I would need more information before using a vaccine	Strongly disagree	.0%	2.4%	.0%	.0%	.6%
	Disagree	3.3%	.0%	1.8%	9.1%	2.4%
	Neither disagree nor agree	6.6%	4.9%	3.6%	9.1%	5.4%
	Agree	21.3%	17.1%	29.1%	36.4%	23.8%
	Strongly agree	68.9%	75.6%	63.6%	45.5%	67.3%
	Don't know	.0%	.0%	1.8%	.0%	.6%

I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	11.5%	19.5%	12.7%	.0%	13.1%
	Disagree	16.4%	14.6%	23.6%	9.1%	17.9%
	Neither disagree nor agree	27.9%	24.4%	20.0%	18.2%	23.8%
	Agree	31.1%	19.5%	30.9%	54.5%	29.8%
	Strongly agree	13.1%	22.0%	9.1%	18.2%	14.3%
	Don't know	.0%	.0%	3.6%	.0%	1.2%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	6.6%	12.2%	10.9%	.0%	8.9%
	Disagree	11.5%	12.2%	9.1%	9.1%	10.7%
	Neither disagree nor agree	11.5%	22.0%	21.8%	18.2%	17.9%
	Agree	45.9%	19.5%	34.5%	45.5%	35.7%
	Strongly agree	23.0%	34.1%	20.0%	27.3%	25.0%
	Don't know	1.6%	.0%	3.6%	.0%	1.8%
Other	Strongly disagree	7.7%	.0%	.0%	.0%	2.7%
	Disagree	.0%	.0%	2.6%	.0%	.9%
	Neither disagree nor agree	.0%	11.1%	2.6%	.0%	3.5%
	Agree	10.3%	3.7%	5.3%	11.1%	7.1%
	Strongly agree	53.8%	55.6%	26.3%	22.2%	42.5%
	Don't know	28.2%	29.6%	63.2%	66.7%	43.4%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	36.1%	38.6%	43.1%	44.1%	39.5%
	Not willing to use this	63.9%	61.4%	56.9%	55.9%	60.5%
The cost is too expensive	Strongly disagree	3.2%	3.2%	.0%	.0%	2.0%
	Disagree	8.5%	3.2%	8.6%	5.3%	6.9%
	Neither disagree nor agree	11.7%	12.9%	5.7%	10.5%	10.2%
	Agree	29.8%	22.6%	31.4%	36.8%	29.0%
	Strongly agree	43.6%	58.1%	52.9%	47.4%	50.2%
	Don't know	3.2%	.0%	1.4%	.0%	1.6%

Doing this would take too much time	Strongly disagree	8.5%	8.1%	2.9%	5.3%	6.5%
	Disagree	26.6%	19.4%	12.9%	31.6%	21.2%
	Neither disagree nor agree	16.0%	29.0%	10.0%	10.5%	17.1%
	Agree	24.5%	14.5%	31.4%	15.8%	23.3%
	Strongly agree	21.3%	29.0%	40.0%	36.8%	29.8%
	Don't know	3.2%	.0%	2.9%	.0%	2.0%
I would need more information before using an additive	Strongly disagree	1.1%	1.6%	4.3%	5.3%	2.4%
	Disagree	4.3%	.0%	2.9%	15.8%	3.7%
	Neither disagree nor agree	6.4%	6.5%	4.3%	5.3%	5.7%
	Agree	20.2%	21.0%	31.4%	26.3%	24.1%
	Strongly agree	68.1%	71.0%	55.7%	47.4%	63.7%
	Don't know	.0%	.0%	1.4%	.0%	.4%
I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	13.8%	17.7%	21.4%	5.3%	16.3%
	Disagree	16.0%	9.7%	28.6%	42.1%	20.0%
	Neither disagree nor agree	23.4%	29.0%	11.4%	5.3%	20.0%
	Agree	35.1%	29.0%	25.7%	31.6%	30.6%
	Strongly agree	11.7%	14.5%	11.4%	15.8%	12.7%
	Don't know	.0%	.0%	1.4%	.0%	.4%
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	6.4%	9.7%	8.6%	.0%	7.3%
	Disagree	10.6%	11.3%	15.7%	21.1%	13.1%
	Neither disagree nor agree	25.5%	22.6%	12.9%	21.1%	20.8%
	Agree	38.3%	35.5%	41.4%	47.4%	39.2%
	Strongly agree	19.1%	21.0%	17.1%	10.5%	18.4%
	Don't know	.0%	.0%	4.3%	.0%	1.2%

Other	Strongly disagree	7.1%	.0%	.0%	.0%	2.6%
	Disagree	.0%	.0%	.0%	.0%	.0%
	Neither disagree nor agree	1.8%	8.1%	2.0%	.0%	3.2%
	Agree	8.9%	5.4%	8.2%	.0%	7.1%
	Strongly agree	33.9%	48.6%	22.4%	15.4%	32.3%
	Don't know	48.2%	37.8%	67.3%	84.6%	54.8%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	12.9%	7.9%	12.2%	5.9%	10.9%
	Of little practicality	9.5%	14.9%	12.2%	8.8%	11.6%
	Moderately practical	8.8%	12.9%	10.6%	5.9%	10.1%
	Practical	24.5%	16.8%	22.0%	35.3%	22.7%
	Very practical	43.5%	44.6%	41.5%	35.3%	42.5%
	Not applicable	.7%	3.0%	1.6%	8.8%	2.2%
Separating animals into different age groups for the majority of the time	Not at all practical	8.8%	5.9%	11.4%	5.9%	8.6%
	Of little practicality	8.2%	4.0%	3.3%	11.8%	5.9%
	Moderately practical	4.8%	16.8%	9.8%	11.8%	9.9%
	Practical	29.3%	18.8%	29.3%	38.2%	27.4%
	Very practical	48.3%	52.5%	43.9%	32.4%	46.7%
	Not applicable	.7%	2.0%	2.4%	.0%	1.5%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	17.0%	20.8%	24.4%	20.6%	20.5%
	Of little practicality	23.1%	19.8%	16.3%	5.9%	18.8%
	Moderately practical	12.9%	18.8%	11.4%	11.8%	13.8%
	Practical	19.7%	16.8%	28.5%	41.2%	23.5%
	Very practical	20.4%	12.9%	13.8%	17.6%	16.3%
	Not applicable	6.8%	10.9%	5.7%	2.9%	7.2%
Reducing your current livestock numbers on the farm	Not at all practical	41.5%	46.5%	49.6%	29.4%	44.2%
	Of little practicality	26.5%	23.8%	17.1%	11.8%	21.7%
	Moderately practical	9.5%	12.9%	13.0%	14.7%	11.9%
	Practical	9.5%	5.0%	10.6%	26.5%	10.1%
	Very practical	9.5%	8.9%	8.1%	5.9%	8.6%
	Not applicable	3.4%	3.0%	1.6%	11.8%	3.5%

Cleaning water troughs daily	Not at all practical	25.9%	12.9%	26.8%	2.9%	21.0%
	Of little practicality	25.9%	20.8%	21.1%	5.9%	21.5%
	Moderately practical	17.0%	16.8%	20.3%	17.6%	18.0%
	Practical	18.4%	17.8%	13.8%	35.3%	18.3%
	Very practical	12.2%	23.8%	15.4%	35.3%	18.0%
	Not applicable	.7%	7.9%	2.4%	2.9%	3.2%
Cleaning feed troughs daily	Not at all practical	8.8%	13.9%	12.2%	8.8%	11.1%
	Of little practicality	16.3%	8.9%	16.3%	2.9%	13.3%
	Moderately practical	15.6%	18.8%	17.9%	14.7%	17.0%
	Practical	25.9%	16.8%	25.2%	35.3%	24.2%
	Very practical	27.9%	35.6%	26.0%	35.3%	29.9%
	Not applicable	5.4%	5.9%	2.4%	2.9%	4.4%
Disinfecting the animal sheds/pens weekly	Not at all practical	40.8%	42.6%	45.5%	14.7%	40.5%
	Of little practicality	28.6%	18.8%	20.3%	35.3%	24.2%
	Moderately practical	14.3%	16.8%	13.0%	20.6%	15.1%
	Practical	7.5%	8.9%	10.6%	14.7%	9.4%
	Very practical	6.8%	6.9%	8.9%	11.8%	7.9%
	Not applicable	2.0%	5.9%	1.6%	2.9%	3.0%
Quarantine and testing of livestock brought to the farm	Not at all practical	6.1%	5.0%	10.6%	8.8%	7.4%
	Of little practicality	12.2%	8.9%	6.5%	2.9%	8.9%
	Moderately practical	15.0%	7.9%	14.6%	14.7%	13.1%
	Practical	25.9%	17.8%	22.8%	32.4%	23.5%
	Very practical	25.2%	47.5%	35.0%	23.5%	33.6%
	Not applicable	15.6%	12.9%	10.6%	17.6%	13.6%
Applying slaked lime to animal bedding every 3 weeks	Not at all practical	12.2%	17.8%	14.6%	5.9%	13.8%
	Of little practicality	18.4%	18.8%	13.0%	14.7%	16.5%
	Moderately practical	15.0%	19.8%	13.8%	14.7%	15.8%
	Practical	33.3%	18.8%	29.3%	32.4%	28.4%
	Very practical	17.0%	14.9%	22.8%	23.5%	18.8%
	Not applicable	4.1%	9.9%	6.5%	8.8%	6.7%

willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	19.0%	17.8%	17.1%	5.9%	17.0%
	Less than £1	15.6%	11.9%	18.7%	11.8%	15.3%
	£1 to £5	44.2%	46.5%	45.5%	61.8%	46.7%
	£5 to £10	12.9%	6.9%	8.9%	11.8%	10.1%
	More than £10	.7%	6.9%	5.7%	5.9%	4.2%
	Not applicable	7.5%	9.9%	4.1%	2.9%	6.7%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	12.9%	13.9%	12.2%	.0%	11.9%
	1 day / year	21.1%	15.8%	17.1%	17.6%	18.3%
	30 min / month	27.9%	24.8%	24.4%	23.5%	25.7%
	30 min / week	24.5%	27.7%	26.0%	29.4%	26.2%
	30 min / day	8.2%	7.9%	11.4%	26.5%	10.6%
	Not applicable	5.4%	9.9%	8.9%	2.9%	7.4%
Had you heard of E. coli O157 before we contacted you?	Yes	72.8%	77.2%	72.4%	61.8%	72.8%
	No	27.2%	22.8%	27.6%	38.2%	27.2%
The last time you heard of E. coli O157 was it about? - Human illness	0	27.1%	20.5%	27.0%	61.9%	27.8%
	Human illness	72.9%	79.5%	73.0%	38.1%	72.2%
The last time you heard of E. coli O157 was it about? - Food contamination	0	76.6%	59.0%	68.5%	66.7%	68.8%
	Food contamination	23.4%	41.0%	31.5%	33.3%	31.2%
The last time you heard of E. coli O157 was it about? - Animal illness	0	77.6%	92.3%	77.5%	57.1%	80.0%
	Animal illness	22.4%	7.7%	22.5%	42.9%	20.0%
Attending open days, or farm demonstrations	Yes	9.3%	10.3%	12.4%	9.5%	10.5%
	No	90.7%	89.7%	87.6%	90.5%	89.5%
Meeting with other farmers	Yes	21.5%	20.5%	24.7%	38.1%	23.4%
	No	78.5%	79.5%	75.3%	61.9%	76.6%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	75.7%	82.1%	83.1%	71.4%	79.3%
	No	24.3%	17.9%	16.9%	28.6%	20.7%
Searching the internet	Yes	13.1%	7.7%	5.6%	4.8%	8.8%
	No	86.9%	92.3%	94.4%	95.2%	91.2%
By asking agricultural consultants	Yes	6.5%	10.3%	5.6%	9.5%	7.5%
	No	93.5%	89.7%	94.4%	90.5%	92.5%
By asking sales people	Yes	9.3%	5.1%	6.7%	4.8%	7.1%
	No	90.7%	94.9%	93.3%	95.2%	92.9%

By asking a veterinary surgeon	Yes	50.5%	43.6%	37.1%	42.9%	44.1%
	No	49.5%	56.4%	62.9%	57.1%	55.9%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government.)	Yes	43.0%	32.1%	20.2%	33.3%	32.5%
	No	57.0%	67.9%	79.8%	66.7%	67.5%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	27.1%	17.9%	12.4%	14.3%	19.3%
	No	72.9%	82.1%	87.6%	85.7%	80.7%
Other	Yes	5.9%	2.0%	3.1%	4.8%	3.9%
	No	94.1%	98.0%	96.9%	95.2%	96.1%
Do you intend to change your farm size in the next 5 years?	Increase size	19.7%	12.9%	14.6%	14.7%	16.0%
	Maintain size	63.3%	72.3%	73.2%	70.6%	69.1%
	Reduce size	6.1%	4.0%	3.3%	5.9%	4.7%
	Don't know	6.8%	8.9%	3.3%	5.9%	6.2%
	Leave farming business	4.1%	2.0%	5.7%	2.9%	4.0%
Do you intend to change public access to the farm in the next five years	Increase	7.5%	2.0%	5.7%	.0%	4.9%
	Stay same	87.8%	93.1%	90.2%	100.0%	90.9%
	Reduce	1.4%	1.0%	1.6%	.0%	1.2%
	Don't know	3.4%	4.0%	2.4%	.0%	3.0%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	27.9%	16.8%	17.9%	8.8%	20.5%
	Stay same	61.2%	70.3%	65.9%	67.6%	65.4%
	Reduce	4.1%	.0%	1.6%	11.8%	3.0%
	Don't know	6.8%	12.9%	14.6%	11.8%	11.1%

Table 22. All variables - frequencies (*E. coli* control measures)

		A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle		Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	
		Willing to use this	Not willing to use this	Willing to use this	Not willing to use this
		Column N %	Column N %	Column N %	Column N %
Location	England	36.3%	36.3%	33.1%	38.4%
	Scotland	25.3%	24.4%	24.4%	25.3%
	Wales	28.7%	32.7%	33.1%	28.6%
	Northern Ireland	9.7%	6.5%	9.4%	7.8%
Gender	Male	86.9%	82.7%	84.4%	85.7%
	Female	13.1%	17.3%	15.6%	14.3%
Which age group are you in?	18-35	8.0%	2.4%	5.6%	5.7%
	36-50	27.0%	39.3%	27.5%	35.1%
	51-65	42.2%	37.5%	40.0%	40.4%
	Over 65	22.8%	20.8%	26.9%	18.8%
What is your status with respect to the farm holding?	Tenanted	13.9%	10.1%	13.1%	11.8%
	Owned	62.9%	58.9%	64.4%	59.2%
	Tenanted & owned	22.8%	28.6%	20.6%	28.2%
	Employee	.4%	2.4%	1.9%	.8%
Educational background (highest degree)	School	44.7%	46.4%	47.5%	44.1%
	College	42.2%	42.3%	43.1%	41.6%
	University	13.1%	11.3%	9.4%	14.3%

Please give an estimate of the total farm land area (in hectares)	less than 10	2.5%	1.8%	2.5%	2.0%
	10.01-50	23.6%	17.3%	25.6%	18.0%
	50.01-100	26.2%	26.2%	24.4%	27.3%
	100.01-150	15.6%	16.1%	15.6%	15.9%
	150.01-200	13.5%	14.9%	14.4%	13.9%
	200.01-250	4.2%	7.1%	4.4%	6.1%
	250.01-500	10.1%	14.9%	9.4%	13.9%
	over 500	4.2%	1.8%	3.8%	2.9%
Dairy cattle	none	75.5%	77.4%	75.6%	76.7%
	0.01-10	.0%	.6%	.0%	.4%
	10.01-50	3.0%	3.0%	3.1%	2.9%
	50.01-100	7.6%	3.6%	8.8%	4.1%
	100.01-200	5.9%	7.1%	6.9%	6.1%
	over 200	8.0%	8.3%	5.6%	9.8%
Beef cattle	none	10.5%	8.3%	10.6%	9.0%
	0.01-10	4.6%	4.8%	4.4%	4.9%
	10.01-50	26.6%	22.0%	28.8%	22.0%
	50.01-100	18.6%	20.8%	19.4%	19.6%
	100.01-150	12.2%	17.9%	13.1%	15.5%
	150.01-200	9.3%	8.3%	9.4%	8.6%
	200.01-250	7.2%	2.4%	5.0%	5.3%
	250.01-300	3.8%	4.2%	3.1%	4.5%
	over 300	7.2%	11.3%	6.3%	10.6%
Sheep	none	43.0%	42.3%	46.3%	40.4%
	0.01-100	13.1%	9.5%	13.8%	10.2%
	100.01-500	21.9%	16.1%	18.8%	20.0%
	500.01-1000	9.7%	11.3%	9.4%	11.0%
	1000.01-1500	5.1%	9.5%	5.6%	7.8%
	over 1500	7.2%	11.3%	6.3%	10.6%
Pigs	none	93.2%	92.3%	91.3%	93.9%
	0.01-100	5.9%	7.1%	7.5%	5.7%
	over 100	.8%	.6%	1.3%	.4%

Goats	none	100.0%	97.6%	98.8%	99.2%
	0.01-2	.0%	2.4%	1.3%	.8%
How many people work on the farm full time?	0	3.8%	3.6%	3.1%	4.1%
	1-3	89.0%	91.1%	91.9%	88.6%
	4-10	6.3%	5.4%	4.4%	6.9%
	more than 10	.8%	.0%	.6%	.4%
How many people work on the farm part time?	none	66.2%	64.3%	69.4%	62.9%
	1-3	31.2%	35.1%	28.8%	35.5%
	more than 3	2.5%	.6%	1.9%	1.6%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	.4%	1.2%	.0%	1.2%
	Less than a quarter	11.4%	6.0%	8.8%	9.4%
	Less than half	17.7%	11.3%	20.0%	11.8%
	Half or more	70.5%	81.5%	71.3%	77.6%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	64.1%	61.9%	66.9%	60.8%
	No	35.4%	36.9%	32.5%	38.4%
	Incomplete	.4%	1.2%	.6%	.8%
Are you certified organic?	Yes	3.8%	6.5%	3.1%	6.1%
	No	95.8%	92.9%	96.3%	93.5%
	In conversion period	.4%	.6%	.6%	.4%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	18.6%	25.0%	16.9%	24.1%
	No	81.4%	75.0%	83.1%	75.9%
Do you charge an entrance fee for petting the animals	Yes	.8%	1.2%	1.9%	.4%
	No	99.2%	98.8%	98.1%	99.6%
Do you allow visits by school-age children to touch the animals	Yes	3.4%	4.2%	3.8%	3.7%
	No	96.6%	95.8%	96.3%	96.3%
Do you allow visits by school-age children to see the animals	Yes	6.8%	6.5%	5.6%	7.3%
	No	93.2%	93.5%	94.4%	92.7%
Do you have any hand-washing facilities for visitors on-farm	Yes	57.8%	56.0%	60.6%	54.7%
	No	42.2%	44.0%	39.4%	45.3%
Do you open the farm on LEAF open days	Yes	1.3%	.6%	1.9%	.4%
	No	98.7%	99.4%	98.1%	99.6%

Do you run a farm produce shop from the premises	Yes	1.7%	2.4%	1.3%	2.4%
	No	98.3%	97.6%	98.8%	97.6%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	33.3%	37.5%	34.4%	35.5%
	No	66.7%	62.5%	65.6%	64.5%
Does your land includes public footpaths	Yes	62.0%	64.9%	64.4%	62.4%
	No	38.0%	35.1%	35.6%	37.6%
Does your land includes ground for camping, caravanning	Yes	4.6%	4.8%	5.0%	4.5%
	No	95.4%	95.2%	95.0%	95.5%
Does your land includes fixed holiday accommodation	Yes	3.8%	6.0%	4.4%	4.9%
	No	96.2%	94.0%	95.6%	95.1%
Other	Yes	1.9%	6.0%	2.9%	4.2%
	No	98.1%	94.0%	97.1%	95.8%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%
	50-99%	1.3%	.6%	2.5%	.0%
	5-49%	2.5%	5.4%	3.1%	4.1%
	<5%	96.2%	94.0%	94.4%	95.9%
Would you be willing to participate in a workshop on E. coli O157	Yes	33.3%	31.7%	42.5%	24.5%
	No	66.7%	68.3%	57.5%	75.5%
Attending open days, or farm demonstrations	Frequently	30.4%	23.2%	30.6%	25.3%
	Infrequently	47.3%	55.4%	47.5%	52.7%
	Never	22.4%	21.4%	21.9%	22.0%
Meeting with other farmers	Frequently	68.4%	64.9%	63.1%	69.4%
	Infrequently	27.8%	31.5%	33.8%	26.5%
	Never	3.8%	3.6%	3.1%	4.1%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	82.3%	79.8%	81.9%	80.8%
	Infrequently	14.3%	16.7%	14.4%	15.9%
	Never	3.4%	3.6%	3.8%	3.3%
Searching the internet	Frequently	31.6%	31.5%	30.6%	32.2%
	Infrequently	25.7%	32.7%	25.6%	30.6%
	Never	42.6%	35.7%	43.8%	37.1%

By asking agricultural consultants	Frequently	22.4%	22.6%	27.5%	19.2%
	Infrequently	43.0%	34.5%	40.6%	38.8%
	Never	34.6%	42.9%	31.9%	42.0%
By asking sales people	Frequently	17.7%	17.3%	17.5%	17.6%
	Infrequently	58.2%	50.0%	56.9%	53.5%
	Never	24.1%	32.7%	25.6%	29.0%
By asking a veterinary surgeon	Frequently	73.4%	71.4%	73.8%	71.8%
	Infrequently	24.9%	24.4%	24.4%	24.9%
	Never	1.7%	4.2%	1.9%	3.3%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	40.1%	31.0%	38.1%	35.1%
	Infrequently	43.5%	39.9%	41.3%	42.4%
	Never	16.5%	29.2%	20.6%	22.4%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	33.8%	28.6%	33.1%	30.6%
	Infrequently	43.0%	39.3%	41.9%	41.2%
	Never	23.2%	32.1%	25.0%	28.2%
Other	Frequently	3.8%	3.6%	2.9%	4.2%
	Infrequently	.6%	1.8%	.0%	1.8%
	Never	95.6%	94.6%	97.1%	94.0%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	.8%	1.8%	.6%	1.6%
	Disagree	2.1%	6.5%	1.9%	5.3%
	Neither agree nor disagree	7.6%	3.6%	6.3%	5.7%
	Agree	42.6%	38.7%	50.0%	35.1%
	Strongly Agree	30.0%	25.0%	23.1%	31.0%
	Don't know	16.9%	24.4%	18.1%	21.2%
E. coli O157 causes mastitis in cattle	Strongly Disagree	6.3%	6.5%	4.4%	7.8%
	Disagree	8.9%	11.3%	6.3%	12.2%
	Neither agree nor disagree	8.4%	9.5%	8.1%	9.4%
	Agree	27.0%	22.0%	28.8%	22.4%
	Strongly Agree	14.8%	12.5%	11.3%	15.5%
	Don't know	34.6%	38.1%	41.3%	32.7%

E. coli O157 causes disease in cattle	Strongly Disagree	3.0%	3.6%	2.5%	3.7%
	Disagree	10.5%	14.9%	10.6%	13.5%
	Neither agree nor disagree	7.2%	7.7%	7.5%	7.3%
	Agree	38.0%	36.9%	40.6%	35.5%
	Strongly Agree	20.7%	15.5%	15.6%	20.4%
	Don't know	20.7%	21.4%	23.1%	19.6%
E. coli O157 causes disease in people	Strongly Disagree	.8%	1.8%	.6%	1.6%
	Disagree	3.4%	2.4%	2.5%	3.3%
	Neither agree nor disagree	2.5%	5.4%	3.8%	3.7%
	Agree	43.5%	38.7%	46.3%	38.4%
	Strongly Agree	38.4%	42.9%	35.6%	43.3%
	Don't know	11.4%	8.9%	11.3%	9.8%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	1.7%	3.6%	3.1%	2.0%
	Disagree	6.8%	10.1%	5.0%	10.2%
	Neither agree nor disagree	12.7%	12.5%	12.5%	12.7%
	Agree	43.9%	34.5%	43.8%	37.6%
	Strongly Agree	19.8%	23.8%	18.8%	23.3%
	Don't know	15.2%	15.5%	16.9%	14.3%
E. coli O157 can be present on raw meat	Strongly Disagree	.4%	1.2%	1.3%	.4%
	Disagree	1.7%	1.2%	.6%	2.0%
	Neither agree nor disagree	7.2%	9.5%	8.1%	8.2%
	Agree	44.3%	39.3%	46.9%	39.2%
	Strongly Agree	32.5%	35.1%	28.1%	37.1%
	Don't know	13.9%	13.7%	15.0%	13.1%

E. coli O157 can be present in raw milk	Strongly Disagree	1.3%	2.4%	.6%	2.4%
	Disagree	3.8%	8.3%	4.4%	6.5%
	Neither agree nor disagree	8.4%	14.3%	10.0%	11.4%
	Agree	35.9%	28.6%	39.4%	28.6%
	Strongly Agree	18.6%	12.5%	11.3%	19.2%
	Don't know	32.1%	33.9%	34.4%	31.8%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	3.0%	4.8%	3.1%	4.1%
	Disagree	6.8%	8.9%	6.9%	8.2%
	Neither agree nor disagree	7.6%	10.1%	7.5%	9.4%
	Agree	37.6%	36.3%	40.0%	35.1%
	Strongly Agree	17.7%	15.5%	12.5%	19.6%
	Don't know	27.4%	24.4%	30.0%	23.7%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	2.5%	3.6%	1.3%	4.1%
	Disagree	4.6%	7.1%	5.6%	5.7%
	Neither agree nor disagree	8.4%	7.1%	8.8%	7.3%
	Agree	32.5%	31.0%	35.6%	29.4%
	Strongly Agree	19.0%	20.2%	14.4%	22.9%
	Don't know	32.9%	31.0%	34.4%	30.6%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	3.0%	5.4%	3.8%	4.1%
	Disagree	3.4%	6.0%	3.1%	5.3%
	Neither agree nor disagree	9.3%	7.1%	6.9%	9.4%
	Agree	51.5%	45.8%	54.4%	45.7%
	Strongly Agree	21.9%	26.2%	18.1%	27.3%
	Don't know	11.0%	9.5%	13.8%	8.2%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	1.3%	3.0%	1.3%	2.4%
	Disagree	5.1%	4.2%	5.0%	4.5%
	Neither agree nor disagree	4.6%	4.2%	6.3%	3.3%
	Agree	37.6%	32.1%	40.6%	31.8%
	Strongly Agree	45.1%	51.8%	40.6%	52.7%
	Don't know	3.8%	3.6%	4.4%	3.3%
	Not applicable	2.5%	1.2%	1.9%	2.0%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	19.0%	32.1%	23.1%	25.3%
	Disagree	35.0%	21.4%	35.0%	25.7%
	Neither agree nor disagree	12.7%	12.5%	13.1%	12.2%
	Agree	17.7%	13.1%	15.0%	16.3%
	Strongly Agree	3.0%	3.0%	1.3%	4.1%
	Don't know	11.8%	16.1%	11.3%	15.1%
	Not applicable	.8%	1.8%	1.3%	1.2%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	.8%	1.2%	1.3%	.8%
	Disagree	.4%	2.4%	1.9%	.8%
	Neither agree nor disagree	2.1%	4.8%	3.8%	2.9%
	Agree	35.4%	30.4%	33.1%	33.5%
	Strongly Agree	59.9%	60.1%	59.4%	60.4%
	Don't know	1.3%	1.2%	.6%	1.6%
	Not applicable	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	11.0%	19.6%	12.5%	15.9%
	Disagree	24.9%	35.7%	21.3%	34.7%
	Neither agree nor disagree	16.5%	16.1%	17.5%	15.5%
	Agree	29.1%	14.3%	29.4%	18.8%
	Strongly Agree	9.3%	7.1%	9.4%	7.8%
	Don't know	6.8%	6.5%	6.9%	6.5%
	Not applicable	2.5%	.6%	3.1%	.8%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	6.3%	10.7%	6.9%	9.0%
	Disagree	13.9%	19.6%	15.0%	17.1%
	Neither agree nor disagree	12.7%	17.9%	15.0%	14.7%
	Agree	39.2%	31.0%	38.8%	33.9%
	Strongly Agree	20.3%	13.7%	16.3%	18.4%
	Don't know	5.1%	5.4%	4.4%	5.7%
	Not applicable	2.5%	1.8%	3.8%	1.2%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	4.6%	14.9%	8.1%	9.4%
	Disagree	9.7%	11.3%	8.1%	11.8%
	Neither agree nor disagree	6.8%	4.8%	5.0%	6.5%
	Agree	6.3%	6.0%	5.6%	6.5%
	Strongly Agree	3.8%	2.4%	2.5%	3.7%
	Don't know	4.6%	3.6%	6.3%	2.9%
	Not applicable	64.1%	57.1%	64.4%	59.2%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	1.7%	8.3%	2.5%	5.7%
	Disagree	11.0%	13.1%	8.1%	14.3%
	Neither agree nor disagree	12.2%	14.9%	10.0%	15.5%
	Agree	38.4%	33.3%	41.9%	32.7%
	Strongly Agree	14.3%	13.7%	12.5%	15.1%
	Don't know	16.0%	10.7%	15.6%	12.7%
	Not applicable	6.3%	6.0%	9.4%	4.1%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	3.0%	12.5%	3.1%	9.4%
	Disagree	14.8%	14.9%	11.9%	16.7%
	Neither agree nor disagree	13.1%	8.9%	13.1%	10.2%
	Agree	28.3%	24.4%	31.3%	23.7%
	Strongly Agree	11.0%	14.3%	9.4%	14.3%
	Don't know	21.1%	19.0%	22.5%	18.8%
	Not applicable	8.9%	6.0%	8.8%	6.9%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	84.8%	86.9%	81.9%	88.2%
	Farm owners	15.2%	13.1%	18.1%	11.8%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	91.6%	91.7%	91.9%	91.4%
	Meat/Milk Processors	8.4%	8.3%	8.1%	8.6%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	90.7%	92.3%	91.3%	91.4%
	Food Retailers	9.3%	7.7%	8.8%	8.6%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	88.2%	89.3%	88.1%	89.0%
	Public	11.8%	10.7%	11.9%	11.0%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	95.8%	90.5%	95.6%	92.2%
	Government	4.2%	9.5%	4.4%	7.8%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	36.7%	39.3%	35.6%	39.2%
	All	63.3%	60.7%	64.4%	60.8%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	94.9%	94.6%	96.9%	93.5%
	Don't know	5.1%	5.4%	3.1%	6.5%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	30.8%	38.1%	30.0%	36.3%
	Farm owners	69.2%	61.9%	70.0%	63.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	96.2%	94.0%	96.3%	94.7%
	Meat/Milk Processors	3.8%	6.0%	3.8%	5.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	97.9%	96.4%	96.3%	98.0%
	Food Retailers	2.1%	3.6%	3.8%	2.0%
Who do you think is responsible for controlling E. coli O157 on-farms - Public	0	98.7%	97.6%	98.1%	98.4%
	Public	1.3%	2.4%	1.9%	1.6%
Who do you think is responsible for controlling E. coli O157 on-farms - Government	0	89.5%	85.7%	91.3%	85.7%
	Government	10.5%	14.3%	8.8%	14.3%
Who do you think is responsible for controlling E. coli O157 on-farms - All	0	80.6%	77.4%	83.1%	76.7%
	All	19.4%	22.6%	16.9%	23.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	94.5%	93.5%	93.1%	94.7%
	Don't know	5.5%	6.5%	6.9%	5.3%

Government or European animal health regulations	Not affected	43.5%	35.7%	50.0%	33.9%
	Slightly affected	30.8%	28.6%	26.3%	32.2%
	Much affected	25.7%	35.7%	23.8%	33.9%
Reports of E. coli O157 outbreaks or incidents	Not affected	87.3%	91.1%	90.0%	88.2%
	Slightly affected	10.1%	6.0%	8.1%	8.6%
	Much affected	2.5%	3.0%	1.9%	3.3%
Experience of E. coli O157 outbreaks or incidents	Not affected	90.3%	94.6%	91.9%	92.2%
	Slightly affected	7.2%	4.2%	7.5%	4.9%
	Much affected	2.5%	1.2%	.6%	2.9%
Incidents of E. coli O157 that occurred on your farm	Not affected	89.9%	94.6%	92.5%	91.4%
	Slightly affected	6.3%	4.2%	5.6%	5.3%
	Much affected	3.8%	1.2%	1.9%	3.3%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	100.0%	.0%	83.1%	42.4%
	Not willing to use this	.0%	100.0%	16.9%	57.6%
The cost is too expensive	Strongly disagree	.0%	3.6%	3.7%	3.5%
	Disagree	.0%	9.5%	3.7%	10.6%
	Neither disagree nor agree	.0%	18.5%	22.2%	17.7%
	Agree	.0%	23.8%	25.9%	23.4%
	Strongly agree	.0%	44.6%	44.4%	44.7%
	Don't know	.0%	.0%	.0%	.0%
Doing this would take too much time	Strongly disagree	.0%	7.1%	7.4%	7.1%
	Disagree	.0%	24.4%	18.5%	25.5%
	Neither disagree nor agree	.0%	19.0%	22.2%	18.4%
	Agree	.0%	27.4%	33.3%	26.2%
	Strongly agree	.0%	22.0%	18.5%	22.7%
	Don't know	.0%	.0%	.0%	.0%

I would need more information before using a vaccine	Strongly disagree	.0%	.6%	.0%	.7%
	Disagree	.0%	2.4%	.0%	2.8%
	Neither disagree nor agree	.0%	5.4%	11.1%	4.3%
	Agree	.0%	23.8%	18.5%	24.8%
	Strongly agree	.0%	67.3%	66.7%	67.4%
	Don't know	.0%	.6%	3.7%	.0%
I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	.0%	13.1%	11.1%	13.5%
	Disagree	.0%	17.9%	14.8%	18.4%
	Neither disagree nor agree	.0%	23.8%	11.1%	26.2%
	Agree	.0%	29.8%	33.3%	29.1%
	Strongly agree	.0%	14.3%	29.6%	11.3%
	Don't know	.0%	1.2%	.0%	1.4%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	.0%	8.9%	11.1%	8.5%
	Disagree	.0%	10.7%	.0%	12.8%
	Neither disagree nor agree	.0%	17.9%	14.8%	18.4%
	Agree	.0%	35.7%	29.6%	36.9%
	Strongly agree	.0%	25.0%	37.0%	22.7%
	Don't know	.0%	1.8%	7.4%	.7%
Other	Strongly disagree	.0%	2.7%	.0%	3.2%
	Disagree	.0%	.9%	.0%	1.1%
	Neither disagree nor agree	.0%	3.5%	.0%	4.2%
	Agree	.0%	7.1%	5.6%	7.4%
	Strongly agree	.0%	42.5%	50.0%	41.1%
	Don't know	.0%	43.4%	44.4%	43.2%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	56.1%	16.1%	100.0%	.0%
	Not willing to use this	43.9%	83.9%	.0%	100.0%

The cost is too expensive	Strongly disagree	1.9%	2.1%	.0%	2.0%
	Disagree	6.7%	7.1%	.0%	6.9%
	Neither disagree nor agree	9.6%	10.6%	.0%	10.2%
	Agree	34.6%	24.8%	.0%	29.0%
	Strongly agree	46.2%	53.2%	.0%	50.2%
	Don't know	1.0%	2.1%	.0%	1.6%
Doing this would take too much time	Strongly disagree	2.9%	9.2%	.0%	6.5%
	Disagree	18.3%	23.4%	.0%	21.2%
	Neither disagree nor agree	18.3%	16.3%	.0%	17.1%
	Agree	26.9%	20.6%	.0%	23.3%
	Strongly agree	30.8%	29.1%	.0%	29.8%
	Don't know	2.9%	1.4%	.0%	2.0%
I would need more information before using an additive	Strongly disagree	1.9%	2.8%	.0%	2.4%
	Disagree	1.0%	5.7%	.0%	3.7%
	Neither disagree nor agree	3.8%	7.1%	.0%	5.7%
	Agree	27.9%	21.3%	.0%	24.1%
	Strongly agree	64.4%	63.1%	.0%	63.7%
	Don't know	1.0%	.0%	.0%	.4%
I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	14.4%	17.7%	.0%	16.3%
	Disagree	15.4%	23.4%	.0%	20.0%
	Neither disagree nor agree	15.4%	23.4%	.0%	20.0%
	Agree	37.5%	25.5%	.0%	30.6%
	Strongly agree	16.3%	9.9%	.0%	12.7%
	Don't know	1.0%	.0%	.0%	.4%

I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	2.9%	10.6%	.0%	7.3%
	Disagree	6.7%	17.7%	.0%	13.1%
	Neither disagree nor agree	13.5%	26.2%	.0%	20.8%
	Agree	51.9%	29.8%	.0%	39.2%
	Strongly agree	23.1%	14.9%	.0%	18.4%
	Don't know	1.9%	.7%	.0%	1.2%
Other	Strongly disagree	3.0%	2.3%	.0%	2.6%
	Disagree	.0%	.0%	.0%	.0%
	Neither disagree nor agree	.0%	5.7%	.0%	3.2%
	Agree	6.0%	8.0%	.0%	7.1%
	Strongly agree	23.9%	38.6%	.0%	32.3%
	Don't know	67.2%	45.5%	.0%	54.8%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	9.3%	13.1%	8.1%	12.7%
	Of little practicality	12.2%	10.7%	10.0%	12.7%
	Moderately practical	10.5%	9.5%	10.0%	10.2%
	Practical	23.6%	21.4%	25.0%	21.2%
	Very practical	41.8%	43.5%	43.8%	41.6%
	Not applicable	2.5%	1.8%	3.1%	1.6%
Separating animals into different age groups for the majority of the time	Not at all practical	5.5%	13.1%	6.9%	9.8%
	Of little practicality	6.3%	5.4%	8.1%	4.5%
	Moderately practical	9.7%	10.1%	9.4%	10.2%
	Practical	28.7%	25.6%	28.8%	26.5%
	Very practical	48.5%	44.0%	45.6%	47.3%
	Not applicable	1.3%	1.8%	1.3%	1.6%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	17.7%	24.4%	16.3%	23.3%
	Of little practicality	17.3%	20.8%	16.9%	20.0%
	Moderately practical	14.3%	13.1%	11.9%	15.1%
	Practical	27.0%	18.5%	28.8%	20.0%
	Very practical	17.7%	14.3%	20.6%	13.5%
	Not applicable	5.9%	8.9%	5.6%	8.2%

Reducing your current livestock numbers on the farm	Not at all practical	43.0%	45.8%	37.5%	48.6%
	Of little practicality	19.0%	25.6%	19.4%	23.3%
	Moderately practical	13.1%	10.1%	13.8%	10.6%
	Practical	11.4%	8.3%	15.6%	6.5%
	Very practical	8.4%	8.9%	8.8%	8.6%
	Not applicable	5.1%	1.2%	5.0%	2.4%
Cleaning water troughs daily	Not at all practical	17.3%	26.2%	14.4%	25.3%
	Of little practicality	20.3%	23.2%	18.8%	23.3%
	Moderately practical	19.0%	16.7%	17.5%	18.4%
	Practical	21.1%	14.3%	24.4%	14.3%
	Very practical	19.8%	15.5%	22.5%	15.1%
	Not applicable	2.5%	4.2%	2.5%	3.7%
Cleaning feed troughs daily	Not at all practical	8.4%	14.9%	8.1%	13.1%
	Of little practicality	11.0%	16.7%	12.5%	13.9%
	Moderately practical	18.1%	15.5%	15.6%	18.0%
	Practical	27.0%	20.2%	27.5%	22.0%
	Very practical	31.2%	28.0%	34.4%	26.9%
	Not applicable	4.2%	4.8%	1.9%	6.1%
Disinfecting the animal sheds/pens weekly	Not at all practical	37.1%	45.2%	31.9%	46.1%
	Of little practicality	23.6%	25.0%	24.4%	24.1%
	Moderately practical	16.0%	13.7%	15.6%	14.7%
	Practical	11.0%	7.1%	13.8%	6.5%
	Very practical	8.9%	6.5%	11.9%	5.3%
	Not applicable	3.4%	2.4%	2.5%	3.3%
Quarantine and testing of livestock brought to the farm	Not at all practical	4.6%	11.3%	6.9%	7.8%
	Of little practicality	8.9%	8.9%	8.1%	9.4%
	Moderately practical	11.4%	15.5%	11.9%	13.9%
	Practical	25.3%	20.8%	23.1%	23.7%
	Very practical	36.3%	29.8%	36.3%	31.8%
	Not applicable	13.5%	13.7%	13.8%	13.5%

Applying slaked lime to animal bedding every 3 weeks	Not at all practical	10.5%	18.5%	8.8%	17.1%
	Of little practicality	14.3%	19.6%	12.5%	19.2%
	Moderately practical	15.6%	16.1%	13.1%	17.6%
	Practical	32.1%	23.2%	32.5%	25.7%
	Very practical	20.3%	16.7%	23.1%	15.9%
	Not applicable	7.2%	6.0%	10.0%	4.5%
willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	7.6%	30.4%	10.0%	21.6%
	Less than £1	13.1%	18.5%	13.1%	16.7%
	£1 to £5	51.9%	39.3%	48.1%	45.7%
	£5 to £10	15.2%	3.0%	15.0%	6.9%
	More than £10	5.9%	1.8%	6.9%	2.4%
	Not applicable	6.3%	7.1%	6.9%	6.5%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	5.5%	20.8%	5.6%	15.9%
	1 day / year	17.3%	19.6%	16.9%	19.2%
	30 min / month	30.0%	19.6%	29.4%	23.3%
	30 min / week	27.8%	23.8%	28.8%	24.5%
	30 min / day	13.5%	6.5%	13.1%	9.0%
	Not applicable	5.9%	9.5%	6.3%	8.2%
Had you heard of E. coli O157 before we contacted you?	Yes	70.5%	76.2%	68.8%	75.5%
	No	29.5%	23.8%	31.3%	24.5%
The last time you heard of E. coli O157 was it about? - Human illness	0	29.9%	25.0%	30.9%	25.9%
	Human illness	70.1%	75.0%	69.1%	74.1%
The last time you heard of E. coli O157 was it about? - Food contamination	0	68.3%	69.5%	63.6%	71.9%
	Food contamination	31.7%	30.5%	36.4%	28.1%
The last time you heard of E. coli O157 was it about? - Animal illness	0	77.2%	83.6%	83.6%	77.8%
	Animal illness	22.8%	16.4%	16.4%	22.2%
Attending open days, or farm demonstrations	Yes	10.2%	10.9%	13.6%	8.6%
	No	89.8%	89.1%	86.4%	91.4%
Meeting with other farmers	Yes	25.1%	21.1%	20.9%	24.9%
	No	74.9%	78.9%	79.1%	75.1%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	81.4%	76.6%	82.7%	77.3%
	No	18.6%	23.4%	17.3%	22.7%

Searching the internet	Yes	7.8%	10.2%	7.3%	9.7%
	No	92.2%	89.8%	92.7%	90.3%
By asking agricultural consultants	Yes	9.6%	4.7%	8.2%	7.0%
	No	90.4%	95.3%	91.8%	93.0%
By asking sales people	Yes	9.6%	3.9%	10.9%	4.9%
	No	90.4%	96.1%	89.1%	95.1%
By asking a veterinary surgeon	Yes	51.5%	34.4%	44.5%	43.8%
	No	48.5%	65.6%	55.5%	56.2%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Yes	37.1%	26.6%	32.7%	32.4%
	No	62.9%	73.4%	67.3%	67.6%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	22.2%	15.6%	22.7%	17.3%
	No	77.8%	84.4%	77.3%	82.7%
Other	Yes	3.5%	4.5%	5.4%	3.1%
	No	96.5%	95.5%	94.6%	96.9%
Do you intend to change your farm size in the next 5 years?	Increase size	19.0%	11.9%	14.4%	17.1%
	Maintain size	67.1%	72.0%	69.4%	69.0%
	Reduce size	3.0%	7.1%	5.0%	4.5%
	Don't know	6.3%	6.0%	5.0%	6.9%
	Leave farming business	4.6%	3.0%	6.3%	2.4%
Do you intend to change public access to the farm in the next five years	Increase	4.6%	5.4%	3.8%	5.7%
	Stay same	91.6%	89.9%	91.9%	90.2%
	Reduce	.4%	2.4%	.0%	2.0%
	Don't know	3.4%	2.4%	4.4%	2.0%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	22.8%	17.3%	17.5%	22.4%
	Stay same	62.9%	69.0%	66.3%	64.9%
	Reduce	4.2%	1.2%	5.0%	1.6%
	Don't know	10.1%	12.5%	11.3%	11.0%

Table 23. All variables - frequencies (willingness to pay to control E.coli O157)

		Willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm					
		Nothing	Less than £1	£1 to £5	£5 to £10	More than £10	Not applicable
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Location	England	40.6%	37.1%	34.4%	46.3%	5.9%	40.7%
	Scotland	26.1%	19.4%	24.9%	17.1%	41.2%	37.0%
	Wales	30.4%	37.1%	29.6%	26.8%	41.2%	18.5%
	Northern Ireland	2.9%	6.5%	11.1%	9.8%	11.8%	3.7%
Gender	Male	81.2%	87.1%	86.8%	82.9%	88.2%	81.5%
	Female	18.8%	12.9%	13.2%	17.1%	11.8%	18.5%
Which age group are you in?	18-35	5.8%	4.8%	5.3%	7.3%	11.8%	3.7%
	36-50	33.3%	35.5%	32.8%	31.7%	29.4%	18.5%
	51-65	37.7%	46.8%	39.7%	39.0%	17.6%	51.9%
	Over 65	23.2%	12.9%	22.2%	22.0%	41.2%	25.9%
What is your status with respect to the farm holding?	Tenanted	13.0%	3.2%	15.9%	7.3%	17.6%	11.1%
	Owned	53.6%	67.7%	60.8%	63.4%	70.6%	59.3%
	Tenanted & owned	33.3%	27.4%	21.7%	26.8%	11.8%	29.6%
	Employee	.0%	1.6%	1.6%	2.4%	.0%	.0%
Educational background (highest degree)	School	47.8%	45.2%	45.0%	43.9%	41.2%	48.1%
	College	43.5%	40.3%	43.4%	36.6%	41.2%	44.4%
	University	8.7%	14.5%	11.6%	19.5%	17.6%	7.4%
Please give an estimate of the total farm land area (in hectares)	less than 10	4.3%	.0%	2.1%	2.4%	5.9%	.0%
	10.01-50	15.9%	16.1%	20.6%	31.7%	29.4%	25.9%
	50.01-100	21.7%	32.3%	24.9%	36.6%	17.6%	22.2%
	100.01-150	18.8%	21.0%	15.9%	7.3%	17.6%	7.4%
	150.01-200	15.9%	17.7%	13.2%	7.3%	5.9%	22.2%
	200.01-250	8.7%	3.2%	6.3%	2.4%	.0%	3.7%
	250.01-500	14.5%	8.1%	13.2%	7.3%	11.8%	14.8%
	over 500	.0%	1.6%	3.7%	4.9%	11.8%	3.7%

Dairy cattle	none	81.2%	66.1%	73.5%	85.4%	76.5%	92.6%
	0.01-10	1.4%	.0%	.0%	.0%	.0%	.0%
	10.01-50	2.9%	1.6%	2.6%	7.3%	5.9%	.0%
	50.01-100	2.9%	8.1%	6.3%	4.9%	5.9%	7.4%
	100.01-200	2.9%	11.3%	7.9%	2.4%	5.9%	.0%
	over 200	8.7%	12.9%	9.5%	.0%	5.9%	.0%
Beef cattle	none	5.8%	8.1%	13.8%	4.9%	5.9%	3.7%
	0.01-10	5.8%	3.2%	5.3%	4.9%	5.9%	.0%
	10.01-50	18.8%	27.4%	23.3%	34.1%	29.4%	25.9%
	50.01-100	21.7%	19.4%	18.0%	24.4%	23.5%	14.8%
	100.01-150	17.4%	16.1%	13.8%	12.2%	11.8%	14.8%
	150.01-200	8.7%	8.1%	9.5%	2.4%	5.9%	18.5%
	200.01-250	4.3%	3.2%	4.2%	9.8%	.0%	14.8%
	250.01-300	7.2%	3.2%	3.7%	2.4%	5.9%	.0%
	over 300	10.1%	11.3%	8.5%	4.9%	11.8%	7.4%
Sheep	none	44.9%	41.9%	41.8%	48.8%	41.2%	37.0%
	0.01-100	8.7%	9.7%	11.6%	12.2%	35.3%	7.4%
	100.01-500	14.5%	16.1%	21.7%	24.4%	5.9%	25.9%
	500.01-1000	8.7%	14.5%	11.1%	4.9%	11.8%	7.4%
	1000.01-1500	4.3%	12.9%	5.8%	7.3%	.0%	11.1%
	over 1500	18.8%	4.8%	7.9%	2.4%	5.9%	11.1%
Pigs	none	97.1%	93.5%	92.1%	90.2%	88.2%	92.6%
	0.01-100	2.9%	4.8%	7.4%	7.3%	11.8%	7.4%
	over 100	.0%	1.6%	.5%	2.4%	.0%	.0%
Goats	none	98.6%	100.0%	98.9%	97.6%	100.0%	100.0%
	0.01-2	1.4%	.0%	1.1%	2.4%	.0%	.0%
How many people work on the farm full time?	0	5.8%	1.6%	2.6%	12.2%	.0%	.0%
	1-3	91.3%	93.5%	88.4%	85.4%	82.4%	100.0%
	4-10	2.9%	4.8%	7.9%	2.4%	17.6%	.0%
	more than 10	.0%	.0%	1.1%	.0%	.0%	.0%

How many people work on the farm part time?	none	62.3%	59.7%	67.2%	63.4%	64.7%	77.8%
	1-3	37.7%	40.3%	29.1%	36.6%	35.3%	22.2%
	more than 3	.0%	.0%	3.7%	.0%	.0%	.0%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	1.4%	1.6%	.5%	.0%	.0%	.0%
	Less than a quarter	10.1%	4.8%	9.0%	19.5%	5.9%	3.7%
	Less than half	15.9%	11.3%	12.2%	29.3%	11.8%	22.2%
	Half or more	72.5%	82.3%	78.3%	51.2%	82.4%	74.1%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	55.1%	59.7%	71.4%	61.0%	52.9%	44.4%
	No	42.0%	40.3%	28.6%	36.6%	47.1%	55.6%
	Incomplete	2.9%	.0%	.0%	2.4%	.0%	.0%
Are you certified organic?	Yes	2.9%	6.5%	4.8%	4.9%	11.8%	3.7%
	No	97.1%	93.5%	94.2%	95.1%	88.2%	96.3%
	In conversion period	.0%	.0%	1.1%	.0%	.0%	.0%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	21.7%	22.6%	19.0%	22.0%	35.3%	22.2%
	No	78.3%	77.4%	81.0%	78.0%	64.7%	77.8%
Do you charge an entrance fee for petting the animals	Yes	.0%	.0%	1.1%	2.4%	.0%	3.7%
	No	100.0%	100.0%	98.9%	97.6%	100.0%	96.3%
Do you allow visits by school-age children to touch the animals	Yes	1.4%	.0%	4.8%	7.3%	5.9%	3.7%
	No	98.6%	100.0%	95.2%	92.7%	94.1%	96.3%
Do you allow visits by school-age children to see the animals	Yes	4.3%	1.6%	8.5%	9.8%	11.8%	3.7%
	No	95.7%	98.4%	91.5%	90.2%	88.2%	96.3%
Do you have any hand-washing facilities for visitors on-farm	Yes	49.3%	64.5%	60.8%	58.5%	41.2%	40.7%
	No	50.7%	35.5%	39.2%	41.5%	58.8%	59.3%
Do you open the farm on LEAF open days	Yes	.0%	.0%	1.1%	4.9%	.0%	.0%
	No	100.0%	100.0%	98.9%	95.1%	100.0%	100.0%
Do you run a farm produce shop from the premises	Yes	1.4%	.0%	3.2%	2.4%	.0%	.0%
	No	98.6%	100.0%	96.8%	97.6%	100.0%	100.0%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	43.5%	27.4%	34.4%	39.0%	52.9%	18.5%
	No	56.5%	72.6%	65.6%	61.0%	47.1%	81.5%
Does your land includes public footpaths	Yes	62.3%	56.5%	65.6%	63.4%	64.7%	63.0%
	No	37.7%	43.5%	34.4%	36.6%	35.3%	37.0%

Does your land includes ground for camping, caravanning	Yes	7.2%	3.2%	1.6%	12.2%	11.8%	7.4%
	No	92.8%	96.8%	98.4%	87.8%	88.2%	92.6%
Does your land includes fixed holiday accommodation	Yes	4.3%	4.8%	4.2%	4.9%	17.6%	.0%
	No	95.7%	95.2%	95.8%	95.1%	82.4%	100.0%
Other	Yes	7.3%	2.1%	2.5%	6.5%	10.0%	.0%
	No	92.7%	97.9%	97.5%	93.5%	90.0%	100.0%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%	.0%	.0%
	50-99%	.0%	.0%	.5%	4.9%	5.9%	.0%
	5-49%	4.3%	4.8%	3.2%	4.9%	5.9%	.0%
	<5%	95.7%	95.2%	96.3%	90.2%	88.2%	100.0%
Would you be willing to participate in a workshop on E. coli O157	Yes	26.3%	25.0%	27.3%	60.0%	50.0%	50.0%
	No	73.7%	75.0%	72.7%	40.0%	50.0%	50.0%
Attending open days, or farm demonstrations	Frequently	18.8%	33.9%	28.0%	26.8%	29.4%	29.6%
	Infrequently	56.5%	45.2%	49.7%	61.0%	41.2%	44.4%
	Never	24.6%	21.0%	22.2%	12.2%	29.4%	25.9%
Meeting with other farmers	Frequently	56.5%	69.4%	69.3%	78.0%	52.9%	63.0%
	Infrequently	37.7%	25.8%	28.6%	19.5%	47.1%	25.9%
	Never	5.8%	4.8%	2.1%	2.4%	.0%	11.1%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	79.7%	85.5%	80.4%	87.8%	88.2%	66.7%
	Infrequently	15.9%	12.9%	15.9%	12.2%	11.8%	22.2%
	Never	4.3%	1.6%	3.7%	.0%	.0%	11.1%
Searching the internet	Frequently	27.5%	45.2%	30.2%	36.6%	23.5%	18.5%
	Infrequently	30.4%	21.0%	31.7%	24.4%	11.8%	37.0%
	Never	42.0%	33.9%	38.1%	39.0%	64.7%	44.4%
By asking agricultural consultants	Frequently	23.2%	22.6%	23.3%	26.8%	5.9%	18.5%
	Infrequently	31.9%	37.1%	41.3%	48.8%	47.1%	33.3%
	Never	44.9%	40.3%	35.4%	24.4%	47.1%	48.1%
By asking sales people	Frequently	14.5%	17.7%	21.7%	7.3%	5.9%	18.5%
	Infrequently	53.6%	53.2%	51.3%	70.7%	70.6%	51.9%
	Never	31.9%	29.0%	27.0%	22.0%	23.5%	29.6%

By asking a veterinary surgeon	Frequently	66.7%	71.0%	75.7%	63.4%	82.4%	77.8%
	Infrequently	27.5%	27.4%	22.2%	36.6%	17.6%	14.8%
	Never	5.8%	1.6%	2.1%	.0%	.0%	7.4%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	29.0%	37.1%	39.2%	29.3%	41.2%	40.7%
	Infrequently	46.4%	43.5%	38.6%	56.1%	35.3%	33.3%
	Never	24.6%	19.4%	22.2%	14.6%	23.5%	25.9%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	30.4%	33.9%	31.7%	29.3%	17.6%	40.7%
	Infrequently	37.7%	38.7%	42.9%	48.8%	58.8%	25.9%
	Never	31.9%	27.4%	25.4%	22.0%	23.5%	33.3%
Other	Frequently	2.4%	4.4%	4.0%	3.3%	.0%	5.3%
	Infrequently	.0%	2.2%	1.6%	.0%	.0%	.0%
	Never	97.6%	93.3%	94.4%	96.7%	100.0%	94.7%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	1.4%	.0%	1.6%	.0%	.0%	3.7%
	Disagree	4.3%	3.2%	4.2%	2.4%	5.9%	3.7%
	Neither agree nor disagree	8.7%	6.5%	6.3%	4.9%	.0%	.0%
	Agree	30.4%	41.9%	43.9%	39.0%	47.1%	44.4%
	Strongly Agree	29.0%	27.4%	25.4%	41.5%	23.5%	25.9%
	Don't know	26.1%	21.0%	18.5%	12.2%	23.5%	22.2%
E. coli O157 causes mastitis in cattle	Strongly Disagree	8.7%	3.2%	7.9%	4.9%	.0%	3.7%
	Disagree	7.2%	11.3%	9.5%	4.9%	5.9%	25.9%
	Neither agree nor disagree	10.1%	9.7%	9.0%	4.9%	11.8%	7.4%
	Agree	20.3%	24.2%	26.5%	26.8%	35.3%	18.5%
	Strongly Agree	17.4%	11.3%	14.8%	12.2%	5.9%	11.1%
	Don't know	36.2%	40.3%	32.3%	46.3%	41.2%	33.3%

E. coli O157 causes disease in cattle	Strongly Disagree	1.4%	4.8%	3.2%	2.4%	.0%	7.4%
	Disagree	15.9%	12.9%	12.7%	2.4%	5.9%	18.5%
	Neither agree nor disagree	4.3%	8.1%	7.9%	7.3%	5.9%	11.1%
	Agree	34.8%	32.3%	37.6%	48.8%	52.9%	29.6%
	Strongly Agree	21.7%	14.5%	18.5%	24.4%	11.8%	14.8%
	Don't know	21.7%	27.4%	20.1%	14.6%	23.5%	18.5%
E. coli O157 causes disease in people	Strongly Disagree	1.4%	1.6%	.5%	2.4%	.0%	3.7%
	Disagree	2.9%	3.2%	3.7%	.0%	.0%	3.7%
	Neither agree nor disagree	4.3%	3.2%	4.2%	.0%	.0%	7.4%
	Agree	30.4%	41.9%	44.4%	43.9%	41.2%	44.4%
	Strongly Agree	52.2%	33.9%	37.0%	43.9%	47.1%	37.0%
	Don't know	8.7%	16.1%	10.1%	9.8%	11.8%	3.7%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	1.4%	6.5%	2.1%	2.4%	.0%	.0%
	Disagree	13.0%	4.8%	10.1%	.0%	11.8%	.0%
	Neither agree nor disagree	13.0%	12.9%	13.2%	9.8%	5.9%	14.8%
	Agree	31.9%	33.9%	42.9%	56.1%	29.4%	37.0%
	Strongly Agree	23.2%	30.6%	19.0%	17.1%	11.8%	25.9%
	Don't know	17.4%	11.3%	12.7%	14.6%	41.2%	22.2%
E. coli O157 can be present on raw meat	Strongly Disagree	1.4%	1.6%	.5%	.0%	.0%	.0%
	Disagree	2.9%	1.6%	1.6%	.0%	.0%	.0%
	Neither agree nor disagree	14.5%	3.2%	9.0%	2.4%	5.9%	7.4%
	Agree	40.6%	40.3%	42.3%	41.5%	47.1%	48.1%
	Strongly Agree	24.6%	37.1%	33.3%	39.0%	41.2%	37.0%
	Don't know	15.9%	16.1%	13.2%	17.1%	5.9%	7.4%

E. coli O157 can be present in raw milk	Strongly Disagree	1.4%	3.2%	2.1%	.0%	.0%	.0%
	Disagree	7.2%	6.5%	6.3%	.0%	11.8%	.0%
	Neither agree nor disagree	8.7%	16.1%	10.6%	2.4%	5.9%	22.2%
	Agree	29.0%	21.0%	35.4%	39.0%	41.2%	37.0%
	Strongly Agree	14.5%	17.7%	15.3%	22.0%	5.9%	18.5%
	Don't know	39.1%	35.5%	30.2%	36.6%	35.3%	22.2%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	2.9%	8.1%	2.6%	4.9%	.0%	3.7%
	Disagree	13.0%	9.7%	6.9%	2.4%	11.8%	.0%
	Neither agree nor disagree	15.9%	8.1%	9.0%	.0%	5.9%	3.7%
	Agree	31.9%	30.6%	38.1%	46.3%	29.4%	48.1%
	Strongly Agree	11.6%	14.5%	18.0%	22.0%	23.5%	14.8%
	Don't know	24.6%	29.0%	25.4%	24.4%	29.4%	29.6%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	1.4%	8.1%	2.1%	4.9%	.0%	.0%
	Disagree	5.8%	4.8%	5.8%	2.4%	17.6%	3.7%
	Neither agree nor disagree	8.7%	4.8%	8.5%	2.4%	17.6%	11.1%
	Agree	27.5%	25.8%	36.0%	26.8%	17.6%	44.4%
	Strongly Agree	20.3%	17.7%	19.6%	26.8%	11.8%	14.8%
	Don't know	36.2%	38.7%	28.0%	36.6%	35.3%	25.9%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	4.3%	8.1%	3.2%	2.4%	.0%	3.7%
	Disagree	4.3%	8.1%	4.2%	.0%	5.9%	3.7%
	Neither agree nor disagree	10.1%	4.8%	9.5%	7.3%	.0%	11.1%
	Agree	43.5%	45.2%	51.3%	53.7%	58.8%	44.4%
	Strongly Agree	27.5%	25.8%	19.6%	26.8%	29.4%	29.6%
	Don't know	10.1%	8.1%	12.2%	9.8%	5.9%	7.4%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	5.8%	1.6%	1.1%	.0%	.0%	3.7%
	Disagree	4.3%	3.2%	4.2%	9.8%	5.9%	3.7%
	Neither agree nor disagree	4.3%	.0%	5.8%	2.4%	.0%	11.1%
	Agree	30.4%	38.7%	33.9%	39.0%	41.2%	40.7%
	Strongly Agree	49.3%	50.0%	49.2%	46.3%	41.2%	37.0%
	Don't know	1.4%	6.5%	3.2%	2.4%	11.8%	3.7%
	Not applicable	4.3%	.0%	2.6%	.0%	.0%	.0%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	31.9%	29.0%	21.7%	17.1%	23.5%	25.9%
	Disagree	20.3%	25.8%	31.7%	39.0%	35.3%	25.9%
	Neither agree nor disagree	8.7%	14.5%	12.7%	17.1%	11.8%	11.1%
	Agree	7.2%	11.3%	19.0%	17.1%	17.6%	22.2%
	Strongly Agree	7.2%	1.6%	2.6%	.0%	5.9%	.0%
	Don't know	21.7%	17.7%	10.6%	9.8%	5.9%	14.8%
	Not applicable	2.9%	.0%	1.6%	.0%	.0%	.0%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	.0%	1.6%	1.6%	.0%	.0%	.0%
	Disagree	2.9%	3.2%	.0%	.0%	.0%	3.7%
	Neither agree nor disagree	5.8%	1.6%	2.6%	2.4%	.0%	7.4%
	Agree	23.2%	22.6%	38.6%	36.6%	41.2%	37.0%
	Strongly Agree	66.7%	69.4%	55.6%	61.0%	58.8%	51.9%
	Don't know	1.4%	1.6%	1.6%	.0%	.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	23.2%	21.0%	9.5%	4.9%	5.9%	33.3%
	Disagree	23.2%	22.6%	34.9%	26.8%	29.4%	25.9%
	Neither agree nor disagree	18.8%	9.7%	16.9%	22.0%	17.6%	11.1%
	Agree	17.4%	29.0%	21.7%	26.8%	23.5%	25.9%
	Strongly Agree	7.2%	11.3%	7.9%	9.8%	17.6%	.0%
	Don't know	8.7%	6.5%	6.9%	7.3%	.0%	3.7%
	Not applicable	1.4%	.0%	2.1%	2.4%	5.9%	.0%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	17.4%	8.1%	5.8%	.0%	.0%	18.5%
	Disagree	20.3%	12.9%	16.9%	12.2%	17.6%	14.8%
	Neither agree nor disagree	13.0%	16.1%	13.2%	17.1%	11.8%	25.9%
	Agree	27.5%	35.5%	38.1%	41.5%	47.1%	25.9%
	Strongly Agree	11.6%	22.6%	19.6%	19.5%	11.8%	7.4%
	Don't know	7.2%	3.2%	4.2%	7.3%	5.9%	7.4%
	Not applicable	2.9%	1.6%	2.1%	2.4%	5.9%	.0%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	13.0%	12.9%	5.8%	14.6%	.0%	7.4%
	Disagree	10.1%	11.3%	9.0%	9.8%	29.4%	7.4%
	Neither agree nor disagree	2.9%	8.1%	7.4%	4.9%	.0%	3.7%
	Agree	1.4%	1.6%	7.9%	12.2%	5.9%	7.4%
	Strongly Agree	1.4%	1.6%	5.3%	2.4%	.0%	.0%
	Don't know	7.2%	3.2%	4.2%	2.4%	.0%	3.7%
	Not applicable	63.8%	61.3%	60.3%	53.7%	64.7%	70.4%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	2.9%	11.3%	2.1%	.0%	.0%	18.5%
	Disagree	17.4%	9.7%	10.1%	9.8%	11.8%	18.5%
	Neither agree nor disagree	14.5%	14.5%	14.3%	9.8%	11.8%	7.4%
	Agree	37.7%	38.7%	33.3%	46.3%	52.9%	22.2%
	Strongly Agree	15.9%	9.7%	14.8%	22.0%	5.9%	7.4%
	Don't know	8.7%	11.3%	17.5%	7.3%	5.9%	22.2%
	Not applicable	2.9%	4.8%	7.9%	4.9%	11.8%	3.7%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	10.1%	8.1%	6.3%	2.4%	.0%	11.1%
	Disagree	13.0%	19.4%	15.9%	14.6%	5.9%	7.4%
	Neither agree nor disagree	15.9%	11.3%	11.6%	7.3%	11.8%	3.7%
	Agree	27.5%	16.1%	25.4%	34.1%	35.3%	40.7%
	Strongly Agree	13.0%	16.1%	11.6%	19.5%	.0%	3.7%
	Don't know	17.4%	19.4%	20.1%	14.6%	29.4%	33.3%
	Not applicable	2.9%	9.7%	9.0%	7.3%	17.6%	.0%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	94.2%	85.5%	83.6%	80.5%	88.2%	85.2%
	Farm owners	5.8%	14.5%	16.4%	19.5%	11.8%	14.8%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	95.7%	83.9%	92.1%	92.7%	88.2%	96.3%
	Meat/Milk Processors	4.3%	16.1%	7.9%	7.3%	11.8%	3.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	89.9%	90.3%	91.5%	92.7%	94.1%	92.6%
	Food Retailers	10.1%	9.7%	8.5%	7.3%	5.9%	7.4%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	81.2%	88.7%	91.5%	85.4%	94.1%	88.9%
	Public	18.8%	11.3%	8.5%	14.6%	5.9%	11.1%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	91.3%	87.1%	94.2%	100.0%	100.0%	96.3%
	Government	8.7%	12.9%	5.8%	.0%	.0%	3.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	42.0%	40.3%	37.0%	29.3%	29.4%	44.4%
	All	58.0%	59.7%	63.0%	70.7%	70.6%	55.6%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	89.9%	96.8%	96.8%	100.0%	100.0%	77.8%
	Don't know	10.1%	3.2%	3.2%	.0%	.0%	22.2%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	37.7%	37.1%	33.9%	17.1%	47.1%	33.3%
	Farm owners	62.3%	62.9%	66.1%	82.9%	52.9%	66.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	95.7%	95.2%	95.2%	97.6%	94.1%	92.6%
	Meat/Milk Processors	4.3%	4.8%	4.8%	2.4%	5.9%	7.4%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	98.6%	96.8%	97.4%	97.6%	100.0%	92.6%
	Food Retailers	1.4%	3.2%	2.6%	2.4%	.0%	7.4%
Who do you think is responsible for controlling E. coli O157 on-farms - Public	0	95.7%	98.4%	98.9%	97.6%	100.0%	100.0%
	Public	4.3%	1.6%	1.1%	2.4%	.0%	.0%
Who do you think is responsible for controlling E. coli O157 on-farms - Government	0	82.6%	87.1%	87.3%	92.7%	100.0%	92.6%
	Government	17.4%	12.9%	12.7%	7.3%	.0%	7.4%
Who do you think is responsible for controlling E. coli O157 on-farms - All	0	75.4%	72.6%	81.5%	87.8%	70.6%	81.5%
	All	24.6%	27.4%	18.5%	12.2%	29.4%	18.5%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	92.8%	95.2%	93.7%	97.6%	88.2%	96.3%
	Don't know	7.2%	4.8%	6.3%	2.4%	11.8%	3.7%

Government or European animal health regulations	Not affected	39.1%	37.1%	42.3%	41.5%	41.2%	33.3%
	Slightly affected	24.6%	22.6%	29.1%	43.9%	41.2%	37.0%
	Much affected	36.2%	40.3%	28.6%	14.6%	17.6%	29.6%
Reports of E. coli O157 outbreaks or incidents	Not affected	91.3%	93.5%	85.7%	87.8%	88.2%	96.3%
	Slightly affected	7.2%	4.8%	11.1%	9.8%	5.9%	.0%
	Much affected	1.4%	1.6%	3.2%	2.4%	5.9%	3.7%
Experience of E. coli O157 outbreaks or incidents	Not affected	97.1%	95.2%	88.9%	92.7%	88.2%	96.3%
	Slightly affected	2.9%	3.2%	8.5%	7.3%	.0%	3.7%
	Much affected	.0%	1.6%	2.6%	.0%	11.8%	.0%
Incidents of E. coli O157 that occurred on your farm	Not affected	97.1%	95.2%	88.9%	92.7%	88.2%	92.6%
	Slightly affected	2.9%	3.2%	6.9%	7.3%	.0%	7.4%
	Much affected	.0%	1.6%	4.2%	.0%	11.8%	.0%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	26.1%	50.0%	65.1%	87.8%	82.4%	55.6%
	Not willing to use this	73.9%	50.0%	34.9%	12.2%	17.6%	44.4%
The cost is too expensive	Strongly disagree	3.9%	3.2%	1.5%	20.0%	.0%	8.3%
	Disagree	17.6%	3.2%	4.5%	60.0%	.0%	.0%
	Neither disagree nor agree	15.7%	12.9%	19.7%	.0%	33.3%	41.7%
	Agree	17.6%	19.4%	33.3%	.0%	.0%	25.0%
	Strongly agree	45.1%	61.3%	40.9%	20.0%	66.7%	25.0%
	Don't know	.0%	.0%	.0%	.0%	.0%	.0%
Doing this would take too much time	Strongly disagree	5.9%	6.5%	7.6%	20.0%	.0%	8.3%
	Disagree	19.6%	12.9%	30.3%	60.0%	33.3%	25.0%
	Neither disagree nor agree	17.6%	12.9%	18.2%	20.0%	33.3%	41.7%
	Agree	27.5%	29.0%	30.3%	.0%	33.3%	16.7%
	Strongly agree	29.4%	38.7%	13.6%	.0%	.0%	8.3%
	Don't know	.0%	.0%	.0%	.0%	.0%	.0%

I would need more information before using a vaccine	Strongly disagree	.0%	.0%	.0%	.0%	33.3%	.0%
	Disagree	3.9%	.0%	3.0%	.0%	.0%	.0%
	Neither disagree nor agree	5.9%	3.2%	3.0%	20.0%	33.3%	8.3%
	Agree	19.6%	16.1%	28.8%	40.0%	.0%	33.3%
	Strongly agree	70.6%	80.6%	63.6%	40.0%	33.3%	58.3%
	Don't know	.0%	.0%	1.5%	.0%	.0%	.0%
I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	19.6%	12.9%	4.5%	40.0%	33.3%	16.7%
	Disagree	17.6%	12.9%	19.7%	20.0%	.0%	25.0%
	Neither disagree nor agree	21.6%	35.5%	18.2%	20.0%	33.3%	33.3%
	Agree	27.5%	19.4%	42.4%	20.0%	.0%	8.3%
	Strongly agree	11.8%	19.4%	15.2%	.0%	33.3%	8.3%
	Don't know	2.0%	.0%	.0%	.0%	.0%	8.3%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	15.7%	9.7%	4.5%	.0%	.0%	8.3%
	Disagree	21.6%	6.5%	6.1%	.0%	.0%	8.3%
	Neither disagree nor agree	17.6%	16.1%	15.2%	20.0%	33.3%	33.3%
	Agree	25.5%	32.3%	43.9%	60.0%	33.3%	33.3%
	Strongly agree	15.7%	35.5%	30.3%	.0%	33.3%	16.7%
	Don't know	3.9%	.0%	.0%	20.0%	.0%	.0%
Other	Strongly disagree	2.9%	5.3%	.0%	.0%	.0%	9.1%
	Disagree	.0%	5.3%	.0%	.0%	.0%	.0%
	Neither disagree nor agree	8.8%	5.3%	.0%	.0%	.0%	.0%
	Agree	11.8%	.0%	4.8%	.0%	50.0%	9.1%
	Strongly agree	38.2%	47.4%	40.5%	80.0%	50.0%	36.4%
	Don't know	38.2%	36.8%	54.8%	20.0%	.0%	45.5%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	23.2%	33.9%	40.7%	58.5%	64.7%	40.7%
	Not willing to use this	76.8%	66.1%	59.3%	41.5%	35.3%	59.3%

The cost is too expensive	Strongly disagree	5.7%	2.4%	.0%	5.9%	.0%	.0%
	Disagree	5.7%	2.4%	7.1%	29.4%	.0%	.0%
	Neither disagree nor agree	9.4%	2.4%	10.7%	.0%	16.7%	37.5%
	Agree	20.8%	19.5%	40.2%	29.4%	.0%	12.5%
	Strongly agree	54.7%	70.7%	42.0%	35.3%	66.7%	50.0%
	Don't know	3.8%	2.4%	.0%	.0%	16.7%	.0%
Doing this would take too much time	Strongly disagree	9.4%	4.9%	6.3%	.0%	.0%	12.5%
	Disagree	20.8%	22.0%	25.0%	23.5%	.0%	.0%
	Neither disagree nor agree	15.1%	4.9%	16.1%	23.5%	33.3%	50.0%
	Agree	18.9%	22.0%	28.6%	29.4%	.0%	6.3%
	Strongly agree	34.0%	43.9%	22.3%	23.5%	50.0%	31.3%
	Don't know	1.9%	2.4%	1.8%	.0%	16.7%	.0%
I would need more information before using an additive	Strongly disagree	.0%	4.9%	1.8%	.0%	33.3%	.0%
	Disagree	7.5%	2.4%	2.7%	5.9%	.0%	.0%
	Neither disagree nor agree	5.7%	2.4%	4.5%	.0%	16.7%	25.0%
	Agree	20.8%	17.1%	31.3%	29.4%	.0%	6.3%
	Strongly agree	66.0%	73.2%	59.8%	64.7%	33.3%	68.8%
	Don't know	.0%	.0%	.0%	.0%	16.7%	.0%
I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	24.5%	19.5%	9.8%	17.6%	16.7%	25.0%
	Disagree	26.4%	19.5%	18.8%	17.6%	.0%	18.8%
	Neither disagree nor agree	20.8%	12.2%	18.8%	23.5%	16.7%	43.8%
	Agree	22.6%	39.0%	38.4%	17.6%	16.7%	.0%
	Strongly agree	5.7%	9.8%	14.3%	23.5%	33.3%	12.5%
	Don't know	.0%	.0%	.0%	.0%	16.7%	.0%

I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	17.0%	12.2%	1.8%	5.9%	.0%	6.3%
	Disagree	26.4%	7.3%	9.8%	11.8%	.0%	12.5%
	Neither disagree nor agree	26.4%	14.6%	18.8%	5.9%	16.7%	50.0%
	Agree	18.9%	46.3%	50.9%	47.1%	16.7%	6.3%
	Strongly agree	9.4%	19.5%	18.8%	29.4%	50.0%	18.8%
	Don't know	1.9%	.0%	.0%	.0%	16.7%	6.3%
Other	Strongly disagree	2.9%	7.7%	.0%	7.7%	.0%	.0%
	Disagree	.0%	.0%	.0%	.0%	.0%	.0%
	Neither disagree nor agree	8.6%	7.7%	.0%	.0%	.0%	.0%
	Agree	14.3%	7.7%	1.6%	7.7%	40.0%	.0%
	Strongly agree	40.0%	26.9%	31.7%	23.1%	40.0%	30.8%
	Don't know	34.3%	50.0%	66.7%	61.5%	20.0%	69.2%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	15.9%	17.7%	7.4%	2.4%	17.6%	14.8%
	Of little practicality	13.0%	12.9%	12.2%	9.8%	5.9%	7.4%
	Moderately practical	8.7%	4.8%	13.2%	7.3%	.0%	14.8%
	Practical	14.5%	21.0%	25.9%	31.7%	23.5%	11.1%
	Very practical	47.8%	43.5%	39.7%	41.5%	47.1%	44.4%
	Not applicable	.0%	.0%	1.6%	7.3%	5.9%	7.4%
Separating animals into different age groups for the majority of the time	Not at all practical	15.9%	9.7%	4.8%	7.3%	17.6%	11.1%
	Of little practicality	5.8%	3.2%	6.9%	7.3%	5.9%	3.7%
	Moderately practical	10.1%	8.1%	11.6%	4.9%	5.9%	11.1%
	Practical	17.4%	37.1%	29.1%	26.8%	23.5%	22.2%
	Very practical	50.7%	40.3%	45.5%	53.7%	47.1%	48.1%
	Not applicable	.0%	1.6%	2.1%	.0%	.0%	3.7%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	24.6%	24.2%	19.0%	17.1%	23.5%	14.8%
	Of little practicality	21.7%	14.5%	20.6%	14.6%	.0%	25.9%
	Moderately practical	14.5%	8.1%	16.4%	9.8%	17.6%	11.1%
	Practical	15.9%	32.3%	24.9%	24.4%	17.6%	14.8%
	Very practical	14.5%	19.4%	13.8%	24.4%	23.5%	14.8%
	Not applicable	8.7%	1.6%	5.3%	9.8%	17.6%	18.5%

Reducing your current livestock numbers on the farm	Not at all practical	46.4%	45.2%	40.7%	41.5%	52.9%	59.3%
	Of little practicality	27.5%	24.2%	22.8%	17.1%	11.8%	7.4%
	Moderately practical	8.7%	11.3%	12.2%	14.6%	23.5%	7.4%
	Practical	5.8%	11.3%	12.7%	4.9%	.0%	14.8%
	Very practical	10.1%	6.5%	7.4%	17.1%	11.8%	3.7%
	Not applicable	1.4%	1.6%	4.2%	4.9%	.0%	7.4%
Cleaning water troughs daily	Not at all practical	31.9%	19.4%	18.0%	19.5%	11.8%	25.9%
	Of little practicality	18.8%	32.3%	20.1%	24.4%	17.6%	11.1%
	Moderately practical	17.4%	19.4%	18.0%	17.1%	17.6%	18.5%
	Practical	10.1%	12.9%	23.3%	14.6%	23.5%	18.5%
	Very practical	18.8%	16.1%	17.5%	22.0%	17.6%	18.5%
	Not applicable	2.9%	.0%	3.2%	2.4%	11.8%	7.4%
Cleaning feed troughs daily	Not at all practical	18.8%	11.3%	7.4%	12.2%	5.9%	18.5%
	Of little practicality	13.0%	24.2%	12.7%	4.9%	17.6%	3.7%
	Moderately practical	17.4%	14.5%	20.1%	7.3%	11.8%	18.5%
	Practical	8.7%	21.0%	28.0%	36.6%	29.4%	22.2%
	Very practical	34.8%	27.4%	27.5%	34.1%	29.4%	33.3%
	Not applicable	7.2%	1.6%	4.2%	4.9%	5.9%	3.7%
Disinfecting the animal sheds/pens weekly	Not at all practical	43.5%	56.5%	36.5%	36.6%	29.4%	37.0%
	Of little practicality	20.3%	29.0%	24.3%	29.3%	23.5%	14.8%
	Moderately practical	13.0%	6.5%	17.5%	9.8%	23.5%	25.9%
	Practical	11.6%	1.6%	11.6%	9.8%	11.8%	3.7%
	Very practical	7.2%	6.5%	7.4%	9.8%	5.9%	14.8%
	Not applicable	4.3%	.0%	2.6%	4.9%	5.9%	3.7%
Quarantine and testing of livestock brought to the farm	Not at all practical	13.0%	14.5%	4.2%	2.4%	11.8%	3.7%
	Of little practicality	20.3%	8.1%	5.8%	7.3%	.0%	11.1%
	Moderately practical	4.3%	25.8%	15.3%	7.3%	.0%	7.4%
	Practical	15.9%	14.5%	30.2%	24.4%	17.6%	18.5%
	Very practical	30.4%	27.4%	32.3%	41.5%	47.1%	44.4%
	Not applicable	15.9%	9.7%	12.2%	17.1%	23.5%	14.8%

Applying slaked lime to animal bedding every 3 weeks	Not at all practical	18.8%	17.7%	12.7%	4.9%	17.6%	11.1%
	Of little practicality	21.7%	22.6%	11.1%	19.5%	17.6%	22.2%
	Moderately practical	13.0%	12.9%	20.1%	12.2%	.0%	14.8%
	Practical	20.3%	21.0%	32.8%	41.5%	11.8%	25.9%
	Very practical	15.9%	24.2%	17.5%	17.1%	29.4%	18.5%
	Not applicable	10.1%	1.6%	5.8%	4.9%	23.5%	7.4%
willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	100.0%	.0%	.0%	.0%	.0%	.0%
	Less than £1	.0%	100.0%	.0%	.0%	.0%	.0%
	£1 to £5	.0%	.0%	100.0%	.0%	.0%	.0%
	£5 to £10	.0%	.0%	.0%	100.0%	.0%	.0%
	More than £10	.0%	.0%	.0%	.0%	100.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%	.0%	100.0%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	56.5%	4.8%	3.2%	.0%	.0%	.0%
	1 day / year	14.5%	43.5%	18.0%	7.3%	.0%	.0%
	30 min / month	7.2%	19.4%	36.0%	29.3%	23.5%	11.1%
	30 min / week	7.2%	21.0%	33.9%	36.6%	35.3%	11.1%
	30 min / day	10.1%	6.5%	6.9%	26.8%	41.2%	3.7%
	Not applicable	4.3%	4.8%	2.1%	.0%	.0%	74.1%
Had you heard of E. coli O157 before we contacted you?	Yes	72.5%	69.4%	73.0%	68.3%	76.5%	85.2%
	No	27.5%	30.6%	27.0%	31.7%	23.5%	14.8%
The last time you heard of E. coli O157 was it about? - Human illness	0	32.0%	25.6%	29.0%	28.6%	23.1%	17.4%
	Human illness	68.0%	74.4%	71.0%	71.4%	76.9%	82.6%
The last time you heard of E. coli O157 was it about? - Food contamination	0	70.0%	72.1%	68.1%	82.1%	61.5%	52.2%
	Food contamination	30.0%	27.9%	31.9%	17.9%	38.5%	47.8%
The last time you heard of E. coli O157 was it about? - Animal illness	0	72.0%	86.0%	84.1%	75.0%	76.9%	69.6%
	Animal illness	28.0%	14.0%	15.9%	25.0%	23.1%	30.4%
Attending open days, or farm demonstrations	Yes	8.0%	7.0%	10.9%	17.9%	7.7%	13.0%
	No	92.0%	93.0%	89.1%	82.1%	92.3%	87.0%
Meeting with other farmers	Yes	20.0%	4.7%	26.1%	35.7%	23.1%	34.8%
	No	80.0%	95.3%	73.9%	64.3%	76.9%	65.2%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	76.0%	83.7%	78.3%	89.3%	53.8%	87.0%
	No	24.0%	16.3%	21.7%	10.7%	46.2%	13.0%

Searching the internet	Yes	12.0%	7.0%	8.0%	10.7%	7.7%	8.7%
	No	88.0%	93.0%	92.0%	89.3%	92.3%	91.3%
By asking agricultural consultants	Yes	2.0%	2.3%	7.2%	17.9%	.0%	21.7%
	No	98.0%	97.7%	92.8%	82.1%	100.0%	78.3%
By asking sales people	Yes	4.0%	2.3%	7.2%	7.1%	7.7%	21.7%
	No	96.0%	97.7%	92.8%	92.9%	92.3%	78.3%
By asking a veterinary surgeon	Yes	42.0%	30.2%	42.8%	71.4%	53.8%	43.5%
	No	58.0%	69.8%	57.2%	28.6%	46.2%	56.5%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Yes	34.0%	18.6%	36.2%	35.7%	38.5%	26.1%
	No	66.0%	81.4%	63.8%	64.3%	61.5%	73.9%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	16.0%	7.0%	20.3%	35.7%	7.7%	30.4%
	No	84.0%	93.0%	79.7%	64.3%	92.3%	69.6%
Other	Yes	6.5%	.0%	4.4%	9.5%	.0%	.0%
	No	93.5%	100.0%	95.6%	90.5%	100.0%	100.0%
Do you intend to change your farm size in the next 5 years?	Increase size	14.5%	19.4%	16.4%	14.6%	23.5%	7.4%
	Maintain size	72.5%	71.0%	68.8%	70.7%	58.8%	63.0%
	Reduce size	5.8%	1.6%	6.9%	.0%	.0%	3.7%
	Don't know	4.3%	4.8%	5.3%	4.9%	11.8%	18.5%
	Leave farming business	2.9%	3.2%	2.6%	9.8%	5.9%	7.4%
Do you intend to change public access to the farm in the next five years	Increase	7.2%	4.8%	4.2%	9.8%	.0%	.0%
	Stay same	89.9%	93.5%	92.1%	80.5%	94.1%	92.6%
	Reduce	1.4%	.0%	1.6%	2.4%	.0%	.0%
	Don't know	1.4%	1.6%	2.1%	7.3%	5.9%	7.4%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	5.8%	27.4%	22.8%	29.3%	11.8%	18.5%
	Stay same	89.9%	62.9%	59.3%	63.4%	64.7%	55.6%
	Reduce	.0%	.0%	4.2%	2.4%	5.9%	7.4%
	Don't know	4.3%	9.7%	13.8%	4.9%	17.6%	18.5%

Table 24. All variables - frequencies (willingness to spend time to control E.coli O157)

		Willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm					
		None	1 day / year	30 min / month	30 min / week	30 min / day	Not applicable
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Location	England	39.6%	41.9%	39.4%	34.0%	27.9%	26.7%
	Scotland	29.2%	21.6%	24.0%	26.4%	18.6%	33.3%
	Wales	31.3%	28.4%	28.8%	30.2%	32.6%	36.7%
	Northern Ireland	.0%	8.1%	7.7%	9.4%	20.9%	3.3%
Gender	Male	77.1%	82.4%	92.3%	82.1%	86.0%	90.0%
	Female	22.9%	17.6%	7.7%	17.9%	14.0%	10.0%
Which age group are you in?	18-35	4.2%	4.1%	6.7%	7.5%	7.0%	.0%
	36-50	31.3%	39.2%	32.7%	32.1%	23.3%	26.7%
	51-65	39.6%	37.8%	35.6%	42.5%	46.5%	46.7%
	Over 65	25.0%	18.9%	25.0%	17.9%	23.3%	26.7%
What is your status with respect to the farm holding?	Tenanted	14.6%	16.2%	11.5%	11.3%	9.3%	10.0%
	Owned	62.5%	66.2%	53.8%	57.5%	67.4%	76.7%
	Tenanted & owned	22.9%	14.9%	34.6%	28.3%	23.3%	13.3%
	Employee	.0%	2.7%	.0%	2.8%	.0%	.0%
Educational background (highest degree)	School	50.0%	41.9%	41.3%	46.2%	51.2%	50.0%
	College	41.7%	47.3%	45.2%	42.5%	30.2%	36.7%
	University	8.3%	10.8%	13.5%	11.3%	18.6%	13.3%
Please give an estimate of the total farm land area (in hectares)	less than 10	6.3%	.0%	1.0%	3.8%	2.3%	.0%
	10.01-50	12.5%	14.9%	19.2%	27.4%	23.3%	30.0%
	50.01-100	25.0%	28.4%	28.8%	22.6%	27.9%	23.3%
	100.01-150	22.9%	13.5%	17.3%	15.1%	14.0%	10.0%
	150.01-200	14.6%	16.2%	9.6%	16.0%	11.6%	20.0%
	200.01-250	4.2%	6.8%	6.7%	2.8%	9.3%	3.3%
	250.01-500	12.5%	13.5%	16.3%	8.5%	9.3%	10.0%
	over 500	2.1%	6.8%	1.0%	3.8%	2.3%	3.3%

Dairy cattle	none	77.1%	75.7%	77.9%	70.8%	74.4%	93.3%
	0.01-10	.0%	.0%	.0%	.9%	.0%	.0%
	10.01-50	2.1%	1.4%	1.9%	5.7%	4.7%	.0%
	50.01-100	4.2%	5.4%	3.8%	6.6%	14.0%	3.3%
	100.01-200	4.2%	6.8%	9.6%	7.5%	2.3%	.0%
	over 200	12.5%	10.8%	6.7%	8.5%	4.7%	3.3%
Beef cattle	none	6.3%	10.8%	11.5%	8.5%	11.6%	6.7%
	0.01-10	4.2%	2.7%	4.8%	7.5%	2.3%	3.3%
	10.01-50	27.1%	24.3%	20.2%	32.1%	20.9%	16.7%
	50.01-100	18.8%	18.9%	21.2%	16.0%	18.6%	30.0%
	100.01-150	12.5%	17.6%	17.3%	11.3%	14.0%	13.3%
	150.01-200	10.4%	8.1%	7.7%	8.5%	11.6%	10.0%
	200.01-250	2.1%	2.7%	7.7%	5.7%	2.3%	10.0%
	250.01-300	8.3%	4.1%	4.8%	.9%	7.0%	.0%
	over 300	10.4%	10.8%	4.8%	9.4%	11.6%	10.0%
Sheep	none	45.8%	41.9%	44.2%	46.2%	37.2%	30.0%
	0.01-100	10.4%	9.5%	9.6%	10.4%	23.3%	13.3%
	100.01-500	16.7%	20.3%	20.2%	20.8%	16.3%	20.0%
	500.01-1000	16.7%	8.1%	11.5%	7.5%	9.3%	13.3%
	1000.01-1500	4.2%	8.1%	5.8%	8.5%	7.0%	6.7%
	over 1500	6.3%	12.2%	8.7%	6.6%	7.0%	16.7%
Pigs	none	97.9%	95.9%	94.2%	89.6%	86.0%	93.3%
	0.01-100	2.1%	4.1%	3.8%	10.4%	11.6%	6.7%
	over 100	.0%	.0%	1.9%	.0%	2.3%	.0%
Goats	none	100.0%	98.6%	100.0%	99.1%	95.3%	100.0%
	0.01-2	.0%	1.4%	.0%	.9%	4.7%	.0%
How many people work on the farm full time?	0	6.3%	4.1%	3.8%	2.8%	4.7%	.0%
	1-3	85.4%	90.5%	90.4%	90.6%	86.0%	96.7%
	4-10	6.3%	5.4%	5.8%	5.7%	9.3%	3.3%
	more than 10	2.1%	.0%	.0%	.9%	.0%	.0%

How many people work on the farm part time?	none	68.8%	68.9%	58.7%	62.3%	69.8%	80.0%
	1-3	29.2%	28.4%	39.4%	35.8%	30.2%	20.0%
	more than 3	2.1%	2.7%	1.9%	1.9%	.0%	.0%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	2.1%	1.4%	.0%	.0%	2.3%	.0%
	Less than a quarter	10.4%	9.5%	9.6%	9.4%	7.0%	6.7%
	Less than half	12.5%	14.9%	14.4%	17.0%	16.3%	13.3%
	Half or more	75.0%	74.3%	76.0%	73.6%	74.4%	80.0%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	54.2%	58.1%	69.2%	70.8%	62.8%	43.3%
	No	43.8%	39.2%	30.8%	29.2%	37.2%	56.7%
	Incomplete	2.1%	2.7%	.0%	.0%	.0%	.0%
Are you certified organic?	Yes	.0%	5.4%	7.7%	4.7%	4.7%	3.3%
	No	100.0%	94.6%	92.3%	94.3%	93.0%	96.7%
	In conversion period	.0%	.0%	.0%	.9%	2.3%	.0%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	16.7%	18.9%	21.2%	21.7%	27.9%	23.3%
	No	83.3%	81.1%	78.8%	78.3%	72.1%	76.7%
Do you charge an entrance fee for petting the animals	Yes	.0%	.0%	.0%	.9%	2.3%	6.7%
	No	100.0%	100.0%	100.0%	99.1%	97.7%	93.3%
Do you allow visits by school-age children to touch the animals	Yes	.0%	.0%	3.8%	3.8%	9.3%	10.0%
	No	100.0%	100.0%	96.2%	96.2%	90.7%	90.0%
Do you allow visits by school-age children to see the animals	Yes	2.1%	4.1%	7.7%	5.7%	14.0%	10.0%
	No	97.9%	95.9%	92.3%	94.3%	86.0%	90.0%
Do you have any hand-washing facilities for visitors on-farm	Yes	43.8%	54.1%	60.6%	60.4%	62.8%	53.3%
	No	56.3%	45.9%	39.4%	39.6%	37.2%	46.7%
Do you open the farm on LEAF open days	Yes	.0%	.0%	.0%	1.9%	4.7%	.0%
	No	100.0%	100.0%	100.0%	98.1%	95.3%	100.0%
Do you run a farm produce shop from the premises	Yes	.0%	2.7%	1.9%	2.8%	2.3%	.0%
	No	100.0%	97.3%	98.1%	97.2%	97.7%	100.0%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	33.3%	35.1%	34.6%	37.7%	34.9%	30.0%
	No	66.7%	64.9%	65.4%	62.3%	65.1%	70.0%

Does your land includes public footpaths	Yes	52.1%	64.9%	70.2%	60.4%	60.5%	66.7%
	No	47.9%	35.1%	29.8%	39.6%	39.5%	33.3%
Does your land includes ground for camping, caravanning	Yes	6.3%	2.7%	4.8%	5.7%	4.7%	3.3%
	No	93.8%	97.3%	95.2%	94.3%	95.3%	96.7%
Does your land includes fixed holiday accommodation	Yes	.0%	4.1%	6.7%	5.7%	7.0%	.0%
	No	100.0%	95.9%	93.3%	94.3%	93.0%	100.0%
Other	Yes	3.3%	.0%	2.7%	4.5%	9.1%	4.0%
	No	96.7%	100.0%	97.3%	95.5%	90.9%	96.0%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%	.0%	.0%
	50-99%	.0%	.0%	1.0%	.9%	4.7%	.0%
	5-49%	2.1%	4.1%	2.9%	6.6%	2.3%	.0%
	<5%	97.9%	95.9%	96.2%	92.5%	93.0%	100.0%
Would you be willing to participate in a workshop on E. coli O157	Yes	28.6%	12.5%	32.0%	37.0%	55.6%	40.0%
	No	71.4%	87.5%	68.0%	63.0%	44.4%	60.0%
Attending open days, or farm demonstrations	Frequently	18.8%	31.1%	32.7%	24.5%	27.9%	23.3%
	Infrequently	50.0%	52.7%	50.0%	50.9%	46.5%	53.3%
	Never	31.3%	16.2%	17.3%	24.5%	25.6%	23.3%
Meeting with other farmers	Frequently	50.0%	71.6%	65.4%	73.6%	65.1%	66.7%
	Infrequently	41.7%	25.7%	31.7%	24.5%	32.6%	23.3%
	Never	8.3%	2.7%	2.9%	1.9%	2.3%	10.0%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	77.1%	82.4%	81.7%	87.7%	79.1%	63.3%
	Infrequently	18.8%	16.2%	17.3%	9.4%	14.0%	23.3%
	Never	4.2%	1.4%	1.0%	2.8%	7.0%	13.3%
Searching the internet	Frequently	18.8%	39.2%	32.7%	35.8%	23.3%	26.7%
	Infrequently	35.4%	32.4%	30.8%	25.5%	20.9%	23.3%
	Never	45.8%	28.4%	36.5%	38.7%	55.8%	50.0%
By asking agricultural consultants	Frequently	25.0%	21.6%	27.9%	21.7%	14.0%	16.7%
	Infrequently	29.2%	48.6%	38.5%	41.5%	34.9%	36.7%
	Never	45.8%	29.7%	33.7%	36.8%	51.2%	46.7%
By asking sales people	Frequently	18.8%	20.3%	18.3%	15.1%	14.0%	20.0%
	Infrequently	50.0%	56.8%	62.5%	59.4%	39.5%	36.7%
	Never	31.3%	23.0%	19.2%	25.5%	46.5%	43.3%

By asking a veterinary surgeon	Frequently	72.9%	70.3%	73.1%	77.4%	67.4%	66.7%
	Infrequently	22.9%	27.0%	26.0%	20.8%	30.2%	23.3%
	Never	4.2%	2.7%	1.0%	1.9%	2.3%	10.0%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	25.0%	29.7%	31.7%	47.2%	39.5%	43.3%
	Infrequently	50.0%	45.9%	50.0%	35.8%	34.9%	23.3%
	Never	25.0%	24.3%	18.3%	17.0%	25.6%	33.3%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	27.1%	29.7%	30.8%	29.2%	41.9%	40.0%
	Infrequently	41.7%	47.3%	47.1%	39.6%	32.6%	26.7%
	Never	31.3%	23.0%	22.1%	31.1%	25.6%	33.3%
Other	Frequently	3.3%	4.7%	2.7%	3.0%	6.1%	4.3%
	Infrequently	.0%	2.3%	2.7%	.0%	.0%	.0%
	Never	96.7%	93.0%	94.7%	97.0%	93.9%	95.7%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	2.1%	2.7%	1.0%	.0%	.0%	3.3%
	Disagree	4.2%	4.1%	.0%	7.5%	4.7%	3.3%
	Neither agree nor disagree	4.2%	4.1%	8.7%	5.7%	9.3%	.0%
	Agree	35.4%	43.2%	50.0%	35.8%	37.2%	36.7%
	Strongly Agree	25.0%	31.1%	21.2%	30.2%	39.5%	23.3%
	Don't know	29.2%	14.9%	19.2%	20.8%	9.3%	33.3%
E. coli O157 causes mastitis in cattle	Strongly Disagree	6.3%	8.1%	1.0%	11.3%	7.0%	3.3%
	Disagree	4.2%	10.8%	9.6%	9.4%	4.7%	26.7%
	Neither agree nor disagree	12.5%	6.8%	10.6%	9.4%	9.3%	.0%
	Agree	22.9%	32.4%	26.0%	17.0%	37.2%	16.7%
	Strongly Agree	14.6%	17.6%	11.5%	12.3%	14.0%	16.7%
	Don't know	39.6%	24.3%	41.3%	40.6%	27.9%	36.7%

E. coli O157 causes disease in cattle	Strongly Disagree	.0%	4.1%	1.9%	4.7%	4.7%	3.3%
	Disagree	10.4%	10.8%	10.6%	16.0%	9.3%	16.7%
	Neither agree nor disagree	6.3%	8.1%	10.6%	6.6%	4.7%	3.3%
	Agree	39.6%	37.8%	44.2%	33.0%	32.6%	33.3%
	Strongly Agree	12.5%	18.9%	15.4%	18.9%	30.2%	20.0%
	Don't know	31.3%	20.3%	17.3%	20.8%	18.6%	23.3%
E. coli O157 causes disease in people	Strongly Disagree	2.1%	.0%	1.9%	.9%	2.3%	.0%
	Disagree	6.3%	1.4%	2.9%	.9%	4.7%	6.7%
	Neither agree nor disagree	2.1%	4.1%	1.0%	7.5%	2.3%	3.3%
	Agree	39.6%	40.5%	49.0%	37.7%	32.6%	46.7%
	Strongly Agree	35.4%	39.2%	36.5%	41.5%	55.8%	36.7%
	Don't know	14.6%	14.9%	8.7%	11.3%	2.3%	6.7%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	.0%	5.4%	1.0%	.9%	9.3%	.0%
	Disagree	12.5%	1.4%	10.6%	8.5%	11.6%	3.3%
	Neither agree nor disagree	12.5%	14.9%	12.5%	11.3%	16.3%	6.7%
	Agree	31.3%	48.6%	43.3%	38.7%	37.2%	30.0%
	Strongly Agree	18.8%	21.6%	18.3%	27.4%	9.3%	33.3%
	Don't know	25.0%	8.1%	14.4%	13.2%	16.3%	26.7%
E. coli O157 can be present on raw meat	Strongly Disagree	4.2%	1.4%	.0%	.0%	.0%	.0%
	Disagree	2.1%	.0%	1.0%	1.9%	2.3%	3.3%
	Neither agree nor disagree	8.3%	5.4%	9.6%	4.7%	16.3%	10.0%
	Agree	41.7%	43.2%	49.0%	36.8%	41.9%	36.7%
	Strongly Agree	25.0%	33.8%	30.8%	40.6%	27.9%	40.0%
	Don't know	18.8%	16.2%	9.6%	16.0%	11.6%	10.0%

E. coli O157 can be present in raw milk	Strongly Disagree	2.1%	.0%	.0%	2.8%	7.0%	.0%
	Disagree	4.2%	2.7%	6.7%	7.5%	7.0%	3.3%
	Neither agree nor disagree	10.4%	14.9%	9.6%	10.4%	2.3%	20.0%
	Agree	35.4%	25.7%	39.4%	28.3%	39.5%	30.0%
	Strongly Agree	8.3%	20.3%	16.3%	15.1%	14.0%	23.3%
	Don't know	39.6%	36.5%	27.9%	35.8%	30.2%	23.3%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	2.1%	2.7%	5.8%	2.8%	7.0%	.0%
	Disagree	12.5%	2.7%	9.6%	9.4%	2.3%	6.7%
	Neither agree nor disagree	14.6%	13.5%	3.8%	10.4%	7.0%	.0%
	Agree	35.4%	32.4%	38.5%	35.8%	44.2%	40.0%
	Strongly Agree	6.3%	20.3%	18.3%	17.9%	14.0%	20.0%
	Don't know	29.2%	28.4%	24.0%	23.6%	25.6%	33.3%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	2.1%	2.7%	2.9%	3.8%	4.7%	.0%
	Disagree	.0%	8.1%	2.9%	8.5%	4.7%	10.0%
	Neither agree nor disagree	12.5%	8.1%	5.8%	9.4%	7.0%	3.3%
	Agree	31.3%	28.4%	31.7%	34.0%	30.2%	36.7%
	Strongly Agree	16.7%	14.9%	21.2%	21.7%	18.6%	23.3%
	Don't know	37.5%	37.8%	35.6%	22.6%	34.9%	26.7%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	2.1%	1.4%	3.8%	2.8%	9.3%	10.0%
	Disagree	4.2%	4.1%	4.8%	4.7%	2.3%	6.7%
	Neither agree nor disagree	8.3%	6.8%	7.7%	8.5%	14.0%	6.7%
	Agree	50.0%	40.5%	56.7%	50.0%	48.8%	40.0%
	Strongly Agree	16.7%	39.2%	17.3%	22.6%	20.9%	26.7%
	Don't know	18.8%	8.1%	9.6%	11.3%	4.7%	10.0%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	2.1%	2.7%	.0%	1.9%	2.3%	6.7%
	Disagree	2.1%	4.1%	1.0%	7.5%	7.0%	10.0%
	Neither agree nor disagree	2.1%	4.1%	4.8%	6.6%	2.3%	3.3%
	Agree	43.8%	35.1%	38.5%	27.4%	37.2%	36.7%
	Strongly Agree	47.9%	44.6%	50.0%	51.9%	44.2%	40.0%
	Don't know	.0%	8.1%	3.8%	2.8%	2.3%	3.3%
	Not applicable	2.1%	1.4%	1.9%	1.9%	4.7%	.0%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	29.2%	29.7%	17.3%	20.8%	30.2%	33.3%
	Disagree	20.8%	24.3%	33.7%	34.9%	37.2%	10.0%
	Neither agree nor disagree	10.4%	10.8%	17.3%	12.3%	7.0%	13.3%
	Agree	10.4%	16.2%	14.4%	19.8%	14.0%	16.7%
	Strongly Agree	4.2%	1.4%	1.9%	3.8%	4.7%	3.3%
	Don't know	22.9%	16.2%	14.4%	7.5%	7.0%	20.0%
	Not applicable	2.1%	1.4%	1.0%	.9%	.0%	3.3%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	2.1%	1.4%	.0%	1.9%	.0%	.0%
	Disagree	2.1%	2.7%	1.0%	.0%	.0%	3.3%
	Neither agree nor disagree	8.3%	4.1%	1.0%	1.9%	4.7%	3.3%
	Agree	27.1%	29.7%	39.4%	30.2%	32.6%	43.3%
	Strongly Agree	56.3%	59.5%	57.7%	66.0%	62.8%	50.0%
	Don't know	4.2%	2.7%	1.0%	.0%	.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	22.9%	12.2%	5.8%	17.0%	14.0%	30.0%
	Disagree	22.9%	29.7%	40.4%	24.5%	27.9%	20.0%
	Neither agree nor disagree	18.8%	13.5%	15.4%	20.8%	11.6%	13.3%
	Agree	20.8%	23.0%	18.3%	23.6%	30.2%	30.0%
	Strongly Agree	6.3%	14.9%	8.7%	7.5%	7.0%	.0%
	Don't know	8.3%	6.8%	9.6%	2.8%	7.0%	6.7%
	Not applicable	.0%	.0%	1.9%	3.8%	2.3%	.0%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	22.9%	2.7%	3.8%	11.3%	2.3%	10.0%
	Disagree	18.8%	23.0%	15.4%	9.4%	18.6%	20.0%
	Neither agree nor disagree	14.6%	9.5%	15.4%	18.9%	9.3%	20.0%
	Agree	27.1%	31.1%	41.3%	36.8%	37.2%	36.7%
	Strongly Agree	4.2%	27.0%	16.3%	17.0%	27.9%	6.7%
	Don't know	8.3%	5.4%	5.8%	3.8%	2.3%	6.7%
	Not applicable	4.2%	1.4%	1.9%	2.8%	2.3%	.0%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	12.5%	12.2%	5.8%	10.4%	4.7%	6.7%
	Disagree	6.3%	16.2%	9.6%	9.4%	11.6%	6.7%
	Neither agree nor disagree	6.3%	5.4%	7.7%	6.6%	.0%	6.7%
	Agree	2.1%	6.8%	6.7%	6.6%	7.0%	6.7%
	Strongly Agree	.0%	2.7%	3.8%	3.8%	7.0%	.0%
	Don't know	2.1%	8.1%	1.9%	2.8%	4.7%	10.0%
	Not applicable	70.8%	48.6%	64.4%	60.4%	65.1%	63.3%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	2.1%	5.4%	1.9%	2.8%	7.0%	16.7%
	Disagree	18.8%	10.8%	11.5%	11.3%	9.3%	10.0%
	Neither agree nor disagree	12.5%	21.6%	12.5%	13.2%	9.3%	3.3%
	Agree	43.8%	33.8%	41.3%	34.9%	32.6%	23.3%
	Strongly Agree	8.3%	14.9%	12.5%	15.1%	20.9%	13.3%
	Don't know	10.4%	9.5%	13.5%	16.0%	11.6%	26.7%
	Not applicable	4.2%	4.1%	6.7%	6.6%	9.3%	6.7%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	.0%	9.5%	3.8%	10.4%	4.7%	13.3%
	Disagree	12.5%	21.6%	17.3%	12.3%	11.6%	6.7%
	Neither agree nor disagree	20.8%	10.8%	8.7%	12.3%	11.6%	3.3%
	Agree	29.2%	17.6%	26.9%	30.2%	27.9%	30.0%
	Strongly Agree	10.4%	14.9%	11.5%	13.2%	11.6%	10.0%
	Don't know	22.9%	17.6%	22.1%	14.2%	23.3%	33.3%
	Not applicable	4.2%	8.1%	9.6%	7.5%	9.3%	3.3%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	91.7%	87.8%	80.8%	87.7%	83.7%	83.3%
	Farm owners	8.3%	12.2%	19.2%	12.3%	16.3%	16.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	97.9%	89.2%	90.4%	92.5%	88.4%	93.3%
	Meat/Milk Processors	2.1%	10.8%	9.6%	7.5%	11.6%	6.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	93.8%	86.5%	91.3%	93.4%	90.7%	93.3%
	Food Retailers	6.3%	13.5%	8.7%	6.6%	9.3%	6.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	91.7%	87.8%	84.6%	91.5%	83.7%	96.7%
	Public	8.3%	12.2%	15.4%	8.5%	16.3%	3.3%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	91.7%	90.5%	95.2%	95.3%	95.3%	90.0%
	Government	8.3%	9.5%	4.8%	4.7%	4.7%	10.0%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	39.6%	37.8%	42.3%	32.1%	34.9%	43.3%
	All	60.4%	62.2%	57.7%	67.9%	65.1%	56.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	85.4%	95.9%	98.1%	97.2%	97.7%	83.3%
	Don't know	14.6%	4.1%	1.9%	2.8%	2.3%	16.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	39.6%	40.5%	29.8%	29.2%	37.2%	33.3%
	Farm owners	60.4%	59.5%	70.2%	70.8%	62.8%	66.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	95.8%	100.0%	93.3%	94.3%	95.3%	93.3%
	Meat/Milk Processors	4.2%	.0%	6.7%	5.7%	4.7%	6.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	97.9%	100.0%	97.1%	95.3%	97.7%	96.7%
	Food Retailers	2.1%	.0%	2.9%	4.7%	2.3%	3.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Public	0	100.0%	95.9%	99.0%	98.1%	97.7%	100.0%
	Public	.0%	4.1%	1.0%	1.9%	2.3%	.0%
Who do you think is responsible for controlling E. coli O157 on-farms - Government	0	85.4%	81.1%	90.4%	88.7%	93.0%	90.0%
	Government	14.6%	18.9%	9.6%	11.3%	7.0%	10.0%

Who do you think is responsible for controlling E. coli O157 on-farms - All	0	70.8%	74.3%	79.8%	84.9%	76.7%	86.7%
	All	29.2%	25.7%	20.2%	15.1%	23.3%	13.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	93.8%	93.2%	96.2%	91.5%	95.3%	96.7%
	Don't know	6.3%	6.8%	3.8%	8.5%	4.7%	3.3%
Government or European animal health regulations	Not affected	41.7%	40.5%	44.2%	34.9%	44.2%	36.7%
	Slightly affected	33.3%	21.6%	29.8%	33.0%	32.6%	30.0%
	Much affected	25.0%	37.8%	26.0%	32.1%	23.3%	33.3%
Reports of E. coli O157 outbreaks or incidents	Not affected	91.7%	91.9%	93.3%	80.2%	83.7%	100.0%
	Slightly affected	8.3%	2.7%	5.8%	16.0%	11.6%	.0%
	Much affected	.0%	5.4%	1.0%	3.8%	4.7%	.0%
Experience of E. coli O157 outbreaks or incidents	Not affected	100.0%	91.9%	95.2%	82.1%	97.7%	96.7%
	Slightly affected	.0%	4.1%	3.8%	15.1%	.0%	3.3%
	Much affected	.0%	4.1%	1.0%	2.8%	2.3%	.0%
Incidents of E. coli O157 that occurred on your farm	Not affected	100.0%	89.2%	95.2%	84.0%	95.3%	96.7%
	Slightly affected	.0%	5.4%	2.9%	12.3%	2.3%	3.3%
	Much affected	.0%	5.4%	1.9%	3.8%	2.3%	.0%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	27.1%	55.4%	68.3%	62.3%	74.4%	46.7%
	Not willing to use this	72.9%	44.6%	31.7%	37.7%	25.6%	53.3%
The cost is too expensive	Strongly disagree	2.9%	3.0%	3.0%	5.0%	.0%	6.3%
	Disagree	14.3%	.0%	6.1%	10.0%	27.3%	12.5%
	Neither disagree nor agree	17.1%	9.1%	21.2%	20.0%	27.3%	25.0%
	Agree	17.1%	30.3%	33.3%	17.5%	9.1%	31.3%
	Strongly agree	48.6%	57.6%	36.4%	47.5%	36.4%	25.0%
	Don't know	.0%	.0%	.0%	.0%	.0%	.0%

Doing this would take too much time	Strongly disagree	2.9%	9.1%	12.1%	5.0%	9.1%	6.3%
	Disagree	20.0%	21.2%	15.2%	32.5%	36.4%	31.3%
	Neither disagree nor agree	22.9%	9.1%	24.2%	12.5%	27.3%	31.3%
	Agree	28.6%	33.3%	24.2%	30.0%	9.1%	25.0%
	Strongly agree	25.7%	27.3%	24.2%	20.0%	18.2%	6.3%
	Don't know	.0%	.0%	.0%	.0%	.0%	.0%
I would need more information before using a vaccine	Strongly disagree	.0%	.0%	.0%	2.5%	.0%	.0%
	Disagree	2.9%	.0%	3.0%	2.5%	.0%	6.3%
	Neither disagree nor agree	5.7%	6.1%	3.0%	2.5%	18.2%	6.3%
	Agree	20.0%	15.2%	36.4%	20.0%	18.2%	37.5%
	Strongly agree	71.4%	78.8%	57.6%	72.5%	63.6%	43.8%
	Don't know	.0%	.0%	.0%	.0%	.0%	6.3%
I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	17.1%	9.1%	9.1%	15.0%	9.1%	18.8%
	Disagree	20.0%	18.2%	9.1%	17.5%	27.3%	25.0%
	Neither disagree nor agree	22.9%	24.2%	24.2%	27.5%	18.2%	18.8%
	Agree	28.6%	24.2%	42.4%	27.5%	36.4%	18.8%
	Strongly agree	11.4%	24.2%	15.2%	12.5%	9.1%	6.3%
	Don't know	.0%	.0%	.0%	.0%	.0%	12.5%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	14.3%	9.1%	3.0%	10.0%	.0%	12.5%
	Disagree	17.1%	6.1%	3.0%	12.5%	18.2%	12.5%
	Neither disagree nor agree	22.9%	9.1%	15.2%	17.5%	27.3%	25.0%
	Agree	31.4%	36.4%	48.5%	30.0%	36.4%	31.3%
	Strongly agree	11.4%	39.4%	27.3%	30.0%	18.2%	12.5%
	Don't know	2.9%	.0%	3.0%	.0%	.0%	6.3%

Other	Strongly disagree	4.5%	.0%	.0%	3.4%	.0%	7.1%
	Disagree	.0%	.0%	.0%	3.4%	.0%	.0%
	Neither disagree nor agree	9.1%	5.6%	.0%	3.4%	.0%	.0%
	Agree	4.5%	11.1%	.0%	13.8%	11.1%	.0%
	Strongly agree	40.9%	44.4%	57.1%	41.4%	33.3%	28.6%
	Don't know	40.9%	38.9%	42.9%	34.5%	55.6%	64.3%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	18.8%	36.5%	45.2%	43.4%	48.8%	33.3%
	Not willing to use this	81.3%	63.5%	54.8%	56.6%	51.2%	66.7%
The cost is too expensive	Strongly disagree	5.1%	2.1%	1.8%	1.7%	.0%	.0%
	Disagree	.0%	6.4%	7.0%	10.0%	9.1%	10.0%
	Neither disagree nor agree	12.8%	8.5%	7.0%	8.3%	4.5%	30.0%
	Agree	23.1%	21.3%	40.4%	31.7%	31.8%	15.0%
	Strongly agree	53.8%	59.6%	43.9%	48.3%	50.0%	45.0%
	Don't know	5.1%	2.1%	.0%	.0%	4.5%	.0%
Doing this would take too much time	Strongly disagree	7.7%	8.5%	1.8%	10.0%	.0%	10.0%
	Disagree	20.5%	17.0%	22.8%	25.0%	22.7%	15.0%
	Neither disagree nor agree	17.9%	14.9%	15.8%	10.0%	22.7%	40.0%
	Agree	23.1%	27.7%	29.8%	23.3%	9.1%	10.0%
	Strongly agree	28.2%	29.8%	28.1%	30.0%	40.9%	25.0%
	Don't know	2.6%	2.1%	1.8%	1.7%	4.5%	.0%
I would need more information before using an additive	Strongly disagree	2.6%	.0%	.0%	6.7%	.0%	5.0%
	Disagree	2.6%	2.1%	3.5%	3.3%	9.1%	5.0%
	Neither disagree nor agree	7.7%	4.3%	5.3%	1.7%	4.5%	20.0%
	Agree	23.1%	23.4%	31.6%	21.7%	27.3%	10.0%
	Strongly agree	64.1%	70.2%	59.6%	66.7%	54.5%	60.0%
	Don't know	.0%	.0%	.0%	.0%	4.5%	.0%

I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	23.1%	12.8%	15.8%	16.7%	9.1%	20.0%
	Disagree	20.5%	27.7%	17.5%	13.3%	22.7%	25.0%
	Neither disagree nor agree	20.5%	21.3%	15.8%	23.3%	9.1%	30.0%
	Agree	28.2%	34.0%	42.1%	26.7%	31.8%	5.0%
	Strongly agree	7.7%	4.3%	8.8%	20.0%	22.7%	20.0%
	Don't know	.0%	.0%	.0%	.0%	4.5%	.0%
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	15.4%	2.1%	3.5%	10.0%	4.5%	10.0%
	Disagree	17.9%	12.8%	12.3%	10.0%	9.1%	20.0%
	Neither disagree nor agree	25.6%	23.4%	17.5%	16.7%	18.2%	30.0%
	Agree	25.6%	42.6%	56.1%	41.7%	31.8%	10.0%
	Strongly agree	12.8%	19.1%	10.5%	21.7%	31.8%	25.0%
	Don't know	2.6%	.0%	.0%	.0%	4.5%	5.0%
Other	Strongly disagree	4.3%	.0%	3.0%	2.7%	5.3%	.0%
	Disagree	.0%	.0%	.0%	.0%	.0%	.0%
	Neither disagree nor agree	8.7%	7.7%	.0%	2.7%	.0%	.0%
	Agree	4.3%	11.5%	.0%	8.1%	21.1%	.0%
	Strongly agree	47.8%	19.2%	24.2%	45.9%	26.3%	23.5%
	Don't know	34.8%	61.5%	72.7%	40.5%	47.4%	76.5%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	14.6%	17.6%	5.8%	8.5%	4.7%	23.3%
	Of little practicality	14.6%	13.5%	11.5%	11.3%	9.3%	6.7%
	Moderately practical	14.6%	6.8%	14.4%	5.7%	11.6%	10.0%
	Practical	10.4%	23.0%	30.8%	22.6%	25.6%	10.0%
	Very practical	45.8%	39.2%	34.6%	50.9%	41.9%	43.3%
	Not applicable	.0%	.0%	2.9%	.9%	7.0%	6.7%

Separating animals into different age groups for the majority of the time	Not at all practical	18.8%	4.1%	7.7%	4.7%	11.6%	16.7%
	Of little practicality	6.3%	9.5%	6.7%	4.7%	4.7%	.0%
	Moderately practical	12.5%	9.5%	9.6%	10.4%	7.0%	10.0%
	Practical	16.7%	29.7%	37.5%	26.4%	20.9%	16.7%
	Very practical	43.8%	45.9%	38.5%	51.9%	55.8%	50.0%
	Not applicable	2.1%	1.4%	.0%	1.9%	.0%	6.7%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	27.1%	20.3%	22.1%	17.0%	14.0%	26.7%
	Of little practicality	27.1%	24.3%	21.2%	12.3%	9.3%	20.0%
	Moderately practical	12.5%	8.1%	14.4%	16.0%	18.6%	13.3%
	Practical	12.5%	23.0%	26.0%	29.2%	23.3%	13.3%
	Very practical	14.6%	17.6%	11.5%	18.9%	25.6%	10.0%
	Not applicable	6.3%	6.8%	4.8%	6.6%	9.3%	16.7%
Reducing your current livestock numbers on the farm	Not at all practical	50.0%	41.9%	44.2%	43.4%	34.9%	56.7%
	Of little practicality	33.3%	18.9%	25.0%	19.8%	16.3%	13.3%
	Moderately practical	8.3%	10.8%	11.5%	11.3%	23.3%	6.7%
	Practical	4.2%	10.8%	9.6%	13.2%	7.0%	13.3%
	Very practical	4.2%	14.9%	6.7%	7.5%	11.6%	6.7%
	Not applicable	.0%	2.7%	2.9%	4.7%	7.0%	3.3%
Cleaning water troughs daily	Not at all practical	27.1%	21.6%	19.2%	22.6%	9.3%	26.7%
	Of little practicality	22.9%	24.3%	26.9%	17.9%	16.3%	13.3%
	Moderately practical	22.9%	14.9%	19.2%	17.9%	16.3%	16.7%
	Practical	12.5%	21.6%	17.3%	17.9%	27.9%	10.0%
	Very practical	12.5%	16.2%	13.5%	19.8%	27.9%	26.7%
	Not applicable	2.1%	1.4%	3.8%	3.8%	2.3%	6.7%
Cleaning feed troughs daily	Not at all practical	16.7%	12.2%	5.8%	13.2%	4.7%	20.0%
	Of little practicality	12.5%	14.9%	13.5%	12.3%	14.0%	13.3%
	Moderately practical	22.9%	13.5%	22.1%	17.0%	7.0%	13.3%
	Practical	14.6%	28.4%	25.0%	26.4%	30.2%	10.0%
	Very practical	25.0%	28.4%	26.0%	30.2%	37.2%	43.3%
	Not applicable	8.3%	2.7%	7.7%	.9%	7.0%	.0%

Disinfecting the animal sheds/pens weekly	Not at all practical	52.1%	59.5%	36.5%	36.8%	18.6%	33.3%
	Of little practicality	20.8%	23.0%	25.0%	26.4%	30.2%	13.3%
	Moderately practical	12.5%	6.8%	14.4%	22.6%	7.0%	26.7%
	Practical	8.3%	8.1%	10.6%	7.5%	16.3%	6.7%
	Very practical	4.2%	1.4%	7.7%	5.7%	25.6%	13.3%
	Not applicable	2.1%	1.4%	5.8%	.9%	2.3%	6.7%
Quarantine and testing of livestock brought to the farm	Not at all practical	18.8%	12.2%	4.8%	2.8%	7.0%	3.3%
	Of little practicality	27.1%	2.7%	4.8%	12.3%	4.7%	3.3%
	Moderately practical	8.3%	18.9%	16.3%	8.5%	11.6%	13.3%
	Practical	10.4%	27.0%	32.7%	17.9%	25.6%	20.0%
	Very practical	22.9%	29.7%	32.7%	37.7%	37.2%	43.3%
	Not applicable	12.5%	9.5%	8.7%	20.8%	14.0%	16.7%
Applying slaked lime to animal bedding every 3 weeks	Not at all practical	25.0%	16.2%	11.5%	10.4%	11.6%	13.3%
	Of little practicality	27.1%	17.6%	20.2%	10.4%	11.6%	13.3%
	Moderately practical	16.7%	18.9%	15.4%	17.9%	9.3%	10.0%
	Practical	14.6%	25.7%	31.7%	33.0%	30.2%	26.7%
	Very practical	8.3%	17.6%	16.3%	20.8%	30.2%	23.3%
	Not applicable	8.3%	4.1%	4.8%	7.5%	7.0%	13.3%
willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	81.3%	13.5%	4.8%	4.7%	16.3%	10.0%
	Less than £1	6.3%	36.5%	11.5%	12.3%	9.3%	10.0%
	£1 to £5	12.5%	45.9%	65.4%	60.4%	30.2%	13.3%
	£5 to £10	.0%	4.1%	11.5%	14.2%	25.6%	.0%
	More than £10	.0%	.0%	3.8%	5.7%	16.3%	.0%
	Not applicable	.0%	.0%	2.9%	2.8%	2.3%	66.7%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	100.0%	.0%	.0%	.0%	.0%	.0%
	1 day / year	.0%	100.0%	.0%	.0%	.0%	.0%
	30 min / month	.0%	.0%	100.0%	.0%	.0%	.0%
	30 min / week	.0%	.0%	.0%	100.0%	.0%	.0%
	30 min / day	.0%	.0%	.0%	.0%	100.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%	.0%	100.0%
Had you heard of E. coli O157 before we contacted you?	Yes	62.5%	77.0%	69.2%	75.5%	69.8%	86.7%
	No	37.5%	23.0%	30.8%	24.5%	30.2%	13.3%

The last time you heard of E. coli O157 was it about? - Human illness	0	30.0%	26.3%	30.6%	31.3%	26.7%	11.5%
	Human illness	70.0%	73.7%	69.4%	68.8%	73.3%	88.5%
The last time you heard of E. coli O157 was it about? - Food contamination	0	56.7%	68.4%	68.1%	72.5%	76.7%	65.4%
	Food contamination	43.3%	31.6%	31.9%	27.5%	23.3%	34.6%
The last time you heard of E. coli O157 was it about? - Animal illness	0	70.0%	87.7%	88.9%	77.5%	70.0%	69.2%
	Animal illness	30.0%	12.3%	11.1%	22.5%	30.0%	30.8%
Attending open days, or farm demonstrations	Yes	6.7%	7.0%	11.1%	11.3%	16.7%	11.5%
	No	93.3%	93.0%	88.9%	88.8%	83.3%	88.5%
Meeting with other farmers	Yes	20.0%	19.3%	22.2%	25.0%	26.7%	30.8%
	No	80.0%	80.7%	77.8%	75.0%	73.3%	69.2%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	66.7%	82.5%	81.9%	76.3%	86.7%	80.8%
	No	33.3%	17.5%	18.1%	23.8%	13.3%	19.2%
Searching the internet	Yes	6.7%	8.8%	12.5%	7.5%	6.7%	7.7%
	No	93.3%	91.2%	87.5%	92.5%	93.3%	92.3%
By asking agricultural consultants	Yes	.0%	5.3%	12.5%	3.8%	10.0%	15.4%
	No	100.0%	94.7%	87.5%	96.3%	90.0%	84.6%
By asking sales people	Yes	.0%	5.3%	11.1%	5.0%	6.7%	15.4%
	No	100.0%	94.7%	88.9%	95.0%	93.3%	84.6%
By asking a veterinary surgeon	Yes	30.0%	38.6%	45.8%	50.0%	50.0%	42.3%
	No	70.0%	61.4%	54.2%	50.0%	50.0%	57.7%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Yes	26.7%	22.8%	33.3%	40.0%	46.7%	19.2%
	No	73.3%	77.2%	66.7%	60.0%	53.3%	80.8%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	13.3%	19.3%	19.4%	16.3%	33.3%	19.2%
	No	86.7%	80.7%	80.6%	83.8%	66.7%	80.8%
Other	Yes	5.6%	5.3%	.0%	5.6%	8.7%	.0%
	No	94.4%	94.7%	100.0%	94.4%	91.3%	100.0%
Do you intend to change your farm size in the next 5 years?	Increase size	10.4%	24.3%	9.6%	16.0%	23.3%	16.7%
	Maintain size	72.9%	60.8%	73.1%	70.8%	74.4%	56.7%
	Reduce size	2.1%	6.8%	6.7%	4.7%	.0%	3.3%
	Don't know	8.3%	5.4%	4.8%	5.7%	2.3%	16.7%
	Leave farming business	6.3%	2.7%	5.8%	2.8%	.0%	6.7%

Do you intend to change public access to the farm in the next five years	Increase	2.1%	5.4%	5.8%	5.7%	4.7%	3.3%
	Stay same	95.8%	90.5%	88.5%	89.6%	93.0%	93.3%
	Reduce	.0%	.0%	1.0%	2.8%	2.3%	.0%
	Don't know	2.1%	4.1%	4.8%	1.9%	.0%	3.3%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	.0%	28.4%	24.0%	21.7%	23.3%	13.3%
	Stay same	89.6%	56.8%	59.6%	67.9%	65.1%	60.0%
	Reduce	.0%	2.7%	1.9%	4.7%	4.7%	3.3%
	Don't know	10.4%	12.2%	14.4%	5.7%	7.0%	23.3%

Table 25. All variables - frequencies (intention to change E. coli O157 control measures on-farm in the next five years)

		Intention to change E. coli O157 control measures on-farm in the next five years			
		Increase	Stay same	Reduce	Don't know
		Column N %	Column N %	Column N %	Column N %
Location	England	49.4%	34.0%	50.0%	22.2%
	Scotland	20.5%	26.8%	.0%	28.9%
	Wales	26.5%	30.6%	16.7%	40.0%
	Northern Ireland	3.6%	8.7%	33.3%	8.9%
Gender	Male	86.7%	84.5%	91.7%	84.4%
	Female	13.3%	15.5%	8.3%	15.6%
Which age group are you in?	18-35	8.4%	4.9%	8.3%	4.4%
	36-50	31.3%	33.6%	25.0%	26.7%
	51-65	42.2%	38.5%	41.7%	46.7%
	Over 65	18.1%	23.0%	25.0%	22.2%
What is your status with respect to the farm holding?	Tenanted	12.0%	13.2%	8.3%	8.9%
	Owned	55.4%	61.1%	66.7%	71.1%
	Tenanted & owned	30.1%	24.9%	25.0%	17.8%
	Employee	2.4%	.8%	.0%	2.2%

Educational background (highest degree)	School	32.5%	47.2%	66.7%	53.3%
	College	48.2%	41.9%	33.3%	35.6%
	University	19.3%	10.9%	.0%	11.1%
Please give an estimate of the total farm land area (in hectares)	less than 10	1.2%	1.9%	8.3%	4.4%
	10.01-50	14.5%	24.9%	16.7%	11.1%
	50.01-100	28.9%	23.0%	25.0%	40.0%
	100.01-150	10.8%	17.7%	25.0%	11.1%
	150.01-200	18.1%	13.2%	16.7%	11.1%
	200.01-250	4.8%	5.7%	.0%	6.7%
	250.01-500	14.5%	11.3%	8.3%	13.3%
	over 500	7.2%	2.3%	.0%	2.2%
Dairy cattle	none	74.7%	77.4%	66.7%	75.6%
	0.01-10	.0%	.4%	.0%	.0%
	10.01-50	2.4%	2.6%	8.3%	4.4%
	50.01-100	6.0%	5.7%	8.3%	6.7%
	100.01-200	8.4%	6.4%	.0%	4.4%
	over 200	8.4%	7.5%	16.7%	8.9%
Beef cattle	none	8.4%	8.7%	16.7%	15.6%
	0.01-10	2.4%	4.9%	8.3%	6.7%
	10.01-50	27.7%	24.5%	25.0%	20.0%
	50.01-100	18.1%	19.2%	16.7%	24.4%
	100.01-150	8.4%	16.2%	8.3%	17.8%
	150.01-200	10.8%	9.4%	16.7%	.0%
	200.01-250	7.2%	4.9%	8.3%	2.2%
	250.01-300	4.8%	4.2%	.0%	2.2%
	over 300	12.0%	7.9%	.0%	11.1%
Sheep	none	44.6%	43.0%	41.7%	37.8%
	0.01-100	13.3%	10.9%	8.3%	13.3%
	100.01-500	18.1%	18.9%	16.7%	26.7%
	500.01-1000	6.0%	11.7%	16.7%	8.9%
	1000.01-1500	8.4%	6.4%	8.3%	6.7%
	over 1500	9.6%	9.1%	8.3%	6.7%

Pigs	none	89.2%	94.0%	100.0%	91.1%
	0.01-100	9.6%	5.7%	.0%	6.7%
	over 100	1.2%	.4%	.0%	2.2%
Goats	none	98.8%	98.9%	100.0%	100.0%
	0.01-2	1.2%	1.1%	.0%	.0%
How many people work on the farm full time?	0	3.6%	4.2%	.0%	2.2%
	1-3	86.7%	90.2%	100.0%	91.1%
	4-10	8.4%	5.3%	.0%	6.7%
	more than 10	1.2%	.4%	.0%	.0%
How many people work on the farm part time?	none	56.6%	65.7%	91.7%	73.3%
	1-3	39.8%	32.8%	8.3%	26.7%
	more than 3	3.6%	1.5%	.0%	.0%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	1.2%	.8%	.0%	.0%
	Less than a quarter	14.5%	7.9%	16.7%	4.4%
	Less than half	16.9%	13.6%	16.7%	20.0%
	Half or more	67.5%	77.7%	66.7%	75.6%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	67.5%	60.8%	66.7%	68.9%
	No	31.3%	38.5%	33.3%	31.1%
	Incomplete	1.2%	.8%	.0%	.0%
Are you certified organic?	Yes	6.0%	3.8%	.0%	11.1%
	No	92.8%	95.8%	100.0%	88.9%
	In conversion period	1.2%	.4%	.0%	.0%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	20.5%	20.8%	33.3%	22.2%
	No	79.5%	79.2%	66.7%	77.8%
Do you charge an entrance fee for petting the animals	Yes	1.2%	1.1%	.0%	.0%
	No	98.8%	98.9%	100.0%	100.0%
Do you allow visits by school-age children to touch the animals	Yes	4.8%	3.0%	8.3%	4.4%
	No	95.2%	97.0%	91.7%	95.6%
Do you allow visits by school-age children to see the animals	Yes	7.2%	5.3%	16.7%	11.1%
	No	92.8%	94.7%	83.3%	88.9%
Do you have any hand-washing facilities for visitors on-farm	Yes	66.3%	54.3%	66.7%	53.3%
	No	33.7%	45.7%	33.3%	46.7%

Do you open the farm on LEAF open days	Yes	1.2%	.8%	.0%	2.2%
	No	98.8%	99.2%	100.0%	97.8%
Do you run a farm produce shop from the premises	Yes	4.8%	1.1%	8.3%	.0%
	No	95.2%	98.9%	91.7%	100.0%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	26.5%	35.5%	41.7%	46.7%
	No	73.5%	64.5%	58.3%	53.3%
Does your land includes public footpaths	Yes	68.7%	60.0%	66.7%	71.1%
	No	31.3%	40.0%	33.3%	28.9%
Does your land includes ground for camping, caravanning	Yes	3.6%	4.5%	.0%	8.9%
	No	96.4%	95.5%	100.0%	91.1%
Does your land includes fixed holiday accommodation	Yes	4.8%	4.5%	.0%	6.7%
	No	95.2%	95.5%	100.0%	93.3%
Other	Yes	7.4%	2.8%	.0%	3.0%
	No	92.6%	97.2%	100.0%	97.0%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%
	50-99%	.0%	1.5%	.0%	.0%
	5-49%	3.6%	3.8%	.0%	4.4%
	<5%	96.4%	94.7%	100.0%	95.6%
Would you be willing to participate in a workshop on E. coli O157	Yes	52.6%	25.5%	33.3%	33.3%
	No	47.4%	74.5%	66.7%	66.7%
Attending open days, or farm demonstrations	Frequently	37.3%	24.2%	25.0%	28.9%
	Infrequently	47.0%	52.5%	50.0%	46.7%
	Never	15.7%	23.4%	25.0%	24.4%
Meeting with other farmers	Frequently	60.2%	67.2%	75.0%	75.6%
	Infrequently	34.9%	29.4%	25.0%	20.0%
	Never	4.8%	3.4%	.0%	4.4%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	80.7%	81.9%	83.3%	77.8%
	Infrequently	14.5%	15.5%	8.3%	17.8%
	Never	4.8%	2.6%	8.3%	4.4%
Searching the internet	Frequently	37.3%	29.4%	25.0%	35.6%
	Infrequently	33.7%	28.3%	25.0%	22.2%
	Never	28.9%	42.3%	50.0%	42.2%

By asking agricultural consultants	Frequently	25.3%	21.1%	16.7%	26.7%
	Infrequently	41.0%	38.5%	50.0%	40.0%
	Never	33.7%	40.4%	33.3%	33.3%
By asking sales people	Frequently	22.9%	15.1%	16.7%	22.2%
	Infrequently	55.4%	54.3%	58.3%	55.6%
	Never	21.7%	30.6%	25.0%	22.2%
By asking a veterinary surgeon	Frequently	84.3%	69.8%	66.7%	68.9%
	Infrequently	14.5%	26.4%	33.3%	31.1%
	Never	1.2%	3.8%	.0%	.0%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	43.4%	34.0%	25.0%	40.0%
	Infrequently	42.2%	42.6%	41.7%	37.8%
	Never	14.5%	23.4%	33.3%	22.2%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	34.9%	30.2%	33.3%	33.3%
	Infrequently	39.8%	42.3%	41.7%	40.0%
	Never	25.3%	27.5%	25.0%	26.7%
Other	Frequently	7.8%	2.3%	.0%	6.1%
	Infrequently	2.0%	.6%	.0%	3.0%
	Never	90.2%	97.2%	100.0%	90.9%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	.0%	1.9%	.0%	.0%
	Disagree	3.6%	4.5%	.0%	2.2%
	Neither agree nor disagree	8.4%	6.0%	.0%	2.2%
	Agree	32.5%	41.5%	41.7%	53.3%
	Strongly Agree	37.3%	26.0%	41.7%	17.8%
	Don't know	18.1%	20.0%	16.7%	24.4%
E. coli O157 causes mastitis in cattle	Strongly Disagree	6.0%	7.2%	16.7%	.0%
	Disagree	14.5%	7.9%	8.3%	13.3%
	Neither agree nor disagree	7.2%	9.4%	.0%	11.1%
	Agree	25.3%	23.8%	25.0%	31.1%
	Strongly Agree	20.5%	12.8%	25.0%	4.4%
	Don't know	26.5%	38.9%	25.0%	40.0%

E. coli O157 causes disease in cattle	Strongly Disagree	4.8%	2.6%	16.7%	.0%
	Disagree	15.7%	12.5%	8.3%	6.7%
	Neither agree nor disagree	4.8%	8.3%	8.3%	6.7%
	Agree	32.5%	37.7%	33.3%	46.7%
	Strongly Agree	26.5%	16.6%	25.0%	13.3%
	Don't know	15.7%	22.3%	8.3%	26.7%
E. coli O157 causes disease in people	Strongly Disagree	2.4%	1.1%	.0%	.0%
	Disagree	6.0%	1.9%	8.3%	2.2%
	Neither agree nor disagree	3.6%	3.8%	16.7%	.0%
	Agree	32.5%	43.0%	33.3%	51.1%
	Strongly Agree	47.0%	40.4%	41.7%	26.7%
	Don't know	8.4%	9.8%	.0%	20.0%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	4.8%	1.5%	.0%	4.4%
	Disagree	7.2%	8.7%	8.3%	6.7%
	Neither agree nor disagree	13.3%	13.6%	8.3%	6.7%
	Agree	34.9%	40.4%	50.0%	44.4%
	Strongly Agree	30.1%	19.6%	25.0%	15.6%
	Don't know	9.6%	16.2%	8.3%	22.2%
E. coli O157 can be present on raw meat	Strongly Disagree	1.2%	.8%	.0%	.0%
	Disagree	2.4%	1.1%	8.3%	.0%
	Neither agree nor disagree	8.4%	6.8%	16.7%	13.3%
	Agree	33.7%	46.8%	16.7%	37.8%
	Strongly Agree	39.8%	32.5%	33.3%	28.9%
	Don't know	14.5%	12.1%	25.0%	20.0%

E. coli O157 can be present in raw milk	Strongly Disagree	.0%	2.6%	.0%	.0%
	Disagree	6.0%	5.7%	.0%	6.7%
	Neither agree nor disagree	10.8%	9.8%	16.7%	15.6%
	Agree	27.7%	35.1%	25.0%	31.1%
	Strongly Agree	30.1%	12.1%	25.0%	11.1%
	Don't know	25.3%	34.7%	33.3%	35.6%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	3.6%	4.2%	8.3%	.0%
	Disagree	4.8%	8.3%	8.3%	8.9%
	Neither agree nor disagree	8.4%	8.3%	25.0%	6.7%
	Agree	38.6%	37.4%	25.0%	35.6%
	Strongly Agree	24.1%	15.8%	16.7%	8.9%
	Don't know	20.5%	26.0%	16.7%	40.0%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	3.6%	3.4%	.0%	.0%
	Disagree	10.8%	4.5%	8.3%	2.2%
	Neither agree nor disagree	7.2%	7.9%	33.3%	2.2%
	Agree	32.5%	32.5%	16.7%	31.1%
	Strongly Agree	26.5%	18.5%	8.3%	15.6%
	Don't know	19.3%	33.2%	33.3%	48.9%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	.0%	5.3%	.0%	4.4%
	Disagree	7.2%	3.4%	8.3%	4.4%
	Neither agree nor disagree	8.4%	9.1%	8.3%	4.4%
	Agree	42.2%	51.7%	50.0%	46.7%
	Strongly Agree	34.9%	21.9%	16.7%	15.6%
	Don't know	7.2%	8.7%	16.7%	24.4%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	1.2%	2.3%	8.3%	.0%
	Disagree	3.6%	4.9%	8.3%	4.4%
	Neither agree nor disagree	6.0%	3.0%	16.7%	6.7%
	Agree	20.5%	38.1%	33.3%	46.7%
	Strongly Agree	61.4%	46.4%	16.7%	40.0%
	Don't know	7.2%	2.3%	16.7%	2.2%
	Not applicable	.0%	3.0%	.0%	.0%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	24.1%	25.3%	25.0%	20.0%
	Disagree	25.3%	32.5%	25.0%	20.0%
	Neither agree nor disagree	16.9%	10.9%	8.3%	15.6%
	Agree	18.1%	14.0%	25.0%	20.0%
	Strongly Agree	3.6%	2.6%	.0%	4.4%
	Don't know	12.0%	13.6%	16.7%	15.6%
	Not applicable	.0%	1.1%	.0%	4.4%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	.0%	1.1%	8.3%	.0%
	Disagree	.0%	1.9%	.0%	.0%
	Neither agree nor disagree	3.6%	3.8%	.0%	.0%
	Agree	22.9%	33.6%	33.3%	51.1%
	Strongly Agree	72.3%	58.1%	58.3%	48.9%
	Don't know	1.2%	1.5%	.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	12.0%	14.7%	16.7%	17.8%
	Disagree	37.3%	26.8%	16.7%	33.3%
	Neither agree nor disagree	15.7%	17.0%	8.3%	15.6%
	Agree	22.9%	22.3%	50.0%	20.0%
	Strongly Agree	6.0%	10.2%	.0%	4.4%
	Don't know	4.8%	7.5%	8.3%	4.4%
	Not applicable	1.2%	1.5%	.0%	4.4%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	8.4%	7.5%	25.0%	6.7%
	Disagree	18.1%	15.8%	16.7%	15.6%
	Neither agree nor disagree	14.5%	15.5%	16.7%	11.1%
	Agree	26.5%	37.7%	25.0%	44.4%
	Strongly Agree	25.3%	16.6%	16.7%	8.9%
	Don't know	6.0%	4.5%	.0%	8.9%
	Not applicable	1.2%	2.3%	.0%	4.4%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	12.0%	9.1%	8.3%	2.2%
	Disagree	9.6%	9.4%	25.0%	13.3%
	Neither agree nor disagree	3.6%	6.8%	.0%	6.7%
	Agree	4.8%	5.3%	8.3%	13.3%
	Strongly Agree	4.8%	3.0%	.0%	2.2%
	Don't know	7.2%	4.2%	.0%	.0%
	Not applicable	57.8%	62.3%	58.3%	62.2%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	4.8%	4.9%	8.3%	.0%
	Disagree	10.8%	12.8%	8.3%	8.9%
	Neither agree nor disagree	24.1%	10.9%	16.7%	6.7%
	Agree	33.7%	36.6%	33.3%	40.0%
	Strongly Agree	16.9%	14.0%	8.3%	11.1%
	Don't know	6.0%	14.3%	16.7%	24.4%
	Not applicable	3.6%	6.4%	8.3%	8.9%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	8.4%	7.2%	16.7%	.0%
	Disagree	16.9%	15.5%	16.7%	6.7%
	Neither agree nor disagree	7.2%	12.8%	8.3%	11.1%
	Agree	27.7%	23.4%	41.7%	40.0%
	Strongly Agree	15.7%	12.8%	.0%	6.7%
	Don't know	15.7%	21.5%	8.3%	24.4%
	Not applicable	8.4%	6.8%	8.3%	11.1%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	81.9%	86.4%	66.7%	93.3%
	Farm owners	18.1%	13.6%	33.3%	6.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	90.4%	91.7%	100.0%	91.1%
	Meat/Milk Processors	9.6%	8.3%	.0%	8.9%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	91.6%	91.3%	100.0%	88.9%
	Food Retailers	8.4%	8.7%	.0%	11.1%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	84.3%	90.6%	91.7%	84.4%
	Public	15.7%	9.4%	8.3%	15.6%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	90.4%	94.3%	100.0%	93.3%
	Government	9.6%	5.7%	.0%	6.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	34.9%	38.5%	41.7%	37.8%
	All	65.1%	61.5%	58.3%	62.2%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	98.8%	93.2%	100.0%	95.6%
	Don't know	1.2%	6.8%	.0%	4.4%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	32.5%	32.5%	25.0%	46.7%
	Farm owners	67.5%	67.5%	75.0%	53.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	90.4%	97.0%	91.7%	95.6%
	Meat/Milk Processors	9.6%	3.0%	8.3%	4.4%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	94.0%	98.5%	91.7%	97.8%
	Food Retailers	6.0%	1.5%	8.3%	2.2%
Who do you think is responsible for controlling E. coli O157 on-farms - Public	0	98.8%	98.1%	100.0%	97.8%
	Public	1.2%	1.9%	.0%	2.2%
Who do you think is responsible for controlling E. coli O157 on-farms - Government	0	86.7%	88.7%	75.0%	88.9%
	Government	13.3%	11.3%	25.0%	11.1%
Who do you think is responsible for controlling E. coli O157 on-farms - All	0	77.1%	80.4%	83.3%	75.6%
	All	22.9%	19.6%	16.7%	24.4%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	98.8%	92.5%	100.0%	93.3%
	Don't know	1.2%	7.5%	.0%	6.7%
Government or European animal health regulations	Not affected	31.3%	43.4%	25.0%	42.2%
	Slightly affected	31.3%	29.4%	50.0%	24.4%
	Much affected	37.3%	27.2%	25.0%	33.3%

Reports of E. coli O157 outbreaks or incidents	Not affected	84.3%	90.2%	75.0%	93.3%
	Slightly affected	15.7%	6.8%	8.3%	4.4%
	Much affected	.0%	3.0%	16.7%	2.2%
Experience of E. coli O157 outbreaks or incidents	Not affected	92.8%	92.8%	58.3%	95.6%
	Slightly affected	6.0%	5.3%	25.0%	4.4%
	Much affected	1.2%	1.9%	16.7%	.0%
Incidents of E. coli O157 that occurred on your farm	Not affected	91.6%	92.8%	58.3%	95.6%
	Slightly affected	6.0%	4.9%	16.7%	4.4%
	Much affected	2.4%	2.3%	25.0%	.0%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	65.1%	56.2%	83.3%	53.3%
	Not willing to use this	34.9%	43.8%	16.7%	46.7%
The cost is too expensive	Strongly disagree	.0%	3.4%	50.0%	4.8%
	Disagree	10.3%	11.2%	.0%	.0%
	Neither disagree nor agree	6.9%	19.8%	50.0%	23.8%
	Agree	24.1%	21.6%	.0%	38.1%
	Strongly agree	58.6%	44.0%	.0%	33.3%
	Don't know	.0%	.0%	.0%	.0%
Doing this would take too much time	Strongly disagree	13.8%	5.2%	50.0%	4.8%
	Disagree	34.5%	24.1%	.0%	14.3%
	Neither disagree nor agree	13.8%	20.7%	.0%	19.0%
	Agree	24.1%	25.9%	50.0%	38.1%
	Strongly agree	13.8%	24.1%	.0%	23.8%
	Don't know	.0%	.0%	.0%	.0%
I would need more information before using a vaccine	Strongly disagree	.0%	.9%	.0%	.0%
	Disagree	.0%	3.4%	.0%	.0%
	Neither disagree nor agree	.0%	6.0%	.0%	9.5%
	Agree	20.7%	20.7%	.0%	47.6%
	Strongly agree	79.3%	68.1%	100.0%	42.9%
	Don't know	.0%	.9%	.0%	.0%

I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	6.9%	13.8%	50.0%	14.3%
	Disagree	17.2%	18.1%	.0%	19.0%
	Neither disagree nor agree	27.6%	22.4%	50.0%	23.8%
	Agree	24.1%	29.3%	.0%	42.9%
	Strongly agree	24.1%	14.7%	.0%	.0%
	Don't know	.0%	1.7%	.0%	.0%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	.0%	11.2%	.0%	9.5%
	Disagree	13.8%	10.3%	.0%	9.5%
	Neither disagree nor agree	6.9%	19.0%	.0%	28.6%
	Agree	27.6%	36.2%	50.0%	42.9%
	Strongly agree	51.7%	21.6%	.0%	9.5%
	Don't know	.0%	1.7%	50.0%	.0%
Other	Strongly disagree	4.3%	2.7%	.0%	.0%
	Disagree	.0%	1.4%	.0%	.0%
	Neither disagree nor agree	.0%	5.5%	.0%	.0%
	Agree	8.7%	5.5%	50.0%	6.7%
	Strongly agree	43.5%	42.5%	50.0%	40.0%
	Don't know	43.5%	42.5%	.0%	53.3%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	33.7%	40.0%	66.7%	40.0%
	Not willing to use this	66.3%	60.0%	33.3%	60.0%
The cost is too expensive	Strongly disagree	1.8%	1.9%	.0%	3.7%
	Disagree	5.5%	8.2%	.0%	3.7%
	Neither disagree nor agree	9.1%	9.4%	.0%	18.5%
	Agree	30.9%	23.9%	50.0%	51.9%
	Strongly agree	50.9%	54.7%	50.0%	22.2%
	Don't know	1.8%	1.9%	.0%	.0%

Doing this would take too much time	Strongly disagree	1.8%	7.5%	.0%	11.1%
	Disagree	25.5%	20.1%	50.0%	14.8%
	Neither disagree nor agree	16.4%	17.0%	.0%	22.2%
	Agree	27.3%	20.1%	.0%	37.0%
	Strongly agree	27.3%	33.3%	50.0%	11.1%
	Don't know	1.8%	1.9%	.0%	3.7%
I would need more information before using an additive	Strongly disagree	.0%	3.1%	.0%	3.7%
	Disagree	3.6%	4.4%	.0%	.0%
	Neither disagree nor agree	3.6%	5.7%	.0%	11.1%
	Agree	23.6%	21.4%	50.0%	37.0%
	Strongly agree	69.1%	64.8%	50.0%	48.1%
	Don't know	.0%	.6%	.0%	.0%
I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	16.4%	18.2%	.0%	7.4%
	Disagree	21.8%	19.5%	25.0%	18.5%
	Neither disagree nor agree	21.8%	17.0%	25.0%	33.3%
	Agree	21.8%	33.3%	.0%	37.0%
	Strongly agree	18.2%	11.3%	50.0%	3.7%
	Don't know	.0%	.6%	.0%	.0%
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	3.6%	9.4%	.0%	3.7%
	Disagree	9.1%	13.8%	25.0%	14.8%
	Neither disagree nor agree	18.2%	21.4%	25.0%	22.2%
	Agree	43.6%	35.8%	25.0%	51.9%
	Strongly agree	25.5%	17.6%	25.0%	7.4%
	Don't know	.0%	1.9%	.0%	.0%

Other	Strongly disagree	6.1%	2.0%	.0%	.0%
	Disagree	.0%	.0%	.0%	.0%
	Neither disagree nor agree	3.0%	4.0%	.0%	.0%
	Agree	6.1%	7.9%	.0%	5.6%
	Strongly agree	33.3%	30.7%	66.7%	33.3%
	Don't know	51.5%	55.4%	33.3%	61.1%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	7.2%	12.1%	.0%	13.3%
	Of little practicality	14.5%	10.6%	.0%	15.6%
	Moderately practical	12.0%	9.8%	8.3%	8.9%
	Practical	21.7%	24.2%	16.7%	17.8%
	Very practical	42.2%	41.5%	66.7%	42.2%
	Not applicable	2.4%	1.9%	8.3%	2.2%
Separating animals into different age groups for the majority of the time	Not at all practical	8.4%	9.1%	.0%	8.9%
	Of little practicality	7.2%	5.7%	8.3%	4.4%
	Moderately practical	4.8%	10.2%	16.7%	15.6%
	Practical	26.5%	27.2%	25.0%	31.1%
	Very practical	50.6%	47.2%	50.0%	35.6%
	Not applicable	2.4%	.8%	.0%	4.4%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	16.9%	23.0%	8.3%	15.6%
	Of little practicality	16.9%	17.7%	16.7%	28.9%
	Moderately practical	13.3%	14.0%	8.3%	15.6%
	Practical	18.1%	24.9%	25.0%	24.4%
	Very practical	24.1%	14.3%	41.7%	6.7%
	Not applicable	10.8%	6.0%	.0%	8.9%
Reducing your current livestock numbers on the farm	Not at all practical	38.6%	46.4%	16.7%	48.9%
	Of little practicality	20.5%	21.5%	25.0%	24.4%
	Moderately practical	12.0%	13.2%	.0%	6.7%
	Practical	13.3%	7.5%	25.0%	15.6%
	Very practical	12.0%	7.5%	25.0%	4.4%
	Not applicable	3.6%	3.8%	8.3%	.0%

Cleaning water troughs daily	Not at all practical	19.3%	22.6%	8.3%	17.8%
	Of little practicality	25.3%	19.2%	16.7%	28.9%
	Moderately practical	19.3%	17.4%	25.0%	17.8%
	Practical	14.5%	18.1%	33.3%	22.2%
	Very practical	20.5%	18.5%	16.7%	11.1%
	Not applicable	1.2%	4.2%	.0%	2.2%
Cleaning feed troughs daily	Not at all practical	4.8%	12.8%	.0%	15.6%
	Of little practicality	15.7%	10.9%	16.7%	22.2%
	Moderately practical	18.1%	17.4%	8.3%	15.6%
	Practical	21.7%	23.8%	41.7%	26.7%
	Very practical	34.9%	30.2%	33.3%	17.8%
	Not applicable	4.8%	4.9%	.0%	2.2%
Disinfecting the animal sheds/pens weekly	Not at all practical	45.8%	41.1%	.0%	37.8%
	Of little practicality	22.9%	24.5%	41.7%	20.0%
	Moderately practical	14.5%	14.0%	25.0%	20.0%
	Practical	1.2%	10.6%	25.0%	13.3%
	Very practical	12.0%	6.8%	8.3%	6.7%
	Not applicable	3.6%	3.0%	.0%	2.2%
Quarantine and testing of livestock brought to the farm	Not at all practical	3.6%	9.1%	8.3%	4.4%
	Of little practicality	9.6%	9.1%	.0%	8.9%
	Moderately practical	14.5%	12.8%	8.3%	13.3%
	Practical	18.1%	24.5%	41.7%	22.2%
	Very practical	43.4%	30.6%	33.3%	33.3%
	Not applicable	10.8%	14.0%	8.3%	17.8%
Applying slaked lime to animal bedding every 3 weeks	Not at all practical	12.0%	15.1%	.0%	13.3%
	Of little practicality	13.3%	16.2%	25.0%	22.2%
	Moderately practical	18.1%	14.3%	25.0%	17.8%
	Practical	18.1%	31.3%	16.7%	33.3%
	Very practical	31.3%	16.6%	25.0%	6.7%
	Not applicable	7.2%	6.4%	8.3%	6.7%

willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	4.8%	23.4%	.0%	6.7%
	Less than £1	20.5%	14.7%	.0%	13.3%
	£1 to £5	51.8%	42.3%	66.7%	57.8%
	£5 to £10	14.5%	9.8%	8.3%	4.4%
	More than £10	2.4%	4.2%	8.3%	6.7%
	Not applicable	6.0%	5.7%	16.7%	11.1%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	.0%	16.2%	.0%	11.1%
	1 day / year	25.3%	15.8%	16.7%	20.0%
	30 min / month	30.1%	23.4%	16.7%	33.3%
	30 min / week	27.7%	27.2%	41.7%	13.3%
	30 min / day	12.0%	10.6%	16.7%	6.7%
	Not applicable	4.8%	6.8%	8.3%	15.6%
Had you heard of E. coli O157 before we contacted you?	Yes	75.9%	72.8%	83.3%	64.4%
	No	24.1%	27.2%	16.7%	35.6%
The last time you heard of E. coli O157 was it about? - Human illness	0	22.2%	29.5%	50.0%	20.7%
	Human illness	77.8%	70.5%	50.0%	79.3%
The last time you heard of E. coli O157 was it about? - Food contamination	0	74.6%	67.4%	100.0%	55.2%
	Food contamination	25.4%	32.6%	.0%	44.8%
The last time you heard of E. coli O157 was it about? - Animal illness	0	85.7%	78.8%	50.0%	86.2%
	Animal illness	14.3%	21.2%	50.0%	13.8%
Attending open days, or farm demonstrations	Yes	11.1%	9.3%	10.0%	17.2%
	No	88.9%	90.7%	90.0%	82.8%
Meeting with other farmers	Yes	25.4%	19.2%	30.0%	44.8%
	No	74.6%	80.8%	70.0%	55.2%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	74.6%	82.4%	70.0%	72.4%
	No	25.4%	17.6%	30.0%	27.6%
Searching the internet	Yes	9.5%	7.8%	20.0%	10.3%
	No	90.5%	92.2%	80.0%	89.7%
By asking agricultural consultants	Yes	14.3%	4.7%	.0%	13.8%
	No	85.7%	95.3%	100.0%	86.2%
By asking sales people	Yes	9.5%	4.1%	30.0%	13.8%
	No	90.5%	95.9%	70.0%	86.2%

By asking a veterinary surgeon	Yes	61.9%	38.3%	60.0%	37.9%
	No	38.1%	61.7%	40.0%	62.1%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Yes	47.6%	28.5%	30.0%	27.6%
	No	52.4%	71.5%	70.0%	72.4%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	34.9%	14.5%	40.0%	10.3%
	No	65.1%	85.5%	60.0%	89.7%
Other	Yes	6.8%	3.8%	.0%	.0%
	No	93.2%	96.2%	100.0%	100.0%
Do you intend to change your farm size in the next 5 years?	Increase size	26.5%	13.6%	8.3%	13.3%
	Maintain size	65.1%	73.6%	66.7%	51.1%
	Reduce size	4.8%	4.5%	.0%	6.7%
	Don't know	2.4%	4.5%	25.0%	17.8%
	Leave farming business	1.2%	3.8%	.0%	11.1%
Do you intend to change public access to the farm in the next five years	Increase	9.6%	4.2%	8.3%	.0%
	Stay same	83.1%	93.2%	91.7%	91.1%
	Reduce	2.4%	.8%	.0%	2.2%
	Don't know	4.8%	1.9%	.0%	6.7%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	100.0%	.0%	.0%	.0%
	Stay same	.0%	100.0%	.0%	.0%
	Reduce	.0%	.0%	100.0%	.0%
	Don't know	.0%	.0%	.0%	100.0%

Table 26. All variables - frequencies (future public access to farm)

		Do you intend to change public access to the farm in the next five years			
		Increase	Stay same	Reduce	Don't know
		Column N %	Column N %	Column N %	Column N %
Location	England	55.0%	35.1%	40.0%	41.7%
	Scotland	10.0%	25.5%	20.0%	33.3%
	Wales	35.0%	30.2%	40.0%	25.0%
	Northern Ireland	.0%	9.2%	.0%	.0%
Gender	Male	85.0%	84.8%	100.0%	91.7%
	Female	15.0%	15.2%	.0%	8.3%
Which age group are you in?	18-35	5.0%	5.7%	.0%	8.3%
	36-50	30.0%	32.6%	20.0%	25.0%
	51-65	40.0%	39.4%	60.0%	58.3%
	Over 65	25.0%	22.3%	20.0%	8.3%
What is your status with respect to the farm holding?	Tenanted	5.0%	12.5%	40.0%	8.3%
	Owned	55.0%	61.4%	40.0%	75.0%
	Tenanted & owned	40.0%	24.7%	20.0%	16.7%
	Employee	.0%	1.4%	.0%	.0%
Educational background (highest degree)	School	40.0%	47.0%	.0%	25.0%
	College	45.0%	41.0%	60.0%	66.7%
	University	15.0%	12.0%	40.0%	8.3%
Please give an estimate of the total farm land area (in hectares)	less than 10	.0%	2.2%	.0%	8.3%
	10.01-50	15.0%	22.3%	.0%	.0%
	50.01-100	30.0%	25.5%	20.0%	41.7%
	100.01-150	10.0%	16.3%	20.0%	8.3%
	150.01-200	15.0%	14.1%	20.0%	8.3%
	200.01-250	15.0%	4.9%	20.0%	.0%
	250.01-500	10.0%	11.7%	20.0%	25.0%
	over 500	5.0%	3.0%	.0%	8.3%

Dairy cattle	none	70.0%	75.8%	100.0%	91.7%
	0.01-10	.0%	.3%	.0%	.0%
	10.01-50	.0%	3.3%	.0%	.0%
	50.01-100	10.0%	5.7%	.0%	8.3%
	100.01-200	10.0%	6.5%	.0%	.0%
	over 200	10.0%	8.4%	.0%	.0%
Beef cattle	none	5.0%	10.1%	.0%	8.3%
	0.01-10	.0%	4.9%	.0%	8.3%
	10.01-50	25.0%	25.0%	.0%	25.0%
	50.01-100	15.0%	20.1%	20.0%	8.3%
	100.01-150	10.0%	14.9%	20.0%	8.3%
	150.01-200	5.0%	8.4%	20.0%	25.0%
	200.01-250	20.0%	4.6%	.0%	.0%
	250.01-300	10.0%	3.5%	.0%	8.3%
	over 300	10.0%	8.4%	40.0%	8.3%
Sheep	none	45.0%	43.2%	.0%	41.7%
	0.01-100	10.0%	11.7%	20.0%	8.3%
	100.01-500	15.0%	19.0%	40.0%	33.3%
	500.01-1000	.0%	10.9%	.0%	16.7%
	1000.01-1500	5.0%	7.1%	20.0%	.0%
	over 1500	25.0%	8.2%	20.0%	.0%
Pigs	none	90.0%	92.9%	100.0%	91.7%
	0.01-100	10.0%	6.3%	.0%	8.3%
	over 100	.0%	.8%	.0%	.0%
Goats	none	90.0%	99.5%	100.0%	100.0%
	0.01-2	10.0%	.5%	.0%	.0%
How many people work on the farm full time?	0	10.0%	3.5%	.0%	.0%
	1-3	80.0%	90.2%	100.0%	91.7%
	4-10	10.0%	6.0%	.0%	.0%
	more than 10	.0%	.3%	.0%	8.3%

How many people work on the farm part time?	none	30.0%	67.4%	80.0%	58.3%
	1-3	60.0%	31.5%	20.0%	33.3%
	more than 3	10.0%	1.1%	.0%	8.3%
Could you, please, tell us what is the share of income from livestock production (i.e. direct sales plus subsidy support) in total farm income	None	.0%	.5%	.0%	8.3%
	Less than a quarter	10.0%	9.2%	.0%	8.3%
	Less than half	10.0%	15.2%	.0%	25.0%
	Half or more	80.0%	75.0%	100.0%	58.3%
Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	75.0%	62.2%	80.0%	66.7%
	No	20.0%	37.5%	20.0%	25.0%
	Incomplete	5.0%	.3%	.0%	8.3%
Are you certified organic?	Yes	10.0%	4.3%	.0%	16.7%
	No	90.0%	95.1%	100.0%	83.3%
	In conversion period	.0%	.5%	.0%	.0%
Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	30.0%	20.1%	40.0%	33.3%
	No	70.0%	79.9%	60.0%	66.7%
Do you charge an entrance fee for petting the animals	Yes	5.0%	.8%	.0%	.0%
	No	95.0%	99.2%	100.0%	100.0%
Do you allow visits by school-age children to touch the animals	Yes	20.0%	2.4%	40.0%	.0%
	No	80.0%	97.6%	60.0%	100.0%
Do you allow visits by school-age children to see the animals	Yes	25.0%	5.4%	40.0%	.0%
	No	75.0%	94.6%	60.0%	100.0%
Do you have any hand-washing facilities for visitors on-farm	Yes	65.0%	56.0%	100.0%	58.3%
	No	35.0%	44.0%	.0%	41.7%
Do you open the farm on LEAF open days	Yes	5.0%	.8%	.0%	.0%
	No	95.0%	99.2%	100.0%	100.0%
Do you run a farm produce shop from the premises	Yes	5.0%	1.6%	.0%	8.3%
	No	95.0%	98.4%	100.0%	91.7%
Is there a water source(s) on your land used for private water supply to a house(s)	Yes	40.0%	34.0%	60.0%	50.0%
	No	60.0%	66.0%	40.0%	50.0%
Does your land includes public footpaths	Yes	60.0%	62.8%	100.0%	66.7%
	No	40.0%	37.2%	.0%	33.3%

Does your land includes ground for camping, caravanning	Yes	20.0%	3.8%	.0%	8.3%
	No	80.0%	96.2%	100.0%	91.7%
Does your land includes fixed holiday accommodation	Yes	10.0%	4.6%	.0%	.0%
	No	90.0%	95.4%	100.0%	100.0%
Other	Yes	28.6%	1.6%	40.0%	.0%
	No	71.4%	98.4%	60.0%	100.0%
What proportion of your farm income is dependent on opening to the public	100%	.0%	.0%	.0%	.0%
	50-99%	10.0%	.5%	.0%	.0%
	5-49%	.0%	3.8%	.0%	8.3%
	<5%	90.0%	95.7%	100.0%	91.7%
Would you be willing to participate in a workshop on E. coli O157	Yes	50.0%	28.2%	75.0%	25.0%
	No	50.0%	71.8%	25.0%	75.0%
Attending open days, or farm demonstrations	Frequently	40.0%	25.3%	60.0%	58.3%
	Infrequently	55.0%	51.1%	40.0%	33.3%
	Never	5.0%	23.6%	.0%	8.3%
Meeting with other farmers	Frequently	90.0%	65.5%	80.0%	66.7%
	Infrequently	10.0%	30.4%	20.0%	33.3%
	Never	.0%	4.1%	.0%	.0%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Frequently	85.0%	81.3%	80.0%	75.0%
	Infrequently	15.0%	14.9%	20.0%	25.0%
	Never	.0%	3.8%	.0%	.0%
Searching the internet	Frequently	45.0%	31.0%	40.0%	25.0%
	Infrequently	35.0%	28.0%	20.0%	41.7%
	Never	20.0%	41.0%	40.0%	33.3%
By asking agricultural consultants	Frequently	20.0%	22.6%	.0%	33.3%
	Infrequently	50.0%	38.0%	60.0%	58.3%
	Never	30.0%	39.4%	40.0%	8.3%
By asking sales people	Frequently	15.0%	18.5%	.0%	.0%
	Infrequently	70.0%	53.3%	40.0%	83.3%
	Never	15.0%	28.3%	60.0%	16.7%

By asking a veterinary surgeon	Frequently	80.0%	72.3%	60.0%	75.0%
	Infrequently	20.0%	25.0%	40.0%	16.7%
	Never	.0%	2.7%	.0%	8.3%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	40.0%	35.9%	40.0%	41.7%
	Infrequently	40.0%	41.8%	40.0%	50.0%
	Never	20.0%	22.3%	20.0%	8.3%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	55.0%	29.9%	80.0%	25.0%
	Infrequently	25.0%	41.8%	20.0%	66.7%
	Never	20.0%	28.3%	.0%	8.3%
Other	Frequently	.0%	3.2%	50.0%	.0%
	Infrequently	.0%	1.2%	.0%	.0%
	Never	100.0%	95.6%	50.0%	100.0%
E. coli O157 causes diarrhoea in calves	Strongly Disagree	.0%	1.1%	.0%	8.3%
	Disagree	5.0%	4.1%	.0%	.0%
	Neither agree nor disagree	10.0%	5.4%	20.0%	8.3%
	Agree	30.0%	41.3%	40.0%	50.0%
	Strongly Agree	30.0%	28.3%	20.0%	16.7%
	Don't know	25.0%	19.8%	20.0%	16.7%
E. coli O157 causes mastitis in cattle	Strongly Disagree	.0%	6.3%	40.0%	8.3%
	Disagree	15.0%	9.8%	.0%	8.3%
	Neither agree nor disagree	5.0%	9.0%	.0%	16.7%
	Agree	15.0%	24.5%	40.0%	50.0%
	Strongly Agree	35.0%	13.0%	20.0%	.0%
	Don't know	30.0%	37.5%	.0%	16.7%

E. coli O157 causes disease in cattle	Strongly Disagree	.0%	3.3%	.0%	8.3%
	Disagree	25.0%	12.0%	20.0%	.0%
	Neither agree nor disagree	5.0%	7.6%	.0%	8.3%
	Agree	30.0%	37.0%	40.0%	66.7%
	Strongly Agree	15.0%	18.5%	40.0%	16.7%
	Don't know	25.0%	21.7%	.0%	.0%
E. coli O157 causes disease in people	Strongly Disagree	.0%	1.1%	.0%	8.3%
	Disagree	5.0%	3.0%	.0%	.0%
	Neither agree nor disagree	10.0%	3.5%	.0%	.0%
	Agree	20.0%	42.7%	20.0%	50.0%
	Strongly Agree	60.0%	39.4%	80.0%	16.7%
	Don't know	5.0%	10.3%	.0%	25.0%
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	5.0%	2.4%	.0%	.0%
	Disagree	.0%	8.7%	20.0%	.0%
	Neither agree nor disagree	15.0%	12.2%	20.0%	16.7%
	Agree	30.0%	39.7%	60.0%	58.3%
	Strongly Agree	35.0%	21.2%	.0%	16.7%
	Don't know	15.0%	15.8%	.0%	8.3%
E. coli O157 can be present on raw meat	Strongly Disagree	.0%	.8%	.0%	.0%
	Disagree	.0%	1.6%	.0%	.0%
	Neither agree nor disagree	5.0%	8.4%	.0%	8.3%
	Agree	30.0%	42.9%	20.0%	50.0%
	Strongly Agree	35.0%	33.4%	80.0%	16.7%
	Don't know	30.0%	12.8%	.0%	25.0%

E. coli O157 can be present in raw milk	Strongly Disagree	.0%	1.6%	20.0%	.0%
	Disagree	.0%	6.0%	.0%	8.3%
	Neither agree nor disagree	15.0%	10.6%	.0%	16.7%
	Agree	15.0%	34.0%	40.0%	25.0%
	Strongly Agree	35.0%	15.2%	40.0%	.0%
	Don't know	35.0%	32.6%	.0%	50.0%
E. coli O157 may contaminate rural drinking water	Strongly Disagree	.0%	3.8%	.0%	8.3%
	Disagree	10.0%	7.6%	.0%	8.3%
	Neither agree nor disagree	15.0%	8.7%	.0%	.0%
	Agree	40.0%	36.7%	60.0%	33.3%
	Strongly Agree	20.0%	16.6%	40.0%	8.3%
	Don't know	15.0%	26.6%	.0%	41.7%
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	.0%	3.3%	.0%	.0%
	Disagree	15.0%	5.4%	.0%	.0%
	Neither agree nor disagree	10.0%	7.9%	.0%	8.3%
	Agree	20.0%	32.1%	40.0%	41.7%
	Strongly Agree	25.0%	19.3%	60.0%	.0%
	Don't know	30.0%	32.1%	.0%	50.0%
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	.0%	4.3%	.0%	.0%
	Disagree	10.0%	4.3%	.0%	.0%
	Neither agree nor disagree	5.0%	8.4%	20.0%	8.3%
	Agree	30.0%	50.3%	40.0%	50.0%
	Strongly Agree	35.0%	22.8%	40.0%	25.0%
	Don't know	20.0%	9.8%	.0%	16.7%

Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	5.0%	1.4%	20.0%	8.3%
	Disagree	.0%	5.2%	.0%	.0%
	Neither agree nor disagree	5.0%	3.5%	20.0%	25.0%
	Agree	30.0%	35.6%	20.0%	41.7%
	Strongly Agree	55.0%	48.6%	40.0%	16.7%
	Don't know	5.0%	3.8%	.0%	.0%
	Not applicable	.0%	1.9%	.0%	8.3%
Do you believe E. coli O157 might be present in cattle on your farm?	Strongly Disagree	10.0%	25.5%	.0%	25.0%
	Disagree	15.0%	29.9%	.0%	50.0%
	Neither agree nor disagree	15.0%	12.5%	.0%	16.7%
	Agree	10.0%	15.8%	80.0%	.0%
	Strongly Agree	20.0%	2.2%	.0%	.0%
	Don't know	30.0%	12.8%	20.0%	8.3%
	Not applicable	.0%	1.4%	.0%	.0%
For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	Strongly Disagree	5.0%	.8%	.0%	.0%
	Disagree	.0%	1.4%	.0%	.0%
	Neither agree nor disagree	5.0%	3.0%	.0%	8.3%
	Agree	25.0%	33.2%	80.0%	33.3%
	Strongly Agree	60.0%	60.6%	20.0%	58.3%
	Don't know	5.0%	1.1%	.0%	.0%
	Not applicable	.0%	.0%	.0%	.0%
If you used control measures for E. coli O157 in cattle on-farm the price for your produce might increase	Strongly Disagree	20.0%	14.4%	40.0%	.0%
	Disagree	20.0%	29.3%	40.0%	41.7%
	Neither agree nor disagree	35.0%	15.5%	.0%	16.7%
	Agree	10.0%	23.9%	20.0%	16.7%
	Strongly Agree	5.0%	8.2%	.0%	25.0%
	Don't know	10.0%	6.8%	.0%	.0%
	Not applicable	.0%	1.9%	.0%	.0%

If you used control measures for E. coli O157 in cattle on-farm it would enhance your reputation with consumers/customers	Strongly Disagree	15.0%	7.3%	20.0%	16.7%
	Disagree	10.0%	16.6%	20.0%	16.7%
	Neither agree nor disagree	25.0%	14.1%	20.0%	16.7%
	Agree	25.0%	36.7%	20.0%	33.3%
	Strongly Agree	15.0%	18.2%	20.0%	.0%
	Don't know	10.0%	4.9%	.0%	8.3%
	Not applicable	.0%	2.2%	.0%	8.3%
If you used control measures for E. coli O157 in cattle on-farm then visitors might increase	Strongly Disagree	5.0%	8.4%	40.0%	16.7%
	Disagree	10.0%	10.1%	20.0%	16.7%
	Neither agree nor disagree	10.0%	5.4%	.0%	16.7%
	Agree	15.0%	5.4%	.0%	16.7%
	Strongly Agree	5.0%	3.3%	.0%	.0%
	Don't know	15.0%	3.8%	.0%	.0%
	Not applicable	40.0%	63.6%	40.0%	33.3%
If you did not use control measures for E. coli O157 in cattle on-farm, you might get sued in the courts	Strongly Disagree	5.0%	4.3%	20.0%	.0%
	Disagree	5.0%	12.2%	20.0%	8.3%
	Neither agree nor disagree	20.0%	12.0%	40.0%	33.3%
	Agree	35.0%	36.4%	.0%	50.0%
	Strongly Agree	15.0%	14.4%	20.0%	.0%
	Don't know	20.0%	13.9%	.0%	8.3%
	Not applicable	.0%	6.8%	.0%	.0%
If you did not use control measures for E. coli O157 in cattle on-farm, you might lose the single farm payment	Strongly Disagree	20.0%	6.0%	40.0%	.0%
	Disagree	15.0%	14.7%	20.0%	16.7%
	Neither agree nor disagree	20.0%	11.1%	.0%	8.3%
	Agree	10.0%	27.2%	40.0%	33.3%
	Strongly Agree	15.0%	12.8%	.0%	.0%
	Don't know	20.0%	20.4%	.0%	25.0%
	Not applicable	.0%	7.9%	.0%	16.7%

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	0	85.0%	85.6%	100.0%	83.3%
	Farm owners	15.0%	14.4%	.0%	16.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	0	80.0%	91.8%	100.0%	100.0%
	Meat/Milk Processors	20.0%	8.2%	.0%	.0%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	0	90.0%	91.6%	100.0%	83.3%
	Food Retailers	10.0%	8.4%	.0%	16.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	0	90.0%	89.1%	60.0%	83.3%
	Public	10.0%	10.9%	40.0%	16.7%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	0	95.0%	93.2%	100.0%	100.0%
	Government	5.0%	6.8%	.0%	.0%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	0	40.0%	37.8%	20.0%	41.7%
	All	60.0%	62.2%	80.0%	58.3%
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Don't know	0	95.0%	95.1%	100.0%	83.3%
	Don't know	5.0%	4.9%	.0%	16.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Farm owners	0	35.0%	33.7%	40.0%	33.3%
	Farm owners	65.0%	66.3%	60.0%	66.7%
Who do you think is responsible for controlling E. coli O157 on-farms - Meat/Milk Processors	0	95.0%	95.4%	100.0%	91.7%
	Meat/Milk Processors	5.0%	4.6%	.0%	8.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Food Retailers	0	95.0%	97.3%	100.0%	100.0%
	Food Retailers	5.0%	2.7%	.0%	.0%
Who do you think is responsible for controlling E. coli O157 on-farms - Public	0	90.0%	98.6%	100.0%	100.0%
	Public	10.0%	1.4%	.0%	.0%
Who do you think is responsible for controlling E. coli O157 on-farms - Government	0	100.0%	87.5%	60.0%	91.7%
	Government	.0%	12.5%	40.0%	8.3%
Who do you think is responsible for controlling E. coli O157 on-farms - All	0	75.0%	79.9%	80.0%	66.7%
	All	25.0%	20.1%	20.0%	33.3%
Who do you think is responsible for controlling E. coli O157 on-farms - Don't know	0	90.0%	94.0%	100.0%	100.0%
	Don't know	10.0%	6.0%	.0%	.0%
Government or European animal health regulations	Not affected	20.0%	41.8%	.0%	41.7%
	Slightly affected	30.0%	29.6%	20.0%	41.7%
	Much affected	50.0%	28.5%	80.0%	16.7%

Reports of E. coli O157 outbreaks or incidents	Not affected	75.0%	89.7%	80.0%	91.7%
	Slightly affected	15.0%	7.9%	20.0%	8.3%
	Much affected	10.0%	2.4%	.0%	.0%
Experience of E. coli O157 outbreaks or incidents	Not affected	85.0%	92.1%	100.0%	100.0%
	Slightly affected	5.0%	6.3%	.0%	.0%
	Much affected	10.0%	1.6%	.0%	.0%
Incidents of E. coli O157 that occurred on your farm	Not affected	85.0%	92.1%	80.0%	100.0%
	Slightly affected	5.0%	5.4%	20.0%	.0%
	Much affected	10.0%	2.4%	.0%	.0%
A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	55.0%	59.0%	20.0%	66.7%
	Not willing to use this	45.0%	41.0%	80.0%	33.3%
The cost is too expensive	Strongly disagree	22.2%	2.6%	.0%	.0%
	Disagree	11.1%	7.9%	25.0%	50.0%
	Neither disagree nor agree	11.1%	18.5%	25.0%	25.0%
	Agree	11.1%	24.5%	25.0%	25.0%
	Strongly agree	44.4%	46.4%	25.0%	.0%
	Don't know	.0%	.0%	.0%	.0%
Doing this would take too much time	Strongly disagree	11.1%	7.3%	.0%	.0%
	Disagree	22.2%	24.5%	25.0%	25.0%
	Neither disagree nor agree	33.3%	18.5%	.0%	25.0%
	Agree	.0%	29.1%	25.0%	25.0%
	Strongly agree	33.3%	20.5%	50.0%	25.0%
	Don't know	.0%	.0%	.0%	.0%
I would need more information before using a vaccine	Strongly disagree	.0%	.7%	.0%	.0%
	Disagree	.0%	2.6%	.0%	.0%
	Neither disagree nor agree	.0%	6.0%	.0%	.0%
	Agree	11.1%	22.5%	50.0%	75.0%
	Strongly agree	88.9%	67.5%	50.0%	25.0%
	Don't know	.0%	.7%	.0%	.0%

I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	.0%	13.9%	.0%	25.0%
	Disagree	.0%	19.2%	25.0%	.0%
	Neither disagree nor agree	44.4%	22.5%	25.0%	25.0%
	Agree	44.4%	27.8%	50.0%	50.0%
	Strongly agree	11.1%	15.2%	.0%	.0%
	Don't know	.0%	1.3%	.0%	.0%
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	22.2%	7.9%	25.0%	.0%
	Disagree	.0%	11.9%	.0%	.0%
	Neither disagree nor agree	22.2%	17.9%	.0%	25.0%
	Agree	33.3%	33.8%	75.0%	75.0%
	Strongly agree	22.2%	26.5%	.0%	.0%
	Don't know	.0%	2.0%	.0%	.0%
Other	Strongly disagree	.0%	3.1%	.0%	.0%
	Disagree	.0%	1.0%	.0%	.0%
	Neither disagree nor agree	.0%	3.1%	25.0%	.0%
	Agree	25.0%	6.1%	.0%	.0%
	Strongly agree	50.0%	40.8%	50.0%	66.7%
	Don't know	25.0%	45.9%	25.0%	33.3%
Additives can be given on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	30.0%	39.9%	.0%	58.3%
	Not willing to use this	70.0%	60.1%	100.0%	41.7%
The cost is too expensive	Strongly disagree	7.1%	1.8%	.0%	.0%
	Disagree	.0%	6.8%	20.0%	20.0%
	Neither disagree nor agree	7.1%	10.0%	20.0%	20.0%
	Agree	42.9%	28.5%	20.0%	20.0%
	Strongly agree	42.9%	51.6%	40.0%	20.0%
	Don't know	.0%	1.4%	.0%	20.0%

Doing this would take too much time	Strongly disagree	7.1%	5.9%	20.0%	20.0%
	Disagree	42.9%	19.9%	20.0%	20.0%
	Neither disagree nor agree	.0%	18.1%	20.0%	20.0%
	Agree	14.3%	24.4%	.0%	20.0%
	Strongly agree	35.7%	29.4%	40.0%	20.0%
	Don't know	.0%	2.3%	.0%	.0%
I would need more information before using an additive	Strongly disagree	7.1%	2.3%	.0%	.0%
	Disagree	7.1%	3.2%	.0%	20.0%
	Neither disagree nor agree	7.1%	5.4%	.0%	20.0%
	Agree	.0%	25.8%	20.0%	20.0%
	Strongly agree	78.6%	62.9%	80.0%	40.0%
	Don't know	.0%	.5%	.0%	.0%
I would be encouraged to use additives if it was used by other farmers that I know	Strongly disagree	14.3%	16.7%	.0%	20.0%
	Disagree	35.7%	19.0%	20.0%	20.0%
	Neither disagree nor agree	21.4%	19.0%	40.0%	40.0%
	Agree	7.1%	32.1%	40.0%	20.0%
	Strongly agree	21.4%	12.7%	.0%	.0%
	Don't know	.0%	.5%	.0%	.0%
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	14.3%	6.8%	20.0%	.0%
	Disagree	14.3%	13.1%	.0%	20.0%
	Neither disagree nor agree	21.4%	19.9%	20.0%	60.0%
	Agree	28.6%	40.7%	20.0%	20.0%
	Strongly agree	21.4%	18.1%	40.0%	.0%
	Don't know	.0%	1.4%	.0%	.0%

Other	Strongly disagree	12.5%	2.1%	.0%	.0%
	Disagree	.0%	.0%	.0%	.0%
	Neither disagree nor agree	.0%	2.8%	25.0%	.0%
	Agree	12.5%	7.1%	.0%	.0%
	Strongly agree	37.5%	32.6%	25.0%	.0%
	Don't know	37.5%	55.3%	50.0%	100.0%
Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	Not at all practical	10.0%	10.6%	40.0%	8.3%
	Of little practicality	5.0%	12.2%	.0%	8.3%
	Moderately practical	5.0%	9.5%	.0%	41.7%
	Practical	35.0%	21.5%	60.0%	25.0%
	Very practical	45.0%	43.8%	.0%	16.7%
	Not applicable	.0%	2.4%	.0%	.0%
Separating animals into different age groups for the majority of the time	Not at all practical	10.0%	8.4%	20.0%	8.3%
	Of little practicality	.0%	6.3%	.0%	8.3%
	Moderately practical	20.0%	9.5%	.0%	8.3%
	Practical	5.0%	28.0%	40.0%	41.7%
	Very practical	65.0%	46.5%	40.0%	25.0%
	Not applicable	.0%	1.4%	.0%	8.3%
Reducing your current livestock numbers kept in cattle sheds	Not at all practical	5.0%	21.2%	40.0%	16.7%
	Of little practicality	10.0%	18.8%	40.0%	25.0%
	Moderately practical	45.0%	12.5%	.0%	8.3%
	Practical	15.0%	24.2%	20.0%	16.7%
	Very practical	25.0%	16.3%	.0%	8.3%
	Not applicable	.0%	7.1%	.0%	25.0%
Reducing your current livestock numbers on the farm	Not at all practical	30.0%	44.3%	80.0%	50.0%
	Of little practicality	20.0%	22.0%	20.0%	16.7%
	Moderately practical	15.0%	11.7%	.0%	16.7%
	Practical	20.0%	10.1%	.0%	.0%
	Very practical	15.0%	8.7%	.0%	.0%
	Not applicable	.0%	3.3%	.0%	16.7%

Cleaning water troughs daily	Not at all practical	50.0%	19.0%	40.0%	25.0%
	Of little practicality	15.0%	21.7%	20.0%	25.0%
	Moderately practical	15.0%	18.2%	20.0%	16.7%
	Practical	10.0%	18.5%	20.0%	25.0%
	Very practical	10.0%	19.0%	.0%	8.3%
	Not applicable	.0%	3.5%	.0%	.0%
Cleaning feed troughs daily	Not at all practical	15.0%	11.4%	.0%	.0%
	Of little practicality	5.0%	13.6%	20.0%	16.7%
	Moderately practical	10.0%	16.6%	20.0%	41.7%
	Practical	25.0%	24.5%	40.0%	8.3%
	Very practical	45.0%	29.3%	20.0%	25.0%
	Not applicable	.0%	4.6%	.0%	8.3%
Disinfecting the animal sheds/pens weekly	Not at all practical	30.0%	40.5%	40.0%	58.3%
	Of little practicality	45.0%	23.1%	40.0%	16.7%
	Moderately practical	10.0%	15.2%	20.0%	16.7%
	Practical	10.0%	9.8%	.0%	.0%
	Very practical	5.0%	8.4%	.0%	.0%
	Not applicable	.0%	3.0%	.0%	8.3%
Quarantine and testing of livestock brought to the farm	Not at all practical	.0%	7.3%	40.0%	8.3%
	Of little practicality	5.0%	8.4%	20.0%	25.0%
	Moderately practical	20.0%	12.8%	.0%	16.7%
	Practical	25.0%	23.1%	20.0%	33.3%
	Very practical	45.0%	34.0%	20.0%	8.3%
	Not applicable	5.0%	14.4%	.0%	8.3%
Applying slaked lime to animal bedding every 3 weeks	Not at all practical	10.0%	13.0%	60.0%	25.0%
	Of little practicality	10.0%	17.4%	.0%	8.3%
	Moderately practical	15.0%	15.5%	.0%	33.3%
	Practical	40.0%	28.3%	40.0%	8.3%
	Very practical	25.0%	18.8%	.0%	16.7%
	Not applicable	.0%	7.1%	.0%	8.3%

willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	25.0%	16.8%	20.0%	8.3%
	Less than £1	15.0%	15.8%	.0%	8.3%
	£1 to £5	40.0%	47.3%	60.0%	33.3%
	£5 to £10	20.0%	9.0%	20.0%	25.0%
	More than £10	.0%	4.3%	.0%	8.3%
	Not applicable	.0%	6.8%	.0%	16.7%
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	5.0%	12.5%	.0%	8.3%
	1 day / year	20.0%	18.2%	.0%	25.0%
	30 min / month	30.0%	25.0%	20.0%	41.7%
	30 min / week	30.0%	25.8%	60.0%	16.7%
	30 min / day	10.0%	10.9%	20.0%	.0%
	Not applicable	5.0%	7.6%	.0%	8.3%
Had you heard of E. coli O157 before we contacted you?	Yes	75.0%	72.8%	100.0%	58.3%
	No	25.0%	27.2%	.0%	41.7%
The last time you heard of E. coli O157 was it about? - Human illness	0	26.7%	28.7%	20.0%	.0%
	Human illness	73.3%	71.3%	80.0%	100.0%
The last time you heard of E. coli O157 was it about? - Food contamination	0	80.0%	68.7%	60.0%	57.1%
	Food contamination	20.0%	31.3%	40.0%	42.9%
The last time you heard of E. coli O157 was it about? - Animal illness	0	80.0%	79.9%	80.0%	85.7%
	Animal illness	20.0%	20.1%	20.0%	14.3%
Attending open days, or farm demonstrations	Yes	13.3%	10.1%	.0%	28.6%
	No	86.7%	89.9%	100.0%	71.4%
Meeting with other farmers	Yes	33.3%	23.1%	.0%	28.6%
	No	66.7%	76.9%	100.0%	71.4%
From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	Yes	93.3%	78.7%	80.0%	71.4%
	No	6.7%	21.3%	20.0%	28.6%
Searching the internet	Yes	6.7%	8.6%	.0%	28.6%
	No	93.3%	91.4%	100.0%	71.4%
By asking agricultural consultants	Yes	6.7%	7.5%	.0%	14.3%
	No	93.3%	92.5%	100.0%	85.7%
By asking sales people	Yes	6.7%	7.1%	.0%	14.3%
	No	93.3%	92.9%	100.0%	85.7%

By asking a veterinary surgeon	Yes	53.3%	43.3%	40.0%	57.1%
	No	46.7%	56.7%	60.0%	42.9%
From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Yes	26.7%	32.1%	40.0%	57.1%
	No	73.3%	67.9%	60.0%	42.9%
From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Yes	33.3%	17.5%	40.0%	42.9%
	No	66.7%	82.5%	60.0%	57.1%
Other	Yes	11.1%	2.7%	50.0%	.0%
	No	88.9%	97.3%	50.0%	100.0%
Do you intend to change your farm size in the next 5 years?	Increase size	30.0%	14.9%	60.0%	8.3%
	Maintain size	50.0%	71.5%	20.0%	50.0%
	Reduce size	10.0%	4.3%	20.0%	.0%
	Don't know	5.0%	5.7%	.0%	25.0%
	Leave farming business	5.0%	3.5%	.0%	16.7%
Do you intend to change public access to the farm in the next five years	Increase	100.0%	.0%	.0%	.0%
	Stay same	.0%	100.0%	.0%	.0%
	Reduce	.0%	.0%	100.0%	.0%
	Don't know	.0%	.0%	.0%	100.0%
Do you intend to change E. coli O157 control measures on your farm in the next five years	Increase	40.0%	18.8%	40.0%	33.3%
	Stay same	55.0%	67.1%	40.0%	41.7%
	Reduce	5.0%	3.0%	.0%	.0%
	Don't know	.0%	11.1%	20.0%	25.0%

A.2 *E. coli* O157 online survey. Basic statistics

Table 27. All variables - frequencies (by region)

		Where is your farm?							
		England		Scotland		Wales		Total	
		Column N %	Mean	Column N %	Mean	Column N %	Mean	Column N %	Mean
Gender	Male	56.6%		66.7%		77.8%		59.1%	
	Female	43.4%		33.3%		22.2%		40.9%	
Which age group are you in?	18-35	11.8%		.0%		11.1%		11.4%	
	36-50	38.2%		33.3%		55.6%		39.8%	
	51-65	40.8%		66.7%		33.3%		40.9%	
	Over 65	9.2%		.0%		.0%		8.0%	
What is your status with respect to the farm holding?	Tenanted	13.3%		.0%		22.2%		13.8%	
	Owned	56.0%		66.7%		55.6%		56.3%	
	Tenanted & owned	14.7%		33.3%		.0%		13.8%	
	Employee	16.0%		.0%		22.2%		16.1%	
How many years have you been involved working on farms			27		38		30		28
How many years have you been involved in the decision making			20		28		18		20
Educational background (highest degree)	School	15.8%		.0%		.0%		13.6%	
	College	31.6%		33.3%		44.4%		33.0%	
	University	52.6%		66.7%		55.6%		53.4%	
total farm land area (in hectares)	under 100	43.4%		33.3%		22.2%		40.9%	
	100-149	14.5%		33.3%		.0%		13.6%	
	150-499	27.6%		33.3%		44.4%		29.5%	
	500-999	11.8%		.0%		.0%		10.2%	
	1000 or more	2.6%		.0%		33.3%		5.7%	

Livestock accessible to public on visits & can be seen from close at hand or touched	none	3.9%		33.3%		11.1%		5.7%	
	1-49	15.8%		.0%		22.2%		15.9%	
	50-99	11.8%		33.3%		.0%		11.4%	
	100-149	22.4%		.0%		.0%		19.3%	
	150-249	15.8%		.0%		11.1%		14.8%	
	250-499	13.2%		.0%		.0%		11.4%	
	500-999	13.2%		.0%		33.3%		14.8%	
	over 1000	3.9%		33.3%		22.2%		6.8%	
Livestock not accessible to public on visits & can be seen from close at hand or touched	none	53.9%		66.7%		55.6%		54.5%	
	1-500	28.9%		.0%		22.2%		27.3%	
	500-999	10.5%		.0%		.0%		9.1%	
	over 1000	6.6%		33.3%		22.2%		9.1%	
How many people are involved in livestock work on the farm full time?	none	9.0%		.0%		22.2%		10.3%	
	1-3	70.1%		50.0%		55.6%		67.9%	
	4-10	19.4%		50.0%		22.2%		20.5%	
	more than 10	1.5%		.0%		.0%		1.3%	
How many people are involved in livestock work on the farm part-time and/or other temporary?	none	12.5%		.0%		22.2%		13.2%	
	1-3	68.8%		66.7%		55.6%		67.1%	
	more than 3	18.8%		33.3%		22.2%		19.7%	
Do you have an identified person who acts as safety officer on farm?	yes	81.6%		100.0%		77.8%		81.8%	
	no	18.4%		.0%		22.2%		18.2%	
Training in public safety during the past 12 months	0	3.9%		.0%		.0%		3.4%	
	to all staff	40.8%		66.7%		11.1%		38.6%	
	full time staff	18.4%		33.3%		11.1%		18.2%	
	no	36.8%		.0%		77.8%		39.8%	
use of a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of livestock	Yes	58.7%		66.7%		88.9%		62.1%	
	No	33.3%		33.3%		11.1%		31.0%	
	Incomplete	8.0%		.0%		.0%		6.9%	
Where is your farm?	England	100.0%		.0%		.0%		86.4%	
	Scotland	.0%		100.0%		.0%		3.4%	
	Wales	.0%		.0%		100.0%		10.2%	
	Total	100.0%		100.0%		100.0%		100.0%	

farm selling agricultural products (meat or milk, etc.) that are produced to standards specified by supermarkets	Yes	28.0%		33.3%		12.5%		26.7%	
	No	72.0%		66.7%		87.5%		73.3%	
farm livestock accessible to public in the past 12 months - visits by school groups of children to touch the animals	Yes	52.1%		66.7%		28.6%		50.6%	
	No	47.9%		33.3%		71.4%		49.4%	
farm livestock accessible to public in the past 12 months - visits by school groups of children to see the animals	Yes	80.8%		66.7%		87.5%		81.0%	
	No	19.2%		33.3%		12.5%		19.0%	
farm livestock accessible to public in the past 12 months - children <10 years old allowed into the pens with ruminant animals	Yes	12.5%		33.3%		12.5%		13.3%	
	No	87.5%		66.7%		87.5%		86.7%	
farm livestock accessible to public in the past 12 months - children <10 years old allowed to bottle feed lambs	Yes	25.4%		33.3%		37.5%		26.9%	
	No	74.6%		66.7%		62.5%		73.1%	
farm livestock accessible to public in the past 12 months - signs warning visitors of health hazards from animal infections	Yes	70.8%		33.3%		75.0%		69.9%	
	No	29.2%		66.7%		25.0%		30.1%	
farm livestock accessible to public in the past 12 months - hot water hand-washing facilities for visitors throughout the farm	Yes	70.0%		66.7%		66.7%		69.6%	
	No	30.0%		33.3%		33.3%		30.4%	
farm livestock accessible to public in the past 12 months - cold/hot water hand-washing facilities for visitors throughout the farm	Yes	89.2%		66.7%		75.0%		86.8%	
	No	10.8%		33.3%		25.0%		13.2%	
farm livestock accessible to public in the past 12 months - open the farm on LEAF open days	Yes	86.3%		66.7%		100.0%		86.9%	
	No	13.7%		33.3%		.0%		13.1%	
farm livestock accessible to public in the past 12 months - run a farm produce shop from the premises	Yes	37.8%		.0%		37.5%		36.9%	
	No	62.2%		100.0%		62.5%		63.1%	

farm livestock accessible to public in the past 12 months - a water source(s) on own land used for private water supply to a house(s)	Yes	29.2%		33.3%		25.0%		28.9%	
	No	70.8%		66.7%		75.0%		71.1%	
farm livestock accessible to public in the past 12 months - land includes public footpaths	Yes	75.3%		100.0%		62.5%		75.0%	
	No	24.7%		.0%		37.5%		25.0%	
farm livestock accessible to public in the past 12 months - land includes ground for camping, caravanning	Yes	15.1%		100.0%		12.5%		17.9%	
	No	84.9%		.0%		87.5%		82.1%	
farm livestock accessible to public in the past 12 months - land includes fixed holiday accommodation	Yes	15.3%		50.0%		25.0%		17.1%	
	No	84.7%		50.0%		75.0%		82.9%	
farm livestock accessible to public in the past 12 months - public to animal contact areas supervised continually by staff	Yes	63.4%		66.7%		100.0%		66.7%	
	No	36.6%		33.3%		.0%		33.3%	
farm livestock accessible to public in the past 12 months - double fencing to separate the animals from all picnic/lunch areas	Yes	35.8%		33.3%		16.7%		34.2%	
	No	64.2%		66.7%		83.3%		65.8%	
farm livestock accessible to public in the past 12 months - premises known to the local authority as an Open Farm	Yes	31.9%		66.7%		71.4%		36.6%	
	No	68.1%		33.3%		28.6%		63.4%	
farm livestock accessible to public in the past 12 months - provide protective overshoes for all visitors	Yes	5.6%		.0%		14.3%		6.1%	
	No	94.4%		100.0%		85.7%		93.9%	
farm livestock accessible to public in the past 12 months - provide disinfectant footbaths at entrances to pens	Yes	29.2%		33.3%		66.7%		32.1%	
	No	70.8%		66.7%		33.3%		67.9%	
farm livestock accessible to public in the past 12 months - have a safety consultant	Yes	31.0%		.0%		37.5%		30.5%	
	No	69.0%		100.0%		62.5%		69.5%	

farm livestock accessible to public in the past 12 months - revised AIS23 an improvement on the advice available in 2010	Yes	63.5%		50.0%		50.0%		62.1%	
	No	36.5%		50.0%		50.0%		37.9%	
proportion of farm income dependent on opening to the public	100%	2.7%		.0%		.0%		2.4%	
	50-99%	11.0%		.0%		12.5%		10.7%	
	5-49%	20.5%		.0%		.0%		17.9%	
	<5%	65.8%		100.0%		87.5%		69.0%	
source of general information for managing the farm: open days/farm demonstrations	Frequently	45.1%		33.3%		50.0%		45.1%	
	Infrequently	45.1%		66.7%		50.0%		46.3%	
	Never	9.9%		.0%		.0%		8.5%	
source of general information for managing the farm: other farmers	Frequently	49.3%		66.7%		75.0%		52.4%	
	Infrequently	43.8%		33.3%		25.0%		41.7%	
	Never	6.8%		.0%		.0%		6.0%	
source of general information for managing the farm: media (press, magazines (Farmers Weekly etc.), radio, TV)	Frequently	68.1%		.0%		75.0%		66.3%	
	Infrequently	29.2%		100.0%		25.0%		31.3%	
	Never	2.8%		.0%		.0%		2.4%	
source of general information for managing the farm: internet	Frequently	54.8%		66.7%		50.0%		54.8%	
	Infrequently	41.1%		33.3%		25.0%		39.3%	
	Never	4.1%		.0%		25.0%		6.0%	
source of general information for managing the farm: agricultural consultants	Frequently	36.1%		.0%		42.9%		35.4%	
	Infrequently	43.1%		66.7%		42.9%		43.9%	
	Never	20.8%		33.3%		14.3%		20.7%	
source of general information for managing the farm: sales people	Frequently	5.6%		.0%		14.3%		6.2%	
	Infrequently	56.3%		33.3%		42.9%		54.3%	
	Never	38.0%		66.7%		42.9%		39.5%	
source of general information for managing the farm: veterinary surgeons	Frequently	47.9%		33.3%		42.9%		47.0%	
	Infrequently	39.7%		66.7%		57.1%		42.2%	
	Never	12.3%		.0%		.0%		10.8%	

source of general information for managing the farm: government (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	Frequently	43.1%		33.3%		37.5%		42.2%	
	Infrequently	48.6%		66.7%		50.0%		49.4%	
	Never	8.3%		.0%		12.5%		8.4%	
source of general information for managing the farm: industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	Frequently	51.4%		33.3%		62.5%		51.8%	
	Infrequently	38.9%		66.7%		25.0%		38.6%	
	Never	9.7%		.0%		12.5%		9.6%	
E. coli O157 causes diarrhoea in calves	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	18.2%		.0%		28.6%		18.4%	
	Neither agree nor disagree	7.6%		.0%		14.3%		7.9%	
	Agree	34.8%		66.7%		14.3%		34.2%	
	Strongly Agree	15.2%		.0%		14.3%		14.5%	
	Don't know	22.7%		33.3%		28.6%		23.7%	
E. coli O157 causes mastitis in cattle	Strongly Disagree	7.6%		.0%		16.7%		8.0%	
	Disagree	27.3%		33.3%		33.3%		28.0%	
	Neither agree nor disagree	15.2%		.0%		.0%		13.3%	
	Agree	16.7%		.0%		16.7%		16.0%	
	Strongly Agree	4.5%		33.3%		16.7%		6.7%	
	Don't know	28.8%		33.3%		16.7%		28.0%	
E. coli O157 causes disease in cattle	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	24.2%		33.3%		33.3%		25.3%	
	Neither agree nor disagree	10.6%		.0%		33.3%		12.0%	
	Agree	30.3%		.0%		16.7%		28.0%	
	Strongly Agree	13.6%		.0%		.0%		12.0%	
	Don't know	19.7%		66.7%		16.7%		21.3%	

E. coli O157 causes disease in people	Strongly Disagree	3.0%		.0%		.0%		2.6%	
	Disagree	3.0%		.0%		.0%		2.6%	
	Neither agree nor disagree	3.0%		.0%		.0%		2.6%	
	Agree	42.4%		66.7%		37.5%		42.9%	
	Strongly Agree	47.0%		33.3%		50.0%		46.8%	
	Don't know	1.5%		.0%		12.5%		2.6%	
Livestock are an important source from which E. coli O157 spreads	Strongly Disagree	4.5%		.0%		.0%		3.9%	
	Disagree	1.5%		.0%		.0%		1.3%	
	Neither agree nor disagree	6.1%		.0%		.0%		5.2%	
	Agree	40.9%		66.7%		62.5%		44.2%	
	Strongly Agree	42.4%		33.3%		37.5%		41.6%	
	Don't know	4.5%		.0%		.0%		3.9%	
E. coli O157 can be present on raw meat	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	4.5%		.0%		.0%		3.9%	
	Neither agree nor disagree	6.1%		.0%		.0%		5.3%	
	Agree	43.9%		.0%		57.1%		43.4%	
	Strongly Agree	36.4%		66.7%		42.9%		38.2%	
	Don't know	7.6%		33.3%		.0%		7.9%	
E. coli O157 can be present in raw milk	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	3.1%		.0%		14.3%		4.0%	
	Neither agree nor disagree	7.7%		33.3%		.0%		8.0%	
	Agree	43.1%		33.3%		42.9%		42.7%	
	Strongly Agree	27.7%		.0%		28.6%		26.7%	
	Don't know	16.9%		33.3%		14.3%		17.3%	

E. coli O157 may contaminate rural drinking water	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	6.1%		.0%		.0%		5.3%	
	Neither agree nor disagree	10.6%		.0%		.0%		9.2%	
	Agree	43.9%		.0%		42.9%		42.1%	
	Strongly Agree	21.2%		66.7%		57.1%		26.3%	
	Don't know	16.7%		33.3%		.0%		15.8%	
E. coli O157 may contaminate produce such as lettuce, apples, spinach	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	.0%		.0%		.0%		.0%	
	Neither agree nor disagree	9.1%		.0%		.0%		7.8%	
	Agree	45.5%		.0%		62.5%		45.5%	
	Strongly Agree	30.3%		66.7%		37.5%		32.5%	
	Don't know	13.6%		33.3%		.0%		13.0%	
People touching calves/ cows may become infected with E. coli O157	Strongly Disagree	1.5%		.0%		.0%		1.3%	
	Disagree	.0%		.0%		.0%		.0%	
	Neither agree nor disagree	7.6%		.0%		.0%		6.5%	
	Agree	45.5%		66.7%		50.0%		46.8%	
	Strongly Agree	37.9%		33.3%		37.5%		37.7%	
	Don't know	7.6%		.0%		12.5%		7.8%	
Your business would be adversely affected if E. coli O157 infection in a person was linked to your farm	Strongly Disagree	1.6%		33.3%		.0%		2.7%	
	Disagree	4.8%		.0%		.0%		4.1%	
	Neither agree nor disagree	7.9%		.0%		25.0%		9.5%	
	Agree	33.3%		33.3%		12.5%		31.1%	
	Strongly Agree	50.8%		33.3%		62.5%		51.4%	
	Don't know	1.6%		.0%		.0%		1.4%	

Do you believe E. coli O157 might be present in cattle on your farm	Strongly Disagree	6.5%		33.3%		14.3%		8.3%	
	Disagree	8.1%		.0%		14.3%		8.3%	
	Neither agree nor disagree	17.7%		.0%		14.3%		16.7%	
	Agree	25.8%		.0%		42.9%		26.4%	
	Strongly Agree	6.5%		.0%		.0%		5.6%	
	Don't know	35.5%		66.7%		14.3%		34.7%	
Do you believe that farms which welcome public visitors pose a greater risk to human health than farms that do not welcome visitors	Strongly Disagree	9.7%		33.3%		25.0%		12.3%	
	Disagree	27.4%		33.3%		25.0%		27.4%	
	Neither agree nor disagree	19.4%		33.3%		12.5%		19.2%	
	Agree	27.4%		.0%		37.5%		27.4%	
	Strongly Agree	14.5%		.0%		.0%		12.3%	
	Don't know	1.6%		.0%		.0%		1.4%	
For you it is very important that you take action to control the infections in animals that may affect humans	Strongly Disagree	.0%		.0%		12.5%		1.4%	
	Disagree	1.6%		.0%		.0%		1.4%	
	Neither agree nor disagree	6.5%		33.3%		.0%		6.8%	
	Agree	45.2%		33.3%		75.0%		47.9%	
	Strongly Agree	46.8%		33.3%		12.5%		42.5%	
	Don't know	.0%		.0%		.0%		.0%	
If you used control measures for E. coli O157 in cattle on farm the price for your produce might increase	Strongly Disagree	11.5%		.0%		14.3%		11.3%	
	Disagree	39.3%		.0%		28.6%		36.6%	
	Neither agree nor disagree	21.3%		.0%		42.9%		22.5%	
	Agree	16.4%		.0%		.0%		14.1%	
	Strongly Agree	3.3%		.0%		.0%		2.8%	
	Don't know	8.2%		100.0%		14.3%		12.7%	

If you used control measures for E. coli O157 in cattle on farm it would enhance your reputation with consumers/customers	Strongly Disagree	1.6%		33.3%		.0%		2.8%	
	Disagree	21.3%		.0%		42.9%		22.5%	
	Neither agree nor disagree	26.2%		.0%		28.6%		25.4%	
	Agree	27.9%		.0%		14.3%		25.4%	
	Strongly Agree	18.0%		.0%		.0%		15.5%	
	Don't know	4.9%		66.7%		14.3%		8.5%	
If you used control measures for E. coli O157 in cattle on farm then visitors might increase	Strongly Disagree	1.6%		33.3%		.0%		2.8%	
	Disagree	14.8%		.0%		28.6%		15.5%	
	Neither agree nor disagree	50.8%		33.3%		57.1%		50.7%	
	Agree	19.7%		.0%		.0%		16.9%	
	Strongly Agree	3.3%		.0%		.0%		2.8%	
	Don't know	9.8%		33.3%		14.3%		11.3%	
If you did not use control measures for E. coli O157 in cattle on farm, you might get sued in the courts	Strongly Disagree	1.6%		.0%		.0%		1.4%	
	Disagree	14.5%		.0%		.0%		12.5%	
	Neither agree nor disagree	24.2%		66.7%		28.6%		26.4%	
	Agree	35.5%		.0%		14.3%		31.9%	
	Strongly Agree	12.9%		.0%		42.9%		15.3%	
	Don't know	11.3%		33.3%		14.3%		12.5%	
If you did not use control measures for E. coli O157 in cattle on farm, you might lose the single farm payment	Strongly Disagree	9.7%		.0%		28.6%		11.1%	
	Disagree	24.2%		.0%		14.3%		22.2%	
	Neither agree nor disagree	22.6%		33.3%		42.9%		25.0%	
	Agree	8.1%		.0%		.0%		6.9%	
	Strongly Agree	1.6%		.0%		.0%		1.4%	
	Don't know	33.9%		66.7%		14.3%		33.3%	
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Farm owners	otherwise	68.9%		33.3%		87.5%		69.4%	
	Farm owners	31.1%		66.7%		12.5%		30.6%	

Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Meat/Milk Processors	otherwise	86.9%		66.7%		87.5%		86.1%	
	Meat/Milk Processors	13.1%		33.3%		12.5%		13.9%	
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Food Retailers	otherwise	78.7%		66.7%		87.5%		79.2%	
	Food Retailers	21.3%		33.3%		12.5%		20.8%	
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Public	otherwise	52.5%		66.7%		75.0%		55.6%	
	Public	47.5%		33.3%		25.0%		44.4%	
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - Government	otherwise	93.4%		66.7%		100.0%		93.1%	
	Government	6.6%		33.3%		.0%		6.9%	
Who do you think would benefit the most from on-farm controls to reduce E. coli O157 in cattle - All	otherwise	54.1%		33.3%		25.0%		50.0%	
	All	45.9%		66.7%		75.0%		50.0%	
Who do you think is responsible for controlling E. coli O157 on farms - Farm owners	otherwise	25.4%		33.3%		12.5%		24.3%	
	Farm owners	74.6%		66.7%		87.5%		75.7%	
Who do you think is responsible for controlling E. coli O157 on farms - Meat/Milk Processors	otherwise	93.7%		66.7%		75.0%		90.5%	
	Meat/Milk Processors	6.3%		33.3%		25.0%		9.5%	
Who do you think is responsible for controlling E. coli O157 on farms - Food Retailers	otherwise	95.2%		100.0%		100.0%		95.9%	
	Food Retailers	4.8%		.0%		.0%		4.1%	
Who do you think is responsible for controlling E. coli O157 on farms - Public	otherwise	87.3%		100.0%		87.5%		87.8%	
	Public	12.7%		.0%		12.5%		12.2%	
Who do you think is responsible for controlling E. coli O157 on farms - Government	otherwise	82.5%		100.0%		75.0%		82.4%	
	Government	17.5%		.0%		25.0%		17.6%	
Who do you think is responsible for controlling E. coli O157 on farms - All	otherwise	76.2%		66.7%		87.5%		77.0%	
	All	23.8%		33.3%		12.5%		23.0%	

perceived effect of Government or European animal health regulations on the way of managing business during the past five years	Not affected	19.0%		.0%		12.5%		17.6%	
	Slightly affected	42.9%		100.0%		37.5%		44.6%	
	Much affected	38.1%		.0%		50.0%		37.8%	
perceived effect of reports of E. coli O157 outbreaks or incidents on the way of managing business during the past five years	Not affected	39.7%		.0%		25.0%		36.5%	
	Slightly affected	42.9%		100.0%		50.0%		45.9%	
	Much affected	17.5%		.0%		25.0%		17.6%	
perceived effect of experience of E. coli O157 outbreaks or incidents on the way of managing business during the past five years	Not affected	81.0%		66.7%		85.7%		80.8%	
	Slightly affected	14.3%		33.3%		.0%		13.7%	
	Much affected	4.8%		.0%		14.3%		5.5%	
perceived effect of incidents of E. coli O157 that occurred on own farm on the way of managing business during the past five years	Not affected	95.2%		100.0%		100.0%		95.8%	
	Slightly affected	3.2%		.0%		.0%		2.8%	
	Much affected	1.6%		.0%		.0%		1.4%	
willingness to use a treatment such as two doses of vaccine that would cost £5 to buy for each animal every year given to 3-18 months old cattle	Willing to use this	44.1%		33.3%		16.7%		41.2%	
	Not willing to use this	55.9%		66.7%		83.3%		58.8%	
The cost of vaccination is too expensive	Strongly disagree	5.4%		.0%		.0%		4.4%	
	Disagree	21.6%		33.3%		20.0%		22.2%	
	Neither disagree nor agree	24.3%		33.3%		40.0%		26.7%	
	Agree	27.0%		33.3%		40.0%		28.9%	
	Strongly agree	21.6%		.0%		.0%		17.8%	
	Don't know	.0%		.0%		.0%		.0%	

Using vaccination would take too much time	Strongly disagree	8.3%		.0%		.0%		6.8%	
	Disagree	30.6%		33.3%		40.0%		31.8%	
	Neither disagree nor agree	33.3%		.0%		60.0%		34.1%	
	Agree	11.1%		66.7%		.0%		13.6%	
	Strongly agree	16.7%		.0%		.0%		13.6%	
	Don't know	.0%		.0%		.0%		.0%	
I would need more information before using a vaccine	Strongly disagree	2.6%		.0%		.0%		2.1%	
	Disagree	.0%		.0%		.0%		.0%	
	Neither disagree nor agree	7.7%		.0%		20.0%		8.5%	
	Agree	33.3%		33.3%		20.0%		31.9%	
	Strongly agree	56.4%		66.7%		60.0%		57.4%	
	Don't know	.0%		.0%		.0%		.0%	
I would be encouraged to use vaccination if it was used by other farmers that I know	Strongly disagree	2.6%		.0%		.0%		2.1%	
	Disagree	23.1%		.0%		20.0%		21.3%	
	Neither disagree nor agree	33.3%		33.3%		60.0%		36.2%	
	Agree	28.2%		33.3%		.0%		25.5%	
	Strongly agree	12.8%		33.3%		20.0%		14.9%	
	Don't know	.0%		.0%		.0%		.0%	
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	Strongly disagree	2.5%		.0%		.0%		2.1%	
	Disagree	10.0%		33.3%		.0%		10.4%	
	Neither disagree nor agree	7.5%		66.7%		.0%		10.4%	
	Agree	55.0%		.0%		40.0%		50.0%	
	Strongly agree	22.5%		.0%		60.0%		25.0%	
	Don't know	2.5%		.0%		.0%		2.1%	
willingness to use additives on a daily basis in feed or water for a group of animals which would cost £15 per year per animal	Willing to use this	27.1%		.0%		.0%		23.5%	
	Not willing to use this	72.9%		100.0%		100.0%		76.5%	

The cost is too expensive	Strongly disagree	2.3%		.0%		.0%		1.9%	
	Disagree	7.0%		.0%		16.7%		7.7%	
	Neither disagree nor agree	16.3%		33.3%		.0%		15.4%	
	Agree	44.2%		66.7%		33.3%		44.2%	
	Strongly agree	27.9%		.0%		50.0%		28.8%	
	Don't know	2.3%		.0%		.0%		1.9%	
Doing this would take too much time	Strongly disagree	7.7%		.0%		.0%		6.4%	
	Disagree	23.1%		.0%		40.0%		23.4%	
	Neither disagree nor agree	30.8%		.0%		40.0%		29.8%	
	Agree	23.1%		100.0%		20.0%		27.7%	
	Strongly agree	12.8%		.0%		.0%		10.6%	
	Don't know	2.6%		.0%		.0%		2.1%	
I would need more information before using additives	Strongly disagree	2.3%		.0%		.0%		1.9%	
	Disagree	4.5%		.0%		.0%		3.8%	
	Neither disagree nor agree	2.3%		.0%		.0%		1.9%	
	Agree	45.5%		33.3%		60.0%		46.2%	
	Strongly agree	45.5%		66.7%		40.0%		46.2%	
	Don't know	.0%		.0%		.0%		.0%	
I would be encouraged to use additives if they were used by other farmers that I know	Strongly disagree	4.8%		.0%		.0%		4.0%	
	Disagree	21.4%		.0%		20.0%		20.0%	
	Neither disagree nor agree	31.0%		66.7%		40.0%		34.0%	
	Agree	28.6%		.0%		40.0%		28.0%	
	Strongly agree	11.9%		.0%		.0%		10.0%	
	Don't know	2.4%		33.3%		.0%		4.0%	

I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	Strongly disagree	4.7%		.0%		.0%		3.9%	
	Disagree	16.3%		66.7%		.0%		17.6%	
	Neither disagree nor agree	16.3%		33.3%		.0%		15.7%	
	Agree	44.2%		.0%		80.0%		45.1%	
	Strongly agree	16.3%		.0%		20.0%		15.7%	
	Don't know	2.3%		.0%		.0%		2.0%	
perceived practicality of keeping bedding dry and replacing contaminated/wet bedding on a daily basis on own farm	Not at all practical	12.5%		33.3%		40.0%		15.6%	
	Of little practicality	12.5%		.0%		20.0%		12.5%	
	Moderately practical	21.4%		.0%		.0%		18.8%	
	Practical	30.4%		66.7%		20.0%		31.3%	
	Very practical	23.2%		.0%		20.0%		21.9%	
perceived practicality of separating animals into different age groups for the majority of the time on own farm	Not at all practical	5.4%		66.7%		20.0%		9.4%	
	Of little practicality	8.9%		.0%		20.0%		9.4%	
	Moderately practical	33.9%		.0%		40.0%		32.8%	
	Practical	35.7%		33.3%		20.0%		34.4%	
	Very practical	16.1%		.0%		.0%		14.1%	
perceived practicality of reducing current livestock numbers kept in cattle sheds on own farm	Not at all practical	30.2%		66.7%		60.0%		34.4%	
	Of little practicality	22.6%		.0%		.0%		19.7%	
	Moderately practical	26.4%		33.3%		40.0%		27.9%	
	Practical	15.1%		.0%		.0%		13.1%	
	Very practical	5.7%		.0%		.0%		4.9%	
perceived practicality of reducing current livestock numbers on own farm	Not at all practical	50.9%		66.7%		60.0%		52.4%	
	Of little practicality	20.0%		33.3%		.0%		19.0%	
	Moderately practical	18.2%		.0%		20.0%		17.5%	
	Practical	7.3%		.0%		20.0%		7.9%	
	Very practical	3.6%		.0%		.0%		3.2%	
perceived practicality of cleaning water troughs daily on own farm	Not at all practical	30.4%		100.0%		60.0%		35.9%	
	Of little practicality	25.0%		.0%		20.0%		23.4%	
	Moderately practical	25.0%		.0%		.0%		21.9%	
	Practical	12.5%		.0%		20.0%		12.5%	
	Very practical	7.1%		.0%		.0%		6.3%	

perceived practicality of cleaning feed troughs daily on own farm	Not at all practical	20.0%		100.0%		40.0%		25.4%	
	Of little practicality	20.0%		.0%		40.0%		20.6%	
	Moderately practical	30.9%		.0%		.0%		27.0%	
	Practical	18.2%		.0%		20.0%		17.5%	
	Very practical	10.9%		.0%		.0%		9.5%	
perceived practicality of disinfecting the animal sheds/pens weekly on own farm	Not at all practical	46.4%		66.7%		100.0%		51.6%	
	Of little practicality	32.1%		.0%		.0%		28.1%	
	Moderately practical	8.9%		.0%		.0%		7.8%	
	Practical	3.6%		33.3%		.0%		4.7%	
	Very practical	8.9%		.0%		.0%		7.8%	
perceived practicality of quarantining and testing of livestock brought to the farm	Not at all practical	3.7%		33.3%		.0%		4.8%	
	Of little practicality	11.1%		.0%		.0%		9.7%	
	Moderately practical	27.8%		.0%		20.0%		25.8%	
	Practical	35.2%		66.7%		40.0%		37.1%	
	Very practical	22.2%		.0%		40.0%		22.6%	
perceived practicality of applying slaked lime to animal bedding every 3 weeks on own farm	Not at all practical	17.9%		.0%		40.0%		18.8%	
	Of little practicality	17.9%		66.7%		.0%		18.8%	
	Moderately practical	32.1%		33.3%		20.0%		31.3%	
	Practical	25.0%		.0%		40.0%		25.0%	
	Very practical	7.1%		.0%		.0%		6.3%	
willingness to pay (money per animal per year) to ensure that E. coli O157 is not present on own farm	Nothing	8.5%		33.3%		.0%		9.0%	
	Less than £1	23.7%		.0%		20.0%		22.4%	
	£1 to £5	42.4%		33.3%		60.0%		43.3%	
	£5 to £10	18.6%		33.3%		20.0%		19.4%	
	More than £10	6.8%		.0%		.0%		6.0%	
willingness to pay (time spent in controlling it) to ensure that E. coli O157 is not present on own farm	None	6.9%		33.3%		.0%		7.6%	
	1 day / year	19.0%		.0%		20.0%		18.2%	
	30 min / month	36.2%		33.3%		40.0%		36.4%	
	30 min / week	31.0%		33.3%		40.0%		31.8%	
	30 min / day	6.9%		.0%		.0%		6.1%	
having had heard of E. coli O157 before survey	Yes	91.8%		100.0%		100.0%		93.0%	
	No	8.2%		.0%		.0%		7.0%	

having had heard of E. coli O157 before survey in relation to human illness	Human illness	100.0%		100.0%		100.0%		100.0%	
having had heard of E. coli O157 before survey in relation to food contamination	Food contamination	.0%		.0%		.0%		.0%	
	2	100.0%		.0%		100.0%		100.0%	
having had heard of E. coli O157 before survey in relation to animal illness	Animal illness	.0%		.0%		.0%		.0%	
	3	100.0%		.0%		.0%		100.0%	
source of useful information on E. coli O157: open days/farm demonstrations	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	31.1%		66.7%		28.6%		32.4%	
	No	60.7%		33.3%		71.4%		60.6%	
source of useful information on E. coli O157: other farmers	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	27.9%		66.7%		42.9%		31.0%	
	No	63.9%		33.3%		57.1%		62.0%	
source of useful information on E. coli O157: media (press, magazines (Farmers Weekly etc.), radio, TV)	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	78.7%		33.3%		85.7%		77.5%	
	No	13.1%		66.7%		14.3%		15.5%	
source of useful information on E. coli O157: internet	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	44.3%		33.3%		28.6%		42.3%	
	No	47.5%		66.7%		71.4%		50.7%	
source of useful information on E. coli O157: agricultural consultants	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	19.7%		.0%		.0%		16.9%	
	No	72.1%		100.0%		100.0%		76.1%	
source of useful information on E. coli O157: sales people	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	.0%		.0%		.0%		.0%	
	No	91.8%		100.0%		100.0%		93.0%	
source of useful information on E. coli O157: veterinary surgeon	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	39.3%		66.7%		57.1%		42.3%	
	No	52.5%		33.3%		42.9%		50.7%	
source of useful information on E. coli O157: government (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	55.7%		66.7%		85.7%		59.2%	
	No	36.1%		33.3%		14.3%		33.8%	

source of useful information on E. coli O157: industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	n.a.	8.2%		.0%		.0%		7.0%	
	Yes	50.8%		66.7%		85.7%		54.9%	
	No	41.0%		33.3%		14.3%		38.0%	
stated intentions to change farm size in the next five years	Increase size	14.8%		.0%		50.0%		17.1%	
	Maintain size	63.9%		100.0%		50.0%		64.3%	
	Reduce size	.0%		.0%		.0%		.0%	
	Don't know	16.4%		.0%		.0%		14.3%	
	Leave farming business	4.9%		.0%		.0%		4.3%	
stated intentions to change public access to the farm in the next five years	Increase	32.8%		66.7%		42.9%		35.2%	
	Stay same	55.7%		33.3%		28.6%		52.1%	
	Reduce	4.9%		.0%		14.3%		5.6%	
	Don't know	6.6%		.0%		14.3%		7.0%	
stated intentions to change E. coli O157 control measures on own farm in the next five years	Increase	52.5%		33.3%		57.1%		52.1%	
	Stay same	34.4%		66.7%		42.9%		36.6%	
	Reduce	.0%		.0%		.0%		.0%	
	Don't know	13.1%		.0%		.0%		11.3%	

What was the total number of public visitors to the farm in 2010?			14100		350		2358		12481
What proportion of these public visitors were children <10 years old	0	1.7%		.0%		.0%		1.4%	
	1	1.7%		.0%		.0%		1.4%	
	2	1.7%		.0%		.0%		1.4%	
	3	1.7%		.0%		.0%		1.4%	
	5	11.7%		.0%		.0%		10.1%	
	8	.0%		.0%		16.7%		1.4%	
	10	13.3%		33.3%		.0%		13.0%	
	15	1.7%		.0%		.0%		1.4%	
	20	16.7%		66.7%		33.3%		20.3%	
	25	1.7%		.0%		.0%		1.4%	
	30	8.3%		.0%		16.7%		8.7%	
	33	3.3%		.0%		.0%		2.9%	
	40	8.3%		.0%		.0%		7.2%	
	45	1.7%		.0%		.0%		1.4%	
	50	13.3%		.0%		33.3%		14.5%	
	60	5.0%		.0%		.0%		4.3%	
	65	1.7%		.0%		.0%		1.4%	
	75	1.7%		.0%		.0%		1.4%	
	80	5.0%		.0%		.0%		4.3%	

B.1 Telephone questionnaire

Introduction

Hi, my name is _____ and I am calling on behalf of Scottish Agricultural College (SAC). SAC is doing a study for the Food Standard Agency (FSA) on the attitudes and perceptions of the UK cattle farmers towards *E. coli* O157.

SAC want to give FSA an understanding of farmer's thoughts and feelings about *E. coli* O157 and your response is vitally important to us so that we can represent farmers' views. Your answers will remain anonymous. The answers will inform us as to how important and practical is *E. coli* O157 control on-farms. I would appreciate if you could spare twenty minutes of your time, to get your opinions and suggestions. Can we do this right now?

The first section of questions are asking information about you and your farm business (*by this I mean your main holding*)

1	Can I confirm you are?	Male		Female		
2	Which age group are you in?	18 – 35	36-50	51-65	Over 65	
3	What is your status with respect to the farm holding?	Tenanted	Owned	Tenanted & owned	Employee	
4	How many years have you been involved	Working on-farms_____		In the decision making____		
5	Your educational background includes?	School	College	University		
6	Please give an estimate of the total farm land area (in hectares) NB. 2.5 acres = 1 hectare	_____				
7	We know you may be calving or lambing but please give an estimate of the highest number of livestock you'd expect to keep on the farm, including the followers	Dairy cattle___	Beef cattle_____	Sheep___	Pigs__ _____	Goats__ _____
8	How many people work on the farm?	1-3 full time	4 -10 full time	More than 10 full time	Part-time/other temporary____	
9	Could you, please, tell us what is the share of income that is from livestock production (i.e. direct sales plus subsidy support) in your total farm income?	None	Less than a quarter	Less than half	Half or more	
10	Do you use a Health Plan written for the farm with assistance from the farm's veterinary surgeon to manage the health of your livestock?	Yes	No	Incomplete		
11	Are you certified organic?	Yes	No	In conversion period		
12	Do you sell from the farm any agricultural products (meat or milk etc) that are produced to standards specified to you by supermarkets.	Yes		No		
13	Have your livestock been accessible to the public by any of the following means in the past 12 months? (select all that apply)			yes	no	
	- Do you charge an entrance fee for petting the animals			❑	❑	
	- Do you allow visits by school-age children to touch the animals			❑	❑	
	- Do you allow visits by school-age children to see the animals			❑	❑	
	- Do you have any hand-washing facilities for visitors on-farm			❑	❑	
	- Do you open the farm on LEAF open days			❑	❑	
	- Do you run a farm produce shop from the premises			❑	❑	
	Is there a water source(s) on your land used for private water supply to a house(s)			❑	❑	

	- Does your land includes public footpaths		❑		❑	
	- Does your land includes ground for camping, caravanning		❑		❑	
	- Does your land includes fixed holiday accommodation		❑		❑	
	- Other, which _____		❑		❑	
14	What proportion of your farm income is dependent on this opening to the public?	100%	50-99%	5-49%		<5%
	If answers to Q13 includes at least **three** 'yes', please ask:					
15	Would you be willing to participate in a workshop on *E. coli* O157 to get more information and to share your opinions?		Yes ❑		No ❑	

Now I would like to ask where you get General Agricultural information from

16	**You get general information for managing the farm from:**	Frequently	Infrequently	Never
	Attending open days, or farm demonstrations	❑	❑	❑
	Meeting with other farmers	❑	❑	❑
	From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	❑	❑	❑
	Searching the internet	❑	❑	❑
	By asking agricultural consultants	❑	❑	❑
	By asking sales people	❑	❑	❑
	By asking a veterinary surgeon	❑	❑	❑
	From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government)	❑	❑	❑
	From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	❑	❑	❑
	Others (which?):			

Now can I ask you about *E. coli* O157

	Below there are some comments gathered from a variety of sources. Please tell me whether you strongly disagree, disagree, agree, strongly agree, or are unsure in response to the following statements:	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Don't know
17	*E. coli* O157 causes diarrhoea in calves	❑	❑	❑	❑	❑	❑
18	*E. coli* O157 causes mastitis in cattle	❑	❑	❑	❑	❑	❑
19	*E. coli* O157 causes disease in cattle	❑	❑	❑	❑	❑	❑
20	*E. coli* O157 causes disease in people	❑	❑	❑	❑	❑	❑
21	Livestock are an important source from which *E. coli* O157 spreads	❑	❑	❑	❑	❑	❑
22	*E. coli* O157 can be present on raw meat	❑	❑	❑	❑	❑	❑
23	*E. coli* O157 can be present in raw milk	❑	❑	❑	❑	❑	❑
24	*E. coli* O157 may contaminate rural drinking water	❑	❑	❑	❑	❑	❑
25	*E. coli* O157 may contaminate produce such as lettuce, apples, spinach	❑	❑	❑	❑	❑	❑
26	People touching calves/ cows may become infected with *E. coli* O157	❑	❑	❑	❑	❑	❑

Now can I follow up to ask about your attitudes to the following

	These are some comments gathered from a variety of sources. Please state whether you strongly disagree, disagree, agree, strongly agree, or are unsure in response to the following:	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Don't know
27	Your business would be adversely affected if *E. coli* O157 infection in a person was linked to your farm	❑	❑	❑	❑	❑	❑
28	Do you believe *E. coli* O157 might be present in cattle on your farm?	❑	❑	❑	❑	❑	❑
29	For you it is very important that you with other UK livestock owners take action to control the infections in animals that may affect humans	❑	❑	❑	❑	❑	❑
30	If you used control measures for *E. coli* O157 in cattle on-farm the price for your produce might increase	❑	❑	❑	❑	❑	❑
31	If you used control measures for *E. coli* O157 in cattle on-farm it would enhance your reputation with consumers/customers	❑	❑	❑	❑	❑	❑
32	If you used control measures for *E. coli* O157 in cattle on-farm then visitors might increase	❑	❑	❑	❑	❑	❑
33	If you did **not** use control measures for *E. coli* O157 in cattle on-farm, you might get sued in the courts	❑	❑	❑	❑	❑	❑
34	If you did **not** use control measures for *E. coli* O157 in cattle on-farm, you might lose the single farm payment	❑	❑	❑	❑	❑	❑

(For questions 35 and 36, please select all that apply)

35	Who do you think would benefit the most from on-farm controls to reduce *E. coli* O157 in cattle?	Farm owners	Meat/Milk Processors	Food Retailers	Public	Government	All	Don't know
36	Who do you think is responsible for controlling *E. coli* O157 on-farms?	Farm owners	Meat/Milk Processors	Food Retailers	Public	Government	All	Don't know

Now may I ask about who or what has influenced your business

37	**During the past five years have the following had an effect on the way you manage your business?**			
	- Government or European animal health regulations	Not affected	Slightly affected	Much affected
	- Reports of *E. coli* O157 outbreaks or incidents	Not affected	Slightly affected	Much affected
	- Experience of *E. coli* O157 outbreaks or incidents	Not affected	Slightly affected	Much affected
	- Incidents of *E. coli* O157 that occurred on your farm	Not affected	Slightly affected	Much affected
38	What did you change?			

Now I'll read you some background information on E. coli* O157 *that is written by experts and given to everyone.

- *E. coli* O157 was first seen as a cause of human illness in 1983 in USA.
- It is a bug that can cause serious illness or even death in people but no disease for farm livestock.
- Cases of human infection have increased in recent years and serious outbreaks have occurred in UK.
- The background levels of infection are around 1200 people affected each year in UK.
- *E. coli* O157 is often considered a problem of food contamination but many individual infections occur in people as a result of direct exposure to farm animals or farm environments.
- Although cattle and sheep are the main carriers of *E. coli* O157, it has also been found in wild animals living near to farmland.
- A small number of *E. coli* O157 bugs can cause illness in humans. These numbers are so small they will not be visible as dirt.

- Exposure to infection would have been less common in previous farming generations and living or working in the countryside does not guarantee protection against illness.

Now I'd like to ask your opinions about *E. coli* O157 control

The following are two examples from around the world of how cattle farmers are trying to control *E. coli* O157 in their livestock. Can we ask your thoughts of using these on your farm?			
39	**A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and that is given by you to cattle between 3-18 months old. You would be:**	willing to use this	not willing to use this

If the answer is **'not willing to use this**', please could you say:

To what extent do you agree or disagree with each of the following statements with respect to vaccination?	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Don't know
The cost is too expensive	❑	❑	❑	❑	❑	❑
Doing this would take too much time	❑	❑	❑	❑	❑	❑
I would need more information before using a vaccine	❑	❑	❑	❑	❑	❑
I would be encouraged to use vaccination if it was used by other farmers that I know	❑	❑	❑	❑	❑	❑
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	❑	❑	❑	❑	❑	❑
Other (which)	❑	❑	❑	❑	❑	❑

40	**Additives can be given on a daily basis in feed or water for a group of animals and would cost £15 per year per animal. You would be:**	willing to use this	not willing to use this

If the answer is **'not willing to use this**', please could you say:

To what extent do you agree or disagree with each of the following statements about additives?	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Don't know
The cost is too expensive	❑	❑	❑	❑	❑	❑
Doing this would take too much time	❑	❑	❑	❑	❑	❑
I would need more information before using additives	❑	❑	❑	❑	❑	❑
I would be encouraged to use additives if they were used by other farmers that I know	❑	❑	❑	❑	❑	❑
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	❑	❑	❑	❑	❑	❑
Other (which)	❑	❑	❑	❑	❑	❑

Next are examples of how cattle farmers are improving hygiene and that may help with *E. coli* O157 control. Can we ask you about your thoughts of the practicality of applying these on your farm?

	Please consider the following according to how ideal they would be to you:	Not at all practical	Of little practicality	Moderately practical	Practical	Very practical	N.A.
41	Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	❑	❑	❑	❑	❑	❑

42	Separating animals into different age groups for the majority of the time	❑	❑	❑	❑	❑	❑
43	Reducing your current livestock numbers kept in cattle sheds	❑	❑	❑	❑	❑	❑
44	Reducing your current livestock numbers on the farm	❑	❑	❑	❑	❑	❑
45	Cleaning water troughs daily	❑	❑	❑	❑	❑	❑
46	Cleaning feed troughs daily	❑	❑	❑	❑	❑	❑
47	Disinfecting the animal sheds/pens weekly	❑	❑	❑	❑	❑	❑
48	Quarantine and testing of livestock brought to the farm	❑	❑	❑	❑	❑	❑
49	Applying slaked lime to animal bedding every 3 weeks	❑	❑	❑	❑	❑	❑
50	To ensure that *E. coli* O157 is not present on your farm, how much would you be willing to spend per animal per year?	Nothing	Less than £1	£1 to £5	£5 to £10	More than £10	
51	To ensure that *E. coli* O157 is not present on your farm, how much time would you be willing to spend in controlling it?	None	1 day/ year	30 min/ month	30 min/ week	30 min/ day	

Please, let us know if there are any measures that you use that you believe help control or prevent *E. coli* O157 infection

_____

_____

We have almost finished but may I ask if you have tried to get information that is specific to *E. coli* O157

52	Had you heard of *E. coli* O157 before we contacted you?	yes	no	
	If answer to question 50 is **'yes'** then:			
53	The last time you heard of *E. coli* O157 was it about?	human illness	food contamination	animal illness
54	**Where have you obtained useful information on *E. coli* O157:** (Multiple responses allowed)	Yes	No	N.A.
	Attending open days, or farm demonstrations	❑	❑	❑
	Meeting with other farmers	❑	❑	❑
	From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	❑	❑	❑
	Searching the internet	❑	❑	❑
	By asking agricultural consultants	❑	❑	❑
	By asking sales people	❑	❑	❑
	By asking a veterinary surgeon	❑	❑	❑
	From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government.)	❑	❑	❑
	From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	❑	❑	❑

Finally may I ask

55	Do you intend to change your farm size in the next 5 years?	Increase size	Maintain size	Reduce size	Don't know	Leave farming business
56	Do you intend to change public access to the farm in the next 5 years?	Increase	Stay same	Reduce	Don't know	
57	Do you think that *E. coli* O157 control measures on your farm in the next few years will?	Increase	Stay same	Reduce	Don't know	

Would you like to add anything else?

_____

_____

_____

_____

That completes the survey. Thank you very much for your time today. If you have questions about *E. coli* O157 and wish to obtain more advice or information please email chris.low@sac.ac.uk

B.2 Online questionnaire

Introduction

SAC is doing a study for the Food Standard Agency (FSA) on the attitudes and perceptions of the UK farmers towards *E. coli* O157. SAC want to give FSA an understanding of farmer's thoughts and feelings about *E. coli* O157 and your response is vitally important to us so that we can represent farmers' views. Whilst the survey is primarily for a random selection of farmers across UK we appreciate if NFAN and LEAF members could contribute their opinions through this separate survey that includes all the questions we are using in the general survey plus some additional background information.

Your answers will remain anonymous. The answers will inform us as to how important and practical is *E. coli* O157 control on-farms. I would appreciate if you could spare your time, to get your opinions and suggestions. Can we do this right now?

The first section of questions are asking information about you and your farm business (*by this I mean your main holding*)

1	Can I confirm you are?	Male		Female	
2	Which age group are you in?	18 – 35	36-50	51-65	Over 65
3	What is your status with respect to the farm holding?	Tenanted	Owned	Tenanted & owned	Employee
4	How many years have you been involved	Working on-farms_____		In the decision making ____	
5	Your educational background includes?	School	College	University	
6	Please give an estimate of the total farm land area (in hectares) NB. 2.5 acres = 1 hectare				
7	Can you give us your total animal stock numbers on the premises in the following categories:				
		Accessible to public on visits Either to see or touch		Not accessible to public These cannot be seen or touched	
	– Adult cattle born before 2010	_____		_____	
	– Replacement cattle born 2010	_____		_____	
	– Calves born 2011	_____		_____	
	– Adult sheep born 2010 or before	_____		_____	
	– Lambs born 2011	_____		_____	
	– Adult pigs born 2010 or before	_____		_____	

	– Piglets born 2011	_____	_____
	– Adult goats born 2010 or before	_____	_____
	– Goat kids born 2011	_____	_____
	– Total number of other ruminants (alpaca etc)	_____	_____
	– Adult horses or ponies	_____	_____
	– Foals born 2011	_____	_____
	– Adult donkeys	_____	_____
	– Donkey foals	_____	_____
	– Total chickens	_____	_____
	– Total ducks	_____	_____
	– Total other poultry or fowl	_____	_____
	– Total ornamental birds	_____	_____
	– Total pet rabbits	_____	_____
	– Total guinea pigs	_____	_____
	– Total other small “furry” animals	_____	_____
	– Total reptiles	_____	_____
	– Others (specify)	_____	_____

8	How many people work on the farm?	1-3 full time	4 -15 full time	More than 15 full time	Number part-time/ other temporary__
9	Have you given in the past 12 months training to staff in public safety?	To all	F/T only	We have a safety officer	None

10	Do you use a Health Plan written for the farm with assistance from the farm’s veterinary surgeon to manage the health of your livestock?	Yes	No	Incomplete
11	Where is your farm?	England	Wales	Scotland

12	Do you sell from the farm any agricultural products (meat or milk, etc.) that are produced to standards specified to you by supermarkets.	Yes	No

13	Have your livestock been accessible to the public by any of the following means in the past 12 months and in what circumstances? (select all that apply)	yes	no
	- Do you allow visits by school groups of children to touch the animals	❑	❑
	- Do you allow visits by school groups of children to see the animals	❑	❑
	- Do you allow children <10 years old into the pens with ruminant animals	❑	❑
	- Do you allow children <10 years old to bottle feed lambs	❑	❑
	- Do you have signs warning visitors of health hazards from animal infections	❑	❑
	- Do you have hot water hand-washing facilities for visitors throughout the farm	❑	❑
	- Do you have cold water hand-washing facilities for visitors throughout the farm	❑	❑
	- Do you open the farm on LEAF open days	❑	❑
	- Do you run a farm produce shop from the premises	❑	❑
	- Is there a water source(s) on your land used for private water supply to a house(s)	❑	❑
	- Does your land includes public footpaths	❑	❑
	- Does your land includes ground for camping, caravanning	❑	❑
	- Does your land includes fixed holiday accommodation	❑	❑
	- Are public to animal contact areas supervised continually by staff	❑	❑
	- Do you have double fencing to separate the animals from picnic/lunch areas	❑	❑
	- Are your premises known to the local authority as an Open Farm	❑	❑
	- Do you provide protective overshoes for all visitors	❑	❑
	- Do you have disinfectant footbaths at entrances to pens	❑	❑
	- Do you have a safety consultant	❑	❑
	- Is the revised AIS23 an improvement on the advice available in 2010	❑	❑
	- Other, comments _____ _____ _____	❑	❑

14	What proportion of your farm income is dependent on this opening to the public?	100%	50-99%	5-49%	<5%
If answers to Q13 includes at least **three** 'yes', please ask:					
15	Would you be willing to participate in a workshop on *E. coli* O157 to get more information and to share your opinions?	Yes		No	

Now I would like to ask where you get General Agricultural information from

16	**You get general information for managing the farm from:**	frequently	infrequently	never
	Attending open days, or farm demonstrations	❑	❑	❑
	Meeting with other farmers	❑	❑	❑
	From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	❑	❑	❑
	Searching the internet	❑	❑	❑
	By asking agricultural consultants	❑	❑	❑
	By asking sales people	❑	❑	❑
	By asking a veterinary surgeon	❑	❑	❑
	From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government.)	❑	❑	❑
	From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	❑	❑	❑
	Others (which?):_____	❑	❑	❑

Now can I ask you about *E. coli* O157

	Below there are some comments gathered from a variety of sources. Please tell me whether you strongly disagree, disagree, agree, strongly agree, or are unsure in response to the following statements:	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Don't know
17	*E. coli* O157 causes diarrhoea in calves	❑	❑	❑	❑	❑	❑
18	*E. coli* O157 causes mastitis in cattle	❑	❑	❑	❑	❑	❑
19	*E. coli* O157 causes disease in cattle	❑	❑	❑	❑	❑	❑
20	*E. coli* O157 causes disease in people	❑	❑	❑	❑	❑	❑
21	Livestock are an important source from which *E. coli* O157 spreads	❑	❑	❑	❑	❑	❑
22	*E. coli* O157 can be present on raw meat	❑	❑	❑	❑	❑	❑
23	*E. coli* O157 can be present in raw milk	❑	❑	❑	❑	❑	❑
24	*E. coli* O157 may contaminate rural drinking water	❑	❑	❑	❑	❑	❑
25	*E. coli* O157 may contaminate produce such as lettuce, apples, spinach	❑	❑	❑	❑	❑	❑
26	People touching calves/ cows may become infected with *E. coli* O157	❑	❑	❑	❑	❑	❑

Now can I follow up to ask about your attitudes to the following

	These are some comments gathered from a variety of sources. Please state whether you strongly disagree, disagree, agree, strongly agree, or are unsure in response to the following:	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Don't know
27	Your business would be adversely affected if *E. coli* O157 infection in a person was linked to your farm	❑	❑	❑	❑	❑	❑
28	Do you believe *E. coli* O157 might be present in cattle on your farm?	❑	❑	❑	❑	❑	❑
29	Do you believe that farms which welcoming public visitors pose a greater risk to human health than farms that do not welcome visitors	❑	❑	❑	❑	❑	❑
30	For you it is very important that you take action to control the infections in animals that may affect humans	❑	❑	❑	❑	❑	❑
31	If you used control measures for *E. coli* O157 in cattle on-farm the price for your produce might increase	❑	❑	❑	❑	❑	❑
32	If you used control measures for *E. coli* O157 in cattle on-farm it would enhance your reputation with consumers/customers	❑	❑	❑	❑	❑	❑
33	If you used control measures for *E. coli* O157 in cattle on-farm then visitors might increase	❑	❑	❑	❑	❑	❑
34	If you did **not** use control measures for *E. coli* O157 in cattle on-farm, you might get sued in the courts	❑	❑	❑	❑	❑	❑
35	If you did **not** use control measures for *E. coli* O157 in cattle on-farm, you might lose the single farm payment	❑	❑	❑	❑	❑	❑
36	Who do you think would benefit the most from on-farm controls to reduce *E. coli* O157 in cattle?	Farm owners	Meat/Milk Processors	Food Retailers	Public	Government	All
37	Who do you think is responsible for controlling *E. coli* O157 on-farms?	Farm owners	Meat/Milk Processors	Food Retailers	Public	Government	All

Now may I ask about who or what has influenced your business

38	**During the past five years have the following had an effect on the way you manage your business?**			
	- Government or European animal health regulations	Not affected	Slightly affected	Much affected
	- Reports of *E. coli* O157 outbreaks or incidents	Not affected	Slightly affected	Much affected
	- Experience of *E. coli* O157 outbreaks or incidents	Not affected	Slightly affected	Much affected

	- Incidents of *E. coli* O157 that occurred on your farm	Not affected	Slightly affected	Much affected
39	What did you change?	_____		

Now I'll read you some background information on E. coli* O157 *that is written by experts and given to everyone.

- *E. coli* O157 was first seen as a cause of human illness in 1983 in USA.
- It is a bug that can cause serious illness or even death in people but no disease for farm livestock.
- Cases of human infection have increased in recent years and serious outbreaks have occurred in UK.
- The background levels of infection are around 1200 people affected each year in UK.
- *E. coli* O157 is often considered a problem of food contamination but many individual infections occur in people as a result of direct exposure to farm animals or farm environments.
- Although cattle and sheep are the main carriers of *E. coli* O157, it has also been found in wild animals living near to farmland.
- A small number of *E. coli* O157 bugs can cause illness in humans. These numbers are so small they will not be visible as dirt.
- Exposure to infection would have been less common in previous farming generations and living or working in the countryside does not guarantee protection against illness.

Now I'd like to ask your opinions about *E. coli* O157 control

The following are two examples from around the world of how cattle farmers are trying to control *E. coli* O157 in their livestock. Can we ask your thoughts of using these on your farm?			
40	**A treatment such as two doses of vaccine that would cost £5 to buy for each animal every year and that is given by you to cattle between 3-18 months old. You would be:**	willing to use this	not willing to use this

If the answer is **'not willing to use this**', please could you say:

To what extent do you agree or disagree with each of the following statements with respect to vaccination?	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Don't know
The cost is too expensive	❑	❑	❑	❑	❑	❑
Doing this would take too much time	❑	❑	❑	❑	❑	❑
I would need more information before using a vaccine	❑	❑	❑	❑	❑	❑
I would be encouraged to use vaccination if it was used by other farmers that I know	❑	❑	❑	❑	❑	❑
I would be encouraged to use vaccination as part of a national program to benefit the reputation of the industry	❑	❑	❑	❑	❑	❑
Other (which)_____	❑	❑	❑	❑	❑	❑

41	**Additives can be given on a daily basis in feed or water for a group of animals and would cost £15 per year per animal. You would be:**	willing to use this	not willing to use this

If the answer is **'not willing to use this**', please could you say:

To what extent do you agree or disagree with each of the following statements with respect to additives?	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Don't know
The cost is too expensive	❑	❑	❑	❑	❑	❑
Doing this would take too much time	❑	❑	❑	❑	❑	❑
I would need more information before using additives	❑	❑	❑	❑	❑	❑
I would be encouraged to use additives if it was used by other farmers that I know	❑	❑	❑	❑	❑	❑
I would be encouraged to use additives as part of a national program to benefit the reputation of the industry	❑	❑	❑	❑	❑	❑
Other (which)_____	❑	❑	❑	❑	❑	❑

Next are examples of how cattle farmers are improving hygiene and that may help with *E. coli* O157 control. Can we ask you about your thoughts of the practicality of applying these on your farm?

	Please consider the following according to how ideal they would be to you:	Not at all practical	Of little practicality	Moderately practical	Practical	Very practical
42	Keeping bedding dry and replacing contaminated/wet bedding on a daily basis	❑	❑	❑	❑	❑
43	Separating animals into different age groups for the majority of the time	❑	❑	❑	❑	❑
44	Reducing your current livestock numbers kept in cattle sheds	❑	❑	❑	❑	❑
45	Reducing your current livestock numbers on the farm	❑	❑	❑	❑	❑
46	Cleaning water troughs daily	❑	❑	❑	❑	❑
47	Cleaning feed troughs daily	❑	❑	❑	❑	❑
48	Disinfecting the animal sheds/pens weekly	❑	❑	❑	❑	❑
49	Quarantine and testing of livestock brought to the farm	❑	❑	❑	❑	❑
50	Applying slaked lime to animal bedding every 3 weeks	❑	❑	❑	❑	❑

51	To ensure that *E. coli* O157 is not present on your farm, how much would you be willing to spend per animal per year?	Nothing	Less than £1	£1 to £5	£5 to £10	More than £10
52	To ensure that *E. coli* O157 is not present on your farm, how much time would you be willing to spend in controlling it?	None	1 day/ year	30 min/ month	30 min/ week	30 min/ day

Please, let us know if there are any measures that you use that you believe help control or prevent *E. coli* O157 infection

_____

_____

_____

_____

_____

_____

_____

_____

We have almost finished but may I ask if you have tried to get information that is specific to *E. coli* O157

53	Had you heard of *E. coli* O157 before we contacted you?	yes		no
If answer to question 50 is **'yes'** then:				
54	The last time you heard of *E. coli* O157 was it about?	human illness	food contam-ination	animal illness
55	**Where have you obtained useful information on *E. coli* O157:** (Multiple responses allowed)	Yes		No
	Attending open days, or farm demonstrations	❑		❑
	Meeting with other farmers	❑		❑
	From articles in the media (Press, Magazines (Farmers Weekly etc.), Radio, TV)	❑		❑
	Searching the internet	❑		❑
	By asking agricultural consultants	❑		❑
	By asking sales people	❑		❑
	By asking a veterinary surgeon	❑		❑
	From Government information sources (e.g. FSA, DEFRA, RERAD, DARDNI, Welsh Government.)	❑		❑
	From industry organisations (e.g. AHDB, QMS, NFU, NFUS, NFU Cymru, NAFN)	❑		❑

Finally may I ask

56	Do you intend to change your farm size in the next 5 years?	Increase size	Maintain size	Reduce size	Don't know	Leave farming busines
57	Do you intend to change public access to the farm in the next 5 years?	Increase	Stay same	Reduce	Don't know	
58	Do you think that *E. coli* O157 control measures on your farm in the next few years will?	Increase	Stay same	Reduce	Don't know	
59	What was the total number of public visitors to the farm in 2010?	_____				
60	What proportion of these public visitors were children <10 years old	_____				

Would you like to add anything else?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

That completes the survey. Thank you very much for your time today.

If you have questions about *E. coli* O157 and wish to obtain more advice or information please email chris.low@ed.ac.uk