Project FS 517005

Improved Food Chain Information (FCI) and Collection and Communication of Inspection Results (CCIR)

A project implemented by Food Control Consultants Ltd (FCC) for the Food Standards Agency

FINAL REPORT

September 2015

Food Control Consultants (FCC) is an independent consultancy firm specialising in the improvement of food safety controls in food businesses and official control bodies.
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ABBREVIATIONS

ACMSF	Advisory Committee on the Microbiological Safety of Food
AHDB	Agriculture and Horticulture Development Board
AHVLA	Animal Health and Veterinary Laboratories Agency
a-m	*Ante mortem*
ARAMS	Animal Reporting and Movement Service
BCMS	British Cattle Movement Service
BCR	Benefit-cost ratio
BPHS	British Pig Health Scheme
bTB	Bovine Tuberculosis
CBA	Cost-benefit analysis
CCIR	Collection and communication of inspection results
CPD	Continuing professional development
CLA	Caseous Lymphadenitis
DALY	Disability adjusted life year
EBLEX	English Beef and Lamb Executive
EFSA	European Food Safety Authority
EID	Electronic identification device
ELISA	Enzyme-Linked Immunosorbent Assay
ESBL	Extended-Spectrum-β-Lactamase
FBO	Food Business Operator
FCC	Food Control Consultants Ltd
FCI	Food chain information
FSA	Food Standards Agency
FVE	Federation of Veterinarians in Europe
HEI	Harmonised epidemiological indicator
IID	Infectious intestinal disease
IRR	Internal rate of return
IT	Information Technology
MHI	Meat Hygiene Inspector
NPV	Net present value
NRCP	National Residue Control Plans
OLAP	On-Line Analytical Programming
OV	Official Veterinarian
PIA	Plant Inspection Assistant
p-m	*Post-mortem*
PMI	*Post-mortem* inspection
PMMI	*Post-mortem* meat inspection
QALY	Quality adjusted life year
RU	Relevant unit
TB	Tuberculosis
U.E.C.B.V	European Livestock and Meat Trades Union
VTEC	Verocytotoxin-producing Escherichia coli
ZNCP	Zoonoses National Control Programme

EXECUTIVE SUMMARY

Introduction

1. As the UK competent authority, the Food Standards Agency (FSA) is responsible for ensuring compliance with food safety legislation. The FSA has identified the need for a more effective, risk based and proportionate approach to meat controls. As well as protecting public health, new approaches should protect animal health and welfare.

2. This study investigates ways of improving the effectiveness and efficiency of meat controls by identifying key Food Chain Information (FCI) and Collection and Communication of Inspection Results (CCIR) data to support a more risk based meat inspection system for cattle, sheep, pigs and poultry under different production systems, as appropriate. The costs and benefits are analysed in terms of better public health, animal health and animal welfare.

3. To be sustainable, an improved risk-based approach to meat controls has to be both more effective (in terms of controlling hazards) and also more efficient (in terms of greater benefit from lower costs) to create incentives for the stakeholders to participate.

4. The study had four specific objectives:
   i) To review the current situation and identify areas for possible improvement of meat controls;
   ii) To design an improved FCI/CCIR model based on a more risk-based approach to meat inspection for cattle, sheep, pigs and poultry;
   iii) To carry out a cost-benefit analysis, where possible, for both primary producers and slaughterhouses; showing benefits in terms of public health, animal health and animal welfare.
   iv) Disseminate study findings and incorporate feedback into the final report.

Review of the current situation

5. The FSA has been considering the issue of modernising the system of ante and post mortem meat inspection for a number of years. The principal issue being examined by this study is that the most important public health hazards, in particularly microbiological hazards, prevalent today are not adequately addressed by the present system. Furthermore some of the methods and procedures used during meat inspection (such as handling of carcasses and cutting lymph nodes) may even be counter-productive and increase the microbiological contamination of the carcasses.

6. There are very marked differences between the production systems and structure of the major food animal species; these are particularly relevant in the marketing of slaughter animals and the consequent arrangements for information exchange between producers and abattoirs. The concept of FCI and CCIR is relatively easily applied in the integrated poultry and pig industries, where meaningful information about food safety hazards in animals in controlled housing conditions can be gathered and slaughter animals are handled as identifiable epidemiological groups to which both FCI and CCIR can be ascribed. In contrast, the cattle and sheep industries, with their high numbers of producers, limited amount of integration and different marketing methods, present difficulties for FCI and CCIR.

7. The FSA (and EFSA) has identified five key pathogens for food-borne disease: Campylobacter, Listeria monocytogenes, norovirus, E. coli O157 and Salmonella. Campylobacter, E. coli O157 and Salmonella are all rated as high risk. Food-borne disease caused by Listeria is almost always associated with ready to eat products where contamination has occurred from the processing environment. Listeria on fresh meat is therefore considered as low risk. The role of food, including meat, in the transmission of viruses in general and Norovirus in particular is the subject of the FSA Food-borne Virus Research Programme. Given the currently limited understanding of the role of food in the transmission of viruses, viruses were not analysed for this study.

8. The study considered the information that may be provided as FCI for food safety hazards categorised as high or medium risk for each of the four food animal species. The legislative requirements for FCI were considered in reviewing the evidence to be provided to the slaughterhouse, including the health status of the animal and holding, the administration of veterinary medicines, the occurrence of relevant diseases, the results of all on-farm testing, and relevant reports about previous *ante-* and *post-mortem* inspections.
9. The study identified where control or reduction measures can be taken at the slaughterhouse on the basis of FCI risk categorisation of production units (farms) or specific consignments of animals.
10. Revised FCI and CCIR requirements have been proposed for the four food animal species. The proposals take into account the practicalities of collecting and recording the information, its quality and its usefulness. Summary tables of the data to be collected have been produced for each species.
11. It can be concluded that the health status of animals arriving at the slaughterhouse is a risk factor for food safety. The correlation between the physical assessment of animal health and food safety risks is not clearly defined. FCI should include information about the health status of animals. Assessment of the health of animals by producers, abattoir FBOs and OVs should be guided by specified indicators as far as possible. We recommend the development of guidance through discussion with stakeholders, particularly veterinary organisations, animal welfare experts, official veterinarians (OVs) and livestock and meat industry representative bodies, led by the FSA. We conclude that the FCI should be evidence based allowing the FBOs and OVs to make effective use of FCI when making decisions about interventions at the abattoir. OVs should take enforcement action when FCI is clearly incorrect.

Design of an improved FCI/CCIR model

12. A new concept for a risk-based FCI/CCIR model is proposed based on two key features: i) increased sampling and laboratory analysis for microbiology and residues, and; ii) enhanced data capture, handling and utilisation.
13. An increased volume of low level sampling (e.g. 0.1% for poultry and 1% for other species) on the slaughter line for food borne infections[1] is proposed, using initially lymph nodes and/ or colon content. This is considered to be a straightforward, precise and reliable method of data collection which will compliment sampling at farm level for risk analysis. The result of the low level sampling can be made anonymous if required to create a baseline reference levels of the prevalence of zoonotic diseases.
14. The food chain information provided by producers to food business operators (FBOs) and official veterinarians (OVs) about animals sent for slaughter and the collection and communication of inspection results (CCIR) for the slaughtered animals will form a cyclical system for transfer of information about public health, animal health and animal welfare, where historical CCIR for a production unit contributes to FCI for subsequent batches.
15. Such information is essential to enable preventive measures and controls to be applied on-farm and at the slaughterhouse in an integrated way to ensure an effective control of the main food safety hazards. CCIR informs herd and flock health planning decisions on the farm to promote improvements in animal health and welfare and thereby to further improve food safety and the efficiency, profitability and sustainability of livestock and meat production.
16. Different sampling programmes can be implemented according to the disease and the nature of the data required. Statistical tables are presented to illustrate sample size calculations for a certain probability of detection however the final decision should be based on scientific risk assessment and economic considerations.

[1] European Commission Draft guidance document on the application of Article 14 of Regulation (EC) No 178/2002 as regards food contaminated with Shiga toxin-producing Escherichia coli (STEC), Brussels

17. Sampling results would be used for:
    - providing evidence based CCIR information to producers concerning the health status of slaughtered animals and herds/flocks;
    - accumulation of epidemiological data at the holding/farm level to inform the producer on disease control strategies;
    - collecting anonymised epidemiological data aggregated for surveillance and advice to the livestock sector as a whole;
    - provide information on the use of veterinary medicinal products and the reason for their use (e.g. diagnosis of disease or preventive).
18. The capture, recording and reporting of inspection results is identified as an area for major improvement. We make a number of recommendations for improvement in the reliability of inspection results, including better case definitions of post-mortem conditions and monitoring of inspection results to promote consistency, and for improved capture of inspection results and their aggregation for each farm on a database. This information is of value in several ways: it provides information to the farmer and informs his herd/flock health planning; it becomes FCI for animals slaughtered in the future; it is a source of data for disease surveillance at the farm, region and national levels.
19. The accumulation, aggregation and dissemination of results from increased sampling and enhanced *ante* and *post-mortem* inspection will contribute to better understanding of disease prevalence on holdings and in regions and enable a risk-based approach to disease monitoring and control.
20. An effective IT system is a precondition for the proposed FCI/CCIR system to be of practical use. A two-stage approach is envisaged for the development of an improved FCI/CCIR IT model: i) development of an initial reference model, and; ii) refinement to create an implementation model. A schema of the reference model is presented in the report.
21. The major components of the proposed system may be summarised as:
    - The implementation of a Cloud-based data collection (repository) based on OLAP architecture. The dimensionality to include the holding as well as the identification of the relevant unit describing the animal (i.e. individual or group) .
    - The provision of web service integration of existing diverse systems to record information for the relevant unit into the data repository - a coordinated effort between the FSA and FBOs to leverage existing systems.
    - Specific capture of veterinary and other relevant interventions in support of the defined EU requirements. This will require the support of the veterinary profession and can be implemented with cooperation of the suppliers of veterinary practice management systems.
    - Real-time capture of the results of microbiological testing of samples collected in the slaughter facility - the frequency and targeting of such testing being driven by an objective risk-based model.
    - Use of encoded data via web services to provide a sufficient level of aggregation to ensure protection of sensitive commercial information.

Cost-benefit analysis - public health

22. The section on public health uses a cost of illness approach to estimate the impact of food-borne disease. It gives a maximum potential financial benefit (to society) of reducing food-borne disease in the population through improved FCI/CCIR. It was informed by material that has come into the public domain during the study period, namely the IID2-Extension report (March 2014) commissioned by FSA and the FSA 2013/14 Scientific Report (September 2014). The impact of both reports is to (i) highlight uncertainty surrounding international costing models of food-borne disease and (ii) distinguish between FBD directly attributable to consumption of meat across beef, lamb, poultry and pork and other sources.

23. The model concentrates on three high volume pathogens: campylobacter, salmonella, VTEC. The contribution of cryptosporidium, listeria and viruses to food-borne illness is acknowledged.

24. The single biggest zoonotic problem emerging from the analysis is Campylobacter in poultry. The largest public health benefit will accrue from reduction in this pathogen.

25. Cost of illness depends on (a) incidence of pathology, (b) cost burden of disease, (c) attribution to species. The strengths and limitations of the modelling approach are explained. While further refinement is possible, the model provides a reasonable base for testing the public health benefits of improvements through the FCI/CCIR interventions.

26. Four potential areas for development and future research include:

    i) Costing model – there is scope to introduce more complex assumptions, i.e. by building a bottom up model relating to the severity of each pathogen;

    ii) Investigate incidence, costs and attribution of low volume diseases such as toxaplasma;

    iii) Obtain data relating to contaminants such as dioxins;

    iv) Gain evidence on the cost of anti-microbial resistance in the food chain and its impact on human health.

Cost-benefit analysis

27. The elements of the proposed changes in FCI/CCIR can be described in terms of the requirements on software development and data management. As a consequence it is possible to cost these with some accuracy. What is very difficult is to identify is the needs of investment in infrastructure for data capture, data storage and communications at different points in the food system. It is likely that a proportion of slaughterhouses will need some investments and similarly a proportion of farms.

28. In addition the improved information system will only generate benefits at farm, slaughter and consumer level if there are associated actions of disease management, improved pharmaceutical use and overall better husbandry.

29. On the benefit side there is a poor understanding of the attributions of changes in farm-levels of pathogens and the subsequent outcomes on public health. In addition the current levels of common animal health problems that are not zoonotic is also uncertain and therefore a baseline to start to estimate potential benefits is cast with uncertainty.

30. They only way to deal with such levels of uncertainty is for the cost-benefit analysis to develop a model that can deal with ranges of inputs variables. Such a model is useful, but the process of developing the model can be equally helpful in terms of identifying critical data gaps.

31. A cost benefit analysis is presented. Given the uncertainty of the benefit streams either through a lack of data and information in the food chain or a lack of clear attribution in human health, the analysis has not attempted to carry out a classic cost-benefit analysis. In addition it is recognized that the proposed system is designed to capture food data and generate through analysis of the food chain information.

32. The costs of the proposed changes have been compared against current impacts for some of the key pathogens. This has been done for pathogens with a public health impact and those with an animal production impact. A table summarising the estimated costs of the changes on a per head basis is presented.

33. The main costs included in the model are the IT structure needed, training of inspectors and other users of the system, sampling/analysis and reporting.

34. The main benefits included are costs saved through less administration and paper work, less condemnation of carcasses, animal production gains, improved productivity and public health changes.

35. The results indicate that Campylobacter in poultry is the food borne disease which has the highest return on investment. The results indicate moreover that monitoring and delivering results on liver fluke can be done with almost no addition costs attached but considerable potential for benefits. These two conditions are therefore considered in particular. Camplylobacter has a public health benefit whilst liver fluke has a producer benefit.

36. It is concluded that the cost and nature of proposed changes to the food chain information system are relatively small in comparison to the numbers of animals slaughtered and the overall impact of the public health and production diseases that the new system would target.

37. In order to return these costs and add further value to the food systems the new food chain information system will need to be carefully linked to systems that will improve the prevention and control measures at farm, slaughterhouse and processing levels. The proposed training inputs should allow this to be initiated and it is important that this is properly funded and managed in the future.

Dissemination of study findings

38. A series of four workshops were held with stakeholders in January 2015 to discuss the findings of the study. Three workshops were held at Stoneleigh in Warwickshire and one at the Moredun Research Institute outside Edinburgh.

39. A total of 133 participants attended (counting some people attending more than one workshop) representing a broad range of stakeholders. Feedback from the workshops was incorporated into the final report as a separate Annex.

Concluding remarks

40. This FSA-commissioned study addresses the four objectives of (i) review of FCI/CCIR, (ii) proposal for development, (iii) cost benefit analysis and (iv) dissemination through workshops. The main elements of our proposal are:

- Enhancement of the existing food safety controls with an evidence-based system that includes integration of treatments, diagnoses and tests undertaken at farm level into the FCI, with possible scope for extending this further, and incorporation of CCIR results for all last batch(es) of animals from each holding of origin slaughtered within a defined period, to includes results of tests taken for food borne zoonoses at the abattoir;

- FBO and OV access to CCIR databases to inform decisions at the abattoir about processing methods, product treatment and use and inspection and sampling procedures.

- Adequate sampling for food borne zoonoses on the slaughter line, using initially mesenteric lymph nodes and or intestinal contents. This system of sampling can be used also for other purposes, as requested by the farmer, the authorities or research institutions.
- Improved systems for the capture and recording of inspection findings to promote accuracy and consistency

- Accessibility of CCIR (including laboratory results) to producers via a central database to inform herd/flock health planning.
- Central data capture and data depository IT system for all the information above (tests, treatments, lab results on farms, ante and post mortem and laboratory results at the abattoir) with a controlled access for stakeholders, including those with an interest in animal disease surveillance and animal welfare monitoring

Our proposals, if adopted, will produce significant change in FCI/CCIR, moving away from organoleptic inspection methods towards microbiological sampling related to food borne disease. It is consistent with the overriding aim of improving food safety to consumers.

Recommendations for further action

41. New requirements for FCI and CCIR for the four main food animal species should be adopted based on the lists and recommendations provided in this report.
42. A new Cloud-based data repository should be introduced to aggregate data from existing diverse systems.
43. A low-level sampling in the slaughterhouse should be introduced for the collection of data on food borne infections. The results could be anonymised for surveillance purposes as required. The new system will enable the aggregation and accumulation of risk-based information on public health, animal health and animal welfare. Different sampling programmes can be implemented according to the disease and nature of the data required.
44. Increased sampling should start with diseases that show the best potential gains, such as Campylobacter.
45. The costs and nature of the changes proposed in this report are relatively small in comparison to the potential benefits such that overall start-up and operating costs can be justified even by modest gains for a small number of key diseases.

1. INTRODUCTION

The Food Standards Agency (FSA) has identified the need for a more effective, risk based and proportionate approach to meat controls. As well as protecting public health, new approaches should protect animal health and welfare.

This study investigates ways of improving the effectiveness and efficiency of meat controls by identifying key Food Chain Information (FCI) and Collection and Communication of Inspection Results (CCIR) data to support a more risk based meat inspection system for cattle, sheep, pigs and poultry under different production systems, as appropriate. The costs and benefits are analysed in terms of better public health, animal health and animal welfare.

2. OBJECTIVES OF THE STUDY

The **wider objective** of the FSA is to improve the effectiveness of meat controls resulting in better public health, animal health and animal welfare.

As the UK competent authority, the FSA is responsible for ensuring compliance with food safety legislation. The FSA has a strategic priority to design a model for a new regulatory and enforcement regime for ensuring meat controls are effective, risk-based and proportionate.

The study had four **specific objectives**:

1. To review the current situation and identify areas for possible improvement of meat controls;
2. To design an improved FCI/CCIR model based on a more risk-based approach to meat inspection for cattle, sheep, pigs and poultry;
3. To carry out a cost-benefit analysis, where possible, for both primary producers and slaughterhouses; showing benefits in terms of public health, animal health and animal welfare.
4. Disseminate study findings and incorporate feedback into the final report.

To be sustainable, an improved risk-based approach to meat controls has to be both more effective (in terms of controlling hazards) and also more efficient (in terms of greater benefit from lower costs) to create incentives for the stakeholders to participate.

There are a number of pre-requisites for an improved risk-based approach. These include the need for more precise risk analysis targeted at individual farms; a high level of data protection to maximise confidentiality whilst at the same time providing the necessary information; the need to focus on readily available, useful and reliable data; the need for an IT system that meets all these needs efficiently, and the need to ensure that food business operators and farmers are motivated to participate actively in the system.

3. APPROACH

3.1. Scientific research

The review of the current situation included a consideration of the findings and recommendations of the research project 'Evaluation of Food Chain Information and Collection and Communication of Inspection Results for all species'[2] carried out for the Food Standards Agency.

Both the FSA and the European Food Safety Authority (EFSA) have undertaken comprehensive research into public health hazards covered by meat inspection. FSA is the prime source of information for the study.

[2] Final Report – Project FS145002, February 2013, Meat and Livestock Commercial Services Ltd. (MLCSL) http://www.foodbase.org.uk/results.php?f_category_id=&f_report_id=796

EFSA has recently completed a major review of meat inspection practices and produced scientific opinions on the public health hazards and technical specifications on harmonised epidemiological indicators for biological hazards to be covered by meat inspection for the main food species as well as farmed game. This scientific data has been taken into account on a species by species basis for developing the risk-based model.

3.2. Other studies

There are a number of concurrent pieces of work that are relevant to or overlap with the current study:

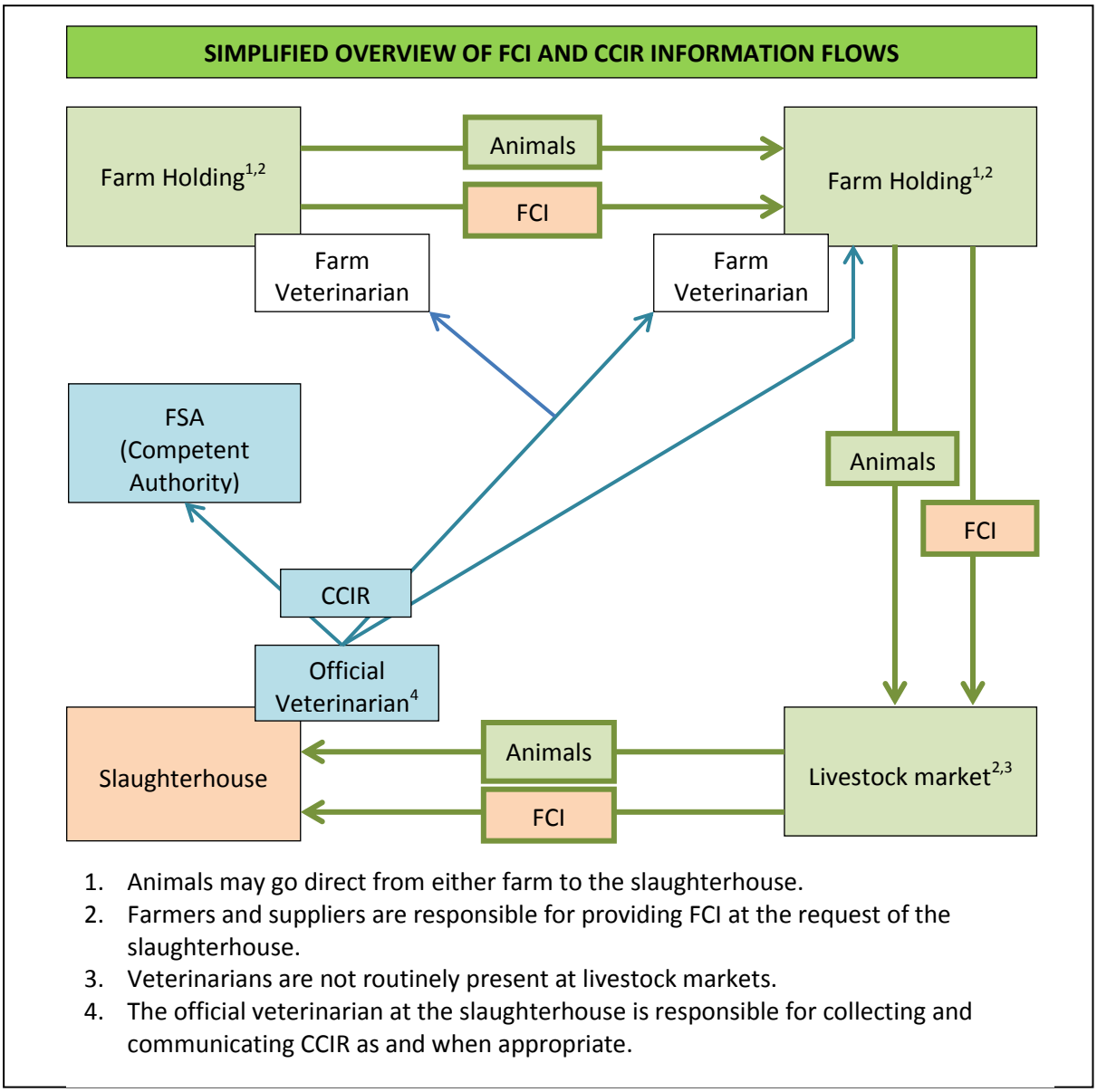
- FSA Digital Data Project
- Commercial operator-led project on visual inspection and CCIR for pigs
- BPEX project on visual inspection and CCIR for pigs

3.3. Model development

Essentially the FCI/CCIR model constitutes a circular flow of information: food chain information is collected from producers and sent to the slaughterhouse to inform meat inspection, and inspection results are fed back to inform producers on improving on-farm and supply chain control measures. Inspection results may be reinforced by specific tests taken at the slaughterhouse.

The following diagram gives a simplified overview of FCI and CCIR information flows:

Figure 1. Simplified overview of FCI and CCIR information flows



The development approach has taken into account that the effectiveness of the new model will be enhanced if FCI and CCIR information: i) is readily available; ii) is of practical use; iii) is of reliable quality, and; iv) helps to deliver positive benefits in terms of public health, animal health and animal welfare.

An additional factor is the need for an effective IT system for electronic transfer of FCI and CCIR data. This involves transmitting FCI and CCIR information along the supply chain whilst at the same time preserving data confidentiality for operators at each stage. The approach involves forming an IT network that is able to select and analyse FCI from producers and CCIR from official veterinarians with linkages to other data sources (such as epidemiological information) to support risk based methods.

The approach also takes into account the role played by a variety of existing supply chain assurance and information reporting schemes and the need to avoid unnecessary duplication.

Food safety and food standards are devolved matters in Northern Ireland, Scotland and Wales and the respective Food Standards Agencies operate within the UK Food Standards Agency. However other bodies, such as some levy boards work independently in each of the four UK countries. The model has been developed as being generic for the UK although it is appreciated that the linkages to other data sources and the data itself may vary between the UK countries.

4. OVERVIEW OF THE CURRENT SITUATION BY SPECIES

4.1. Pigs

4.1.1. Industry structure

The UK pig industry has a high level of vertical integration, and a relatively small number of businesses producing pigs for slaughter: 35 businesses are reported to account for 50% of production[3].

Vertically integrated pig companies control breeding pyramids - sequential production levels from parent and multiplier breeding units through breeding herds to finishing of slaughter pigs.

Virtually all prime pigs slaughtered move directly from farm to the abattoir and are delivered in clearly defined batches. Cull breeding animals (sows and boars) commonly move to slaughter via agents and collection centres and arrive at abattoirs as mixed groups.

All pigs are required to be identified at the batch level with the unique herd mark of holding of despatch. This is generally achieved by means of a slap mark - a permanent ink mark of the herd mark, applied to each front shoulder area of the pig. Slap marks should be legible on the dressed carcase.

More than 90% of pigs slaughtered are covered by the Red Tractor assurance scheme[4]. The pig industry has been active in developing systems at an industry level to address both animal health and food safety issues, and was an early adopter of electronic systems for exchange of FCI and CCIR, based on an existing industry database of assurance scheme members.

BPEX is a division of the Agriculture and Horticulture Development Board (AHDB) and represents pig levy payers in England. BPEX is focused on enhancing the competitiveness, efficiency and profitability for English pig levy payers and driving demand for English pork and pig meat products in Britain and globally. Quality Meat Scotland (QMS) and Hybu Cig Cymru (HCC) fulfil similar roles in Scotland and Wales respectively.

4.1.2. FCI

Electronic movement notification is mandatory for all pig movements, including movements to slaughter. In England and Wales the movement system and database is operated on contract for Defra by BPEX/MLCSL[5]. This function is provided by Scoteid in Scotland[6].

The eAML2 and Scoteid electronic movement forms include FCI for the batch of pigs being moved to slaughter. FCI is based on a model document and includes: i) production site details; ii) details of the specific consignment, and; iii) additional information where necessary.

Movement information together with FCI is sent electronically via the BPEX/Scoteid systems to both the food business operator and the official veterinarian at the slaughterhouse.

4.1.3. CCIR

Inspection results are recorded at the batch level, where a batch comprises the pigs sent from a farm. In the case of pigs from a market (<1% total kill) or collection centre (e.g. cull sows and boars), a batch comprises all the animals from the market or collection centre.

Batches are usually identified on the slaughter line by means of local systems of marking the first and last pigs in the batch. Accurate correlation of *post-mortem* findings with batches can be hampered when pigs are moved off the main line onto detour lines for rectification.

[3] BPEX – personal communication

[4] Defra (2008)Animal Health and Welfare Strategy, Indicator Data Sheet, Core Indicator 5.2 – Farm Assurance Schemes http://www.defra.gov.uk/foodfarm/policy/animalhealth/eig/indicators/pdf/5-2data.pdf

[5] https://www.gov.uk/pigs-identification-registration-and-movement

[6] http://www.scoteid.com/Public/Documents/pigs/PRIMO_guidance_for_keepers_covering_letter.pdf

Capture of *post-mortem* findings by Meat Hygiene Inspectors (MHIs) in the majority of plants is by manual methods – paper, boards, mechanical tallies ('clickers'). Some food business operators (FBOs) have installed touch screen terminals for capture of *post-mortem* results.

Where manual data capture systems are used, recording is by manual input on FSA terminals or laptops by FSA inspectors/official veterinarians intermittently during the day or at the end of a day's kill.

Inspection results are recorded on the Innova system using specific input screens.

In the case of data capture on online terminals, a print out of the results may be given to FSA staff for manual input to the Innova system. Two FBOs and five abattoirs have a direct, real time, link to Innova for inspection results.

Inspection results are reported back by email to producers who submit FCI electronically directly to the BPEX system and for whom BPEX have an email address.

4.1.4. Visual-only inspection

EU legislation now permits the application of visual-only inspection procedures for pigs. FSA is currently in the process of implementing visual-only inspection in UK. Many operators have not agreed to the implementation of visual-only *post-mortem* inspection because of issues relating to the acceptance by third country export customers of the new inspection system.

Visual-only inspection may have implications for the collection of *post-mortem* inspection results.

4.1.5. British Pig Health Scheme - BPHS

The British Pig Health Scheme (BPHS) is a voluntary BPEX herd health scheme that uses specialist pig veterinarians to assess a range of health conditions in pig carcasses slaughtered in designated pig abattoirs throughout Britain.

The scheme aims to assess at least one batch of pigs from each scheme member's unit every quarter. Assessments are carried out by veterinarians with experience of pig medicine and production who inspect every other pig in a batch, up to 50 pigs per batch. Carcasses are assessed under a defined list of categories, more detailed than the categories used by FSA inspectors.

The scheme also makes some estimates of the financial benefits for producers that might be gained by application of the results of the carcass *post-mortem* assessments.

Concern amongst BPEX levy payers that abattoir monitoring under both CCIR and the BPHS is effectively paid for twice has led to BPEX commissioning a study into the possibility of CCIR replacing BPHS as a means of health monitoring in pig production[7].

4.1.6. Zoonoses National Control Programme - ZNCP

The objective of the UK Zoonoses National Control Programme (ZNCP) is the reduction of risk to consumers from Salmonella and other zoonoses in pig meat products. In particular, ZNCP is focusing on increasing understanding of Salmonella risk and control throughout the pork chain.

Previously the ZNCP allocated scores to producer farms based on the results of a meat juice Elisa test, but this has been discontinued for technical reasons.

4.1.7. AHVLA survey of zoonotic organisms in slaughter pigs

A recently published (March 2014) study[8] from the Animal Health and Veterinary Laboratories Agency (AHVLA) on a number of zoonotic organisms (including organisms showing antimicrobial resistance) reported the prevalence of organisms in live pigs and on carcasses.

[7] BPEX 2104. Collection and Communication of Inspection Results (CCIR) as a means of health monitoring in pig production in place of the British Pig Health Scheme (BPHS): What would success look like?

[8] http://www.defra.gov.uk/ahvla-en/files/pig-survey-key-findings.pdf

A consistently lower prevalence of bacteria (Salmonella and Yersinia) was found on the carcass compared with carriage of the same microorganisms in live animals.

4.2. Cattle

4.2.1. Industry structure

Cattle consigned for slaughter are either prime animals reared specifically for beef or cull breeding animals, either cull dairy cattle or beef cattle. Small numbers of young calves, surplus to the dairy industry requirements, are also slaughtered.

About half of prime animals currently originate from beef herds and half from dairy herds. The majority of cattle from the dairy herd undergo two or more movements before being consigned for slaughter.

Most prime cattle for slaughter (>80% of slaughter animals) move directly from farm to abattoir and are sold on a deadweight basis. In some cases the holding from which cattle are despatched may be an intermediate agent or a collection centre. The balance of prime cattle and most cull cattle are sold through livestock markets on a live weight basis.

Groups of cattle arriving at a slaughterhouse may comprise animals that have been born and reared on the holding, animals that have been born on a number of different holdings and finished on the same holding or mixed animals from a range of holdings that have come from a market or have spent only a short residency on the final holding.

All cattle are individually identified by ear tags and must have a physical passport. All cattle movements must be reported to the BCMS central database, either electronically or by post. Every animal should be readily traceable throughout its life.

Although some processing companies have close relationships with their cattle suppliers, there is generally little integration in the cattle sector.

4.2.2. FCI

FSA has published model documents for cattle FCI which are used in paper form. Some FBOs have incorporated FCI into their own animal acceptance paperwork, which may include limited information in addition to the minimum requirements of the model document.

Normal industry practice is for paper FCI forms to accompany animals to the abattoir. Cattle procured through livestock markets are usually delivered to the abattoir on the day of sale and therefore advance notification of FCI is difficult.

4.2.3. CCIR

Inspection results may be captured for individual animals or for batches. Batch recording by FSA inspectors may be a group of animals from a farm, a consignment load from a market or an entire day's kill at the abattoir.

Individual animal identification is subject to pre-slaughter passport checks and is usually maintained after head removal (including ear tags) by marking carcasses with a kill number.

Capture of *post-mortem* findings by MHIs in the majority of plants is by manual methods – paper, boards, mechanical tallies ('clickers'). A small number of plants have installed touch screen terminals for capture of *post-mortem* results, but there is no integration of FBO systems with Innova.

Inspection results are recorded by manual input into the Innova system by FSA staff during breaks or at the end of the day's production. Inspection results are recorded on the Innova system using specific input screens. Carcasses, parts of carcasses and offals that are considered unfit for human consumption are recorded on a daily Rejected Meat Receipt which is passed to the FBO.

In most abattoirs *post-mortem* findings are not captured at the level of the individual animal or batch from the same source holding – an exception being (for financial reasons) when part of, or an entire carcase is rejected. *Post-mortem* results for offals (pluck, liver, intestines) are seldom recorded against the individual animal or batch.

Some FBOs have implemented systems for the capture of *post-mortem* inspection results for individual animals in order to report these back to their producers as part of a commercial service for their regular suppliers.

There is no formal system for communication of inspection results to cattle suppliers. Local arrangements are used at each abattoir, and may include paper copies of rejected meat receipts passed from FSA directly to the producer or indirectly via the FBO (together with carcass weights and classification results for deadweight sales).

Few producers currently receive inspection results directly from FSA. The MLCSL 2012 report for FSA reported that *'In plants killing cattle, 73% of the OVs replied that currently they were sending no information back to the producers.'* However, some FBOs themselves report inspection results to producers together with carcase weights and grades as a supply chain management service for their regular trading partners.

Where exceptional findings are made at inspection, Official veterinarians may take it upon themselves to inform the producer.

4.3. Sheep

4.3.1. Industry structure

The structure of the UK sheep industry is complex. Some prime lambs may be born and raised on a single farm, from which they are moved for slaughter. Many lambs ('stores') will move from their farm of birth to another farm for finishing.

Sale of prime lambs and cull sheep through livestock markets is an important feature of the sheep industry – about 50% of lambs are sold through markets.

Many abattoir FBOs make use of agents or dealers to procure batches of sheep for slaughter – such batches may comprise sheep from many different holdings.

A consequence of the above features of the sheep industry is that most loads of sheep arriving at abattoirs will bear identification marks of a wide range of holdings of birth.

At the time of writing, sheep identification and movement recording in England is in a state of transition. New rules implemented on 1 April 2014 require all sheep movements to be reported (electronically or on paper) to the Animal Reporting and Movement Service (ARAMS). From this date, abattoirs will be required to report movements electronically. From 1 January 2015 in England and 1 January 2016 in Wales, all slaughter lambs must be electronically identified. Electronic identification of all slaughter lambs in Scotland is currently required.

Once the new requirements and databases have been implemented it should be possible to trace the movements of sheep throughout their lives.

4.3.2. FCI

The FSA has published a model FCI document. In England this information was included on the movement form AML2 and is now included on the new form ARAMS1[9].

For sheep procured from a livestock market, FSA has published model composite documents for mixed consignments of sheep from several farms, containing a declaration from the market operator that all the sheep have been accompanied to the market with FCI.

Current practice is for sheep to be accompanied by paper FCI forms on arrival at the abattoir.

[9] http://www.arams.co.uk/docs/ARAMS-1.pdf

4.3.3. CCIR

Inspection results are generally recorded on a batch basis. Depending on local arrangements at the abattoir, batches may be a group of sheep from a farm, a consignment load on a vehicle or, at the extreme, a day's kill at the abattoir.

An input document has been designed for recording inspection results on the Innova system, but sheep have not been added to the system and the document is redundant. In practice a shorter list of inspection result categories is used.

Capture of *post-mortem* findings by MHIs in the majority of plants is by manual methods – paper, boards, mechanical tallies ('clickers'). A small number of plants have installed touch screen terminals for capture of *post-mortem* results. There is no integration of FBO systems with FSA recording systems.

Where FBO on-line terminals are used, a print-out is used by FSA staff to compile weekly reports.

The Innova system is not used for recording of inspection results. FSA staff submit a composite weekly return of inspection results on a Rejected Meat Receipt to FSA York, for manual input of data onto an FSA database, distinct from Innova.

The recording of inspection results on the FSA database does not distinguish between prime lambs and adult, cull sheep.

Reporting of inspection results to producers is determined by local arrangements – there is no formal system. Few producers receive reports of inspection results – the MLCSL 2012 report for FSA found that 77% of OVs did not send information back to producers.

We are aware of one abattoir that routinely captures and reports inspection results for individual sheep. However, most sheep slaughter lines and inspection systems do not currently permit inspection results to be collected at either an individual animal or batch level.

4.4. Poultry

4.4.1. Industry structure

The poultry industry is highly integrated, with the majority of production being controlled by a small number of companies who operate vertically integrated production systems and meat plants. As a consequence there is internal communication and exchange of information between production and slaughter

Most poultry are reared in indoor systems under controlled housing conditions. A small proportion of birds are kept in free range or organic systems, with access to the outdoors.

All in – all out systems are universal and the slaughter batch is therefore usually the entire population of a single house which will have been managed as a unique epidemiological unit. A significant feature in many systems is the partial depopulation or 'thinning' of a house. Thinning enables more birds to be reared in a house for each production cycle and thus improves the profitability of the operation.

4.4.2. FCI

FCI for poultry must be provided to the slaughterhouse FBO at least 24 hours in advance before the arrival of the poultry at the slaughterhouse.

FSA has published model documents for Poultry FCI. FCI is usually provided in paper form; one form may cover several loads from the same house.

4.4.3. CCIR

Inspection results are recorded on a batch basis, a batch generally being all the birds removed from one house.

In common with the other species, a variety of methods may be used to capture inspection results: touch screen terminals, tallies, paper etc. Where FBO screens are used, there is currently no integration with FSA systems and no direct input to Innova.

Meat Hygiene Inspectors generally record inspection results on line using their own sub-set of conditions from the full list on Innova.

Methods for reporting inspection results are determined by local arrangements. Innova reports may be emailed to producers or sent by hard copy or rejected meat receipts may be sent.

5. FOOD CHAIN INFORMATION

5.1. Scope - legal basis

The formal concept of FCI is contained in EU food safety legislation.

Regulation (EC) No 853/2004:

Food business operators operating slaughterhouses must, as appropriate, request, receive, check and act upon food chain information as set out in this Section in respect of all animals, other than wild game, sent or intended to be sent to the slaughterhouse.

Slaughterhouse operators must not accept animals onto the slaughterhouse premises unless they have requested and been provided with relevant **food safety information** contained in the records kept at the holding of provenance

'Relevant food safety information' that should be included in FCI is laid out in Section III of the Regulation.

The primary function of FCI is therefore food safety but, as discussed later, FCI is also of importance for both animal health and welfare.

The Regulation requires FCI to be provided no less than 24 hours before the arrival of animals at the abattoir but, if the competent authority so permits FCI may arrive less than 24 hours before the arrival of the animals or accompany these animals to the slaughterhouse. FSA has applied this exemption and permits FCI for cattle and sheep to accompany the animals.

5.2. Actions arising from FCI

The purpose of FCI is to provide information from primary production about animals consigned for slaughter to inform the actions of abattoir FBOs and OVs.

A stated aim of this project in respect of FCI is that FCI should be:

- useful to the slaughterhouse operator to make decisions about accepting animals or slaughtering procedures from an efficiency and public health perspective;
- useful to the official veterinarian to inform *ante-mortem* and *post-mortem* inspection and the control of public health, animal health and animal welfare.

The requirements for FCI are therefore determined to a great extent by the range of decisions and actions that are available to the FBO and OV. We therefore begin our consideration of FCI by listing the possible actions that FBOs and OVs might take; these actions are considered in greater detail under specific hazards and activities.

FBO actions

- **Refuse to accept the consignment**
  Having assessed FCI, FBOs may decide not to accept a consignment of animals. This option requires the FBO to analyse the FCI before the animals are delivered and ideally well in advance of the planned slaughter. In our experience FCI is not always analysed by FBOs before delivery and this can create difficulties because animal health rules generally prevent animals being removed from abattoirs.

- **Slaughter schedule**
  Slaughtering animals with a low risk of carrying food safety hazards before high risk animals – so called 'logistic slaughter' - can reduce the likelihood of contaminating processing equipment at the abattoir and subsequent batches of carcases.

  A further action proposed by an EFSA opinion is to schedule the slaughter of low risk animals on 'clean days' - *'Negative (VTEC sheep) batches could be scheduled for slaughter on 'clean days' or directed to VTEC-negative slaughterhouses to avoid cross-contamination during the slaughter process.'*

- **Processing conditions**
  High risk animals may be processed under specific conditions to reduce the risk of contamination. For example, slaughter line speed may be reduced.

- **Decontamination treatments**
  FCI may be used to inform decisions about the use of post-processing decontamination treatments such as lactic acid washes for beef or thermal treatments for poultry.

- **Product use or placement**
  An example of the application of FCI in making decisions about the use of product is the heat treatment of meat from poultry flocks that give positive results for Salmonella testing.

- **Selection of abattoir**
  An action proposed in the EFSA Opinions is to classify abattoirs on the basis of an assessment of their capability to control or reduce carcase contamination, and to direct high-risk animals to abattoirs that are assessed as being most capable. While recognising the logic of this proposal, we have reservations about its commercial feasibility.

  Abattoir standards are driven by the need to comply with legislation and by customer requirements. Abattoirs that supply the major retailers are subject to regular external audit, and thus may operate to higher standards than the FSA-enforced legislative standard. Such abattoirs must fulfil retailers' conditions for livestock procurement, which usually require, as a minimum, that animals come from farms that are members of farm assurance schemes, and often from farms that meet the higher standards of individual retailers.

  Consequently it can be concluded that the 'best' (lowest risk for food safety, animal health and welfare) animals are procured by the most capable abattoirs. In commercial reality, abattoirs considered most capable of controlling hazards are unlikely to accept the highest risk animals.

Official veterinarian actions

- **Focused ante-mortem inspection**
  Scrutiny of FCI assists the OV in the identification of animals that require particular attention at ante-mortem inspection.

- **Slaughter schedule**
  FCI contributes to OV decisions about the order of slaughter of animals to reduce the risk of contamination from high risk animals.

- **Slaughter line speed**
  The OV can require line speed to be reduced (or line spacing increased) if FCI indicates that inspectors will need more time to deal with high levels of pathology.

- **Number of inspectors**
  FCI will give an indication of the levels of pathology likely to be expected in batches of animals and to determine the number of inspectors required to perform *post-mortem* inspection. In practice opportunities for this may be limited because of fixed inspection points, space restrictions and inspection staff deployment issues. FCI provided more than 24 hours in advance would be necessary to make inspection staffing arrangements.

- **Sampling frequency**
  FCI should provide valuable information to enable targeted sampling for chemical residues and for microbiological hazards.

- **Risk-based inspection**
  EFSA has made proposals to discontinue *post-mortem* inspection of all birds in a flock and to move to inspecting only a proportion of the flock. If such changes are implemented, FCI is essential information to make decisions about the proportion of each flock to be inspected.

5.3. FCI - Public health

5.3.1. Microbiological and chemical food safety hazards

A list of microbiological and chemical hazards of relevance for public health has been compiled using the following main information sources:

- the series of EFSA Scientific Opinions[10] on the public health hazards to be covered by inspection of meat for bovine animals, sheep and goats, swine and poultry;
- the series of scientific reports of EFSA[11] on Technical specifications on harmonised epidemiological indicators for biological hazards to be covered by meat inspection of bovine animals, sheep and goats, swine and poultry;
- risk assessments carried out for UK conditions for inspection of pigs and cattle, sheep and goats[12];
- the key pathogens identified by the Food Standards Agency[13].

The list of relevant hazards is shown in the following table:

Table 1. List of relevant hazards

EFSA scientific opinions on public health hazards	EFSA risk rating	EFSA harmonised epidemiological indicators HEI
POULTRY		
Campylobacter spp	High	Campylobacter spp
Salmonella spp	High	Salmonella spp
ESBL/AmpC E. coli	Medium - High	ESBL/AmpC E.coli

[10] http://www.efsa.europa.eu/en/efsajournal/pub/2741.htm
http://www.efsa.europa.eu/en/efsajournal/pub/2351.htm
http://www.efsa.europa.eu/en/efsajournal/pub/3266.htm
http://www.efsa.europa.eu/en/efsajournal/pub/3265.htm

[11] http://www.efsa.europa.eu/en/efsajournal/pub/3277.htm
http://www.efsa.europa.eu/en/efsajournal/pub/2764.htm
http://www.efsa.europa.eu/en/efsajournal/pub/2371.htm
http://www.efsa.europa.eu/en/efsajournal/doc/3276.pdf

[12] Hill et al (2014) Food Control 38 96-103
Hill et al (2011) http://www.foodbase.org.uk/results.php?f_category_id=&f_report_id=695

[13] Annual Report of the Chief Scientist
http://www.food.gov.uk/sites/default/files/multimedia/pdfs/publication/cstar_2013.pdf

ESBL/AmpC Salmonella	Low- Medium	
Dioxins/DL-PCBs	High	
Unlicensed antimicrobials	High	
Veterinary medicinal products	Negligible - low	
PIGS		
Salmonella spp	High	Salmonella spp
Yersinia enterocolitica	Medium	Yersinia enterocolitica
Toxoplasma gondii	Medium	Toxoplasma gondii
Trichinella	Medium	Trichinella
		Cysticercus
		Mycobacteria
Dioxins/DL-PCBs	High	
Veterinary medicinal products	Negligible - Low	
CATTLE		
Salmonella spp	High	Salmonella spp
VTEC	High	VTEC
Bacillus anthracis	Low	
Campylobacter spp	Low	
Sarcocystis hominis	Low	
Cysticercus (Taenia saginata)	Low	Cysticercus (Taenia saginata)
Toxoplasma gondii	Undetermined	
ESBL/AmpC E. coli	Undetermined	
		Mycobacteria
Dioxins/DL-PCBs	High	
Veterinary medicinal products	Negligible - Low	
SHEEP		
Toxoplasma gondii	High	Toxoplasma gondii
VTEC	High	VTEC
		Mycobacteria
Dioxins/DL-PCBs	High	
Veterinary medicinal products	Negligible - Low	

5.3.2. EFSA Scientific Opinions on the public health hazards to be covered by inspection of meat

As part of the EU work on the modernisation of meat controls, EFSA was asked to develop Scientific Opinions on the public health hazards to be covered by inspection of meat for each of the four main food animal species – poultry, pigs, cattle and sheep.

Each EFSA Opinion proposed the development of generic integrated meat safety assurance systems, combining a range of preventive measures and controls applied both on the farm and at the abattoir in a longitudinally integrated way, as the most effective approach to control the main food safety hazards. All the Opinions concluded that FCI is an essential component of all integrated meat safety assurance systems.

5.3.3. EFSA scientific reports on Technical specifications on harmonised epidemiological indicators for biological hazards to be covered by meat inspection

A parallel piece of work by EFSA produced Reports on harmonised epidemiological indicators (HEIs) for biological hazards to be covered by meat inspection for each of the four species.

The EFSA Reports foresee that 'the indicators will be used in the [species] carcase meat safety assurance system outlined in the EFSA Scientific Opinion, particularly to help categorise farms/herds/flocks and slaughterhouses according to the risk related to the hazards as well as setting appropriate specific hazard-based targets in/on carcases and, when appropriate, in farms/herds/flocks'.

***Harmonised epidemiological indicator (HEI)*:** prevalence or concentration of the hazard at a certain stage of the food chain or an indirect indicator of the hazards (such as audits of farms or evaluation of process hygiene) that correlates to human health risk caused by the hazard

The proposed HEIs have two main components:

1. Prevalence/concentration of hazard at determined points in the production chain – microbiology.
2. Audit of primary production - good practices may reduce the likelihood and level of hazards.

5.3.4. FSA key pathogens

FSA has identified five key pathogens for food-borne disease: Campylobacter, Listeria monocytogenes, norovirus, E. coli O157 and Salmonella.

Campylobacter, E. coli O157 and Salmonella are all rated as high risk in the EFSA Opinions and are addressed in this report.

EFSA excluded Listeria at an early stage of the risk ranking process because it requires bacterial growth during steps following carcase chilling, and food-borne disease caused by Listeria is almost always associated with ready to eat products where contamination has occurred from the processing environment. Listeria on fresh meat is therefore considered as low risk.

The role of food, including meat, in the transmission of viruses in general and Norovirus in particular is the subject of the FSA Food-borne Virus Research Programme. Given the currently limited understanding of food-borne viruses, we have not included viruses as relevant hazards for this study.

We note that viruses were not considered by EFSA in its Opinions or in the Harmonised Epidemiological Indicators reports.

5.4. Public health hazards for food animal species

In this section the information that may be provided as FCI about the list of food safety hazards categorised as high or medium risk is considered for each food animal species.

5.4.1. Poultry

EFSA scientific opinions on public health hazards	EFSA risk rating	EFSA harmonised epidemiological indicators HEI
POULTRY		
Campylobacter spp	High	Campylobacter spp
Salmonella spp	High	Salmonella spp
ESBL/AmpC E. coli	Medium - High	ESBL/AmpC E.coli
ESBL/AmpC Salmonella	Low- Medium	
Dioxins/DL-PCBs	High	
Unlicensed antimicrobials	High	
Veterinary medicinal products	Negligible - low	

5.4.1.1. Salmonella

5.4.1.1.1. EFSA Proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Method and specimen	FCI relevance
HEI 1 Salmonella in breeding parent flocks	Farm	Microbiology (detection and serotyping) Pooled faeces (e.g. boot swabs)	
HEI 2 Salmonella in poultry flocks prior to slaughter(a)	Farm	Microbiology (detection and serotyping) Pooled faeces (e.g. boot swabs)	Y
HEI 3 Controlled housing conditions at farm for laying hens and fattening flocks (including biosecurity)	Farm	Auditing	Y
HEI 4 Salmonella in birds - carcasses after slaughter process and chilling	Slaughter - house	Microbiology (detection and serotyping) Neck and breast skin	

5.4.1.1.2. HEI 2 - Salmonella in poultry flocks prior to slaughter

Since 2009 all EU Member States have been obliged to implement national control programmes for Salmonella in broiler flocks in accordance with Regulation (EC) No 2160/2003. Minimum detection requirements in broiler flocks laid down in the Regulation include the statutory sampling of flocks within the three weeks before the birds are moved to the slaughterhouse, taking at least two pairs of boot/sock swabs per flock. Samples are tested for *S.* Enteritidis and *S*. Typhimurium.

Where partial depopulation (thinning) is practised, samples should be taken before the first birds are removed to determine the status of the flock.

Most samples are collected by the operator of the production unit; a proportion of samples are collected by officials on behalf of the Competent Authority as official samples. All samples must be tested at accredited laboratories inspected and approved for Salmonella testing.

Test results must be reported as Food Chain Information.

More detailed information about the statutory testing regime can be found in the UK National Control Programme for Salmonella[14].

5.4.1.1.3. HEI 3 - Controlled housing conditions at farm for laying hens and fattening flocks (including biosecurity)

Regulation (EC) No 2160/2003 requires that effective measures are taken to prevent, detect and control Salmonella at all relevant stages of production, processing and distribution, particularly in primary production, in order to reduce Salmonella prevalence and the risk to public health.

The majority of poultry slaughtered are housed in indoor houses which comply with the definition of 'controlled housing conditions'.

Controlled housing conditions: a type of animal husbandry in which poultry are kept at all times and for their whole life under conditions controlled by the food business operator with regard to feeding, housing and biosecurity of the holding. The controlled housing condition requirements are in some cases not applicable to free-range production of poultry.

The requirements of controlled housing conditions and biosecurity are contained in the Red Tractor Scheme[15] standards, which cover the majority of poultry production. Membership of the Scheme is conditional on satisfactory routine audit.

[14] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/183080/Salmonella-broilers.pdf

Information about assurance scheme membership is currently a component of the minimum elements of FCI.

5.4.1.1.4. Actions at the abattoir

Flocks that test positive for *S.* Enteritidis or *S*. Typhimurium must be slaughtered at the end of a production run at the abattoir i.e. logistic slaughter.

EU legislation on microbiological criteria, Commission Regulation (EC) No 2073/2005, requires sampling and testing of fresh poultry meat and sets food safety criteria for Salmonella – absence of S. Enteritidis or *S*. Typhimurium in 25g. When testing against this criterion provides unsatisfactory results, fresh poultry meat may not be placed on the market but may be submitted to further treatment that eliminates the hazard. Consequently, meat from Salmonella positive flocks is routinely subject to heat treatment.

5.4.1.1.5. Summary – Salmonella in poultry

- Poultry are reared and slaughtered in batches as distinct epidemiological units.
- Risk categorisation of flocks by sampling on the farm and microbiological detection and serotyping is a reliable method and has been effectively applied for many years.
- Flock prevalence of *S.* Enteritidis or *S*. Typhimurium is very low (<0.1% ECDC 2011[16])
- The epidemiology and methods for the control of Salmonella in primary production for poultry are well understood
- Risk mitigation actions at the abattoir effective and commonly applied – logistic slaughter of infected flocks and heat treatment of meat
- FCI for Salmonella in poultry is an essential component of the meat safety assurance system

5.4.1.1.6. Conclusions – Salmonella in poultry

We recommend continued inclusion in FCI of information about membership of farm assurance schemes and the results of on farm sampling and testing for Salmonella.

The national control programme for Salmonella in the UK has been very successful due, in large part, to the knowledge and application of measures to control Salmonella in primary production, namely vaccination and biosecurity measures.

5.4.1.2. Campylobacter

5.4.1.2.1. EFSA Proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Method and specimen	FCI relevance
HEI 1 Campylobacter in poultry flocks prior to slaughter	Farm	Microbiology – real-time PCR Caecal droppings	Y
HEI 2 Controlled housing conditions at farm for poultry flocks (including biosecurity)	Farm	Auditing	(Y)
HEI 3 Use of partial depopulation in the flock	Farm	Food chain information	Y

[15] http://assurance.redtractor.org.uk/resources/000/965/989/Poultry_Scheme_-_Broilers_and_Poussin_Standards.pdf
http://assurance.redtractor.org.uk/resources/000/965/990/Poultry_Scheme_-_Catching_and_Transport_Standards.pdf

[16] ECDC. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2011

Indicators (animal/food category/other)	Food chain stage	Method and specimen	FCI relevance
HEI 4 Campylobacter in birds - incoming to slaughter process (evisceration stage)	Slaughter - house	Microbiology - enumeration Caecal content	(Y)
HEI 5 Campylobacter in birds - carcases after slaughter process and chilling	Slaughter - house	Microbiology - enumeration Neck and breast skin	

5.4.1.2.2. HEI 1 - Campylobacter in poultry flocks prior to slaughter

Once Campylobacter enters a broiler house and infects the first birds, spread is very rapid and virtually all birds are colonised within one week. Since a flock may become infected very rapidly, the interval between testing and slaughter must be a short as possible for pre-slaughter testing to be a reliable method of risk categorisation of flocks. The use of rapid microbiological methods such as PCR enables flocks to be tested 2-3 days before slaughter.

Caecal droppings are the sample recommended by EFSA rather than boot swabs because of the lack of data in the published literature regarding the sensitivity of boot swabs for Campylobacter detection. Caecal droppings allow better Campylobacter spp. survival and provide more accurate results than boot swabs. Boot swabs might however be a more suitable sampling method as they could also be used as the sample type for other organisms (e.g. Salmonella), making sampling more cost-effective.

It is beyond the scope of this report to consider in detail the sampling methodology; further work may be needed to define the optimal type and number of samples by flock to achieve an acceptable level of sensitivity allowing the detection of Campylobacter-positive flocks.

Thinning is an acknowledged risk factor for colonisation of flocks. Flocks should therefore be tested on each occasion birds are removed for slaughter (further sampling and testing of flocks that test positive before thinning would not be necessary).

5.4.1.2.3. HEI 2 - Controlled housing conditions at farm for poultry flocks (including biosecurity)

Investigation of the risk factors for colonisation of flocks and possible risk control measures is currently the subject of much research. The application of biosecurity measures that are able to prevent colonisation of flocks with Salmonella do not appear to be effective against Campylobacter.

Audit of housing conditions and biosecurity measures (e.g. as a condition of membership on an assurance scheme) is therefore currently not a reliable predictor of the risk of colonisation with Campylobacter. This situation may change in the future as control measures in primary production become better understood and are included as additional requirements in the definition of controlled housing conditions and biosecurity.

Poultry that are reared with outdoor access are very likely to be colonised with Campylobacter and can therefore be classified as high risk at all times.

5.4.1.2.4. HEI 3 - Use of partial depopulation in the flock

Since partial depopulation is known to be a major risk factor for Campylobacter colonisation, knowledge of thinning in the management of poultry houses is of value for risk categorisation of slaughter flocks.

5.4.1.2.5. HEI 4 - Campylobacter in birds - incoming to slaughter process (evisceration stage)

The results of sampling and testing a consignment birds after slaughter clearly cannot be included in FCI for the batch, but is included here because this information may be included in the history of the farm, be incorporated in FCI and used to make risk categorisation decisions for subsequent consignments from the same farm.

A benefit of sampling and testing birds at this point is that it would provide quantitative information about Campylobacter in caecal contents rather than simply the presence/absence result from on-farm sampling and testing. In addition such results would provide information about the effect of catching and transport to the abattoir.

Post-mortem sampling and testing is considered in greater detail in Section 8.

5.4.1.2.6. Actions at the abattoir

A recent FSA survey[17] of Campylobacter contamination of fresh poultry meat at retail sale revealed that 73% of chickens tested gave positive results for Campylobacter. Campylobacter is the subject of much research on interventions throughout the food production chain to reduce levels on poultry meat and to meet the FSA's targets for reduction.

The prevalence of Campylobacter-colonised broiler batches in the UK was estimated as 70 – 80 % in 2008[18].

The high prevalence of Campylobacter positive flocks is currently an impediment to applying specific measures to their slaughter and processing (c.f. Salmonella Enteritidis and Typhimurium: flock prevalence <0.1%).

Risk categorisation of batches of slaughter poultry into Campylobacter-negative and – positive categories could be used to inform a number of interventions at the abattoir:

- Logistic slaughter
- Improvements in Good Hygienic Practice Application of physical and chemical decontamination treatments
- Product use/placement

Decontamination **t**reatments have been assessed and pilot trials are currently in progress. We are not aware of any decontamination treatments that are currently used in commercial production.

Unlike Salmonella, there are no microbiological criteria for Campylobacter and therefore no specific prohibition on the marketing of poultry meat contaminated with Campylobacter.

Given the current prevalence of Campylobacter-colonised broiler batches, any requirement to subject meat from positive batches to treatment that reduces the hazard would have a dramatic impact on the UK poultry industry.

5.4.1.2.7. Responses to positive pre-slaughter test results

Positive results from pre-slaughter sampling and testing of poultry must be included in FCI. The known prevalence of Campylobacter in slaughter batches means that it can be assumed that most batches are positive. However there is an important difference between assuming and having definite knowledge (through sampling and testing) of positive status. The response of FBOs, FSA and retailers to such knowledge could have significant repercussions. This issue is considered in more detail in Section 8.

5.4.1.2.8. Summary - Campylobacter

- Poultry are reared and slaughtered in batches as distinct epidemiological units. Pre- and post- thinning batches should be treated as separate units.
- Risk categorisation of flocks by sampling on the farm and microbiological detection is possible and should be reliable.
- Detection of late and rapid colonisation of flocks can be addressed by the use of rapid detection methods

[17] http://www.food.gov.uk/sites/default/files/Campylobacter-retail-survey-q3-results.pdf
[18] http://www.efsa.europa.eu/en/efsajournal/doc/1503.pdf

- Risk mitigation interventions at the abattoir are available, although not yet fully assessed or implemented
- Flock prevalence of Campylobacter is high (70 – 80%)
- Risk factors and mitigation interventions in primary production are not fully understood. Knowledge of the Campylobacter status (presence/absence or quantitative) of all slaughter batches is of value in assessing on-farm risk factors and the effectiveness of mitigation measures in both primary production and at the abattoir.
- Producer knowledge of the Campylobacter status of each slaughter batch may induce producers to apply mitigation interventions.

5.4.1.2.9. Conclusions - Campylobacter

- All slaughter batches should be sampled and tested for Campylobacter and the results included in FCI.
- Test results should be used initially for surveillance purposes rather than risk categorisation and interventions at the abattoir.
- During the initial phase samples may be taken either at the farm or at the abattoir.
- Results for each farm should be included in the farm records to build a historical record of each farm.
- In the longer term, as risk control measures on farm become more understood and/or risk mitigation procedures at the abattoir are applied, pre-slaughter test results in FCI should be used to inform interventions at the abattoir.

5.4.1.3. ESBL/AmpC-producing bacteria

5.4.1.3.1. EFSA Proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Method/specimen	FCI relevance
HEI 3 ESBL-/AmpC-producing *E. coli* in poultry flocks prior to slaughter	Farm	Microbiology, enumeration, molecular methods for characterisation on a subsample. Pooled faeces (boot swabs)	
HEI 4 Controlled housing conditions	Farm	Auditing	
HEI 5 Use of antimicrobials during the whole life time of the flock (including *in ovo*, hatching, rearing, laying, all types of flocks)	Hatchery/ farm	Food chain information (from hatchery to farm, from farm to slaughterhouse)	
HEI 6 ESBL-/AmpC-producing *E. coli* in birds - carcasses after slaughter process and chilling	Slaughter - house	Microbiology, enumeration, molecular methods for characterisation on a subsample. Neck (and breast) skin	

5.4.1.3.2. HEI 3 - ESBL-/AmpC-producing *E. coli* in poultry flocks prior to slaughter

EFSA states that information on risk and protective factors for the occurrence of bacterial strains producing ESBL/AmpC is limited and that the establishment of such risk factors is particularly complicated by the lack of data or inaccurate data.

Surveillance for antimicrobial resistance in all food animal species is the responsibility of the Veterinary Medicines Directorate. Scanning surveillance for resistant organisms is carried out by APHA veterinary laboratories.

We are not aware of any plans to extend the scope of surveillance to include batches of slaughter poultry. The cost of the EFSA proposal would be high and would need to be considered when determining the requirements for surveillance for antimicrobial resistance.

5.4.1.3.3. HEI 5 - Use of antimicrobials during the whole life time of the flock

Information about the use of veterinary medicinal products is required for FCI in the context of preventing the presence of residues in meat; this is covered in Section 5.7.4.1.

5.4.1.3.4. Actions at the abattoir

Abattoir food safety management systems have the objective of controlling the contamination of meat with organisms carried in or on birds when they arrive at the abattoir. The current microbiological focus is on Campylobacter. It can be assumed that any intervention measures applied to control Campylobacter will also control other microbiological hazards, including ESBL-/AmpC-producing *E. coli.*

5.4.1.3.5. Summary - ESBL/AmpC

- There are no intervention measures at the abattoir specific for the control of resistant organisms.
- Information about the use of veterinary medicinal products in poultry is included in FCI for other purposes.
- Surveillance for resistant organism could use the same samples collected on-farm or at the abattoir for testing for meat-borne pathogens.
- The use of routine sampling and testing of slaughter batches for surveillance should be considered in the context of a national surveillance programme.

5.4.1.3.6. Conclusions - ESBL/AmpC

- FCI should include information about all the veterinary medicinal products, including antimicrobials, administered during the lifetime of the flock
- We do not believe that routine use of pre-slaughter sampling and testing alone of poultry for ESBL-/AmpC-producing E. coli would provide public health benefits

5.4.2. Pigs

EFSA scientific opinions on public health hazards	EFSA risk rating	EFSA harmonised epidemiological indicators HEI
PIGS		
Salmonella spp	High	Salmonella spp
Yersinia enterocolitica	Medium	Yersinia enterocolitica
Toxoplasma gondii	Medium	Toxoplasma gondii
Trichinella	Medium	Trichinella
		Cysticercus
		Mycobacteria
Dioxins/DL-PCBs	High	
Toxoplasma gondii	High	Toxoplasma gondii
Veterinary medicinal products	Negligible - Low	

5.4.2.1. Salmonella

5.4.2.1.1. EFSA proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Method and specimen	FCI relevance
HEI 1 Salmonella in breeding parent flocks	Farm	Microbiology (detection and serotyping). Pooled faeces samples	
HEI 2 Salmonella in fattening pigs prior to slaughter	Farm	Microbiology (detection and serotyping). Pooled faeces samples	Y
HEI 3 Controlled housing conditions at farm (both for breeding pigs and fattening pigs)	Farm	Auditing	Y
HEI 4 Transport and lairage conditions (both for breeding pigs and fattening pigs)	Transport and slaughter -house	Auditing of time, mixing of batches and reuse of pens in lairage	(Y)
HEI 5 Salmonella in fattening pigs incoming to slaughter process (evisceration stage)	Slaughter - house	Microbiology (detection and serotyping) Ileal contents	(Y)

5.4.2.1.2. HEI 2 - Salmonella in fattening pigs prior to slaughter

EFSA proposes the farm as the epidemiological unit for this indicator, that the sampling strategy should include a representative sample (random or systematic) of fattening pigs and that testing be 'repeated at a frequency (to be determined by risk managers) adequate to characterise the farm risk (in terms of the range of serotypes present)'.

If sampling and testing is used a method for categorisation of farm as Salmonella positive or negative, the frequency of testing would need to be sufficient to provide the desired level of confidence, taking account of the rate at which the status of farms might be expected to change.

Risk categorisation of batches of slaughter pigs (as opposed to farms) would require sampling and testing of the specific group of pigs to be consigned for slaughter. Slaughter batches would need to be determined and sampled close to slaughter. Clearly this would provide more reliable information about the status of each batch of slaughter pigs but will incur additional sampling and testing costs.

The proposed method is sampling of pooled faeces and microbiological analysis and typing of Salmonella spp. to provide data on specific serovars.

Serological testing of meat juice is used in some countries and was included in the BPEX ZNCP until 2012, when its use was suspended because of limitations of the test in providing evidence of changing Salmonella status at an individual farm level. Serology provides no information about Salmonella serotypes. While acknowledging that serology is used in some Member States for basic screening purposes, we concur with the EFSA view that serological testing is not an effective indicator.

An essential component of any programme that aims to reduce the prevalence of Salmonella on pig farms is a method to assess the impact of on-farm interventions. Our view is that sampling and microbiological testing is required to fulfil this requirement. Sampling at this point provides information about the farm, and the results are not compromised by any events that may occur during transport and lairaging, between leaving the farm and the point of slaughter.

5.4.2.1.3. HEI 3 - Controlled housing conditions at the farm

Controlled housing conditions: a type of animal husbandry where pigs are kept at all times and for their whole life under conditions controlled by the food business operator with regard to feeding, housing and biosecurity of the holding.

Farm assurance schemes (e.g. the Red Tractor Scheme) generally include in their standards the requirements for controlled housing conditions and biosecurity described in the EFSA opinion.

The conditions of the Red Tractor Assurance Pig Scheme include the requirement for a veterinary health plan which must include a Salmonella Control Plan.

The risk factors for Salmonella carriage by slaughter pigs have been the subject of much investigation in the EU and UK. EFSA[19] has proposed a hierarchy of control measures: 'a high prevalence in breeder pigs needs to be addressed first, followed by control of feed and then control of environmental contamination. A 'farm tool'[20] has been developed by BPEX to assist producers and veterinarians to implement control measures on farm.

An EFSA QMRA analysis concluded that it appears that an 80% or 90% reduction of lymph node prevalence should result in a comparable reduction in the number of human cases attributable to pig meat products. We note the statement in this paper that 'The control of Salmonella in pig reservoir in the EU is a reasonable objective'.

5.4.2.1.4. HEI 4 Transport and lairage conditions

Transport and lairage conditions can influence the shedding of Salmonella by pigs. Information about transport and lairage would contribute to the assessment of risks throughout the production chain.

5.4.2.1.5. HEI 5 Salmonella in fattening pigs incoming to slaughter process (evisceration stage)

The results of sampling and testing of batches of pigs after slaughter cannot be included in FCI for the batch, but this information may be included in the history of the farm and be incorporated in FCI and used to make risk categorisation decisions for subsequent consignments from the same farm.

Sampling and testing at this point may be an alternative to on-farm sampling for the risk categorisation of farms. Sampling of ileal contents could provide quantitative information about Salmonella in the slaughter pigs.

5.4.2.1.6. Abattoir interventions

Information included in FCI about the risk category of farms or batches could be used to apply logistic slaughter principles – slaughter of low risk (Salmonella negative) pigs on cleaned and disinfected lines – slaughter of positive pigs after negative or slaughter on different days.

FBOs could apply knowledge of the Salmonella status of batches of slaughter pigs to change processing conditions or to make decisions about the use of decontamination treatments.

5.4.2.1.7. Summary – Salmonella in pigs

- Slaughter pigs are generally transported from farm to abattoir in distinct batches as single epidemiological units.
- Sampling and testing, either on-farm or at the abattoir, is essential to assess the effectiveness of interventions to control Salmonella on the farm. Regular sampling and testing on the farm would permit risk categorisation of farms. Reliability of categorisation is dependent on the frequency of testing.
- All test results should be recorded on farm records to permit categorisation of farms.
- Herd prevalence of Salmonella is about 30% (EFSA Baseline survey)
- Risk reduction interventions at the abattoir are available.
- Accurate information about herd prevalence of Salmonella is essential to assess the effectiveness of on-farm reduction interventions.

[19] EFSA 2010. Scientific Opinion on a Quantitative Microbiological Risk Assessment of Salmonella in slaughter and breeder pigs

[20] http://blog.bpex.org.uk/2012/09/Salmonella-control-try-new-farm-tool.html

5.4.2.1.8. Conclusions – Salmonella in pigs

- We believe that the combination of methods for categorisation of slaughter pigs, the level of herd prevalence of Salmonella and the feasibility of risk reduction measures at the abattoir support the inclusion of on-farm sampling and test results in FCI as part of a meat safety assurance scheme.
- The value for public health of categorisation of batches, rather than farms, requires further consideration in terms of epidemiology and economics.

Sampling and testing, either on-farm or at the abattoir, is essential to assess the effectiveness of interventions to control Salmonella on the farm. We note that a condition of membership of the Red Tractor Pig Scheme is quarterly veterinary visits. We suggest that a starting point for the risk categorisation of farms may be the addition of sampling and testing for Salmonella at these visits.

5.4.2.2. Yersinia (medium risk hazard – EFSA Opinion)

5.4.2.2.1. EFSA Proposed HEIs

No HEIs are proposed for primary production or before slaughter.

Knowledge of the epidemiology and risk factors contributing to the infection of pigs is currently limited.

No useful harmonized indicator for *Y. enterocolitica* can be used at the farm level at present. In order to determine the infection status of pigs at the farm level, tonsil samples would be the best but is clearly not practical. Examination of faeces leads to considerable underestimation of the number of positive pigs at the farm level (Nesbakken et al., 2006[21]). In addition, the presence of antibodies cannot be directly linked to the presence of *Y. enterocolitica* in pigs to be slaughtered. Consequently, serological testing of slaughter pigs is not a good harmonized epidemiological indicator to detect infected pigs.

5.4.2.2.2. Conclusion - Yersinia

No useful harmonized indicator for Y. enterocolitica can be used at the farm level at present and hence no information of value can be provided for FCI.

5.4.2.3. Toxoplasma (medium risk hazard – EFSA Opinion)

There is currently debate in the UK about the importance of Toxoplasma as a zoonotic disease in humans and the role of meat in transmission. These matters are discussed in detail in section 5.4.4. Sheep.

The main risk factor relating to Toxoplasma infection in pigs is access to outdoors, with higher prevalence in pigs with outdoor access. Other risk factors include age (adults being higher risk than young animals), the presence of cats and the effectiveness of cleaning and disinfection.

[21] Nesbakken T, Iversen T, Eckner K and Lium B, 2006. Testing of pathogenic *Yersinia enterocolitica* in pig herds based on the natural dynamic of infection. International Journal of Food Microbiology,111, 99-104.

5.4.2.3.1. EFSA Proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Analytical/ diagnostic method	FCI relevance
HEI 1 Farms with officially recognized controlled housing conditions (including control of cats and boots)	Farm	Auditing	
HEI 2 *Toxoplasma* in breeding pigs from officially recognized controlled housing conditions	Slaughter - house	Serology	
HEI 3 *Toxoplasma* in breeding pigs from non-officially recognized controlled housing conditions	Slaughter - house	Serology	

5.4.2.3.2. HEI 1 - Farms with officially recognized controlled housing conditions

Finishing pigs reared under controlled housing conditions with the exclusion of cats should pose little risk for Toxoplasma.

We propose that farm assurance schemes consider adding to their standards the exclusion of cats from pig houses.

5.4.2.3.3. HEI 2 - Toxoplasma serology

While Toxoplasma serology may be of interest for surveillance purposes, we do not consider that this would be of current value for risk categorisation of pig farms for food safety purposes.

5.4.2.3.4. Abattoir interventions

We are not aware of any interventions directed specifically at the control or reduction of Toxplasma cysts in meat.

5.4.2.3.5. Conclusions – Toxoplasma in pigs

- Uncertainty about role of meat in human infection.
- No risk categorisation method.
- No relevant information for FCI.
- Recommend that farm assurance schemes add the condition of exclusion of cats from pig housing.

5.4.2.4. Trichinella

5.4.2.4.1. EFSA Proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Analytical/ diagnostic method	FCI relevance
HEI 1 *Trichinella* in free range and backyard pigs (both fattening and breeding pigs)	Slaughter - house	Digestion Meat	
HEI 2 *Trichinella* in pigs from non-officially recognized controlled housing conditions officially recognized controlled housing conditions (both fattening and breeding pigs)	Slaughter - house	Digestion Meat	
HEI 3 Farms with officially recognized controlled housing conditions and *Trichinella* free status [(a)]	Farm	Auditing	
HEI 4 *Trichinella* in wildlife (eg. wild boar, bear, racoon, dog, fox, jackal, wolf, lynx, wild cats, genet, mustelids)	Environment	Digestion Meat	

The UK has carried out surveys of wildlife to support its application to the European Commission to be officially recognised as a region presenting a negligible risk of Trichinella to domestic swine, in accordance with Commission Regulation (EC) No 2075/2005.

5.4.2.4.2. Trichinella testing

At present, Commission Regulation (EC) No 2075/2005 requires all breeding sows and boars and pigs from non-controlled housing conditions to be tested for Trichinella in UK.

5.4.2.4.3. HEI 3 Farms with officially recognized controlled housing conditions and *Trichinella* free status

The requirements for officially recognised controlled housing conditions are set out in EU legislation Commission Regulation (EC) No 2075/2005.The majority of the conditions are covered by the common farm assurance scheme standards. Producers are currently required to declare whether their production system conforms to these requirements; finishing pigs from conforming systems are exempt from testing for Trichinella.

There is currently no official guidance on risk assessment for pigs that do not spend their entire lives under controlled housing conditions but have some access to outdoor facilities; guidance is being developed to assist producers in interpretation of the legislation.

5.4.2.4.4. Conclusion – Trichinella

- Trichinella is not believed to be present in the UK, and work is ongoing to provide evidence to support this assertion.
- Some testing is required to comply with EU legislation and to maintain access to international markets.
- Producers must provide FCI information about conformance with officially recognised controlled housing conditions to enable identification of pigs that require sampling and testing.

5.4.2.5. Mycobacteria

Although Mycobacteria are considered low risk for food safety by the EFSA Opinion on pigs, EFSA has proposed HEIs for Mycobacteria.

Transmission of Mycobacteria by the meat-borne route is not considered to be a food safety hazard, and EFSA states that there is currently no evidence of pork-related transmission of mycobacteria to humans.

However, the introduction in the EU of visual only PMMI for pigs has created issues for international trade, and some pig processors continue to require incision of the submaxillary lymph nodes in the inspection protocol. We understand that discussions are in progress about recognition of the equivalence of EU inspection procedures for international trade.

In the Netherlands a serological test for Mycobacterium avium[22] in pigs has been employed to categorise the risk for pig herds but this test has not been validated. The EFSA HEI report stated *'Considering some limitations of the serological testing, such as lack of sensitivity, specificity and the poor detection of more advanced clinical cases, serological testing was not proposed in the HEI.'*

5.4.2.5.1. Conclusions – Mycobacteria

- There is no evidence of transmission of Mycobacteria to humans through the consumption of pig meat
- There is no validated test for Mycobacteria in pigs
- No relevant information about Mycobacteria that could be included in FCI

[22] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3799521/

5.4.3. Cattle

EFSA scientific opinions on public health hazards	EFSA risk rating	EFSA harmonised epidemiological indicators HEI
CATTLE		
Salmonella spp	High	Salmonella spp
VTEC	High	VTEC
Bacillus anthracis	Low	
Campylobacter spp	Low	
Sarcocystis hominis	Low	
Cysticercus (Taenia saginata)	Low	Cysticercus (Taenia saginata)
Toxoplasma gondii	Unknown	
ESBL/AmpC E. coli	Unknown	
		Mycobacteria
Dioxins/DL-PCBs	High	

5.4.3.1. Salmonella

5.4.3.1.1. EFSA proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Sample/ method	FCI relevance
HEI 1: Practices which increase the risk of introducing Salmonella into the farm (purchase policy, mixing with other herds, access to pasture, access to surface water)	Farm	Auditing	
HEI 2: On-farm practices and conditions	Farm	Auditing	
HEI 3: Salmonella status of the group(s) of bovine animals containing animals to be slaughtered within one month	Farm	Pooled faeces	
HEI 4: Transport and lairage conditions	Transport and lairage	Auditing	
HEI 5: Visual inspection of hide conditions of animals at lairage (clean animal scoring system)	Slaughter - house	Visual inspection	Y
HEI 6: Salmonella on incoming animals (after bleeding and before dehiding)	Slaughter - house	Microbiology (detection and serotyping). Hide swabs	
HEI 7: Salmonella in incoming animals (evisceration stage)	Slaughter - house	Microbiology (detection and serotyping). Lymph nodes	
HEI 8: Salmonella on carcases pre-chilling	Slaughter - house	Microbiology (detection and serotyping). Carcase swabs	
HEI 9: Salmonella on carcases post-chilling	Slaughter - house	Microbiology (detection and serotyping). Carcase swabs	

5.4.3.1.2. HEI 1 - Practices which increase the risk of introducing Salmonella into the farm

5.4.3.1.3. HEI 2 - On-farm practices and conditions

Purchase of infected animals, mixing with other herds, access to pasture and access to surface water are recognised risk factors for the introduction of Salmonella to farms.

EFSA proposes audit of controlled husbandry conditions as a method for assessing risk on farms.

Controlled husbandry conditions: a type of animal husbandry in which bovine animals are kept at all times and for their whole life under specific conditions that effectively exclude all relevant risk factors or maintains a constant level of risk. Such conditions are controlled by the food business operator with regard to feeding, hygiene and the biosecurity of the holding and are specific for each hazard.

Table 2. Examples of requirements proposed by EFSA to investigate for controlled husbandry conditions for cattle

efsa European Food Safety Authority — Epidemiological indicators for meat inspection of bovine animals

Appendices

Appendix A. Proposed requirements for controlled husbandry conditions on farms

Table 8. Proposed requirements for controlled husbandry conditions on farms by pathogen

Measures	*Salmonella*	Pathogenic VTEC	*Cysticercus*	Mycobacteria	
				M. bovis	NTM
Practices which increase the risk of introducing pathogens into the farm					
Purchase policy	√	√	√	√	√
Contact with other animals/ herds	√	√		√	√
Contact with wildlife (including avifauna)				√	√
Access to pasture	√	√	√		
Access to surface water	√	√	√		
Feeding fresh grass			√		
On-farm practices and conditions contributing to transmission of pathogens					
Animal density	√	√		√	
Ventilation	√	√		√	
Bedding	√	√			
Slurry	√	√			
Storage conditions of feed	√				
Age mixing	√	√			
Waste management	√	√			

Production systems for many cattle in the UK involve movements of animals between farms. For example, calves born on dairy farms may move soon after birth to dedicated calf rearers, then to other farms for further rearing and may then move again as stores to specialist finishers.

Some animals may be resident on the holdings of cattle dealers for a short period before slaughter when they will mix with animals from other farms.

Under UK conditions for husbandry of most cattle (grazing at pasture, open housing) we do not consider that the concept of controlled husbandry is applicable. In the case of more intensively-, indoor-reared bull beef, the majority will not fulfil the controlled husbandry conditions because they originate in dairy herds and undergo several movements during their life.

Farm assurance schemes generally contain requirements for farm biosecurity but these are not directed at the control of food safety hazards that do not affect animal health, including Salmonella.

Audit of farm conditions is therefore considered of limited value for risk categorisation of farms for Salmonella under UK conditions.

5.4.3.1.4. HEI 3 - Salmonella status of the group(s) of bovine animals containing animals to be slaughtered within one month

EFSA proposes testing of pooled samples of faeces from slaughter animals for detection and typing of Salmonella spp. Common practice is to select individual animals from a group or groups of cattle as they are assessed to be of a condition suitable for slaughter. The exact epidemiological unit of the slaughter batch may therefore not be clearly defined.

In the case of cattle finished outdoors at pasture, pre-slaughter sampling is unlikely to be a feasible or valid method to assess the presence of Salmonella.

Sampling and testing of housed cattle prior to slaughter may be a reliable method to categorise batches at the time of sampling but may not give guarantees that a batch that tested negative will remain so until leaving the farm, since most housing is not sufficiently 'controlled' to ensure that animals are not exposed to risk of infection after sampling. Risk categorisation of slaughter batches could be improved by sampling and testing cattle closer to the time of slaughter.

5.4.3.1.5. HEI 4 - Transport and lairage conditions

There is a large body of published work (summarised by ukmeat.org[23]) that demonstrates the significant role of transport and lairage in the contamination of cattle hides at slaughter with Salmonella and other enteric pathogens.

Contamination is exacerbated by mixing of animals between leaving the farm arriving at the abattoir, as may occur during transport or at market.

Lairage pens and the general lairage environment have all been shown to be important sources of contamination of cattle hides. It is common practice in most lairages for pens to be used for more than one group of animals during a day, and all animals come into contact with the race and associated handling pens before the stunning box.

Furthermore, the stress of handling, transport and mixing of animals that occurs between leaving the farm and slaughter has been shown to increase the excretion of enteric pathogens, leading to further contamination of the transport and abattoir environment and subsequent contamination of cattle hides.

5.4.3.1.6. HEI 5 - Visual inspection of hide conditions of animals at lairage (clean animal scoring system)

Dirty cattle are widely recognised as a presenting a high risk for food safety. Whilst the sole information of the degree of visual cleanliness of the hide cannot be used as an indicator of absence or presence of the hazard in cattle, it can be assumed that animals dirty with faecal material could present a higher risk for cross-contamination of the slaughter line environment, including the carcases (EFSA Opinion).

Regulation (EC) No 853/2004 requires abattoir FBOs to ensure that *each lot of animals accepted onto the slaughterhouse premises is clean.* Scoring systems, such as that developed by the former Meat Hygiene Service[24], aim to ensure that excessively dirty animals are not sent from the farm to slaughter or that appropriate interventions are applied at the abattoir.

Farmers should be aware of the requirement to send only clean cattle for slaughter and of the system used for scoring cleanliness. Although scoring of cleanliness is open to a degree of individual interpretation, we recommend that a requirement for farmer assessment of cleanliness score be included in FCI to focus attention on animal cleanliness and reduce the number of dirty animals sent for slaughter.

[23] http://www.ukmeat.org/FSAMeat/CattleLairage.htm

[24] http://multimedia.food.gov.uk/multimedia/pdfs/publication/cleanbeefsaf1007.pdf
http://multimedia.food.gov.uk/multimedia/pdfs/cleancattleposters.pdf

5.4.3.1.7. HEI 6 - Salmonella on incoming animals (hide swabs after bleeding and before dehiding)

We believe that, because of the cross contamination issues during transport and lairage, there is no public health value in routine microbiological testing of hides post slaughter.

5.4.3.1.8. HEI 7: Salmonella in incoming animals (evisceration stage)

Sampling and testing of lymph nodes may be a useful method for assessing the on-farm prevalence of Salmonella since it overcomes many of the problems for on-farm sampling and transport and lairage contamination. This could be used as a useful method of surveillance and possible risk ranking of farms.

5.4.3.1.9. Abattoir interventions

Animals categorised as high risk may be subject to a number of interventions, primarily logistic slaughter where high risk animals are slaughtered at the end of the day or a production run and slaughter is carried out at a slower rate to enable process hygiene controls to be applied more carefully.

Carcases from high risk animals may be selected for the application of decontamination treatments, including the use of lactic acid washes.

Handling of dirty animals can be a difficulty for abattoir FBOs, since legislation concerning animal disease control does not permit any animal, no matter how dirty, to leave an abattoir once it has arrived. Pre-slaughter clipping in the lairage is an option but has health and safety implications for operatives. Some abattoirs have facilities for post-slaughter clipping of cattle but this is not an option for most abattoirs for reasons of design and space We propose that consideration be given to changing animal movement legislation with a view to allowing excessively dirty animals to leave the abattoir to be returned to the premises from which they were consigned. We acknowledge the animal health implications of movements off abattoirs; clearly these would need to be subject to the imposition of appropriate animal health and movement controls on the destination premises.

Summary – Salmonella in cattle

- The concept of controlled husbandry conditions is not applicable to the vast majority of UK cattle production systems.
- Pre-slaughter sampling and testing of batches of cattle for risk categorisation may be possible in some circumstances but is not universally applicable.
- Cross contamination with Salmonella during transport and lairage (and at market, if relevant)is a significant factor in hide contamination at the point of slaughter.
- Post-slaughter sampling and testing of lymph nodes may be valuable for surveillance of on-farm prevalence of Salmonella and risk categorisation of farms (notwithstanding cross contamination issues after leaving the farm).
- Dirty cattle present a risk for contamination of meat during slaughter and dressing.
- Abattoir interventions are available for animals categorised as high risk.

5.4.3.1.10. Conclusions – Salmonella in cattle

- The combination of husbandry conditions and pre-slaughter sampling and testing issues do not enable batches of slaughter cattle to be reliably categorised for Salmonella status.
- There is a high risk of cross contamination of hides after leaving the farm (during transport and in the abattoir lairage (and at market, if applicable) which negates the benefit of any batch or farm categorisation system.
- Categorisation of farms for food safety risk management purposes is not considered a practical option under current systems.

- Cattle cleanliness is a risk factor for contamination of meat. While recognising that there is an element of subjectivity in assessing cleanliness scores, we propose that requiring cleanliness scores to be included in FCI will focus the attention of producers on the cleanliness of the animals they consign for slaughter.Abattoir FBOs must apply appropriate interventions to dirty cattle to minimise carcase contamination.
- Consideration should be given to changing animal health legislation and to enable excessively dirty animals to be removed from the abattoir.

5.4.3.2. VTEC

5.4.3.2.1. EFSA proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Sample/ method	FCI relevance
HEI 1: Practices which increase the risk of introducing pathogenic VTEC into the farm (purchase policy, mixing with other herds, access to pasture, access to surface water)	Farm	Auditing	
HEI 2: On-farm practices and conditions	Farm	Auditing	
HEI 3: Pathogenic VTEC status of the group(s) of bovine animals containing animals to be slaughtered within one month	Farm	Microbiology Pooled faeces or floor samples	
HEI 4: Transport and lairage conditions	Transport and lairage	Auditing	
HEI 5: Visual inspection of hide conditions of animals at lairage (clean animal scoring system)	Slaughter – house	Visual inspection	Y
HEI 6: Pathogenic VTEC on incoming animals (after bleeding and before dehiding)	Slaughter – house	Hide swabs	

Proposals for HEIs for VTEC are very similar to those for Salmonella and all of the discussion above about Salmonella applies to VTEC.

5.4.3.2.2. HEI 1 - Practices which increase the risk of introducing pathogenic VTEC into the farm and HEI 2 - On-farm practices and conditions

Current knowledge of the epidemiology VTEC and of the risk factors for the carriage and shedding of VTEC by animals is not sufficient to allow control measures to be applied in primary production. Consequently information about farm management practices provides no indication of the risk of animals on individual farms carrying VTEC. This situation may change as knowledge improves and interventions such as vaccination are developed.

5.4.3.2.3. HEI 3 - *Pathogenic VTEC* status of the group(s) of bovine animals containing animals to be slaughtered within one month

Transmission of VTEC amongst groups of animals is complicated by the presence of super-shedders. The number of pathogenic VTEC O157 organisms shed in faeces is variable, with some animals excreting very high numbers. It has been estimated[25] that such super-shedding animals contribute up to 80 % of all VTEC transmitted on the farm and during transport, lairage and slaughter operations.

When VTEC are shed in the faeces of cattle, they can survive well in the farm environment, including water, animal manure and slurry, feed and farm surfaces. Transmission of VTEC O157 and other VTEC serogroups can occur rapidly in groups of co-housed bovines on farms.

[25] Matthews L, McKendrick IJ, Ternent H, Gunn GJ, Synge B and Woolhouse MEJ, 2006. Super-shedding cattle and the transmission dynamics of *Escherichia coli* O157. Epidemiology and Infection, 134, 131–142.

5.4.3.2.4. HEI 4: Transport and lairage conditions

At slaughter, the bovine hide represents a key source of VTEC contamination into slaughter plants. VTEC has been shown to transfer easily between the surfaces of animals during mixing, transport and lairaging.

Mather et al (2007)[26] reported that 'cross-contamination appeared to be the predominant mechanism for hide contamination of cattle with *Escherichia coli* O157. This suggests that it is not sufficient for individual farmers to eliminate *E. coli* O157 from their herds but rather there should be a coordination of intervention strategies aimed at reducing the prevalence of hide contamination and/or preventing contact between animals from different sources after they leave the farm of origin'.

5.4.3.2.5. HEI 5: Visual inspection of hide conditions of animals at lairage (clean animal scoring system)

A number of studies have investigated the correlation between visual cleanliness of the hide of cattle and contamination with pathogens such as VTEC. While some studies have found a positive relationship between hide cleanliness and total viable counts (TVCs) occurring on the carcases[27], other studies[28] have shown no correlation with pathogens or VTEC. Notwithstanding this, it is generally agreed that it is good hygiene to control the amount of faecal matter going into the abattoir.

5.4.3.2.6. HEI 6: Pathogenic VTEC on incoming animals (hide swabs after bleeding and before dehiding)

We believe that, because of the cross contamination issues during transport and lairage, there is no public health value in routine microbiological testing of hides post slaughter.

EFSA makes no proposal for sampling and testing after slaughter for VTEC carried in animals. While we do not propose that, under the current state of knowledge about VTEC, testing for VTEC at this point be used as a method for risk categorisation of farms, it may be of value in research and surveillance for VTEC.

5.4.3.2.7. Abattoir interventions

The same abattoir interventions apply as for Salmonella.

5.4.3.2.8. Summary

- The concept of controlled husbandry conditions is not currently applicable for VTEC.
- Risk categorisation by pre-slaughter sampling and testing of batches of cattle is not considered appropriate for VTEC.
- Cross contamination with VTEC during transport and lairage is a significant factor in hide contamination at the point of slaughter.
- Dirty cattle present a risk for contamination of meat during slaughter and dressing.
- Abattoir interventions are available for animals categorised as high risk.

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[26] Mather, A. E., Innocent, G. T., McEwen, S. A., Reilly, W. J., Taylor, D. J., Steele, W. B., Gunn, G. J., Ternent, H. E., Reid, S. W. J. and Mellor, D. J. 2007. Risk factors for hide contamination of Scottish cattle at slaughter with *Escherichia coli* O157. *Preventative Veterinary Medicine* **80,** 257-270.

[27] McEvoy JM, Doherty AM, Finnerty M, Sheridan JJ, McGuire L, Blair IS, McDowell DA and Harrington D, 2000. The relationship between hide cleanliness and bacterial numbers on beef carcasses at a commercial abattoir. Letters in Applied Microbiology, 30, 390–395.

[28] McCleery DR, Stirling JME, McIvor K and Patterson MF, 2008. Effect of ante- and postmortem hide clipping on the microbiological quality and safety and ultimate pH value of beef carcasses in an EC-approved abattoir. Journal of Applied Microbiology, 104, 1471–1479.

Thomas KM, McCann MS, Collery MM, Logan A, Whyte P, McDowell DA and Duffy G, 2012. Tracking verocytotoxigenic *Escherichia coli* O157, O26, O111, O103 and O145 in Irish cattle. International Journal of Food Microbiology, 153, 288-296.

5.4.3.2.9. Conclusions

- The combination of husbandry conditions and pre-slaughter sampling and testing issues do not enable batches of slaughter cattle to be reliably categorised for VTEC status.
- There is a high risk of cross contamination of hides after leaving the farm (during transport and in the abattoir lairage (and at market, if applicable) which negates the benefit of any batch or farm categorisation system.
- Categorisation of farms for food safety risk management purposes is not considered a practical option under current systems.
- Cattle cleanliness is a risk factor for contamination of meat. Producers should be required to provide cleanliness scores as FCI.
- Abattoir FBOs must apply appropriate interventions to dirty cattle to minimise carcase contamination.
- We propose that consideration be given to changing animal movement legislation with a view to allowing excessively dirty animals to leave the abattoir to be returned to the premises from which they were consigned. We acknowledge the animal health implications of movements off abattoirs; clearly these would need to be subject to the imposition of appropriate animal health and movement controls on the destination premises.

5.4.3.3. Cysticercus (Taenia saginata)

Cysticercus is rated as a low risk hazard by the EFSA Opinion and by Hill et al[29] in the UK as very-low to low risk for changing to a visual-only meat inspection system. Interest in cysticercus as a food safety hazard appears to exceed its low risk assessment because of an EFSA recommendation for a targeted risk based control for Cysticercus bovis, as opposed to the current regime which requires incision and/or palpations of all predilection sites on all cattle.

FSA has commissioned research for a more targeted and cost effective meat inspection for Cysticercus bovis[30]. The objective of this research is to develop a model based on EFSA's recommendations (including the possible use of harmonised epidemiological indicators, HEI) and using Food Chain Information and Collection and Communication of Inspection Results as a tool to assess the appropriate inspection method on a herd (or group to slaughter) basis.

The desired outcome is to develop a model to categorise bovine animals or herds sent to slaughterhouse to inform the appropriate inspection method for each category identified and advice on potential impact on public health.

Serological testing has been proposed as a possible means of risk categorisation of farms.

The important risk factor for infestation with C. bovis is exposure to human faeces. Research suggests that the prevalence of bovine cysticercosis in the EU as determined through current meat inspection procedures is greatly underestimated (Dorny & Praet, 2007)[31] and that the actual prevalence could be 3 to 10 times higher.

Nevertheless, the results of current *post-mortem* inspection may enable risk categorisation of farms and identification of farming practices that relate to increased risk. Risk categories could then be included in FCI to determine the appropriate inspection procedures.

5.4.3.3.1. Abattoir interventions

Possible abattoir interventions are:

- Enhanced inspection of animals categorised as high risk – more incisions at the predilection sites.

[29] Hill et al (2014) Food Control 38 96-103

[30] https://fsa-esourcing.eurodyn.com/epps/cft/prepareViewCfTWS.do?resourceId=53093

[31] P. Dorny & N. Praet (2007) Veterinary Parasitology, Volume 149, Issues 1–2, 21 October 2007, Pages 22–24

- Freezing treatment of positive cases.

5.4.3.3.2. Conclusion

- Improved CCIR will contribute to the identification of high risk farms
- Information about risk category to be included in FCI
- Further use of FCI will depend on the outcome of the FSA commissioned research

5.4.3.4. Mycobacterium bovis (bTB)

The EFSA Opinion is that the risk of transmission of M. Bovis to humans by meat consumption as negligible and, in the UK, ACMSF states that the risk level classification for the human health risks associated with the consumption of meat from animals with evidence of M. bovis infection is very low.

Given the low food safety risk of bTB, it is not included here but is discussed in the context of FCI for animal health in section 5.

5.4.4. Sheep

EFSA scientific opinions on public health hazards	EFSA risk rating	EFSA harmonised epidemiological indicators HEI
SHEEP		
Toxoplasma gondii	High	Toxoplasma gondii
VTEC	High	VTEC
		Mycobacteria
Dioxins/DL-PCBs	High	
Veterinary medicinal products	Negligible - Low	

5.4.4.1. Toxoplasma gondii

Toxoplasma is one of the two hazards rated by the EFSA Opinion as high risk, and is considered an important food-borne pathogen in some countries. It has been assessed as causing the highest disease burden of seven food-borne pathogens in the Netherlands, and in France it was estimated to be the third most common cause of death from food-borne illness. The Center for Disease Control and Prevention considers toxoplasmosis to be a leading cause of death attributed to food-borne illness in the United States[32].

In the UK the ACMSF reported[33] in 2012 that:

> *'The relative importance of toxoplasmosis in terms of disease burden and compared to other food-borne pathogens is not well established.'*
>
> and:
>
> *'The relative contribution of food associated with toxoplasma infection is not well-defined, and not known in the UK'.*

ACMSF has recently (June 2014) stated[34] that '*There is however, general agreement that the costs of the relatively small proportion of cases with severe disease make toxoplasmosis one of the most costly of gastro-intestinal infections'.*

[32] http://www.cdc.gov/parasites/toxoplasmosis/

[33] http://multimedia.food.gov.uk/multimedia/pdfs/committee/acmsfrtaxopasm.pdf

[34] http://acmsf.food.gov.uk/sites/default/files/mnt/drupal_data/sources/files/multimedia/pdfs/committee/acmsf/acm_1151_toxo.pdf

ACMSF has identified data gaps relating to human disease, animal disease, contamination of meat and other foods and risk management measures. The FSA is participating in an EFSA project[35] as part of a consortium of EU countries that aims to provide information about:

- the relationship between seroprevalence in the main livestock species and presence and infectivity of T. gondii cysts in their meat and other edible tissues;
- risk factors for T. Gondii infection in the main livestock species;
- the available methods for detecting the presence and infectivity of T. Gondii cysts, including their sensitivity and specificity, and;
- the anatomical distribution of the cysts in meat and other edible tissues, to inform the optimal sampling;
- choices for slaughtered animals for optimisation of detection.

5.4.4.1.1. EFSA proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Sample/ method	FCI relevance
HEI 1: Farms with controlled husbandry conditions	Farm	Auditing	
HEI 2: Information on the age of the animals	Slaughterhouse	Food chain information	
HEI 3: Detection of *T. gondii* infection	Slaughterhouse	Serology	

Risks factors associated with *T. gondii* infection in small ruminants are age, presence of cats, grazing, source of drinking water, abortion history, absence of vaccination against *T. gondii*, geographical location and various other farm management characteristics.

Given the extensive nature of most sheep production in the UK, we do not consider the concept of controlled husbandry conditions to be applicable to UK sheep production systems (the first condition proposed by EFSA is *'Livestock is not allowed outdoor access').* For controlled husbandry to effectively reduce the risks of *T. gondii*, the flock must be protected from all or most of the relevant risk factors. This is likely to be possible only in a very small proportion of sheep farming systems in the UK.

Good husbandry practices should apply to all keeping of sheep irrespective of the ability to comply with controlled husbandry requirements. We note that the standards for some assurance schemes include in the protection of feed storage facilities against the harbouring of domestic animals (including cats), wildlife and vermin.

Infection of pregnant sheep with Toxoplasma is an important cause of abortion, and vaccines to protect against congenital toxoplasmosis are used in the UK. The feasibility of vaccination to prevent tissue cyst formation has not been widely tested but recent work[36] has demonstrated that vaccination of lambs can protect against establishment of tissue cysts following challenge with T. gondii. This appears to be an area for further investigation for food safety purposes, although vaccination may have an impact on serological testing as an epidemiological indicator.

[35] http://www.efsa.europa.eu/en/art36grants/docs/art36grantsagreements2013.pdf
http://www.efsa.europa.eu/en/biohaz201301/docs/gpefsabiohaz201301guide.pdf

[36] Katzer F et al (2014)Immunization of lambs with the S48 strain of Toxoplasmagondii reduces tissue cyst burden following oral challengewith a complete strain of the parasite. Veterinary Parasitology 205 (2014) 46–56

5.4.4.1.2. HEI 3: Detection of *T. gondii* infection

EFSA proposes serological testing of various cohorts of slaughter sheep as epidemiological indicators that could be used for either surveillance or risk management purposes, and that risk categorisation of animals may reduce the consumer's risk of infection, e.g. by specifically using low-risk animals for high-risk products such as raw meat products and cuts that are more likely to be consumed undercooked, or by routing carcases of high-risk animals for heated or frozen meat products.

Serological testing of slaughter sheep may be useful for surveillance and will contribute to better understanding of the epidemiology of the disease but we agree with the EFSA conclusion that 'the feasibility of serologically testing all animals is low (time-consuming and costly)' and do not consider that its use to differentiate all sheep into low and high risk categories is practical or justified at present. This view should be reconsidered in light of any new information about sheep meat as a source of human infection that arises from the EFSA/FSA project.The EFSA suggestion of classifying meat as low or high risk is therefore not applicable. However, meat that may be consumed undercooked is very likely to be from young lambs, which pose a lower risk than older sheep. Meat from young sheep (lambs and hoggs) is differentiated from meat from adult sheep through the different marketing and retail routes that are applied in the UK for cultural and commercial reasons.

5.4.4.1.3. Abattoir interventions

Cysts of Toxoplasma cannot be detected at PMMI, and slaughter and dressing conditions do not influence the presence of cysts in meat.

Freezing or heat treatment of meat will inactivate Toxoplasma.

5.4.4.1.4. Conclusions – Toxoplasma in sheep

- Although Toxoplasma is categorised as high risk by EFSA, its importance as a food borne disease is not well established in the UK.
- Toxoplama cannot be detected at PMI.
- There is currently no validated method for risk categorisation of farms.
- Pending the outcome of EFSA research into Toxoplasma there is no relevant information that can be included in FCI at present.

5.4.4.2. VTEC

The relative importance for human disease of transmission of VTEC from sheep to humans by consumption of contaminated meat or contact with a contaminated environment is not fully understood. Although some source attribution studies have indicated a minor role for meat from small ruminants as a source of human cases of VTEC (Kosmider et al. (2010))[37], the high severity of disease and the evidence that meat from small ruminants poses a risk for human disease has led EFSA to consider pathogenic VTEC as a hazard of high public health relevance for sheep (EFSA BIOHAZ Panel, 2013).

5.4.4.2.1. EFSA proposed HEIs

Indicators (animal/food category/other)	Food chain stage	Sample/ method	FCI relevance
HEI 1: Occurrence of pathogenic VTEC in slaughter batch/group of animals one month before slaughter	Farm	Microbiology. Pooled faecal samples	

[37] Kosmider RD, Nally P, Simons RRL, Brouwer A, Cheung S, Snary EL and Wooldridge M, 2010. Attribution of Human VTEC O157 Infection from Meat Products: A Quantitative Risk Assessment Approach. Risk Analysis, 30, 753-765.

HEI 2: Occurrence of pathogenic VTEC on fleece/pelt samples (after bleeding and before fleece/pelt removal)	Slaughter - house	Microbiology. Fleece sample/pelt swab	

EFSA proposes microbiological testing of pooled faecal samples on farm one month before slaughter as a means of risk categorising batches of sheep, and that this information be used to inform risk management decisions. Its view is that individual animals shed intermittently but this is rarely synchronised within a group of animals, and there will always be some animals shedding the bacteria, if VTEC is present. Interpreting results by aggregation at group level rather than individual level would increase the sensitivity of testing and the classification of the batch would be reliable.

There are few longitudinal studies of VTEC in sheep flocks and we are not aware of evidence of a correlation between the presence/absence of VTEC one month before slaughter and at the time of slaughter.

Except for sheep that spend their whole life on one farm, definition of batches as epidemiological units is problematical, particularly when sheep are procured from store finishers, markets or dealers, which account for the majority of slaughter sheep.

The feasibility of obtaining reliable results from sampling and testing of sheep from outdoor environments is questionable.

At slaughter, the fleece is believed to represent a key source of microbial contamination of carcases (EFSA, 2007)[38]; greater than gut contents and faeces as a source of carcase contamination. Transmission of *E. coli* O157 and other VTEC can occur rapidly in groups of animals on farms, in transport and in lairage, with contamination of fleece taking place from faecally contaminated environments.

Significant cross-contamination from animal to animal can occur during transport to the slaughterhouse and in the lairage (Small et al 2002, 2003)[39]. Mixing of animals from different farms and herds will increase the risk during transport and lairaging – this is particularly significant in light of the fact that the majority (2012: 57.8% sheep sold live weight[40]) of slaughter sheep are sold through livestock markets, with the mixing of groups of sheep that this entails.

Given the opportunity for external contamination of sheep with VTEC between leaving the farm of origin and the point of slaughter, our view is that on-farm sampling and testing for VTEC is not an effective basis for the risk categorisation of batches of slaughter sheep.

The EFSA HEI report acknowledges that 'generally, visually clean animals produce less contaminated carcases than dirtier animals, although individual variation exists', and evidence that dirty sheep result in contamination of carcases with indicator organisms (TVC and Enterobacteriaceae) (Byrne et al., 2007)[41].

[38] EFSA (European Food Safety Authority), 2007b. Scientific Opinion of the Panel on Biological Hazards on a request from EFSA on monitoring of verotoxigenic Escherichia coli (VTEC) and identification of human pathogenic VTEC types. The EFSA Journal 2007, 579, 1-61.

[39] Small A, Reid CA, Avery SM, Karabasil N, Crowley C and Buncic S, 2002. Potential for the spread of *Escherichia coli* O157, Salmonella, and Campylobacter in the lairage environment at abattoirs. Journal of Food Protection, 65, 931-936.

Small A, Reed CA and Buncic S, 2003. Conditions in lairages at abattoirs for ruminants in Southwest England and in vitro survival of *Escherichia coli* O157, Salmonella kedougou, and Campylobacter jejuni on lairage-related substrates. Journal of Food Protection, 66, 1570-1575.

[40] EBLEX

[41] Byrne B, Dunne G, Lyng J and Bolton DJ, 2007. The development of a 'clean sheep policy' in compliance with the new Hygiene Regulation (EC) 853/2004 (Hygiene 2). Food Microbiology, 24, 301-304.

EFSA cites the results of other studies which did not demonstrate a correlation between cleanliness of the animal coat and the occurrence of VTEC (McCleery et al., 2008; Thomas et al., 2012[42]), and has excluded a clean animal scoring system at entry to the slaughterhouse as a HEI because of '*lack of evidence for association between VTEC occurrence and visually dirty fleece or pelts'.*

We are not persuaded by this conclusion by EFSA, and support the logic of the statement in the FSA published guidance on clean sheep[43] that 'research results have shown that the dirtier the fleeces, the greater the potential for carcase contamination and the higher the risk to human health'.

5.4.4.2.2. Abattoir interventions

On the basis of an assessment of animal cleanliness dressing conditions can be adapted to prevent or reduce visual contamination of carcases e.g. by operating at a slower line speed.

Some abattoirs have facilities to clip sheep that they consider to be dirty.

An EFSA proposal is that negative batches (as assessed by on farm sampling) could be scheduled for slaughter on 'clean days' or directed to VTEC-negative slaughterhouses to avoid cross-contamination during the slaughter process. Such action would require direct movements from farm and a very high standard of cleaning and disinfection of transport, lairages and slaughterlines. Many lairages e.g. those with mesh floors, are not designed for easy cleaning and disinfection.

Current legislation places a duty on abattoir FBOs to ensure that sheep accepted onto the slaughterhouse premises are clean but, once animals arrive at the abattoir, they cannot be removed and must be slaughtered. As we discuss under cattle, a relaxation of this rule would be beneficial for public health by allowing dirty animals to be removed.

The cleanliness of slaughter sheep has an impact on meat safety, can be assessed by farmers and can be used to inform decisions at the abattoir. We therefore propose that sheep cleanliness scores be included in FCI.

5.4.4.2.3. Conclusions

- Sampling and microbiological testing of slaughter sheep is not considered a reliable method for risk categorisation for VTEC.
- Cross contamination of sheep with VTEC after leaving the farm, during transport and lairaging, is a significant factor which is likely to negate the benefit of any batch or farm categorisation system.
- Sheep cleanliness is a risk factor for contamination of meat. Producers should be required to provide cleanliness scores as FCI.
- Abattoir FBOs must apply appropriate interventions to dirty sheep to minimise carcase contamination.
- Consideration should be given to changing animal health legislation and to enable excessively dirty animals to be removed from the abattoir.

5.5. Chemical food safety hazards

Chemical hazards in meat cannot be detected by current inspection procedures at the abattoir. There are no interventions at the abattoir that can reduce the risk of contamination of meat with chemical hazards present in live animals. Control of such chemical hazards relies on effective control measures in primary production.

[42] Thomas KM, McCann MS, Collery MM, Logan A, Whyte P, McDowell DA and Duffy G, 2012. Tracking verocytotoxigenic *Escherichia coli* O157, O26, O111, O103 and O145 in Irish cattle. International Journal of Food Microbiology, 153, 288-296.

[43] http://multimedia.food.gov.uk/multimedia/pdfs/publication/cleansheep0507.pdf

Chemical food safety hazards in animals may result from ingestion of substances in feed or the environment or from residues of veterinary medicinal products and other treatments administered to the animals.

Veterinary medicinal products in the context of FCI are considered in Section 5.9.

The EFSA Opinions rank dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs) as being of high potential concern owing to their known bioaccumulation in the food and their toxicological profile. EFSA ranks a range of other chemicals as medium risk, mainly because of the low level of non-compliant results reported under EU Member States' National Residue Control Programmes.

Sampling and testing of meat and other tissues at the abattoir are important components of surveillance for chemical hazards in meat and also provide disincentives to the development of undesirable practices.

Animals and tissues may be subject to sampling on-farm and laboratory testing during the investigation of suspect poisoning or intoxication events. An example is lead poisoning of cattle and sheep from geochemical sources or the ingestion of paint, discarded batteries or other waste. Animals from affected farms that may have been exposed to the chemical contaminant may be excluded from the food chain for a period, usually on an agreed, voluntary basis.

Where such positive results for chemical contaminants are obtained from testing of samples from a holding, these must be included in FCI. We believe that the inclusion of all test results of public health relevance for every holding on a database, either the CCIR database or a linked database to which abattoir FBOs and OVs have access, would provide a more robust system rather than relying solely on the diligence producers.

Historical information about holdings would enable future sampling at the abattoir to be carried out in a targeted manner.

5.6. Physical food safety hazards

Physical food safety hazards in meat may arise from processing operations but rarely originate in live animals. An exception is that needles may break during the injection of animals and be present in meat. The equipment commonly used to detect metal in meat may not be sufficiently sensitive to detect needles.

The Red Tractor assurance scheme standards for pigs, beef and lamb include the requirement that an animal containing a broken needle is only sold for slaughter if it is identifiable up to the time of slaughter and the FCI includes information about the site of injection. We recommend that this requirement should be extended to all cattle, sheep and pigs sent for slaughter ie: those not in RT or similar schemes

5.7. Detailed legislative requirements for FCI

Regulation (EC) No 853/2004, Annex II, Section III.3 requires that *'slaughterhouse operators must not accept animals onto the slaughterhouse premises unless they have requested and been provided with relevant food safety information contained in the records kept at the holding of provenance'.*

The information required for FCI is set out in the Regulation as in the box. Each of points is considered in detail in the paragraphs below.

5.7.1. Regulation (EC) No 853/2004 Annex ii

SECTION III: FOOD CHAIN INFORMATION

Food business operators operating slaughterhouses must, as appropriate, request, receive, check and act upon food chain information as set out in this Section in respect of all animals, other than wild game, sent or intended to be sent to the slaughterhouse.

1. Slaughterhouse operators must not accept animals onto the slaughterhouse premises unless they have requested and been provided with relevant food safety information contained in the records kept at the holding of provenance in accordance with Regulation (EC) No 852/2004.

2. Slaughterhouse operators must be provided with the information no less than 24 hours before the arrival of animals at the slaughterhouse, except in the circumstances mentioned in point 7.

3. The relevant food safety information referred to in point 1 is to cover, in particular:

(a) the status of the holding of provenance or the regional animal health status;

(b) the animals' health status;

(c) veterinary medicinal products or other treatments administered to the animals within a relevant period and with a withdrawal period greater than zero, together with their dates of administration and withdrawal periods;

(d) the occurrence of diseases that may affect the safety of meat;

(e) the results, if they are relevant to the protection of public health, of any analysis carried out on samples taken from the animals or other samples taken to diagnose diseases that may affect the safety of meat, including samples taken in the framework of the monitoring and control of zoonoses and residues;

(f) relevant reports about previous *ante-* and *post-mortem* inspections of animals from the same holding of provenance including, in particular, reports from the official veterinarian;

(g) production data, when this might indicate the presence of disease; and

(h) the name and address of the private veterinarian normally attending the holding of provenance.

The EU Commission has recently drafted an Implementing Regulation amending Regulation (EC) No 2074/2005 as regards minimum harmonized data for food chain information[44]

5.7.2. Point 3a: The status of the holding of provenance or the regional animal health status

Our interpretation is that this heading refers to the official disease status of the holding. Official disease status for notifiable endemic and exotic diseases is the responsibility of government agriculture departments.

Under normal circumstances bovine Tuberculosis (bTB) is the only disease in GB for which official disease status is applicable.

Specific information may be required during outbreaks of exotic notifiable diseases.

Bovine tuberculosis (bTB, Mycobacterium bovis)

The EFSA Opinion is that the risk of transmission of M. Bovis to humans by meat consumption is 'negligible' and, in the UK, ACMSF states that the risk level classification for the human health risks associated with the consumption of meat from animals with evidence of M.bovis infection is 'very low'.

Actions at the abattoir relating to bTB are primarily of importance for animal health. PMMI is an important component of surveillance for bTB in the cattle population.

All farms with cattle are given an official status by agriculture departments as determined by the results of routine testing of cattle on the farm or the results of post-mortem of animals from the farm. Farms that are considered free of bTB are under no movement restrictions and are described as Officially bTB Free (OTF). Herds where bTB has been suspected or confirmed will have their OTF status suspended (OTFS) or withdrawn (OTFW).

Animals that are classed as reactors to the bTB test must be slaughtered at specifically approved abattoirs, be accompanied by a movement licence and information about their bTB test status and be subject to detailed *post-mortem* inspection.

[44] SANCO 10514/2014

Movements of cattle from farms that do not have OTF status are restricted, and movements to slaughter require a licence in addition to FCI about the herd bTB status.

The routine bTB testing frequency for herds is determined by APHA on the basis of the farm's status and the prevalence of disease in the area. Herds in high risk areas are tested annually and those in lower risk areas are tested every 4 years. The testing frequency of a herd therefore gives a risk categorisation for bTB.

Actions at abattoir include more detailed *post-mortem* inspection for animals from high risk farms (for animal health surveillance purposes).

For epidemiological surveillance of bTB, PMMI is more important in low prevalence areas (with less frequent, 4 year testing) since the detection at PMMI of a suspect bTB case in an animal from such an area is of greater epidemiological significance than detection of a suspect from a high prevalence area.

Therefore the same, high, standard of inspection should be applied to all animals.

Knowledge of the testing interval (and hence the bTB prevalence of the area) applicable to the herd from which animals were consigned to slaughter is of value in determining the significance of positive findings.

Since all farmers will be aware of the testing frequency for their herd and this information is of relevance to FSA staff at the abattoir, we recommend that this information be included in FCI.

5.7.3. Point 3b: The animals' health status

The MLCSL Evaluation of FCI for FSA indicated serious deficiencies in the provision of FCI about the health of animals, particularly for cattle and sheep, and reported that it was seldom that any animals were recorded as being in less than perfect health, prompting to requirement for 'additional information' on the current model FCI declarations. This is in accord with our own experience and observations.

We believe that the reasons for the current deficiencies include a combination of:

- the wording of the model FCI templates
- the lack of guidance for producers, FBOs and OVs about interpretation of 'health'
- the reluctance of producers to draw attention to animals showing any abnormal signs – particularly in the knowledge that no action is likely to be taken
- the lack of any actions or sanctions taken when FCI does not provide information about animals that are clearly showing signs of poor health

Interpretation of the requirement for information about 'the animals' health status' depends on the definition of 'health'. The simplest definition is: 'the state of being free from illness or injury'.

Regulation (EC) No 853/2004 requires abattoir FBOs to accept only animals that are 'healthy, as far as the food business operator can judge'. The corollary is that producers should send only 'healthy' animals for slaughter.

Regulation (EC) No 853/2004 on official controls (i.e. rules for OVs) states:

> *'Animals with a disease or condition that may be transmitted to animals or humans through handling or eating meat and, in general, animals showing clinical signs of systemic disease or emaciation, are not to be slaughtered for human consumption.'*

Some animals received at an abattoir are in less than perfect health and many do not present an increased risk to public health and should be permitted to be slaughtered for human consumption.

The food safety case is that an 'unhealthy' animal, even if the direct cause of its lack of health is no direct risk for food safety, may have an impaired immune response, through being subject to stress/poor appetite, and may be more likely to excrete any pathogenic organisms it is carrying asymptomatically e.g. Salmonella, VTEC. In addition, animals with pathology such as abscesses, pleural or abdominal adhesions or other significant lesions will require extra trimming or further handling during the carcase dressing process, and this handling may increase the likelihood of contamination of meat.

The logical basis for requiring information about the health status of slaughter animals is to categorise animals as low risk or high risk and then to use this to apply specific interventions to the high risk group.

There is a lack of published information about the correlation between the physical signs of disease or illness in animals and the presence of food safety hazards on meat derived from them which would enable evidence-based decisions to be made about the risk categorisation of animals on the basis of their physical appearance.

However, we consider it beneficial to be able to set standards about what deviation from perfect health of an animal or prevalence of a condition in a batch should trigger the need for specific information. Such standards should be determined by:

- the ability of the producer to detect and correctly classify deviations from perfect health i.e. to provide accurate and reliable information;
- the use that will be made of the information at the abattoir.

Any information required as FCI should be that which a producer should be expected to be aware of regarding the health of his/her animals. However, without defined parameters, a general statement about the health of animals is considered inadequate.

We note that the draft EU Commission Implementing Regulation about minimum harmonized data for food chain information[45] proposes addressing the health status by the question 'Do the animals show abnormal signs? Yes/No'. In its response to this draft Regulation, the Federation of Veterinarians in Europe (FVE) proposes 'Do the animals show any signs of health problems?' We do not consider either of these proposals to be an improvement on the current situation.

An option may be to define specific indicators of health which producers must record in FCI.
For example, body condition scoring systems are recognised management tools for ruminants[46], and could be used in FCI to give an indication of the health of an animal or animals. Similarly, lameness scoring systems are in common use and may be applicable for this purpose.

The EFSA Opinion for cattle includes: 'Animal based welfare indicators have been developed for the on-farm assessment of lameness in bovine animals (dairy cows) and could be adapted for use during routine *ante-mortem* inspection in slaughterhouses'. Animal-based welfare indicators include

- Body condition
- Abnormal respiration
- Diarrhoea
- Lameness
- Injuries
- Demeanour – dull/signs of illness

[45] SANCO 10514/2014

[46] http://dairy.ahdb.org.uk/resources-library/technical-information/health-welfare/body-condition-scoring/#.VfL3XPlViko

We propose that these welfare indicators should be developed for each of the food animal species to provide more objective guidance for producers about animal health and welfare information for FCI. Such guidance would be equally applicable for abattoir FBOs and OVs in assessing the health of animals as they arrive at the abattoir.

It has been argued that there is little value in producers providing information about conditions that the OV will be able to detect at *ante-mortem* inspection. However, conditions for *ante-mortem* inspection are frequently less than ideal; it can be difficult for OVs to inspect all animals in lairage pens effectively, and it is not always possible for OVs to observe all animals moving to/from pens in the course of their wider duties in abattoirs. Consequently, we believe there is value in including in FCI information that will direct the attention of the OV to higher risk animals or batches of animals.

Furthermore, requiring producers to answer specific questions about the health of animals consigned for slaughter will bring their attention to the important link between animal health and food safety.

There should be further advantages – for animal health and welfare, in addition to food safety - in requiring producers to formally assess, and to include specific information about, the health of animals they wish to consign to slaughter.

Clearly the benefits of making defined animal health information a requirement for FCI will only arise if FCI is properly enforced by OVs at abattoirs. It is apparent from the MLCSL Report and our own observations that the requirements of Regulation (EC) No 854/2004 are currently not consistently enforced:

> *The competent authority is to take appropriate action if it discovers that the accompanying records, documentation or other information do not correspond with the true situation on the holding of provenance or the true condition of the animals or aim deliberately to mislead the official veterinarian.*

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Enforcement of legislation by FSA is not within the scope of this project – but it must be noted that a major problem with FCI at present is that enforcement is inadequate. Producers know that they can state that all animals are healthy – irrespective of their true state – with impunity. Effective enforcement, together with FBOs and OVs making use of FCI about the health of animals to make decisions about interventions at the abattoir, are essential to achieve the potential benefits of FCI.

Conclusions on the animals' health status

- The health status of animals arriving at the abattoir is a risk factor for food safety.
- The correlation between the physical assessment of animal health and food safety risks is not clearly defined.
- FCI should include information about the health status of animals.
- Assessment of the health of animals by producers, abattoir FBOs and OVs should be guided by specified indicators as far as possible. We recommend the development of guidance through discussion with stakeholders, particularly species veterinary organisations, animal welfare experts, OVs and livestock and meat industry representative bodies.
- FBOs and OVs should make effective use of FCI in making decisions about interventions at the abattoir.
- OVs should take enforcement action when FCI is clearly incorrect.

5.7.4. Point 3c: Veterinary medicinal products or other treatments administered to the animals within a relevant period and with a withdrawal period greater than zero, together with their dates of administration and withdrawal periods.

Information about the use of veterinary medicines in slaughter animals may be of value in several ways:

- prevention of residues of veterinary medicines in meat;
- as an indicator of disease status of the animals;
- antimicrobial resistance.

5.7.4.1. Residues

EU and UK legislation requires producers to keep records of use of all veterinary medicines for food animals[47].

Current UK guidance on FCI is:

Poultry: detailed information for entire life of broilers breeding and laying birds – minimum of last 6 weeks

Pigs: detailed information for the previous 28 days

Cattle and sheep: the statement 'Withdrawal periods have been observed for all veterinary medicines and other treatments administered to the animals while on this holding and previous holdings.'

It is questionable whether better prevention of residues of veterinary medicines in meat would be achieved by including the additional detail the legislation requires for all species. We note that the view of FVE is that a simple declaration for pigs that withdrawal periods have been respected is sufficient, compared with the Commission proposal for detailed information for the previous 60 days.

Testing for residues is currently carried out by sampling of tissue specimens collected at abattoirs according to the National Residue Control Plans (NRCP) as defined in Council Directive 96/23/EC. The prescribed regular sampling and testing for chemical residues is a proven disincentive for the development of bad practices.

All the EFSA Opinions recommend that sampling strategies for residues should be risk-based by making use of FCI e.g.:

> *'Information-based sampling strategies for the control of residues and contaminants taking into account the origin of slaughtered pigs and the available FCI should be implemented.'*
>
> *'It is recommended that future monitoring programmes should be based on the risk of occurrence of chemical residues and contaminants, taking into account the completeness and quality of the FCI supplied and the ranking of chemical substances into categories of potential concern, which ranking needs to be regularly updated.'*

These recommendations therefore support the provision of detailed information about use of veterinary medicines as FCI.

5.7.4.2. Veterinary medicines usage as an indicator of animal health

A secondary use of information about therapeutic veterinary medicines use is as a proxy for disease. There may be value in information about animals which are now deemed suitable for slaughter for human consumption but which had previously been ill enough to require medication. For example, animals which had been treated for pneumonia but which now appear healthy may have lesions in the lungs and thorax which will result in problems during processing and the need for actions at PMMI.

[47] DIRECTIVE 2001/82/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 November 2001 on the Community code relating to veterinary medicinal products

There are marked differences in the methods used for administration of therapeutic medicines between the food animal species. Medication of poultry is always of the entire group (house) of birds. Medication of pigs is often at the group level, but individual therapeutic treatment may also occur. In the case of cattle, prophylactic treatment is usually the group; the therapeutic treatment unit may be the individual animal or group. Therapeutic medicines are used to a lesser extent in sheep; treatment may be administered to individual or specific groups of animals.

In the context of FCI, information about the treatment of entire batches of animals consigned for slaughter will be of greater relevance to inform decisions at the abattoir.

5.7.4.3. Antimicrobial resistance

Antimicrobial resistance is recognised as a major problem for both human and animal health. The development of resistance to antimicrobial agents in organisms in animals – both pathogenic and commensal organisms – is a risk to public health since resistant organisms may be transmitted to humans through the consumption of contaminated meat.

Provision of information about the use of antimicrobial agents in slaughter animals as FCI will not affect usage of antimicrobials per se. However, a requirement to provide this information may have a positive influence in reducing their use in food animals.

Some major retailers have a condition for livestock suppliers that 'protected' antimicrobials (fluoroquinolones and 3rd and 4th generation cephalosporins) must not be used on their farms. Confirmation of compliance with this condition forms part of the commercial FCI for abattoirs slaughtering for these retailers.

5.7.4.4. On-farm recording of veterinary medicines usage

EU and UK legislation requires producers to keep records of use of all veterinary medicines for food animals. The methods for recording the information are not stipulated, and vary from simple, paper systems to more sophisticated electronic methods.

Electronic recording by veterinary practices of medicines usage in the poultry sector in UK is widely used.

Some farm assurance schemes now include in their standards a requirement for analysis of medicines records e.g. the AFS Red Tractor Scheme Pig Standards requires 'Collated data reviewed annually with your vet'.

An ideal system for recording medicines usage would include the recording of all administrations on a central database. In Denmark, antimicrobial resistance has been addressed through a surveillance programme for the medical consumption of antimicrobials for production animals that has collected all data in a national database, Vetstat[48], since 2000.

The use of antimicrobials in food animals is under scrutiny in the EU and several countries, including UK, are carrying out pilot trials on how better data about antimicrobial use could be collected.

The European Commission has recently published proposals for new legislation on veterinary medicinal products. The draft Regulation contains a requirement for data on sales and use of antimicrobials to be collected in all Member States and submitted to the Commission annually. The draft also proposes that powers be given to the Commission to specify the method to be used by Member States for collecting and submitting data.

5.7.4.5. Conclusions on veterinary medicines

An ideal long term aim for FCI is the recording all use of veterinary medicines for all food animals on a central database to which OVs and abattoir FBOs have access for consignments from a holding. The reference model presented in this report provides for such recording. The main driver for the development of such a system are concerns about antimicrobial resistance and any legislation arising from these concerns.

[48] http://www.icar.org/documents/aarhus_2013/Manuscripts/Dupont.pdf

In the absence of universal electronic recording of medicine use, paper –based recording and reporting places limitations on the practicality of information exchange and on the evaluation and value of the information at the abattoir.

Our recommendations for the short to medium term are on a species basis:

5.7.4.5.1. Poultry

FCI should include details of all veterinary medicines administered to the flock during its lifetime. Information about use of vaccines has no direct impact on decisions at the abattoir and should not be mandatory but may be required by FBOs for commercial reasons.

Electronic information exchange should be encouraged and promoted.

5.7.4.5.2. Pigs

FCI should include details of all veterinary medicines administered on a batch basis to the consignment of animals during a specific period before slaughter. The stipulated period currently applied is 28 days although we are not aware of how this figure was determined; further consideration of the exact period may be required.

A declaration that all withdrawal periods have been respected is needed to cover any animals that have received individual treatment.

Electronic information recording and exchange should be encouraged and promoted.

5.7.4.5.3. Cattle

A declaration that all withdrawal periods have been respected should be required.

Systems for passing information about medicines administered to animals when they change ownership should be in place to ensure that finishers and others who may keep animals for a relatively short period before slaughter have all the information about purchased animals to enable them to make the declaration about withdrawal periods. Producers should be aware that some parasiticides have withdrawal periods of several months.

Cattle are not generally reared and slaughtered in such well-defined epidemiological units as pigs and poultry. Treatment is often at the individual animal level rather than the entire batch and provision of more detailed information would be complex. We consider that improving FCI about the health of animals is of higher priority and that requiring more detailed information about medicines at this stage would make significant improvements for food safety.

5.7.4.5.4. Sheep

A declaration that all withdrawal periods have been respected should be required.

Systems for passing information about medicines administered to animals when they change ownership should be in place to ensure that finishers and others who may keep animals for a relatively short period before slaughter have all the information about purchased animals to enable them to make the declaration about withdrawal periods. Producers should be aware that some parasiticides have withdrawal periods of several months.

Taking account of the generally low level of therapeutic treatment of batches of sheep and the practical issues about defining epidemiological units, we do not consider that requiring more detailed information at this stage would make significant improvements for food safety at this time.

5.7.5. Point 3d: The occurrence of diseases that may affect the safety of meat

As discussed above, any disease affecting an animal has the potential to affect the safety of meat. Judgements about whether diseases may or may not affect the safety of meat are difficult and, we believe, are beyond the competence of producers (farmers)– even though a statement to this affect is included in the current model FCI documents for all species.

In cases where a specific diagnosis of a zoonotic disease has been made, this information is required elsewhere under Section III.3 (e):

'*the results, if they are relevant to the protection of public health, of any analysis carried out on samples taken from the animals or other samples taken to diagnose diseases that may affect the safety of meat*...'

5.7.5.1.1. Conclusion on diseases that may affect the safety of meat

No information is required under this heading beyond that provided under Section III.3(b) for the animals' health status.

5.7.6. Point 3e: Results relevant to the protection of public health

3 (e) - the results, if they are relevant to the protection of public health, of any analysis carried out on samples taken from the animals or other samples taken to diagnose diseases that may affect the safety of meat, including samples taken in the framework of the monitoring and control of zoonoses and residues

Microbiological testing of samples for specific food safety hazards has been discussed above under HEIs for public health.

Another situation where the results of microbiological testing may be available is when samples have been taken from animals for diagnostic purposes.

The requirement for all results of relevance for public health to be recorded in FCI can present serious difficulties for producers and abattoir FBOs. Two examples are:

- the Godstone Farm incident, where children were infected with VTEC after visiting a 'petting' farm. Subsequently no abattoir was willing to accept animals from the farm for slaughter.
- a research project on VTEC in slaughter cattle was unable to analyse the samples at the time of collection because of concerns about actions that might be imposed on meat from any animal that tested positive. The problem was overcome only by freezing the samples for several months, by which time all the meat from the sampled animals would have been consumed, before microbiological analysis.

Any sampling or testing done in the context of research or surveillance on meat-borne pathogens raises questions about how positive results are handled.

EFSA is currently consulting on the development of a guidance document on the application of Regulation (EC) 178/2002 as regards food contaminated with food contaminated with VTEC. The draft document proposes actions to be taken both when pathogenic VTEC is detected in ready-to-eat food or food that is likely to be consumed without a treatment that will eliminate the organism and when specified serotypes of VTEC are isolated from food that will undergo treatment to eliminate or reduce to acceptable levels the risk of infection. The outcome of the consultation may have a major impact on the meat industry and the measures taken to control VTEC on carcases.

It is essential that, before any sampling and testing for meat-borne pathogens at any point in the production chain from live animals to retail sale is undertaken, there is a clear understanding of the actions to be taken when positive results arise.

We consider that,in parallel with the development of guidance for food, including meat, for retail sale, FSA should produce formal guidance for processors and retailers about sampling and testing in primary production in order that research can be carried out on risk mitigation measures at this stage of the chain. This is of particular importance for all pathogens of major concern for which on-farm control measures are not well understood and includes Campylobacter in poultry as well as VTEC in ruminants.

Results of tests for chemical residues do not appear to be recorded in a manner that permits abattoir FBOs or OVs to have access to them. The incentive to inform the FBO rests solely with the producer. We recommend that all results of such tests are recorded on the CCIR database against the farm and are available to FBOs and OVs as part of FCI.

5.7.6.1.1. Conclusions on results relevant to the protection of public health

- Information about test results for zoonoses and residues should be included in FCI.
- FBOs should make interventions at the abattoir based on FCI where appropriate.
- FSA should provide guidance to FBOs and retailers about actions to be taken in response to positive findings for zoonoses from samples taken for research or surveillance purposes.
- Results of tests for chemical residues should be recorded on a database to which FBOs and OVs have access for FCI.

5.7.7. Point 3f: Relevant inspection reports

3 (f) - relevant reports about previous ante- and post-mortem inspections of animals from the same holding of provenance including, in particular, reports from the official veterinarian.

This is the information provided by CCIR.

We consider this information to be of great importance for FCI since it provides independently-gathered information about animals from every farm. As we discuss in the section on CCIR, we propose that the inspection results for all animals from a farm are recorded on a database to which the FBO and OV have access.

We note the proposal of the Commission in its draft Regulation 'Do the *ante*- and *post-mortem* inspection results of the official veterinarian for the last group of animals sent in for slaughter indicate that a copy of this report these results should be added to the food chain information for the next group of animals sent in for slaughter?'. We consider this to be an unhelpful proposal, based as it is on paper records, a single consignment of animals and the OV's interpretation of the results for one batch.

As we discuss in the CCIR section, we propose electronic communication of results and aggregation of results for all batches from the farm over a defined period.

Information to be included in 'relevant reports' is considered in detail in the section on CCIR.

5.7.8. Production data, when this might indicate the presence of disease

Production data that might indicate the presence of disease includes mortality rates, food conversion ratios and growth rates.

In light of the different production systems, we consider production data on an individual species basis below.

5.7.8.1. Poultry

Mortality rates are a commonly used indicator of health and disease for poultry.

Currently FCI guidance includes a requirement for percentage mortality at 14 days and cumulative daily mortality rate. Inclusion of 14-day mortality enables account to be taken of the effect of early mortality rates on the cumulative rate.

Industry representatives consider that mortality rates at the very end of the production period - in the last two days before slaughter – provide a more reliable indication of the health of the flock at the point of slaughter. Provision of this information would require effective electronic systems to ensure that it is available to the OV and FBO at the abattoir in advance of arrival of the birds.

- FCI should include the following mortality rates: 14 days; cumulative daily; last two days before slaughter.

5.7.8.2. Pigs

Mortality rates of finishing pigs can be indicator of the health of a herd. Assessment of herd health using mortality rates requires a consistent method of recording and measuring deaths. Farms may use different criteria and methods for recording mortality e.g. may or may not include pigs actively culled.

Calculation of mortality rates may differ according to the production system. For all-in/all-out finishing systems the batch is well defined, the denominator is known and mortality rates should be easily calculated. For continuous systems where pigs are consigned for slaughter on a regular basis, the group is not so clearly defined and mortality rates may be determined as a percentage of deaths in a designated time period.

Some farm assurance schemes include in their standards a requirement to keep mortality records ('fallen stock' and animals euthanased) together with summary statistics.

Mortality rates for pigs would be a useful component of FCI but only if standardised methods of determination were employed on all farms. Similar comments apply to more sophisticated production data such as feed conversion rates and growth rates

- Mortality data may be a useful measure of herd health but we do not propose their inclusion in FCI at this stage without a common, standardised methodology to enable meaningful interpretation.

5.7.8.3. Cattle and sheep

Production data for the less intensively reared cattle and sheep are not so commonly available and are therefore not likely to provide useful information about animals consigned for slaughter.

Fallen stock disposal records for farms may provide information on the overall health status of animals. Most animals that die or are killed on farm will be disposed of through a licensed fallen stock facility and therefore the number and weight of animals that die or are killed on farm should be available. Calculating a mortality rate for a farm is complicated by many issues including the age and weight of dead animals and problems in determining the denominator number/weight of animals.

- Production data are not currently considered a reliable measure of herd/flock health.
- Consideration should be given to developing standardised methods of determining fallen stock data as a measure of animal health (and welfare) on farm.

5.8. Third party assurance schemes

A number of third party assurance schemes are in place across the meat production chain, covering on-farm production, markets and abattoirs. Most third party assurance schemes have been developed in response to demands from major retailers for independent verification, but it has been proposed that they could perform some of the functions associated with inspections and other interventions by regulators.

EU legislation on FCI permits abattoir FBOs not to be provided with some items of FCI if the FBO 'is already aware of this information (for example, through a standing arrangement or a quality assurance scheme)'.

FSA has recognised[49] that 'Third party food assurance schemes can provide information to contribute to the accurate determination of risk-based frequency inspection regimes' and commissioned a study to assess and compare third party assurance schemes in the food sector[50].

The Red Tractor Assurance schemes and its recognised equivalent schemes, Quality Meat Scotland (QMS) and Farm Assured Welsh Livestock (FAWL), are the main schemes to which livestock

[49] http://www.food.gov.uk/science/research/choiceandstandardsresearch/fs245006#.Ul0PQhC1ulE
[50] http://www.food.gov.uk/sites/default/files/835-1-1534_GSB_CR2435_3rd_Party_Assurance_Scheme_R2_V8_FCA.pdf

producers belong; this report will therefore use these most common schemes for consideration of the role of third party assurance schemes in the provision of FCI.

The record-keeping requirements of Red Tractor standards include, and in some cases go beyond, many of the information requirements of FCI.

5.8.1. Poultry

The Broiler Standard has standards for the pro-active management of bird health and welfare and requires a Flock Health Plan, prepared and reviewed by a vet. Records must be kept of the health and performance of flocks, including the results of *post-mortem* inspections; all records must be reviewed regularly and veterinary advice sought when defined tolerance levels are exceeded.

In addition to the statutory testing requirements for Salmonella, the Standard stipulates that a formal cleaning and disinfection procedure is implemented if positive results are obtained.

The Standard includes effective biosecurity measures to prevent the spread of disease and to protect food safety and bird health. Depopulation must be carried out by companies registered with the Red Tractor Scheme, using catching teams trained to understand biosecurity issues.

Other than the statutory testing for Salmonella and the prescribed biosecurity measures, the Standard contains no specific measures for the control or monitoring of other microbiological food safety hazards, including Campylobacter.

5.8.2. Pigs

The Pig Standard includes the legal requirement that Food Chain Information (FCI) is sent to the receiving abattoir with each consignment of pigs.

The Standard requires farmers to retain the services of a specialist pig vet, registered with Red Tractor, who must carry out an inspection of the farm and produce a report every quarter. The farm must have a Veterinary Health Plan, produced by a vet, and this Plan must include a Salmonella Control Plan and a biosecurity policy; there is no stipulated requirement to assess the outcome of the Salmonella Control Plan. Production records, including abattoir condemnations and feedback,must be maintained and regularly reviewed.

5.8.3. Cattle and Sheep

The Red Tractor Beef and Lamb Standard includes the legal requirement that Food Chain Information (FCI) accompanies each consignment of livestock sent to slaughter (including those going via a livestock market).

Currently, Assured farms must have a Livestock Health Plan to 'manage and improve health and welfare of livestock' but, in contrast to the Broiler and Pig Standards, it is only a recommendation that a vet is involved in the writing and annual review of health plans. Records of health and performance must include, as a minimum: medicine records, including reason for treatment; culling and mortality records and possible reasons for culling/ mortality; and abattoir feedback (where provided). The Standard makes no specific reference to microbiological food safety hazards.

5.8.4. Conclusions

Third party assurance schemes for primary production of meat animals are widely used and provide independent verification of some aspects of production, particularly animal welfare inputs and the use of veterinary medicinal products. Studies[51] have shown that membership of a farm assurance scheme reduced the risk of non-compliance with animal welfare legislation.

51

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16613

Agriculture departments now take account of assurance scheme membership when making risk based assessment for frequency of on-farm inspections - assured farms are less likely to be selected for routine inspections by government inspectors.

With the exception of statutory testing of poultry for Salmonella, none of the schemes provide information or guarantees about the status of farms with respect to microbiological food safety hazards.

Assurance scheme standards focus on health and performance of animals and recording of reasons for any treatments administered, as well as good record-keeping for veterinary medicinal products. However, while we recognise that membership of a third part assurance scheme and independent audit of scheme standards promote animal health and welfare, we do not believe that membership of an assurance scheme is necessarily an indicator of consistently high animal health status.

We conclude that information about membership of third party assurance schemes is a valuable adjunct to FCI in the risk-ranking of farms for animal health and welfare but provides little information about microbiological food safety hazards and does not replace the specific information requirements of FCI.

We note that all the Red Tractor Schemes require producers to make use of feedback from the abattoir – CCIR – in monitoring health and performance of animals on the farm. We suggest that this information and any information from the abattoir about the accuracy of FCI provided by the farmer could be used as part of the process of audit of assurance scheme members.

5.9. Proposed FCI requirements for the food animal species

5.9.1. Practical considerations

The timing of the receipt of FCI should enable the FBO and OV to assess it and to make appropriate decisions about procedures and interventions at the abattoir.

FCI for poultry is required at least 24 hours before slaughter; this permits FCI to be analysed well in advance of arrival of the birds and logistic slaughter or other arrangements to be put in place.

FCI for pigs may accompany the animals to the abattoir but most is provided before slaughter by means of the BPEX/Scoteid electronic system. We recommend the FCI for all clean pigs should be received in advance of slaughter.

While we acknowledge that the systems for procurement of cattle and sheep for slaughter in some circumstances, e.g. animals from markets, do not enable FCI to be provided in advance of slaughter, we recommend that advance provision should be the default position and that FCI should accompany animals to the abattoir only when advance provision is not possible.

Our experience is that, when FCI for cattle and sheep accompanies the animals to the abattoir, in most instances it is not analysed until after they have been unloaded. This is contrary to the principles of FCI that FBOs should analyse FCI before accepting the animals; once animals are unloaded at an abattoir they must be slaughtered there.

5.9.2. Summarised FCI for the food animal species

Below is summarised the proposals for FCI for each of the food animal species.

5.9.2.1. Poultry

POULTRY FCI		PH	AH	AW	COMMENTS
HOLDING INFORMATION					
Holding number					
Producer name, address and contact details					
Assurance scheme details	Scheme name				
	Membership number				
Name, address and contact details of veterinary surgeon and veterinary practice responsible for the holding					
HISTORICAL RESULTS FOR THE HOLDING					
Post-mortem inspection results		Y	Y	Y	Aggregated results for the holding held on database(s)
Salmonella test results		Y			
Campylobacter test results		Y			
Residue test results (if applicable)		Y			
CONSIGNMENT INFORMATION					
Name, position and contact details of person providing FCI					
Declaration that person responsible for providing FCI for the consignment has authorisation of animals' keeper and access to all necessary records					
Proposed slaughter date					
Species					
Breed or hybrid (broilers only)					
Age					
Production type e.g. housed, free range		Y	Y		
Batch/house identification					
Number of birds in batch					
Information about depopulation/thinning	Partial depopulation	Y			
	House previously depopulated	Y			
	Complete depopulation	Y			
Maximum stocking density (broilers only)				Y	
Mortality %	At 14 days		Y	Y	
	Cumulative daily rate		Y	Y	
	In last 2 days before slaughter		Y	Y	

Veterinary medicinal products or other treatments					
Information about all veterinary medicinal products administered to the flock		Y	Y		Abattoir FBO and OV should have access to medicines records held on producer's or responsible veterinarian's database
Declaration that all withdrawal periods have been respected		Y			
Test results					
Statutory Salmonella test result		Y			
Pre-slaughter Campylobacter test information	Date of test and test result	Y			
Declaration that no analysis of samples taken from animals on the holding or other samples has shown that the animals in this consignment may have been exposed to • any disease or condition, other than Salmonella and Campylobacter, that may affect the safety of meat • substances likely to result in residues in meat		Y			

5.9.2.2. Pigs

PIG FCI		PH	AH	AW	COMMENTS
HOLDING INFORMATION					
Holding number					
Owner name, address and contact details					
Assurance scheme details	Scheme name				
	Membership number				

HISTORICAL RESULTS FOR THE HOLDING						
A-M inspection results		Y	Y	Y	Results for the holding held on database(s)	CCIR. Prevalence levels of *ante-mortem* and *post-mortem* conditions during defined period. ('traffic light' system)
post-mortem inspection results		Y	Y	Y		
Salmonella test results		Y				Salmonella status of the holding based on the most recent test results
Residue test results (if applicable)		Y				
CONSIGNMENT INFORMATION						
Name, position and contact details of person providing FCI						
Declaration that person responsible for providing FCI for the consignment has authorisation of animals' keeper and access to all necessary records						
Type of pigs & Production system Controlled = from a holding applying controlled housing conditions	Intended number of pigs in consignment				These categories are taken from the current FCI guidance and are used to determine testing requirements for Trichinella. Testing is carried out to comply with EU legislation, to demonstrate the absence of Trichinella in UK and to enable access to international markets.	
Finisher – controlled						
Finisher – non-controlled						
Cull Sows and boars						
Farmed wild boar						
Domestic pig < 5 weeks of age						
Cull and controlled finishers						
Cull and non-controlled finishers						
Identification of animals					Slapmark	
Official disease status						
Holding or area under restrictions for animal health or other reasons		(Y)	Y			
Animal health status						
As far as the person providing the FCI can judge, all the animals are		Y	Y	Y	Guidance for farmers will be required on	

healthy and none is showing signs of • Abnormal breathing • Diarrhoea • Injury • General signs of illness • Lameness] • Poor body condition (condition score 1 or less) In the case of a 'NO' answer, the identification of the animal(s) and additional information should be provided.				assessment of these headings.
Veterinary medicinal products or other treatments				
Declaration that withdrawal periods have been observed for all veterinary medicines and other treatments administered to the pigs	Y			
Information about veterinary medicinal products or other treatments administered to the consignment in the past [x] days	Y			This information need not be specifically provided if all treatments are recorded on a database to which the FBO and OV have access.
Information about veterinary medicinal products or other treatments administered to individual pigs in the past [x] days	Y			
Test results				
Declaration that no analysis of samples taken from animals on the holding or other samples has shown that the animals in this consignment may have been exposed to • any disease or condition, other than Salmonella, that may affect the safety of meat • substances likely to result in residues in meat	Y			
Physical hazards				
Information about any pigs that may contain a broken needle Identification of animal and site of needle.	Y			

5.9.2.3. Cattle

CATTLE FCI			PH	AH	AW	COMMENTS
HOLDING INFORMATION						
Holding number						
Owner name, address and contact details						
Assurance scheme details	Scheme name					
	Membership number					
HISTORICAL RESULTS FOR THE HOLDING						
A-M inspection results			Y	Y	Y	Results for the holding held on CCIR database(s). Prevalence levels of *ante-mortem* and *post-mortem* conditions during defined period. ('traffic light' system)
post-mortem inspection results			Y	Y	Y	
Microbiological test results (if applicable)			Y			
Residue test results (if applicable)			Y			
CONSIGNMENT INFORMATION						
Name, position and contact details of person providing FCI						
Declaration that person responsible for providing FCI for the consignment has authorisation of animals' keeper and access to all necessary records						
Number of animals in consignment	Prime cattle					
	Dairy cows					
	Beef cows					
	Breeding bulls					
	Calves					
Identification of animals						List of official identification marks
Official disease status						
Bovine TB						
Officially TB free (OTF)				Y		
Under TB movement restrictions (OTFS/OTFW)				Y		
Herd TB testing interval	6 months			Y		
	12 months			Y		
	4 years			Y		
Herd under movement restriction for any other reason			(Y)	Y		

Animal health status				
As far as person providing FCI can judge, all the animals are healthy and none is showing signs of • Abnormal breathing • Diarrhoea • Lameness (mobility score 3 [e.g. DairyCo]) • Poor body condition (condition score 2 or less on a 5-point scoring system) • Injury • General signs of illness In the case of a 'NO' answer, the identification of the animal(s) and additional information should be provided.	Y	Y	Y	Guidance for farmers will be required on assessment of these headings.
Animal cleanliness				
Information about any animals in category 4 or 5 of the cattle cleanliness scoring system?	Y			Former MHS scoring system
Information about clipping of cattle	Y			
Veterinary medicinal products or other treatments				
Declaration that withdrawal periods have been observed for all veterinary medicines and other treatments administered to the animals	Y	Y		
Declaration that, for animals purchased in the previous , information has been provided by previous owners about veterinary medicines and other treatments administered to the animals	Y	Y		
Test results				
Declaration that no analysis of samples taken from animals on the holding or other samples has shown that the animals in the consignment may have been exposed to • any disease or condition that may affect the safety of meat • substances likely to result in residues in meat	Y			
Physical hazards				
Information about any animals that may contain a broken needle. Identification of animal and site of needle.	Y			

5.9.2.4. Sheep

SHEEP FCI		PH	AH	AW	COMMENTS
HOLDING INFORMATION					
Holding number					
Owner name, address and contact details					
Assurance scheme details	Scheme name				
	Membership number				
HISTORICAL RESULTS FOR THE HOLDING					
A-M inspection results		Y	Y	Y	Results for the holding held on CCIR database(s). Prevalence levels of *ante-mortem* and *post-mortem* conditions during defined period. [traffic light system]
post-mortem inspection results		Y	Y	Y	
Microbiological test results (if applicable)		Y			
Residue test results (if applicable)		Y			
CONSIGNMENT INFORMATION					
Name, position and contact details of person providing FCI for the consignment					
Declaration that person responsible for providing FCI for the consignment has authorisation of animals' keeper and access to all necessary records					
Number of animals in consignment	Lambs and hoggs				
	Ewes and rams				
Identification of animals					
Official disease status					
Information about flock movement restrictions for any other reason (excluding 6-day 'standstill')		(Y)	Y		
Animal health status					
As far as the person providing FCI for the consignment can judge, all the animals are healthy and none is showing signs of • Abnormal breathing • Diarrhoea • Lameness (lameness score) • Poor body condition (condition score 2 or less on a 5-point scoring system) • Injury		Y	Y	Y	Guidance for farmers will be required on assessment of these headings.

• General signs of illness In the case of a 'NO' answer, the identification of the animal(s) and additional information should be provided.				
Animal cleanliness				
Information about any animals in category 4 or 5 of the sheep cleanliness scoring system?	Y			Former MHS scoring system
Information about clipping of sheep	Y			
Veterinary medicinal products or other treatments				
Declaration that withdrawal periods have been observed for all veterinary medicines and other treatments administered to the animals	Y	Y		
Declaration that, for animals purchased in the previous , information has been provided by previous owners about veterinary medicines and other treatments administered to the animals	Y	Y		
Test results				
Declaration that no analysis of samples taken from animals on the holding or other samples has shown that the animals in the consignment may have been exposed to • any disease or condition that may affect the safety of meat • substances likely to result in residues in meat	Y			
Physical hazards				
Information about any animals that may contain a broken needle. Identification of animal and site of needle.	Y			

6. COLLECTION AND COMMUNICATION OF INSPECTION RESULTS

The legal basis for CCIR is contained in Regulation (EC) No 854/2004, Annex I, Section II, Chapter I Communication of Inspection Results, which requires the OV to:

- record and to evaluate the results of inspection activities;

- inform the [abattoir] food business operator if inspections reveal the presence of any disease or condition that might affect public or animal health, or compromise animal welfare;

- inform the veterinarian attending the holding of provenance and the food business operator responsible for the holding of provenance when the problem identified arose during primary production.

Inspection results subsequently become a component of FCI under Annex II, Section III of the Regulation, which requires that slaughterhouse operators must be provided with relevant food safety information, including:

'relevant reports about previous ante- and post-mortem inspections of animals from the same holding of provenance including, in particular, reports from the official veterinarian;'

Inspection activities described in legislation include ante- and *post-mortem* inspection, animal welfare and laboratory testing.

6.1. *Ante-mortem* inspection

Legislation requires the OV to carry out an ante-mortem inspection of all animals before slaughter to determine whether there is any sign that welfare has been compromised or of any condition which might adversely affect human or animal health.

In addition, FBOs are required to have procedures in place to guarantee that animals accepted for slaughter are healthy, as far as the food business operator can judge, clean and in a satisfactory state as regards welfare. FBOs must notify the OV in the event of failure to comply with any of these requirements.

6.2. *Post-mortem* inspection

Regulation (EC) No 854/2004 requires all carcases and accompanying offal to be subjected to *post-mortem* inspection, and sets out in detail the inspection procedures for each of the species.

In the case of pigs, the default inspection procedure is visual-only inspection but the OV may elect to apply additional post-mortem inspection procedures using incision and palpation of the carcase and offal where, in his or her opinion, analysis of the FCI or the results of ante-mortem inspection indicates a possible risk to public health, animal health or animal welfare. Access requirements for some export markets may dictate that traditional inspection methods, with palpation and incision, are used.

6.3. Laboratory testing

The OV must ensure that sampling and testing is carried out for the monitoring and control of zoonotic agents, the detection of unauthorised substances or products and the control of regulated substances, in particular within the framework of National Residue Plans, and the detection of animal diseases for which animal health rules are laid down in EU legislation. The OV must also ensure that any other necessary testing takes place.

6.4. CCIR information requirements

This section contains an assessment of the recipients of inspection results and the needs of each recipient for inspection results. *Ante-* and *post-mortem* Inspection must satisfy the needs of a number of different categories of recipients, cover a range of separate but inter-related topics and address sometimes conflicting requirements.

Recipients of inspection results may receive it directly or may be indirect recipients.

CCIR is considered in general in this section and in detail for each species in Section 4.

6.4.1. Direct Recipients of inspection results

6.4.1.1. Abattoir FBOs

The primary need of abattoir FBOs for the results of inspections is to describe the reasons for the rejection and exclusion from the human food chain of carcases, parts of carcases and offals. At this level FBOs require commercial information about material that has been rejected (sometimes referred to as 'condemned').

Information about animals from specific livestock suppliers may inform FBOs' subsequent procurement actions, but it is important to note that a supplier may sell his animals to a number of abattoirs and that the animals slaughtered at any one abattoir may not be representative of all animals from the holding. Only composite inspection results of all animals from a farm, irrespective of the place of slaughter, will give a true indication of the animal health status of the farm.

6.4.1.2. Livestock producers and their veterinarians

Inspection results are of value to FBOs in primary production and their veterinarians by providing information about their animals which informs herd/flock health planning and enables them to make changes to their production systems to improve animal health and welfare and consequently public health.

Some diseases and conditions of animals that may not be apparent in the live animal can be detected at *post-mortem* inspection. These diseases have an impact on the health of the animals and may cause economic production losses. Actions taken at the farm level on the basis of CCIR have the potential to improve the economic performance of livestock enterprises as well as benefits for animal health and welfare and public health

6.4.1.3. Surveillance bodies

Since the vast majority of food production animals (all animals except those that die or are killed on farm) are slaughtered for human consumption and undergo *ante-* and *post-mortem* inspection, information gathered at abattoirs is a valuable source of surveillance data for animal health and welfare.

Government agriculture departments therefore have an interest in inspection results in the context of disease surveillance and animal welfare.

Surveillance data is also of value to livestock industry bodies that promote the interests of livestock farmers.

The value of inspection results for disease surveillance was recognised by Watson et al[52] in a review for the Veterinary Laboratories Agency (VLA – now APHA): *'There are considerable opportunities for FSA to engage with stakeholders and develop the contribution of [ante-mortem and post-mortem inspection] data, protecting animal health – both at the farm level and to complement national disease surveillance'.*

6.4.1.4. Animal welfare monitoring

Inspection results for broilers are used to identify possible on-farm welfare problems and to fulfil the requirements of the EU Meat Chicken Directive. Cumulative daily mortality rate and seven routine *post-mortem* conditions are monitored together with a specific welfare indicator for foot pad dermatitis. Where levels of these conditions exceed a certain threshold, known as a 'trigger level', the owner/keeper of the animals and APHA is alerted.

[52] Eamon Watson, Elizabeth Marier and Jon Weston (2011) Review of historic ante mortem and *post-mortem* inspection data (VLA project code FS245001)

Improved CCIR would enable similar animal welfare monitoring of the other food animal species. We are aware of a Defra-commissioned project that is assessing the feasibility of measuring animal welfare indicators for cattle and sheep at the abattoir as a means of monitoring animal welfare on farm and in transit to the abattoir.

6.4.1.5. Others

Comprehensive and accurate data about animals may have a potential commercial value for industries that service the livestock sector e.g. pharmaceutical companies.

6.4.2. Indirect recipients of inspection results

Inspection results communicated to the producer form an important component of FCI for subsequent animals consigned for slaughter from the farm.

We believe this information to be the most important component of FCI since it is gathered systematically and independently of the producer by government officials at abattoirs. Composite CCIR – information about all animals from a farm collated from all the abattoirs at which they were slaughtered - gives a robust indication of the health and welfare status of animals on the farm and may provide valuable information for public health.

The indirect recipients of inspection results in the form of FCI are the OVs and FBOs at abattoirs to which subsequent animals are sent for slaughter.

6.5. Scope of inspection results

Ante- and *post-mortem* inspection results provide information about:

6.5.1. Food safety and public health

Regulatory inspection has been in place in UK and EU for many years for public health purposes.

Ante-mortem inspection can identify animals that show clinical signs of disease and ensure that they are excluded from the human food chain.

The need for changes to meat inspection has been recognised in the EU, and EFSA has published Opinions that provide the scientific basis for the modernisation of meat inspection across the EU. EFSA has identified and ranked public health hazards in meat and has recommended improvements to meat inspection procedures to protect consumers from risks related to such hazards.

Traditional practices of meat inspection are not able to detect the main meat-borne hazards such as Campylobacter and Salmonella or contamination by chemical substances. EFSA scientific experts have recommended improvements to existing practices or alternative methods for the inspection of meat.

As part of the EU modernisation of meat inspection, some changes to meat inspection, such as visual inspection of pigs, have now been implemented under specific circumstances.

6.5.2. Animal health

Ante- and *post-mortem* inspection findings are an important source of information about animal health. Many of the gross pathological lesions detected at *post-mortem* inspection provide information of greater relevance to animal health than public health.

Most animals are slaughtered in abattoirs and inspection at the abattoir plays an important role in the detection and surveillance of animal diseases that may not be apparent in live animals.

6.5.3. Animal welfare

Ante-mortem inspection provides an opportunity to assess the welfare of live animals. Specific animal welfare indicators may be measured at both *ante-* and *post-mortem* inspection.

Animal health has a direct bearing on animal welfare, and therefore inspection results that record the detection of animal diseases have significance for animal welfare.

For poultry, EU legislation requires the recording of inspection results for a number of welfare indicators.

6.5.4. Ante-mortem inspection

Legislation requires that all animals are subject to an ante-mortem inspection. The inspection may be carried out at the holding of provenance for pigs and poultry but this is not believed to be practised in the UK.

The stated aim of ante-mortem inspection is to determine whether there are signs that animal welfare has been compromised or of any condition which might adversely affect human or animal health.

6.5.4.1. Ante-mortem inspection condition categories

OVs currently record *ante-mortem* inspection findings for the red meat species under from 20 to more than 30 separate condition headings. The MLCSL Report recorded that the frequency of *ante-mortem* inspection findings for cattle, sheep and pigs was 1.5%, 1.5% and 1% respectively.

Watson et al[53] reported that, of the 20 – 30+ possible condition headings, 80% of recorded findings were covered by 10, 5 and 5 headings for cattle, sheep and pigs respectively.

There are no diagnostic criteria or case definitions for OVs to apply in performing *ante-mortem* inspection. It is therefore inevitable that there will be a lack of consistency between OVs in the recording of *ante-mortem* inspection results. We discuss in Chapter 5 the issues about FCI and the health status of animals, and propose the development and use of guidance on signs of animal health and welfare. While acknowledging the challenges of producing such objective guidance, we believe that it would promote consistency for both FCI and the recording of *ante-mortem* inspection results.

Many of the conditions detected at *ante-mortem* inspection have a bearing on animal welfare, and we are aware of a project currently being carried out to assess the feasibility of measuring animal-based indicators of welfare at the abattoir. We are conscious of the practical difficulties that OVs face, as described below, and that better recording of *ante-mortem* inspection results may be difficult under current arrangements in many abattoirs.

We propose that recording of *ante-mortem* inspection results should be simplified by reducing the number of condition headings used. We make suggestions for each species at Section 6.11 as the basis for the development of a reduced list of conditions categories. Case definitions should then be produced for each category.

The physical recording of *ante-mortem* inspection findings should be simplified by the use of hand-held devices by OVs in the lairage, as we discuss later in the Report. We understand that FSA is currently trialling such technology.

6.5.4.2. Practical aspects of ante-mortem inspection

Our view is that the design and operation of many lairages are not conducive to consistently effective ante-mortem inspection. The ideal situation of being able to inspect animals from both sides and in motion is often not possible because of a combination of the design of lairages and the time constraints on FSA staff.

[53] Eamon Watson, Elizabeth Marier and Jon Weston (2011)
Review of historic ante mortem and *post-mortem* inspection data (VLA project code FS245001)

The practicalities of inspecting groups of animals in lairages mean that identification of individual animals showing signs of abnormality may not be feasible and that recording of *ante-mortem* findings is often limited to the batch level.

The detection of signs that animal welfare had been compromised leads to the expectation that the OV will take specific actions directed at the transporter and/or the consignor of the animal(s). As a result there is motivation for OVs to record only animals showing severe signs of animal health or welfare conditions. Similarly, it is likely that only those animals whose condition the OV considers warrants specific interventions at the abattoir will be recorded.

A consequence of the above points, together with the absence of case definitions ante-mortem inspection, is that, while ante-mortem inspection results include animals whose condition has provoked actions by the OV, our view, supported by our own observations, is that there is under-recording of low level signs of ill health e.g. lameness.FCI and ante-mortem inspection.

The MLCSL report for FSA recorded the views of many OVs that FCI concerning the health status of animals consigned for slaughter was frequently inaccurate and did not include 'additional information' about animals that were displaying signs of abnormality. Our own experience of FCI found serious deficiencies in much FCI, particularly for cattle and sheep.

Legislation requires FBOs to notify the OV if animals accepted onto the abattoir premises are not 'healthy, as far as the food business operator can judge' or 'in a satisfactory state as regards welfare on arrival at the slaughterhouse'. During our research for this project we have observed that many FBOs do not fulfil this requirement.

With the exception of events that occur during transport, signs of abnormality should be recognisable equally by producers at loading and by FBO staff and OVs during unloading and in the lairage. *Ante-mortem* inspection should therefore be verification by the OV that the FCI is correct, followed by a determination of the required actions in response to this information.

We recommend that OVs use their powers to 'take appropriate action' if they discover 'that the accompanying records, documentation or other information do not correspond with ..... the true condition of the animals', or if FBOs do not comply with their requirement to inform the OV about the health or welfare of animals. We consider that our proposal for the development of guidance and case definitions for animal health will provide clearer interpretation for all parties and better support enforcement by OVs.

6.5.5. Post-mortem inspection

Apart from at the smallest of abattoirs, *post-mortem* inspection is carried out by a team of inspectors operating at a number of inspection stations. The number of inspection stations and the inspection tasks carried out at each one are dependent on the speed and layout of the slaughter line. For the red meat species there is generally one station for carcase inspection and one or more for head, red offal and green offal inspection as appropriate for the species.

Details of the inspection procedures to be carried out for each species are set out in EU legislation.

6.5.5.1. Level of detail of inspection results

Inspection results may be recorded with varying levels of detail. As an example, pig lungs may be recorded, at the lowest level of detail, as 'abnormal', or at a high level of detail (as used by the BPHS system[54]) as having 'enzootic pneumonia-like lesions' (with a numerical score), 'viral like lesions', 'chronic pleuropneumonia-like lesions', 'acute pleuropneumonia', 'abscess – discrete' or 'pyaemia – multiple abscesses'.

Inspection results may be gathered and recorded at a level of detail dependent on:

[54] http://www.bpex.org.uk/2ts/documents/BPHSdiseasesandscoring.pdf

- **Descriptive versus syndromic or diagnostic results**

The current categories used to record *post-mortem* inspection findings include both descriptive terms, e.g. 'abscess', and syndromic or diagnostic terms, e.g. 'milk spot' and 'cysticercus ovis'. Syndromic and diagnostic terms, which state or imply the aetiological agent, carry the risk that true diagnosis is not possible without laboratory confirmation and that the recorded diagnosis may be incorrect.

Incorrect identification of an agent may lead to inappropriate actions being taken by the farmer – and could leave FSA open to claims for compensation.

Note that in the example of pig lungs above, BPHS assessments - all carried out by experienced pig veterinarians - use the suffix '- like' for all conditions to avoid this potential risk.

- **Categorisation of slaughter animals by age and class**

The current recording systems used by FSA for inspection findings categorise animals of each species into different classes on the basis of information that is required for charging FBOs for inspection services. This method of categorisation does not enable effective recording and analysis of ante- and *post-mortem* inspection data and thereby reduces the value of the data for use in informing on-farm health planning and animal disease surveillance.

For example, inspection results for sheep are recorded under a single category; there is no differentiation of results for prime, young animals and cull, adult breeding sheep. The prevalence of pathology detected by inspection at the abattoir is much less in young lambs and hoggs than in cull breeding sheep, and there may be marked differences in the epidemiological significance of similar findings in the two classes.

- **Practical arrangements for inspection and recording**

Fast slaughter lines provide little time for inspectors to record results. This is especially the case for poultry but also applies to modern pig and sheep lines.

Terminals for electronic capture of findings may facilitate better recording but available time will remain an impediment to detailed recording.

Clearly the methods employed by inspectors for recording inspection findings are a critical factor; these are considered in chapter 5 of this report.

A further level of detail currently applied to the recording of *post-mortem* inspection results is the location of lesions on carcases. In the case of pigs, the carcase is sub-divided into 21 different locations. We have reservations about the value of this type of detail and the effort required to capture it.

Double recording of post-mortem findings, e.g. recording of pleurisy in a single animal at both the carcase and offal inspection points, is a potential problem that systems for the capture of inspection findings must be designed to prevent.

6.6. Receipt of inspection results

Legislation requires the Competent Authority, FSA, to inform producers about inspection results that reveal the presence of any disease or condition that might affect public or animal health, or compromise animal welfare when the problem identified arose during primary production. However the MLCSL report recorded that the majority of the cattle and sheep producers interviewed did not routinely receive the result of inspections. Investigations by the project team also identified that, although there are some examples of good practice, inspection results for cattle and sheep are not reported back to most producers.

6.7. Quality of inspection results

The MLCSL report for FSA on FCI and CCIR reported dissatisfaction with the accuracy and consistency of inspection results.

We have been made of aware of informal trials where pigs from the same batch have been sent to different abattoirs, with marked differences in the inspection results reported. We have been presented with evidence of several-fold differences in the rejection rate of broilers from the same house slaughtered on different shifts at an abattoir and inspected by different inspection teams.

A report commissioned by BPEX[55] about a proposed transition from the BPHS to using CCIR as a means of health monitoring in pig production reported 'Whilst meat inspection and CCIR reports theoretically record all pigs slaughtered, there is lack of confidence in the data generated...'

We acknowledge that there are examples of good practice in the recording and communication of inspection results but we believe there is much evidence to support our view that the general level of satisfaction with the quality on inspection results received by producers is low.

Our view is that the quality of inspection results is compromised by the following factors:

6.7.1. Lack of standard definitions for disease/condition categories

It is inevitable that there will be some degree of subjectivity in the interpretation of lesions detected by inspectors. In order to achieve a high level of consistency it is necessary to use subjective measures to the greatest practical extent. This is analogous to the concept of 'case definition' in epidemiology where a set of uniform criteria are used to define a disease to classify and count cases consistently across reporting jurisdictions.

FSA has produced a series of 'condition cards' for poultry which describe in text and photographs the criteria for categorisation of *post-mortem* findings. While we consider these condition cards go some way to fulfilling case definition requirements, we believe they require further refinement to better define conditions and promote consistency of reporting.

No similar 'case definitions' for *post-mortem* findings currently exist for the other species but we understand that FSA is developing condition cards for pigs.

6.7.2. Number of condition headings

A VLA study[56] reported that more than 40 *post-mortem* condition recording headings were available for FSA inspectors for cattle and more than 30 for sheep. For cattle, 5 conditions accounted for more than 80% of all recorded findings and 10 conditions for more than 95%; similar figures for 80 and 95% of findings were 5 and 11 for sheep and 6 and 12 for pigs. It is apparent from these figures that many conditions in the current lists used by FSA are very seldom identified or recorded.

We concur with the findings of the MLCSL Report, that the number of condition headings that is currently used for recording inspection findings is excessive, particularly on fast slaughter lines where there are practical operational difficulties for inspectors to have a large number of options from which to select.

The MLCSL study reported the most common post-mortem conditions in the table below.

CATTLE	**SHEEP**	**PIGS**
Fascioliasis	Cysticercus tenuicollis	Milk spot
Kidney lesions	Fascioliasis	Septicaemia/toxaemia
Pleurisy/pneumonia	Contamination	Abscess
Abscess	Pleurisy/pneumonia	Metritis
Lung lesions	Abscess	Nephritis

[55] REPORT FOR BPEX: BPHS-CCIR Transition October 2014. Collection and Communication of Inspection Results (CCIR) as a means of health monitoring in pig production in place of the British Pig Health Scheme (BPHS): What would success look like?

[56] Eamon Watson, Elizabeth Marier and Jon Weston (2011) Review of historic ante mortem and *post-mortem* inspection data (VLA project code FS245001)

In some cases the recording of findings is impaired by the presence of several heading options under which similar lesions may be recorded. For example, post-mortem headings for pigs include: 'Pleurisy'; 'Pneumonia with abscess'; 'Pneumonia without abscess'; and 'Pneumonia with pleurisy'.

Decisions about the number and detail of condition headings should be based on the accuracy by which they can be identified and recorded and on the value of the information for herd/flock health planning and disease surveillance purposes. Efforts should be concentrated on gathering information that can be used directly by producers and their veterinary advisers to improve the health and productivity of subsequent groups of animals.

6.7.3. Data recording facilities at inspection points

Accurate recording of inspection results requires systems that are easy for inspectors to use at inspection points. Many systems currently employed, such as mechanical counters, white boards, paper and inspector memory are not considered adequate for this purpose. Electronic systems (e.g. fixed terminals, hand held devices or voice-activated equipment) situated close to inspection points are preferable. Data capture systems should automatically identify the animal being inspected or the batch to which it belongs to ensure that the results are correctly correlated.

6.7.4. Training of inspectors

There appears to be little emphasis on training for MHIs, either for new recruits or as CPD, that focuses on the determination and recording of inspection results.

6.7.5. Monitoring of post-mortem inspection

The FSA Manual for Official Controls instructs OVs to 'verify the *post-mortem* inspection of a sample of carcases and offals that have been health marked (or inspected, in the case of poultry)'.

There is no requirement for OVs to assess the performance of inspectors in the recording of *post-mortem* findings.

Similarly, there appears to be no formal system for comparing inspection results between inspection teams, abattoirs or regions. There should be broadly similar results for inspection of all animals derived from a population, irrespective of the abattoir at which they are slaughtered. Analysis of results on a regional or national scale would enable investigation of the reasons for any significant differences; these may be true variation in the prevalence of conditions detected at inspection or may indicate a lack of consistency between inspectors/inspection teams/abattoirs/regions. Identification of inconsistencies should lead to FSA taking action to identify the reasons and to take corrective action or implement training if appropriate.

We note that the BPHS *post-mortem* inspection system includes arrangements to promote consistency between the veterinarians employed to carry out inspection and also monitors the results of each individual veterinarian to enable anomalous results or significant outliers to be detected and investigated.

6.7.6. Lack of involvement of OVs and MHIs with the CCIR databases

OVs and MHIs are responsible for recording inspection findings on the relevant FSA databases but do not appear to have any further involvement with the data. We believe that this lack of interaction with the data gives FSA operational staff no connection with the outcome of their labour and little incentive for accurate recording.

6.8. Inspection results and disease surveillance

The VLA study identified that little use is currently made of inspection results for surveillance purposes. This is regrettable, particularly at a time when budgets for surveillance are under pressure. Abattoirs can be considered as a 'pinch point' in food animal production systems, where all animals are slaughtered in little over 300 abattoirs.

Reasons cited for inspection results being little used for disease surveillance are lack of confidence in their accuracy and the absence of geographical or holding identifiers. Where inspection results are recorded against the abattoir only (which may slaughter animals from a very wide geographical area), there is limited opportunity for effective analysis.

6.9. Interpretation and communication of inspection results

Legislation requires the OV to record and to evaluate the results of inspection activities and to inform the FBO responsible for the holding of provenance if inspections reveal the presence of any disease or condition that might affect public or animal health, or compromise animal welfare. This implies that the OVs must make a judgement about conditions that might impact animal health on a farm when they may have only very limited knowledge of the farm. A finding of a condition on a high health status farm may be of major importance, whereas a similar finding may be of less significance on a farm with a known disease problem.

Recording only inspection results which the OV considers 'might affect public or animal health, or compromise animal welfare' could result in low levels of prevalence or severity of a condition in individuals animals or batches of animals not being recorded and a failure to identify a common finding in all animals from a single farm.

It has been proposed that threshold levels for all conditions could be determined for OVs to report inspection results when such levels are exceeded. For the above reasons we reject this proposal and strongly recommend that all inspection results should be recorded on a database under the holding. Both the results for the batch and the aggregated results for all animals from the holding would then be available for analysis and interpretation by producers and their vets and any third parties with an interest e.g. for welfare monitoring.

Notwithstanding the above, we believe that the provision of raw inspection results to producers in the absence of any analysis may not result in the best use being made of them. We believe that some degree of statistical analysis, including the prevalence of conditions and benchmarking of the prevalence of conditions in animals from each holding against other producers will generate greater value for producers and provide indications of areas where they might improve the health of their animals.

Simple analysis could be included in the design of the inspection results database. Once a database of inspection findings for each holding has been in place for a suitable time, we envisage the application of a 'traffic light' system whereby the results for a batch or the aggregated results for a holding that exceeded an agreed percentile (or other statistically-determined) level would be highlighted.

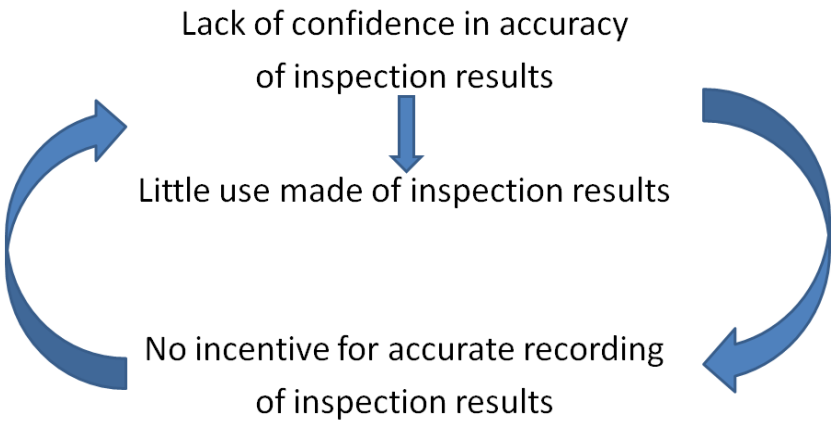
Such highlighted holdings could then be easily recognised by the abattoir FBO or OV when the historical inspection results are viewed as a component of FCI for subsequent consignments.

More detailed analysis of the inspection results database and benchmarking of producers could be carried out by levy or other industry bodies to add value to the data, as is currently done by BPHS and BPEX in the pig sector.

6.9.1. The CCIR 'vicious circle'

We believe that the current way in which inspection results are collected and the issues with their quality have led to a 'vicious circle' as shown below.

Figure 2. Vicious circle of inspection results



6.9.2. Note on Meat Hygiene Inspectors

We wish to stress that our views on current CCIR arrangements are in no way a criticism of meat inspectors and official veterinarians. The systemic faults we have identified do not enable accurate and reliable recording of inspection results or provide any incentive for inspectors to record information more accurately.

We believe that addressing the factors listed above will provide an incentive for better recording of inspection results, enable inspectors to add value to the meat production chain and thereby increase job satisfaction and motivation.

6.10. Recommendations for improvements in CCIR

6.10.1. Condition categories

We consider that, with the possible exception of cattle, the categories or headings under which *post-mortem* inspection findings are recorded should be refined and reduced.

Findings should generally be recorded in descriptive terms that will ensure a high level of consistency between inspectors and plants. Recording of syndromic or diagnostic findings should be included only when there is evidence that an acceptable level of accuracy can be achieved.

There is an inevitable compromise between the number and level of detail of conditions and the accuracy with which they can be recorded.

We believe that the accuracy of inspection should be determined and assessed in a similar manner to any other form of test – by consideration of its sensitivity and specificity. Taking pig lung lesions as an example, we propose that trials be carried out to assess the number of conditions (from one - 'abnormal' – to 6 – as in the current BPHS) that inspectors can record at normal, commercial line speeds while achieving a pre-determined level of sensitivity and specificity. The results of such a trial would enable a practical list of conditions to be determined for routine use.

Our view is that a revised condition list should err on the side of accuracy in order to gain confidence in the system. Once there is better confidence in the system it will be possible to consider amending the condition headings to accommodate more detailed information.

The requirement for the number and level of detail of condition categories is dependent on the value of the results for both herd/flock health planning and animal disease surveillance purposes. Clearly there will be an incentive to record more detailed information where this can be used to determine on-farm interventions for animal health and production.

Proposals are offered below for post-mortem inspection categories for each of the food animal species. These proposals include 'low level', descriptive headings and more detailed 'high level' categories. Decisions about the exact categories to be recorded should be made through collaboration between all interested parties, specifically OVs, meat inspectors, livestock and meat industry representative bodies, veterinary species specialists and disease surveillance experts.

Where recording of descriptive findings indicates a problem, then further more detailed investigative examinations or tests may be carried out, either on the animals/carcases concerned or on subsequent batches of animals from the farm.

A further option may be to provide a more detailed (chargeable?) inspection regime where this is specially requested by producers.

6.10.2. Case definitions for post-mortem finding categories

Accurate, reliable and consistent recording of inspection results require clear 'case definitions' for each category heading. So-called condition cards are available for poultry and, we understand, are being developed for pigs.

We recommend that the poultry cards be improved by better defining the parameters for inclusion and exclusion from each heading, making use of photographs and other aids (such as colour charts for abnormal colour) where possible.

Similar condition cards should be developed for the other species.

For conditions that may be identified at more than one inspection point (e.g. pleurisy at the carcase and pluck inspection points), rules should be determined for their recording to avoid double recording. Alternatively, electronic systems for recording of results may be designed to prevent double recording.

6.10.3. Categorisation of animals by age and class

We recommend that, for each of the food animal species, inspection results be recorded against age and class categories that provide the most useful information to producers and their vets and better data for animal disease surveillance purposes.

We suggest that the final determination of the most appropriate categories should be an outcome of the collaboration by stakeholders on establishing condition categories and their case definitions. We give our proposals for animal categories for each species in the table below.

POULTRY	
Species	
Age	Production birds
	Adult breeders
Production type	Indoor
	Outdoor

PIGS
Prime pigs
Adult sows/boars

FCI for pigs requires pigs to be allocated to a wider range of categories to enable the testing procedure for Trichinella to be determined; this wider range is not carried forward to the recording of inspection results

CATTLE
Calves
Prime cattle
Dairy cows
Breeding cows/bulls

SHEEP
Lambs/hoggs
Adult ewes/rams

The above categories are proposed as a minimum; further sub-categorisation of inspection results by class of animal and production system should be considered where this would provide more valuable data for the analysis of diseases and other conditions at the individual farm, regional and national level.

6.10.4. Animal identification at the inspection point

Abattoir systems must ensure that every animal can be correctly identified at the point of inspection to guarantee correlation of inspection results with the animal. This applies particularly to pigs, where batch identification can be lost due to line breakdowns or the diversion of carcases onto rectification loops, and to sheep which are not normally identified on line once the head is removed.

On many slaughter lines identification of the individual animal or batch to which it belongs does not occur until the weigh point, after the *post-mortem* inspection point. Correlation of inspection results with the animal(s) concerned requires this identification to be possible at the point of inspection of the carcase and its offals.

6.10.5. Meat inspector training

Training of meat inspectors in the accurate recording of inspection results, together with a better understanding of the use to which the information will be put and the importance of its accuracy is an essential component of an improved CCIR system.

A short period of training in the use of newly-developed case definitions will be required for all inspectors and OVs. Training should include elements of animal health and animal production to improve the understanding of the significance of *post-mortem* findings for animal health and production.

There may be an option for additional training for some inspectors to deliver an enhanced level of inspection when requested.

6.10.6. Inspection performance monitoring

A system of regular monitoring of inspector performance should be instigated to ensure consistency of recording of findings between individual inspectors, abattoirs and regions. We envisage a system whereby monitoring of performance is cascaded from a responsible veterinarian or inspector through the different operational levels. An OV or inspector at each plant would have responsibility for consistency of inspection at their abattoir, backed up by regular comparison with colleagues in other plants.

In parallel with operational consistency monitoring, scrutiny of results from each abattoir would enable inconsistent or unusual results to be identified and investigated. The use of quality assurance systems (e.g. ISO or EN standards) should be considered and how they can be applied to the *ante-mortem*/*post-mortem* system.

6.10.7. OV and MHI access to inspection results database

Under our proposal for improved CCIR to form an important component of FCI, OVs will have access to the CCIR database. We recommend that, subject to appropriate confidentiality conditions, all FSA operational staff be able to access the database to enable them to be better connected with the output of inspection activities and to add value to the meat production chain.

6.11. CCIR for the food animal species

6.11.1. Poultry

6.11.1.1. EFSA Proposals

In its Opinion on poultry, EFSA proposes that '*post-mortem* visual inspection is replaced by setting targets for the main hazards on the carcass, and by verification of the food business operator's hygiene management, using Process Hygiene Criteria'. However, the Opinion also recognises that 'meat inspection is a valuable tool for surveillance and monitoring of specific animal health and welfare conditions'.

EFSA suggests that other approaches should be applied to compensate for the loss of information of animal disease and welfare conditions, and recommends two approaches:

a) *post-mortem* checks continue on each carcass that is removed from the food chain, as part of a meat quality assurance system for example, due to visible pathological changes or other abnormalities;

b) detailed inspection is conducted on a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information about animal disease and welfare conditions. Targeted surveillance of each batch should be risk-based with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch.

We consider that it is beyond the scope of this project to comment on the main EFSA proposal to replace *post-mortem* visual inspection with criteria based on targets for hazards and assessment of FBOs' hygiene management, but we support the continued inspection of carcases with visible pathological changes or other abnormalities removed from the line.

Restriction of inspection to a subset of carcases requires FCI, which includes CCIR from previous batches, to be sufficiently accurate and reliable to enable risk based decisions about sampling levels to be made. When the improvements to FCI and CCIR proposed in this report have been implemented, it will be possible to investigate the use of statistically-based sampling methods.

6.11.1.2. Poultry CCIR

The comments below are applicable to broilers and may not be relevant for larger, more valuable individual birds (turkeys, ducks, geese) that are generally processed at a slower rate.

Inconsistency between inspection teams in recording inspection results is reported by industry as a major problem. We have been presented with evidence of several-fold differences in rejection rates for birds from the same house slaughtered at different abattoirs or on different shifts at the same abattoir. Clearly this level of discrepancy results in a serious lack of confidence in CCIR.

In addition to the inability of flock owners and their veterinarians to make decisions about actions to improve the health of subsequent flocks, with potential impact on public health, unreliable CCIR may cause meat to be unnecessarily rejected, raising sustainability issues and causing a financial impact on the poultry industry.

Our view is that inconsistency in broiler inspection is due to a combination of high line speeds and a lack of clarity in differentiating between public health conditions and meat quality issues.

Poultry inspection may be performed by qualified meat inspectors (MHIs/PMIs) or by plant inspection assistants (PIAs). We make no distinction in this report between inspection by the two groups of inspectors.

6.11.1.3. Line speed

High line speeds (175 birds per minute is common) affording little time for inspectors to make decisions about carcases, remove them from the line and record their findings. Regulation (EC) No 854/2004 states that '*The speed of the slaughter line and the number of inspection staff present must be such as to allow for proper inspection*.'

Accurate decisions and recording about broilers by inspectors are unlikely to be achieved while operating at high line speed; closer examination of carcases which have been removed from the line would be required to achieve this.

The EFSA Opinion on poultry states '*The high speed of the slaughter lines reduces the sensitivity of detection of lesions or faecal carcass contamination by visual inspection and only, at best, a sample of the carcases can be thoroughly examined*'.

Modern poultry processing lines have sophisticated systems for selection and categorisation of carcases at the end of the line. Technological solutions using similar systems may enable carcases with visible pathological changes or other abnormalities to be identified and removed from the line for more detailed inspection.

6.11.1.4. Public health and meat quality

The table below lists the current *post-mortem* categories *post-mortem* categories recorded on the FSA Innova system:

Table 3. Innova *POST-MORTEM* categories

BIRD-RELATED CATEGORIES
Abnormal colour/fever
Ascites/Oedema
Brusing/Fractures
Cellulitis
Dermatitis
Emaciation
Hepatitis
Joint lesions
Overscald
Pericarditis
Perihepatitis/peritonitis
Respiratory disease (air sacculitis)
Salpingitis
Tumours/nodules.
Other farm (Jaundice, Oregon, White muscle, Congenital malformations)
PROCESSING-RELATED CATEGORIES
Contamination
Machine Damage
Other factory (poor plucking, product requirements not met)

Most of the bird-related conditions pose no risk for food safety, and carcases showing signs are rejected on grounds of quality rather than food safety. The main food borne pathogens identified as of relevance to public health – Salmonella and Campylobacter - are not implicated in the aetiology of the conditions on the list.

Current EU legislation, Regulation (EC) No 854/2004, requires meat to be declared unfit for human consumption if it:

- derives from animals affected by a generalised disease, such as generalised septicaemia, pyaemia, toxaemia or viraemia;
- derives from emaciated animals.

It is worthy of note that there are marked differences between countries in the EU (and worldwide) in the number of reasons for rejection of carcases and also in the actions taken (whole bird or partial rejection) for individual conditions[57].

It is not in the scope of this report to discuss all of the possible reasons for rejection. Ascites and abnormal colour are considered here as examples.

Ascites/oedema is an important reason for rejection of whole birds in UK and is a condition whose aetiology/epidemiology is not fully understood but is generally considered to be a metabolic disorder, not an infectious disease. It can be concluded that rejection of carcases for ascites is done for reasons of meat quality rather than food safety. Ascites is usually detected at whole-bird inspection, but the decision whether to reject carcases is a very subjective, and so there can be significant variations in rejection rates between inspectors and inspection teams.

Accurate recording of the level of ascites in a flock is important because it may stimulate action to be taken on the farm of origin to prevent or reduce occurrence in subsequent batches.

Removing ascites suspects from the line for more detailed inspection, together with a more precise case definition for recording ascites, would promote more accurate recording.

Abnormal colour, which is usually detected at whole-bird inspection, may occur as a result of septicaemia, pyaemia, toxaemia or viraemia. However, several other conditions may cause discoloured carcases, and the recording of 'abnormal colour' as a reason for rejecting carcases may provide little valuable information for producers or their veterinarians.

Again, the removal of carcases with abnormal colour from the line for more detailed inspection, together with more precise definitions for recording abnormal colour, would promote more accurate recording and may result in a reduction in the number of whole bird rejections.

6.11.1.5. Actions following detection of *post-mortem* conditions

The current list of *post-mortem* conditions recorded by inspectors uses the headings 'whole rejections' or 'partial rejections'. This terminology does not permit the recording of conditions that do not result in rejection of meat, and promotes the categorisation of birds identified with any of the listed conditions as unfit for human consumption.

We propose that there should be separation of the terms used for conditions recorded and for the judgement of fitness for human consumption; 'rejection' should be restricted to carcases that are detected as displaying signs of conditions of public health significance. Where some of the conditions in the list are detected and rejected on quality grounds, it may be possible to salvage some meat following a more detailed inspection of carcases.

We have been made aware of recent changes to the actions taken on detection of hepatitis and pericarditis, namely partial rejection rather than whole-bird rejection as previously.

Such a move may provide an incentive for FBOs to invest in modifications to their equipment and the deployment of additional inspectors to allow the selective removal of carcases for detailed inspection. Positive outcomes would be that detailed inspection of carcases with visible pathological changes or other abnormalities would generate more accurate and reliable inspection results and the reduced rejection of edible meat.

6.11.1.6. Recommendations – poultry CCIR

- The list of conditions under which *post-mortem* inspection findings are recorded should be subject to expert scrutiny to distinguish between those that present a public health risk and those that are meat quality issues.

[57] http://www.efsa.europa.eu/en/search/doc/298e.pdf

- An optimal list of condition categories to be recorded should be determined by collaboration between all stakeholders including producers, processors, poultry veterinary specialists, disease surveillance and poultry welfare experts.
- Case condition definitions should be developed for recorded headings to increase the objectivity and consistency of decisions by inspectors.
- Technological changes to processing lines should be investigated with a view to implementing systems that allow carcases with visible pathological changes or other abnormalities to be removed from the line for further examination.
- Carcases with visible pathological changes or other abnormalities should be subject to more detailed examination, with concomitant improvement in the accuracy and reliability of inspection results.
- Processing line inspection points should be equipped with data capture facilities – ideally electronic - commensurate with the line speed.

We present below our proposals for inspection results categories. These proposals, which have been developed in collaboration with industry representatives, include a wider range of conditions of relevance to product quality whose inclusion in CCIR reported back to producers has the potential to inform flock health planning decisions and to improve the health and welfare of subsequent batches. Applying this longer list of conditions is clearly not feasible for inspectors working at normal line speeds and would require the implementation of systems that remove abnormal birds from the line for further inspection.

6.11.1.7. Proposed CCIR poultry

Condition	Sub-category	Public Health	Animal Health	Animal Welfare	Meat/ product quality	Comments
ANTE-MORTEM						
Dead on Arrival			Y	Y		
A-M rejects (cull/runts)			Y	Y		
POST-MORTEM						
BIRD/FARM-RELATED CONDITIONS						
Ascites/oedema			Y	Y	Y	Welfare indicator
Abnormal colour	Toxaemia/ septicaemia	Y	Y	Y		
	Dehydration		Y	Y	Y	
	Physical causes			Y	Y	
	Other causes					
Pus in the body cavity/around the organs			Y	Y	Y	
Skin lesions (not tears)			Y	Y	Y	
Leg bruised				Y	Y	
Breast abnormality	Superficial pectoral myositis ("wooden breast")		Y	Y	Y	
	Deep pectoral myopathy ("oregan disease")		Y	Y	Y	
Emaciation		Y	Y	Y		Welfare indicator. Reject on PH grounds
Bacterial septicaemia		Y	Y	Y	Y	Reject on PH grounds
Pericarditis			Y	Y	Y	

Perihepatitis			Y	Y	Y	
Peritonitis			Y	Y	Y	
Focal hepatitis			Y	Y	Y	
Air Sacculitis			Y	Y	Y	Welfare indicator
Arthritis			Y	Y	Y	Welfare indicator
Tendon rupture			Y	Y	Y	
Cellulitis			Y	Y	Y	Welfare indicator
Dermatitis			Y	Y	Y	Welfare indicator
Skin tumour			Y	Y	Y	
Jaundice			Y	Y	Y	
Dehydration			Y	Y	Y	
Visceral tumour			Y	Y	Y	
Fractures			Y	Y	Y	
Bruises			Y	Y	Y	
Foot pad dermatitis			Y	Y	Y	Welfare indicator
PROCESS-RELATED CONDITIONS						
Tears					Y	
Overscald					Y	
Plucking					Y	
Poor bleeding					Y	
Contamination		Y				
Machine damage					Y	

6.11.2. Pigs

The BPHS CCIR Transition Roadmap is a BPEX project that is investigating CCIR provided by FSA and how this may replace the animal health information currently gathered by the BPHS.

BPHS is a voluntary, chargeable scheme for pig producers and operates by the collection of post-mortem findings by a team of specialist pig veterinarians at abattoirs at regular intervals. BPEX now plans to discontinue the scheme, and the BPHS CCIR Transition Roadmap involves a number of projects that have a similar objective to the subject of this report, namely to improve CCIR for pigs.

The premise of the BPEX Roadmap is 'Health data from pigs post-slaughter is a valuable source of information for vets and farmers to manage disease and improve carcase quality and performance efficiency'. BPEX recognises that, if the data is to be used for decision making, there needs to be confidence that the data is robust and reliable' and its stated aim is 'Cost-efficient communication of reliable health information on slaughter pigs for processors, vets, producers and other industry stakeholders'.

The BPEX BPHS-CCIR Transition Report has been published during the preparation of this report. The views expressed in the BPEX report are very much in accordance with our general findings.

In line with our general discussion above, we propose that a fundamental review of condition categories associated case definitions is carried out by pig veterinarians, surveillance experts and pig and meat industry representative bodies to determine their requirements for inspection results and the appropriate level of accuracy.

We include below, as a starting point for stakeholder discussions, our proposals for inspection results categories.

6.11.2.1. Proposed CCIR Pigs

CLASS OF PIGS
Prime pigs
Adult sows/boars

ANTE-MORTEM

CONDITION	PH	AH	AW	COMMENTS
Dead on arrival (DOA)		Y	Y	
Dead in lairage (DIL)		Y	Y	
Moribund/ Recumbent	Y	Y	Y	
Signs of illness or distress/suspect fever	Y	Y	Y	
Poor body condition	Y	Y	Y	Condition score 1 (emaciated) or less
Lame	(Y)	Y	Y	Mobility score
Abnormal respiratory signs	Y	Y	Y	
[bloody] Diarrhoea	Y	Y	Y	
Neurological signs	Y	Y	Y	Not on current list
Skin condition		Y	Y	Not on current list – detected at *post-mortem*?
Eye condition		Y	Y	Not on current list
Rectal prolapse		Y	Y	
Wounds			Y	
Hernia/rupture			Y	
Suspect notifiable disease		Y		
Other				
OMITTED				
Mastitis				Difficult to detect at *ante-mortem* inspection
Orchitis				
Twisted snout				
Tail bite				Detected at *post-mortem* inspection

CARCASE

LOW LEVEL RECORDING		**HIGH LEVEL RECORDING**	**ADDITIONAL**	PH	AH	AW	Product Quality	COMMENTS
Joint lesions					Y	Y	Y	
Peritonitis				Y	Y		Y	
Pleurisy				Y	Y		Y	
Tail Bite					Y	Y	Y	
Skin Condition		Papular dermatitis	Score		Y	Y	Y	BPHS system
		Erysipelas-like lesions			Y		Y	
		Fight wounds				Y	Y	
Bruising						Y	Y	
Abscess					Y		Y	
Swelling/abnormal tissue mass					Y		Y	
TB-like lesions (Notifiable)					Y		Y	
Kidney lesion					Y			
Other - Pathology					Y		Y	
Machine damage							Y	
Overscald							Y	
Other - Processing fault							Y	
Contamination	gut content			Y			Y	
	bile						Y	
	grease						Y	
	hair						Y	
OMITTED from current list								
Bursitis								
Fracture								
Joint lesions - Other								
Mastitis								

OFFALS

LOW LEVEL RECORDING		HIGH LEVEL RECORDING	ADDITIONAL	PH	AH	AW	Product Quality	COMMENTS
Lung lesions		Enzootic pneumonia-like lesions	Score		Y			BPHS categories
		Viral-like lesions			Y			
		Chronic pleuropneumonia			Y			
		Active pleuropneumonia			Y			
		Discrete lung abscess			Y			
		Pyaemia – multiple small abscesses			Y			
Liver abnormal		Milk spot			Y		Y	BPHS categories
		Hepatic scarring			Y		Y	
		Other			Y		Y	
Heart abnormal					Y		Y	
Enteric disease					Y			
Other – Pathology					Y		Y	
Processing conditions								
Contamination	gut content			Y			Y	
	bile						Y	
Blood Splash						Y	Y	
Other - Processing fault							Y	
OMITTED from current list								
Abscess								
Endocarditis								
Kidney lesion								Carcase
Machine damage								
Milk Spot - Localised								
Milk Spot - Generalised								
Pericarditis								
Peritonitis								Carcase
Pleurisy								Carcase
Pneumonia with abscess								
Pneumonia without abscess								
Pneumonia with pleurisy								
TB like lesions (Notifiable)								Head glands inspected with carcase

6.11.3. Cattle

The speed of cattle slaughter lines provides more time for recording of inspection results and so our proposal for a reduced number of condition heading may not apply to cattle.

Where touch screens or similar electronic recording devices are used, we recommend that the main screen at each inspection point should include only a limited number of commonly recorded findings.

We further recommend that the value of the large number of body parts and organs that are included on the current Innova input screen is assessed with a view to reducing the number to facilitate the rapid recording of inspection findings.

One area where we believe there is an opportunity to increase the number of headings is fascioliasis, which has significant economic impacts on production. Furthermore there are concerns about the development of resistance to flukicides; more detailed recording of liver pathology may contribute to surveillance for resistance.

We include below, as a starting point for stakeholder discussions, our proposals for inspection results categories.

6.11.3.1. Proposed CCIR cattle

CLASS OF ANIMAL
Calves
Prime cattle
Dairy cows
Beef cows/bulls

ANTE-MORTEM

CONDITION	PH	AH	AW	COMMENTS
Dead on arrival (DOA)		Y	Y	
Dead in lairage (DIL)		Y	Y	
Moribund/ Recumbent	Y	Y	Y	
Signs of illness/suspect fever	Y	Y	Y	
Poor body condition	Y	Y	Y	Condition score 2 or less on a 5-point scoring system
Lame	(Y)	Y	Y	Mobility score
Abnormal respiratory signs	Y	Y	Y	
Diarrhoea	Y	Y	Y	
Neurological signs	Y	Y	Y	
Skin condition		Y	Y	
Eye condition		Y	Y	
Prolapse		Y	Y	
Wounds		Y	Y	
Suspect notifiable disease		Y		
Other				

POST-MORTEM

CARCASE

LOW LEVEL RECORDING	HIGH LEVEL RECORDING		PH	AH	AW	Meat Quality	COMMENTS
Pleurisy				Y		Y	
Peritonitis			Y	Y		Y	
Abscess				Y		Y	
C. bovis			Y			Y	
Joint lesion				Y	Y		
Swelling/abnormal tissue mass				Y	Y	Y	
Bruising					Y	Y	
Kidney abnormal							
Uterus - pregnant				Y	Y		
Emaciation/oedema				Y	Y	Y	
Septicaemia			Y	Y		Y	
Generalised abnormality	Abnormal colour	Anaemia		Y		Y	
		Suspect fever	Y	Y		Y	
		Jaundice				Y	
Other – Pathology						Y	
Processing conditions							
Contamination	Faeces/gut contents		Y			Y	
	Bile					Y	
	Hair		Y			Y	
	Grease					Y	
Other - Processing fault						Y	

HEAD, PLUCK AND GUTSET

LOW LEVEL RECORDING		HIGH LEVEL RECORDING	PH	AH	AW	Product Quality	COMMENTS
Lung abnormal		Pneumonia		Y		Y	Pleurisy – record under carcase
		Lungworm		Y		Y	
		Abscess		Y		Y	
Heart abnormal		Endocarditis		Y		Y	
		Pericarditis		Y		Y	
Liver abnormal		Fluke (immature) in parenchyma		Y		Y	
		Fluke (mature) in bile ducts		Y		Y	
		Fluke - scars/historical lesions		Y		Y	
		Abscess		Y		Y	
		Other		Y		Y	
Head Swelling/abnormal tissue mass				Y		Y	
Suspect TB				Y			
C. bovis			Y			Y	
Gutset abnormal		Enteritis		Y			Peritonitis – record under carcase
		Traumatic reticulitis	Y	Y			
Uterus - pregnant				Y	Y		
Other – Pathology				Y		Y	
Processing conditions							
Contamination	Faeces/gut contents		Y			Y	
	Bile					Y	
Other - Processing fault						Y	
OMITTED							
Mastitis							Udder removed before inspection

6.11.4. Sheep

We consider that the number of conditions for carcase and offals and the number of body parts and organs on the current recording screen is excessive for accurate recording on fast sheep slaughter lines.

MLCSL report recorded that the most commonly

We have produced the draft list of conditions below as a starting point for discussion amongst stakeholders.

6.11.4.1. Proposed CCIR sheep

CLASS OF SHEEP
Lambs/hoggs
Adult ewes/rams

ANTE – MORTEM

CONDITION		PH	AH	AW	COMMENTS
Dead on arrival (DOA)			Y	Y	
Dead in lairage (DIL)			Y	Y	
Moribund/ Recumbent		Y	Y	Y	
Signs of illness or fever		Y	Y	Y	
[Poor body condition]		Y	Y	Y	< condition score 1 or less. Assessment generally not feasible for unshorn sheep
Lame		(Y)	Y	Y	Lameness score. Differentiation into foot/joint/musculo-skeletal causes not considered feasible.
Abnormal respiratory signs		Y	Y	Y	Includes altered respiratory rate/depth, nasal discharge, coughing, nasal discharge
Diarrhoea		Y	Y	Y	
Neurological signs		Y	Y	Y	
Skin condition	Suspect scab		Y	Y	
	Fly strike		Y	Y	
	Other				
Eye condition			Y	Y	
Prolapse			Y	Y	

POST – MORTEM CARCASE

LOW LEVEL RECORDING	HIGH LEVEL RECORDING		PH	AH	AW	Meat Quality	COMMENTS
Body cavity abnormality	Pleurisy			Y	Y	Y	Avoid double recording – carcase and pluck/guts
	Peritonitis			Y	Y	Y	Avoid double recording – carcase and pluck/guts
Contamination	Contamination	Faeces/gut contents	Y			Y	
		Wool/hair	Y			Y	
		Bile				Y	
		Grease				Y	
Cysts	Cysts - includes C. Ovis, C.tenuicollis, hydatid (echinococcus), sarcocyst			Y		Y	Similar epidemiology and control measures (management of dogs on farm). No requirement to identify cyst type. Need (IT?) system to avoid double recording – carcase and pluck/guts
Generalised abnormality	Abnormal colour	Anaemia		Y		Y	
		Suspect fever	Y	Y		Y	
		Jaundice				Y	
Oedema/emaciation				Y	Y	Y	
Focal swelling/damage (single location)	Joint lesions			Y	Y	Y	
	Abscess			Y		Y	
	Fracture				Y		
	Swelling/abnormal tissue mass			Y		Y	
	Fly strike			Y	Y	Y	
	Bruising				Y	Y	
Kidney abnormal				Y		Y	
Septicaemia			Y	Y	Y	Y	
Suspect CLA				Y		Y	
Suspect TB				Y		Y	
Other – Pathology*				Y		Y	
Other - Processing fault*						Y	

OFFALS - PLUCK AND GUTSET

LOW LEVEL RECORDING	**HIGH LEVEL RECORDING**		PH	AH	AW	Product Quality	COMMENTS
Heart abnormal				Y		Y	
Lungs abnormal	Lungworm			Y	Y	Y	
	Pneumonia			Y	Y	Y	Record pleurisy under carcase – to avoid double recording
Liver abnormal	Fluke (immature) in parenchyma			Y		Y	
	Fluke (mature) in bile ducts			Y		Y	
	Fluke - scars/historical lesions			Y		Y	
Cysts	Cysts - includes C. Ovis, C.tenuicollis, hydatid (echinococcus), sarcocyst			Y		Y	Similar epidemiology and control measures (management of dogs on farm). No requirement to identify cyst type.
Guts abnormal/ Enteric disease				Y			
							Kidney moved to carcase
Uterus - pregnant				Y			May be removed before inspection point
Processing conditions							
Contamination	Contamination	Faeces/gut contents	Y			Y	
		Bile				Y	

6.12. Notes on FCI, CCIR and the holding of provenance

Legislation requires abattoir FBOs not to accept animals unless they have received FCI contained in the records kept at the holding of provenance, and the OV to communicate inspection results to the food business operator responsible for the holding of provenance.

The concept of a flow of information – FCI and CCIR – between the holding of provenance and the abattoir, upon which the EU legislation has been based, serves well the intensively-reared species, poultry and pigs, where the holding of provenance is usually clearly defined and movements to slaughter are directly from the holding where the animals have been reared or finished to the abattoir.

For a significant proportion of the ruminant species, the marketing arrangements may include a change of ownership in the period immediately before slaughter, through markets and/or intermediaries (dealers, collection centres). In such cases the identity of the 'holding of provenance' is less clearly defined.

6.12.1. FCI

For FCI, our view is that it is the owner of the animals at the time they are consigned for slaughter who is required to provide FCI; a consignor who has owned the animals for only a short period must ensure that they have received relevant information from previous owners to enable them to provide the FCI. In the case of declarations about veterinary medicinal products, it should be noted that some products have withdrawal periods up to 5 months.

FCI for animals, particularly sheep, sent for slaughter from markets presents major difficulties, since a consignment (lorry load) may comprise a mixed group of animals from a large number of holdings.

In the case of slaughter animals sold through markets, FSA has produced model FCI documents[58] which take the form of a composite declaration, to be provided by the auctioneer.

As we have discussed under food safety hazards, the practicality and value of FCI is diminished by the movement and mixing of animals from different sources and by deviation from integrated production chains.

6.12.2. CCIR

Communicating inspection results to the FBO (farmer) of the holding of provenance is straight forward for direct movements from the farm where the animals have spent their entire lives or the finishing period. Inspection results will be of relevance to the operators of these holdings of provenance.

We understand that current arrangements for communicating inspection results, where this is done, are limited to reporting to the consignor. For cattle, which are identifiable at the abattoir throughout the process, including at the *post-mortem* inspection point, and whose life time movements are traced, it would be possible to record the inspection results for each animal against its last holding or any other previous holding on which it resided.

Similarly, once all slaughter sheep are electronically identified, it should be technically possible for each sheep to be individually identified at the inspection point and its inspection results to be recorded against any holding on which it resided.

Where animals have moved and changed ownership in the immediate pre-slaughter period (e.g. finishers or dealers), the decision about the holding against which the inspection results should be recorded is more difficult. CCIR should be recorded against the holding where the issue is most likely to have arisen, both to inform herd/flock health planning decisions and to be included in the holding FCI profile for subsequent batches. There will be limited or no benefit for preventative health planning or FCI purposes in recording CCIR against the holding of a dealer who has owned the

[58] http://www.food.gov.uk/sites/default/files/multimedia/pdfs/fcimarketdec.pdf

animals for a period of days. The position for animals that have been purchased for finishing will be dependent on the duration of the finishing period and the nature and epidemiology of the problem(s) identified.

Although public and animal health benefits of recording CCIR against the holding of dealers or short-term finishers are limited, these FBOs will have commercial interest in CCIR to inform their procurement policies for subsequent purchases i.e. not to purchase from areas or producers whose animals CCIR shows to have health or productivity problems.

We consider that there is a need to establish rules about which holding to allocate inspection results for animals that have moved in the immediate pre-slaughter period, including determination of relevant residence periods on holdings; such rules should be determined through discussion between FSA and all relevant stakeholders.

6.12.3. FCI and herd/flock health planning

FVE definition of herd/flock health planning is 'a method to optimise animal health and welfare using systematic analysis of relevant data and regular clinical observations of the animals and their environment to allow informed and timely decisions to improve animal health and farmer profitability'[59].

The aims of herd/flock health planning include

- Optimal animal health and welfare.
- Optimal farmer profitability and reduced farmer stress.
- Quality safe food and increased consumer confidence.
- Prevention of zoonoses
- Disease surveillance

Analysis of relevant data is an essential component of health planning to measure health and welfare and to assess the impact of on-farm interventions on health and welfare and profitability.

Health planning is applied to varying extents in animal production systems. Herd health planning is highly developed in the dairy industry which uses milk production data and other cow performance information as measures of the outcome of management decisions. For meat animal production, many of the important outcomes are based on the assessment of carcases e.g. carcase weight and conformation category, back fat measurements for pigs.

Post-mortem inspection findings are valuable data for herd/flock health planning by providing information about conditions that may have an impact on the health and performance of animals but which may not be apparent in live animals.

Detailed discussion about the practical application of CCIR in health planning is beyond the scope of this project; Sanchez-Vazquez[60] et al have published comprehensive consideration of the use of *post-mortem* inspection results in informing herd health planning for pigs, their added value of providing nationwide disease monitoring information and use as a useful surveillance tool for emerging and enzootic conditions.

Most third party farm assurance schemes, including all the Red Tractor Standards, include the requirement for formal herd/flock health planning. Some schemes stipulate the involvement of the producer's vet in the development and regular review of health plans. Study of abattoir feedback (CCIR) is required as part of the regular review of health plans.

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http://www.fve.org/uploads/publications/docs/fve_10_054_hhplan_uevh_uevp_final_2010%20%282%29.pdf

[60] M. J. Sanchez-Vazquez, W. D. Strachan, D. Armstrong, M. Nielen, G. J. Gunn (2011) The British pig health schemes: integrated systems for large-scale pig abattoir lesion monitoring. *Veterinary Record* 2011 169: 413

The value of *post-mortem* inspection findings as a data source for health planning in the pig sector is demonstrated by the current investment in the BPHS.

Reliable CCIR gives information to producers about conditions in their animals and can be used at the industry level to generate information for an entire sector about specific conditions and to enable the individual producers to benchmark their performance and thus to identify areas for possible action.

We have discussed earlier in the report the critical importance of the accuracy and reliability of CCIR, the issues about feedback of information to producers, particularly for cattle and sheep, and the actions needed to improve CCIR. Some abattoir FBOs have, on their own initiative, implemented systems for providing CCIR to their cattle and sheep suppliers but most producers do not currently receive this information.

An illustrative example of the opportunities for improved CCIR informing herd/flock health planning and benefitting animal health and productivity is liver fluke, Fascioliasis.

6.12.4. Liver Fluke (Fascioliasis)

Fasciola hepatica is an economically significant parasite of cattle and sheep. Sources of economic losses include impaired growth rates, reduced reproductive efficiency and reduced milk yields in infested animals and the rejection of affected livers at *post-mortem* inspection. Fluke can cause acute or chronic liver damage and is generally seasonal in occurrence.

Changes in the pattern of fluke infestations in GB have been observed in recent years; possible reasons for this that have been cited include climate change, drug resistance, animal movements and farm-specific factors.

Post-mortem meat inspection is of great importance in the detection of liver fluke at the herd/flock level. Differentiation of the stage of disease – immature fluke in liver parenchyma; mature fluke in bile ducts; scars/historical lesions – provides important epidemiological information about the disease for producers and, for this reason and the economic impact of fluke, we have proposed a higher level of detail for the recording of *post-mortem* results for fluke.

Accurate information about the prevalence of fluke in cattle and sheep will enable producers to take actions to control fluke in other animals on the farm and to assess the effectiveness of control measures.

Fluke prevalence data recorded against farms of origin will be of improved value for surveillance of the disease on geographical and seasonal bases and may provide information about possible drug resistance.

CCIR data are currently used for health planning at the sectoral level by the intensively-reared poultry and pig sectors and to a lesser extent by the ruminant sector. Improved CCIR will provide better data for all sectors; we believe there are marked opportunities for the ruminant species to develop sector-wide schemes, as exemplified by the recommendations of the Scottish Beef 2020 Report.

6.12.5. Scottish Beef 2020 Report[61]

This 2014 report for the Scottish Government was commissioned to develop recommendations to policy makers and others that will facilitate sustainable and long term growth in beef production levels within Scotland.

The Beef 2020 Report cites the Scottish pig industry, through the cooperative venture Wholesome Pigs, as an exemplar of how feedback of clinical and sub clinical animal health indicators can lead to significant economic benefit to producers. By collecting evidence at time of slaughter of subclinical disease the pig industry has been able to take prompt action to prevent health issues gaining ground among pig herds and through that improve market returns.

[61] http://www.gov.scot/Publications/2014/08/2085/downloads#res457906

One of the Report's recommendations is to 'develop an integrated and accessible database containing livestock traceability data, farm assurance status and non-financial information collected at various points in the animal's life including breeding information related to physical performance, carcase weight, grade and health status as well as downgrades'.

This recommendation is supported by our proposals for improved CCIR and for the development of IT systems that will enable CCIR to be integrated with animal movement and traceability data and to be recorded against the animals' farm of provenance. The Report envisages that the data held on individual animals would be accessible by all those who have owned the animal at any point. This will allow calf producers to monitor how their animals finally grade and finish and help to inform their breeding decisions.

The Beef 2020 Report states that producers will also benefit from being able to assess the performance outcomes of different production decisions as well as the effectiveness of disease prevention measures, all of which will lead to a more sustainable and productive industry.

The wider community will gain through the improved efficiency of beef production by reduction in greenhouse gas emissions per kilogram of beef produced.

With reference to our comments above about fluke, it is worthy of note that a specific animal health recommendation in the Beef 2020 Report, in recognition of the economic significance of fluke, is for an industry-wide initiative for the reduction and control of liver fluke.

7. IDENTIFICATION OF AREAS FOR IMPROVEMENT

7.1. General – all species

The FSA has been considering the issue of modernising the system of *ante* and *post-mortem* meat inspection for a number of years. The principal issue being examined by this study is that the most important veterinary public health, animal health and animal welfare hazards prevalent today are not adequately addressed by the present system of *ante* and *post-mortem* inspection. Furthermore some of the methods and procedures used during meat inspection (such as handling of carcasses and cutting lymph nodes) may even be counter-productive and increase the microbiological contamination of the carcasses.

Visual-only meat inspection (pigs and poultry) has been introduced on EU level, where the meat inspectors do not touch the carcass or cut the lymph nodes as is the practice in the existing system – except in case of pathological changed being detected. A precondition for that system is the parallel introduction and use of reliable and relevant food chain information presented by the producer to the slaughterhouse, providing the OV with information on animal health and treatments at farm level. This system of food chain information and visual inspection was introduced in European Union legislation in 2004 and has been implemented step by step since[62].

The food chain information is at present generally more useful when it is provided as part of a health scheme and when there is integration or linking along the supply chain. The nature of pig and poultry supply chains means therefore that provision of FCI tends to be more advanced than the beef and sheep sectors. In situations where industry health schemes are already working effectively, it may be that no further action is required by the FSA beyond monitoring the control systems. However, as reported in section 4, zoonotic diseases are still prevalent and a further harmonization of the approach between the species would be helpful.

[62] See for consolidated texts:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2004R0854:20091101:EN:PDF
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2005R2073:20100519:EN:PDF
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2004R0853:20100101:EN:PDF

Carcase contamination with pathogenic organisms is a function of the presence/absence of or number of organisms in/on live animals on arrival at the abattoir and the effectiveness of the FBO's food safety management systems to prevent contamination of meat during the slaughter and dressing process.

For beef and sheep producers in particular, it can be difficult and costly to collect information on microbiological hazards at farm level. They may also have a conflict of interest in some circumstances when providing information on diagnosis and treatments on their farms which may result in penalties for high levels of infection although at present there are no penalties based on the ante or *post-mortem* results.

A further problem with regard to zoonotic infections is that live animals may show little or no symptoms of disease: if there are no obvious animal health (or welfare) effects, the producer has little motivation to invest in controlling the hazards without some sort of incentive. Even when an animal shows clinical signs of disease at meat inspection, the producer may not be penalised if the animal has been sold on a live weight basis.

The system laid down today in the European Union legislation does not answer the question of how and where to collect the data regarding zoonotic infection (e.g. Salmonella, Campylobacter, and E. coli (VTEC)) but the decision on further investigation rests with the official veterinarian, (see Annex I, Chapter II (D), 2 of Regulation 854/2004[10]: "Additional examinations are to take place, such as ….. and laboratory tests, whenever considered necessary: (a) to reach a definitive diagnosis").

The system of pharmcovigilance has been introduced on EU level, but not fully implemented in the UK. This system requires the registration of the use of veterinary medicines in livestock, both for preventive and treatment purposes. One of the main reasons for this is a steady increase in antimicrobial resistance requiring new drugs to be developed and resulting in reduced efficiency when used to treat diseases in humans. The legislation stipulates that animals which are treated should be identified or batch of animals if applicable. In some countries this treatment register has been centralised in nation-wide database providing access to official veterinarians at slaughterhouses and food business operators. This has not been implemented as yet in the United Kingdom. While systems are in place to collect samples for the national residue control program, there are no risk based systems for targeted sampling from farms and animals with increased used of veterinary medicinal products.

7.2. Quality of inspection results

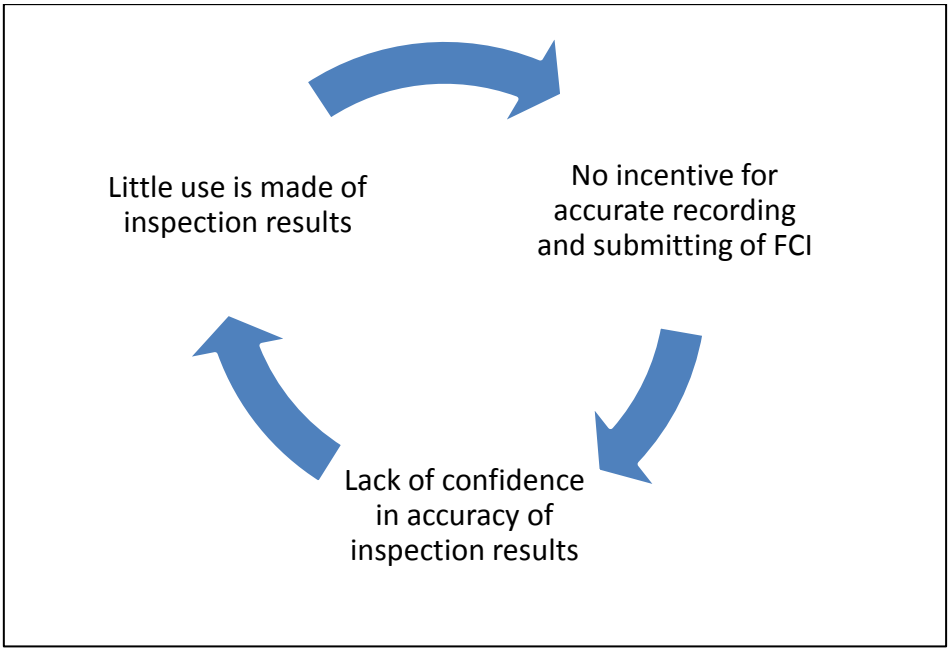
A lack of confidence in the quality of inspection results has been identified as a major problem by the industry.

One processor in the pig sector has produced evidence of marked variations in the reporting of inspection results for pigs from the same farm consigned to different abattoirs and is currently working directly with FSA to develop so-called 'disease cards' – in effect, case definitions for each category of *post-mortem* finding recorded.

The accuracy and reliability of inspection results are questioned in all species. There is a lack of consistency between MHIs in ascribing findings to specific categories; there are no standard definitions for *post-mortem* findings. The inspection should be improved and harmonized through intensive training and better technology. The CCIR data will only be as good as the primary data available at the time of collection. Poor data will erode the trust of intended users.

It is our conclusion that the current system of FCI and CCIR is not fit for purpose due to the deficiencies referred to above. For illustration purposes we have summarised this graphically as a "Vicious Circle", see below:

Figure 3. Vicious Circle of FCI/CCIR



7.3. Data capture methods

In most plants, the method by which inspection results are captured by MHIs is determined by the inspectors themselves. On fast-moving lines, systems based on mechanical tallies and paper may not be adequate for effective and accurate data capture.

FBO-owned touch screen terminals are in use in some plants, but in most cases these are not integrated with FSA systems, resulting in laborious and time-consuming manual transfer. It is an essential precondition for any system to avoid double entry of data.

7.4. FSA IT systems – Innova

The study understands that FSA took a decision in 2011 not to continue to up-date the Innova system but instead to replace it with its own system. A replacement system has not been introduced and the Innova system has been continued on a maintenance-only basis and has not been amended or up-dated since 2011.

Innova is used for recording of information for cattle, pigs and poultry, but plans to include sheep have never been implemented.

Improvements in FSA IT systems for FCI and CCIR are included in the FSA Digital Data Project.

7.5. Actions at the abattoir

A principle of this study is that information contained in both FCI and CCIR must be of tangible use and value to the recipients. In the case of FCI, the information should provoke actions at the abattoir by either the FBO or the FSA officials. Consideration is required of the possible actions that might be taken by both parties when deciding on the specific FCI to be included in the updated model.

The inspection methods applied today do not capture the main food hazards prevalent in the food chain today, such as Salmonella, Campylobacter, VTEC and veterinary medicinal drugs. These hazards can only be captured using laboratory methods.

7.6. Role of Authorised Meat Inspectors

Improvement in FCI and CCIR systems will involve a change in focus of Meat Hygiene Inspector activities in abattoirs. Training is needed to inform inspectors of the changes to the system and harmonize the inspection results.

7.7. Pigs

7.7.1. Visual-only inspection

The implementation of visual-only inspection, which is in progress, will have an impact on food safety and CCIR. Changes to inspection procedures may place additional burdens on FCI but at the same time increase its value considerably.

7.7.2. British Pig Health Scheme - BPHS

The BPHS represents a significant cost to the pig industry, and some producers question the need for an independent assessment of pig carcasses when every carcass is inspected by a Meat Hygiene Inspector. Consideration is needed as to how routine inspection might replace or compliment the BPHS.

7.8. Sheep

The nature of the sheep industry, in particular marketing arrangements for sheep pose major problems for both FCI and CCIR. Although traceability is a legal requirement, in practice it is very difficult to correlate sheep in mixed batches with their farms of origin. The requirement for abattoir FBOs to read the EID tags of all sheep received is new, and it remains to be seen how this will affect the market for procurement of sheep and the ability of FBOs to connect sheep with their farms of origin.

8. DESIGN OF IMPROVED FCI/CCIR MODEL

8.1. Proposed enhanced inspection procedures

8.1.1. The FCI/CCIR model – a new conceptual risk-based approach

In order to break the vicious circle illustrated above, an enhanced FCI/CCIR system is proposed based on information flows provided. The key attributes of the new model are:

- enhanced data capture, handling and utilisation, and;
- increased sampling and laboratory analysis (microbiology and residues).

In the first instance the circle would be broken not only by requiring improved FCI from producers, but also by increased sampling on the slaughter line during meat inspection. This is considered to be a straightforward, precise and reliable method of data collection which will compliment sampling at farm level. This sampling location is considered to be the only place along the food chain where sampling can be carried out economically by an independent agent (third party) by avoiding expensive traveling and time consuming sampling on farms.

This approach applies to the same extent whether or not FCI is satisfactory as low level sampling would always be done for monitoring purposes creating a baseline reference level of prevalence of zoonotic diseases. The level of sampling and the selection of diseases could be decided annually or multi-annually by the FSA based on scientific risk assessment and changes in prevalence of the pathogens concerned.

The results of both types of sampling, for microbiology and for residues of veterinary medicinal products, could be used to determine the level of sampling of the next batch of animals from the same holding (risk-based sampling). In case of a positive result for either of these parameters, the level of sampling would be increased or decreased as the case might be. It could be considered at a later stage to charge the producer of the animals for additional sampling and analysing, introducing an incentive for the producer to improve the health situation in holding.

The system described in section 8.2 below could be used to register the use of veterinary medicinal products and the reason for their use (e.g. diagnosis of disease or preventive) at farm level. This information could be used at the slaughterhouse for risk-based sampling referred to above for

improved detection of veterinary medicinal products, as well as being used centrally to register trends in their general use. The impact of these products on the consumer is discussed below in Chapter 9.

It is anticipated to use (i.e. to link to) the animal identification and movement control system to ensure that the owner of the animals being slaughtered, intermediates and initial owner are informed of results in any case as appropriate.

Whilst we recognise that the epidemiology of the main zoonotic agents is not always fully understood and we do not necessarily know how to control them in primary production, we emphasise that no progress is possible without knowledge of their presence or absence on individual farms.

The low level sampling (circa 1% for all animals except poultry, which would be 0.1%) is presented here to illustrate how to create and maintain information on the baseline prevalence level. The samples would be taken by the official veterinarian/meat inspector *post-mortem*, to be delivered to a laboratory for analysis. The results would be fed directly into a central database. The cost would be an integrated part of the overall inspection costs.

It is underlined that the samples referred to here are over and above any statutory sampling done today and referred to in Commission Regulation (EC) No 2073/2005[63].

The new results from sampling proposed by our study would be used for four purposes:

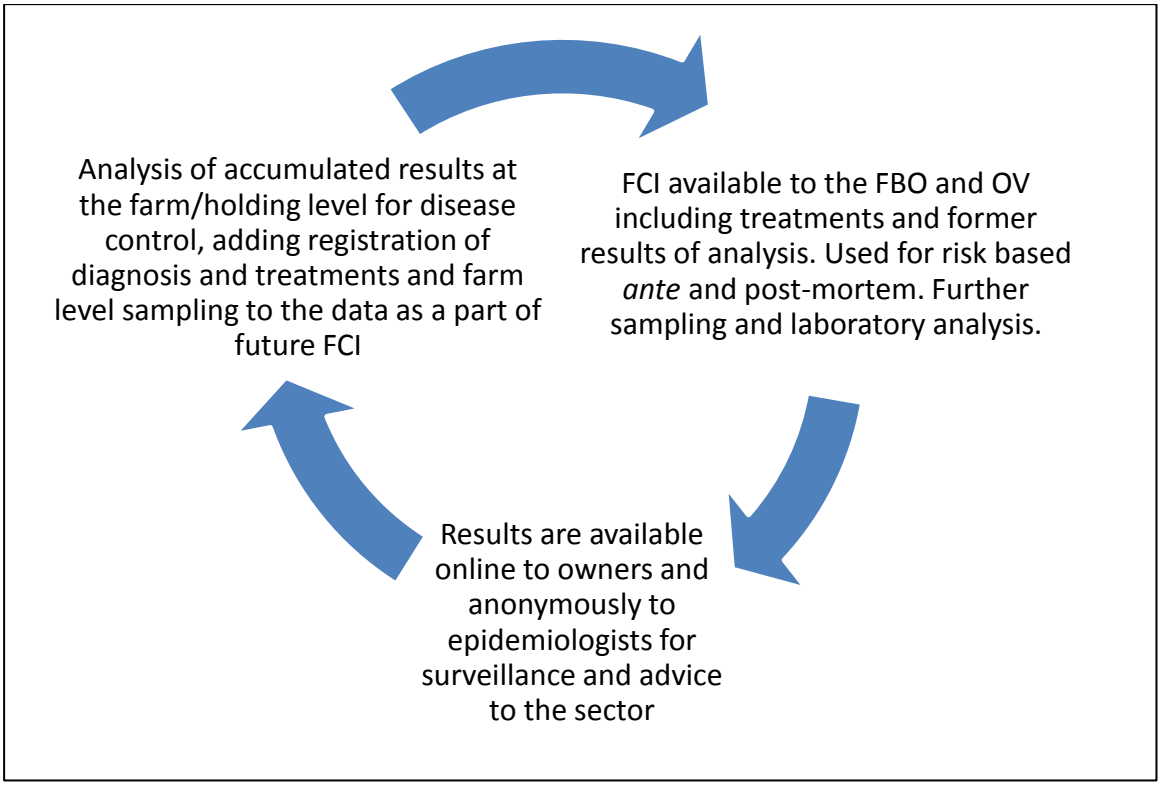
- provide CCIR to the producer concerning the health status of the animal or animals slaughtered;
- accumulation of epidemiological data at the holding/farm level to inform the producer on disease control strategies;
- collect anonymised epidemiological data aggregated for surveillance and advice to the particular livestock sector as a whole;
- provide information on the use of veterinary medicinal products and the reason for their use (e.g. diagnosis of disease or preventive).

As well as gathering information on the animal or batch slaughtered, producers will over time gain a more comprehensive picture of the health status of their herds and flocks. Statistical analysis of sample results together with other data collected at slaughter (e.g. slaughter weights) could provide more sophisticated profiling for animal health and production purposes.

As a result of the profiling, both the FCI and the CCIR will be more evidence-based than at present, providing relevant information to the slaughterhouse and the producers, completing the circle of information and transforming the above mentioned “vicious circle” into a “virtuous circle”:

[63] Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs (OJ L 338, 22.12.2005, p. 1)

Figure 4 Virtuous Circle of FCI/CCIR



It is proposed that this system would utilise the power of modern laboratories and computer systems to create and deliver information on food-borne infections as decided by the FSA, as well as on treatments on farms in an efficient and effective manner.

The current FCI/ CCIR system provides useful information to producers only in some cases (particularly in intensive systems for poultry and pigs), and there is a particular lack of information on the food-borne diseases, which are not easily detected by the presently used methods of meat inspection. The new system however will provide this information to a) the producers through improved inspection procedures, sampling and dissemination of the results and b) the slaughterhouse FBOs and OVs to be used as input for a risk based inspection (*ante* and *post-mortem*). The result could be an increase level of sampling in case of high prevalence of a zoonotic disease or increased slaughter line speed in case of low prevalence or absence.

The primary responsibility of any food business operator (including the primary producer) is to produce safe food. The increased knowledge of the infection status on a farm might create a positive incentive for the producer to introduce control measures where possible, since this information will be available to the slaughterhouse operators as well as the competent authority. While this incentive might over time improve the health situation on farms, it will also provide producers with a tool for improving the health and productivity of their herds.

At this stage it would not be necessary to introduce any new legislation or require producers to provide specific FCI or take particular control measures on the farm as the legal provision are already in place[64].

The accumulation, aggregation and dissemination of results from increased sampling and enhanced *ante* and *post-mortem* inspection will moreover contribute to better understanding of disease prevalence in holdings and regions, supporting the producer in improving herd health and productivity. Liver fluke could serve as a good example in this case.

[64] Regulation (EC) 854/2004, Annex I, Chapter II, F (2)

8.1.2. Sampling procedures

The new sampling being proposed by this study takes account of that this is a new approach and at present most of the producers either do not receive the inspection results or if they do, they are of limited use.

An attempt has been made to assess the statistically relevant sampling level needed, but at this stage this should just be seen as an indication (see below). It is beyond the scope of this study to produce detailed proposals for the procedure needed to determine the true prevalence at herd level and neither should it be the task of *ante* and *post-mortem* inspection to investigate in detail the disease situation in a holding, but that task should fall within the obligation of the producer having the primary legal responsibility to produce safe food.

The overall system (of *ante* and *post-mortem*) impact of the new approach needs to be scientifically estimated at a later stage and compared with existing procedures. While we consider this being beyond the scope of our study, we assume that the impact on particular conditions, such as the major pathogens not detected today (Salmonella, Campylobacter, VTEC) and detection of veterinary medicinal products would be considerable.

8.1.3. Sampling frequency

Final decisions on the sampling frequency should be based on proper risk assessment, taking due account of the impact of the pathogens in the human population, the prevalence in the animal population and economic parameters. This will require further attention; the suggestions presented here are just an example to give an idea of scope of what might be required.

The objective of this sampling In general terms is to detect any batch of animals being slaughtered that are affected or infected by single or a range of potential food-borne pathogens, classifying the batch as 'affected' or 'clear', based on a sampling strategy with a given probability of detecting at least one affected animal or carcase if the batch is affected.

The definition of ‘batch’ in this context is a group of animals from one site, herd or farm that are being slaughtered at the same time and place. We consider that cross-contamination is likely in transit and in the lairage, however it is possible to increase the probability of detecting “farm based infection” by using either lymph nodes or blood as samples. We acknowledge furthermore an additional problem of attributing a health problem to a particular herd where animals have been in several herds during their live time.

We have also considered the consequence of sampling and analysing, which can range from positive consequences (e.g. where an animal health condition is detected that was unknown to the producer), to negative (for the producer) where food-borne disease is detected which requires further corrective action being introduced by the producer – including a veterinary investigation of the herd with further sampling on site. The most common consequence would be an increased sampling of the next animals arriving from that particular herd for slaughter using a sample size designed to provide a prevalence estimate with a particular precision – e.g. 95% confidence interval of +/- 5%. The corrective action should in general lead to reduced risk to consumers and/ or an improved productivity for the farmer.

Using a well-established approach as described by Cannon and Roe (1982), we have created an excel table which provides a tabular view of sample size calculations where a certain probability of detection can be selected as well as the Minimum Detectable Prevalence (MDP) and population sizes.

The tables below are presented as examples.

Table 4. Sample sizes to detect a condition. Probability of detection: 95%

	Minimum Detectable Prevalence (design prevalence)										
Population / batch size	**50%**	**40%**	**30%**	**20%**	**15.0%**	**10.0%**	**5.0%**	**2.0%**	**1.0%**	**0.5%**	**0.1%**
10	4	5	6	8	9	10	10	10	10	10	10
20	5	6	7	10	13	16	19	20	20	20	20
40	5	6	8	12	15	21	31	40	40	40	40
60	5	6	8	13	16	23	38	55	60	60	60
100	5	6	9	13	17	25	45	78	95	100	100
200	5	6	9	14	18	27	51	105	155	190	200
300	5	6	9	14	18	28	54	117	189	260	300
400	5	6	9	14	19	28	55	124	211	311	400
500	5	6	9	14	19	28	56	129	225	349	499
750	5	6	9	14	19	28	57	135	246	412	737
1 000	5	6	9	14	19	29	57	138	258	450	950
10 000	5	6	9	14	19	29	59	148	294	581	2 588

The numbers in the body of the table are the required number of animals to sample to be 95% certain that at least one of the sampled animals is affected by the condition (given the minimum prevalence at the head of the column). The implication is that if this number of animals is randomly selected for each batch then 95% of infected batches will be identified by the screening process, and also 5% will not be identified.

The excel sheet can be used to calculate the required sample size for any scenario where the sensitivity of the detection test procedure (e.g. diagnostic test) used can be adjusted.

While the calculated sample size determines the number of individual animals to be sampled, if the laboratory testing sensitivity is such that detection is assured even if the biological samples from a single infected animal are mixed with samples from 'X-1' non-infected animals, then biological samples from several (i.e. 'X') animals from the same batch can be pooled and only one laboratory test per X animals sampled is required. This depends on the bacteriological sensitivity of detection in the laboratory, which needs to be considered more carefully. This pooling would save costs related to the laboratory tests and recognises that the objective is to detect the presence of an agent in a batch, not to identify individual affected animals; therefore individual animal traceability of any one positive result is not necessarily required.

The **Minimum Detectable Prevalence** (design prevalence) should be decided based upon epidemiological evidence / knowledge (i.e. what is realistic and reasonable) but also can be adjusted according to what is considered economically / politically / socially a meaningful prevalence to detect on screening at any given time.

The desired probability of detection is a matter of choice. To provide some examples, sample sizes that provide 90% and 80% probabilities of detection (see example tables below) are presented. The probability of detection is the sensitivity of the screening system, which is analogous to the sensitivity of a diagnostic test. This can be used in policy and economics considerations.

For example, with different sample sizes per batch the screening is expected to fail to detect 5% (or 10% or 20%) of infected batches: the trade-offs between increasing sample sizes (increasing cost) and increasing proportion of undetected batches (reducing the potential benefits) can be explored, assuming that changes in human health / livestock productivity losses can be linked or attributed to changes in the proportion of undetected infected batches.

It must therefore be emphasised that deciding on the probability of detection to aim for is to a large extend an economic / political / social issue and not a statistical one.

The sample sizes to provide other probabilities of detection are presented in the following. Other possibilities can be calculated as required.

Table 5. Sample sizes to detect a condition. Probability of detection: 90%

	Minimum Detectable Prevalence (design prevalence)										
Population / batch size	**50%**	**40%**	**30%**	**20%**	**15.0%**	**10.0%**	**5.0%**	**2.0%**	**1.0%**	**0.5%**	**0.1%**
10	3	4	5	7	8	9	10	10	10	10	10
20	4	5	6	9	11	14	18	20	20	20	20
40	4	5	7	10	12	17	28	38	40	40	40
60	4	5	7	10	13	19	32	52	59	60	60
100	4	5	7	10	14	20	37	69	90	100	100
200	4	5	7	11	14	21	41	87	137	180	200
300	4	5	7	11	14	22	42	95	161	236	300
400	4	5	7	11	14	22	43	100	175	274	400
500	4	5	7	11	14	22	43	102	184	301	496
750	4	5	7	11	15	22	44	106	198	344	716
1 000	4	5	7	11	15	22	44	108	205	369	900
10 000	4	5	7	11	15	22	45	114	227	449	2 056

Table 6. Sample sizes to detect a condition. Probability of detection: 80%

	Minimum Detectable Prevalence (design prevalence)										
Population / batch size	**50%**	**40%**	**30%**	**20%**	**15.0%**	**10.0%**	**5.0%**	**2.0%**	**1.0%**	**0.5%**	**0.1%**
10	3	3	4	6	7	8	10	10	10	10	10
20	3	4	5	7	8	11	16	20	20	20	20
40	3	4	5	7	9	13	22	35	40	40	40
60	3	4	5	7	10	14	25	45	57	60	60
100	3	4	5	7	10	15	27	56	80	97	100
200	3	4	5	8	10	15	30	66	111	160	200
300	3	4	5	8	10	15	30	70	125	198	299
400	3	4	5	8	10	16	31	73	133	221	394
500	3	4	5	8	10	16	31	74	138	237	481
750	3	4	5	8	10	16	31	76	145	262	663
1 000	3	4	5	8	10	16	31	77	148	275	800
10 000	3	4	5	8	10	16	32	80	159	316	1 486

The actual prevalence of infection in an infected batch of animals will never be known exactly in advance; they will be as different as they are many. The sampling for screening should therefore be designed to sample just sufficient animals to detect what is considered the minimum likely prevalence at any given time, if infection is present at all. Clearly this will not be the theoretical absolute minimum; there is room for trading-off of cost (high sample size) against what is considered likely and/or what might be considered a significant prevalence with respect to human health risk. Logically this might change over time and must therefore be re-evaluated on a regular basis.

In the following tables we have presented the probability of detection and sample size based on certain criteria. The formulae used are provided below each table.

The first table illustrates the calculation that a sample size of 60 animals randomly selected from a batch of 200 would give a 97% probability of infection, if it is present at prevalence of at least 30%:

Table 7. Probability of detection, given a minimum prevalence, a certain number of animals and sample size[65]

Probability of detection, given the sample size, number of animals and prevalence	
Minimum prevalence	30%
Number of animals (N)	200
Sensitivity of test	1
Number of detectable units in the batch of animals (d)	60
Samples size taken (n)	10
Probability of detection (a)	97.44%
Probability of failure (100%-a)	2.56%

Where :

$$a = 1 - \left(1 - \left(\frac{d}{N - (n-1)/2}\right)\right)^n$$

where

a = detection probability

d = number diseased

N = population size

and, n = the sample size

The next table illustrates that to achieve a 75% probability of detecting infection in batch of 200 animals in which infection is present at 30% prevalence (or more) would require sampling of just 4 animals

Table 8. Calculation of a sample size from a single flock

Sample size required given a certain probability of detection, the sample size, number of animals and minimum prevalence	
Required probability of detection (a):	75%
Number of animals / birds / units (N):)	200
Minimum prevalence:	30%
Sensitivity of diagnostic test:	1
Number of detectable diseased units in the group (d):	60
Sample size required (n):	4

Where:

$$n = [1 - (1 - a)^{\frac{1}{d}}] \times [N - \frac{d-1}{2}]$$

where

a = detection probability (e.g. 0.99 or 0.95)

d = number diseased

N = population size

and, n = the sample size

It may be worth considering that for some agents, sampling on farms may be a more cost-effective way to identify infected herds / flocks than sampling individual animals at the slaughterhouse. For example, this might be the case for Salmonella in birds, where it might be easier to detect the agent

[65] Formulae adapted from: CANNON, R.M. and ROE, R.T. (1982). Livestock disease surveys. A field manual for veterinarians. Page 14. Department of Primary Industry, Bureau of Rural Science. Australian Government Publishing Service, Canberra 1982.

from a few pooled environmental samples (e.g. fresh faeces from the floor) than having to sample many individual birds at the slaughterhouse.

Testing on farms has its benefits and drawbacks. On the positive side, it provides a real test from the farm environment. On the negative side, it is not done by an independent agent in most cases and it is not really in the interest of the farmers. The slaughterhouse is considered to be the only location in the food chain where there are independent agents (state officials) looking at the animals/ carcasses and taking samples and checking for health problems. In practice, a combination of sampling on farms and at the slaughterhouse could be considered, depending on the animal species and disease.

8.1.4. Sample type

The aim of the new sampling regime is to collect information that reflects the farm environment rather than the slaughterhouse environment; the latter being provided under the statutory regime in place today. It is therefore proposed to use lymph nodes or parts of the intestine as sample material in the first instance.

Reference is made to a recent Europe-wide survey for Salmonella in pigs where lymph nodes were sampled (5 per sample). This was considered to give a better indication of the presence or absence of the pathogen in the holding of origin than sampling intestinal content. There are reports of Salmonella infection reaching the lymph nodes within four hours post infection, however this is rare and so far this technique is considered to provide the best indication of infected herds, although it provides poor indication of whether they are uninfected.

Different samples should be considered for different animals. However, further study is required on this subject.

8.1.5. Microbiology

The various methods of testing for microbiology have not been evaluated in this study. However the latest technology should be used where possible and economical, such as real time PCR, at least for confirmation purposes (e.g. Salmonella serovars). In other cases and for basic screening purposes classical microbiology could be used if appropriate. The sensitivity of the classical microbiological method is considered to be poor (false negative rate could be high), but the specificity is considered to be good (false positive rate low), in particular when using lymph nodes for sampling.

8.1.6. ELISA tests

Meat juice has been used extensively in the past to determine the absence/ presence of antibodies to pathogens, mainly for Salmonella in pigs. Further research has been carried out in Germany (D. Meemken et al, 2013) creating a multi-test for several pathogens including the zoonotic Salmonella spp., Toxoplasma gondii, Trichinella spiralis, Yersinia enterocolitica, hepatitis E virus as well as the production diseases: influenza A virus, Mycoplasma hyopneumoniae, PRRSV, Actinobacillus pleuropneumoniae.

The value of ELISA tests in this context has been investigated, e.g. by Nollet N[66], et al. (2002), who investigated the correlation between bacteriology of lymph nodes and serology for Salmonella diagnosis in slaughter pigs in Belgium and found associations between the serological and the bacteriological diagnosis, although not significant (OR 1.54 (0.83 - 2.2) and Kranker[67], Søren, et al. (2003), who carried out a longitudinal Study of Salmonella enterica Serotype Typhimurium Infection in three Danish farrow-to-finish swine herds in 2003 and came to very similar conclusions.

[66]Nollet N, Huysmans K., Maes D., Houf K, Imberechts H., de Kruif A., De Zutter L., Van Hoof J., Geers R., (2002) correlation between bacteriology of lymph nodes and serology for Salmonella diagnosis in slaughter pigs. Presentation.

[67]Søren Kranker, Lis Alban, Jaap Boes, and Jan Dahl, (2003) longitudinal Study of Salmonella enterica Serotype Typhimurium Infection in Three Danish Farrow-to-Finish Swine Herds, Journal of Clinical Microbiology , June 2003, p. 2282–2288.

These methods are most probably valuable but taking into account that the information collected is retrospective; they only indicate that the animal concerned has been in contact with the pathogen at some point in time, but does not determine if infection is still present.

8.2. Proposed Information Exchange System

8.2.1. Type of model

An effective IT system is a precondition for the proposed system to be efficient; it is a prerequisite for an improved risk-based approach to meat controls.

A two-stage approach has been adopted for the development of an improved FCI/CCIR IT model:

- development of a Reference Model; and
- further refinement to create an Implementation Model.

The design of the Reference Model takes into account all conceivable aspects of information exchange covering the requirements of diverse species. Thus, the Reference Model is not limited to just those elements of FCI and CCIR that show a positive cost-benefit.

The final Implementation Model may initially be more limited than the Reference Model as it will exchange only information for which a positive cost-benefit has been determined.

This integrated approach is justified by the argument that the alternative approach of piecemeal IT development might fail to capitalise on possible synergistic effects from being able to analyse the whole body of data that is collected. To this end an architecture based on OLAP (OnLine Analytical Programming) is proposed to provide the most flexible data storage schema.

This approach will yield a clearer understanding:

- to guide strategic decision-making in the food safety arena;
- to inform systems development planning in the individual food sectors;
- to maximise the benefits that can be gained from modern IT technologies.

8.2.2. Over-arching principles behind the reference model

The design of the Reference Model has been based on the following common principles:

- accuracy and completeness of all data observations;
- usefulness of any observation, in its own right, and as a contributor to a wider information picture towards improved food safety, animal health and animal welfare;
- recording of the data just once, making use of any existing data where appropriate; this will be achieved through use of Web Service technology taking data from diverse existing systems;
- recording of the data as close to real-time as possible, ideally direct into an electronic format using appropriate technology;
- promoting the adoption of electronic data flows through the introduction of a user portal;
- consistency in identification and recording of diagnosis (although this is likely to be addressed more fully through informative materials and education than through direct IT involvement);
- cost of the data collection, capture and analysis;
- cost-effectiveness or cost-benefit ratio of the cost versus the gains in either non-tangible items such as credibility or monetary returns on productivity and public health impacts.

These issues represent some challenges given the organisational constraints and pressure on margins for FBOs. However continued reliance on piecemeal solutions will continue to deny the industry the real benefits which a unified structure based on sound IT principles can deliver.

8.2.3. The Reference Model

The Reference Model is presented in schematic form in section 8.3. It is emphasised that this is an idealised model, rather than a finalised implementation model.

The model is derived by bringing together elements from several systems:

- national animal identification and movement control. These have been installed as integrated systems in some EU Member States (including in the new Member States where there were no pre-existing food safety IT systems and lessons could be learned from the implementations in older Member States). These feature a central database approach with a strong emphasis on monitoring interventions such as vaccinations and movements and linking these to a health status at animal, herd and holding levels;
- risk based systems for inspections - both primary producers and FBOs (slaughterhouses, *ante* and *post-mortem*);
- an accessible internet user portal as commonly seen in diverse social and financial systems;
- development of autonomous handheld data-collection devices which can operate independently of mobile data networks and Wi-Fi architecture;
- data-mining technology which takes a stream of individual observations and adds the ability to 'slice' the data to allow informed focussing, together with the ability to "drill down" into low-level data to assist understanding and interpretation of issues;
- in this context, INNOVA acting as a central repository is a notable development, and its ultimate replacement may meet many of the design goals which this project is elaborating.

The Reference Model is based on proven technology: every component already exists in a working environment or in an advanced state of development. This integrated technology is physically achievable and should be assessed for its economic profitability using either cost-effectiveness analysis or cost benefit analysis. Such a process of technical and economic assessment can inform final decisions.

In some countries, animal identification systems [AIS] have led the way for strengthening of pharmacovigilance recording and control. This is achieved by recording veterinary and self-administered interventions in the form of an electronic medicines register (sometimes more generally referred to as an intervention register). This would be implemented via the user portal and data could be originated by the primary producer or his veterinarian.

Examples of best practice in the EU show what can be achieved: for example, full electronic medicines registers work exceptionally well in Denmark. In stark contrast, a large part of the British systems are based on manual registers (paper based) which lack any ability for rapid assessment and analysis and lead to poor evidence of prompt and accurate recording.

The use of autonomous handheld data capture technology seeks to streamline situations where rapid access to data is crucial to workflow - an example being that of an official veterinarian inspecting arriving animals in the lairage. These devices are pre-loaded with a relevant subset of data based on the day's workload, but can operate independently of any data network, whilst retaining the ability to synchronise immediately when network resources become available (mobile data network or Wi-Fi). This leads to rapid operation, and provides an ability to capture relevant observations as they occur. There are existing systems offered by commercial systems providers, and the FSA has a development project with similar objectives.

The development of a user portal will contribute to the on-line real-time data collection goal, as well as providing the means for rapid notifications back to primary producers. The recently introduced sheep recording system (ARAMS) uses such portals, and the FSA has plans for a wider-ranging industry and public portal. Experience with portals across a wide range of applications suggests that they should be introduced with simple core functionality with enhanced and increased functions being added in response to user experience.

A significant component of the Reference Model is the extension of the risk-based approach to all aspects of inspection. This is one of the key changes proposed. Whilst a FCI statement from a primary producer is recorded in the Reference Model, the inspection (CCIR) results are aggregated into the data repository. Accumulation of this data allows an increasingly detailed picture to be compiled at the holding level. This historical data will become an additional independently derived component of the FCI, and can be used by the Official Veterinarian to inform his inspections of consecutive consignments of animals in the lairage and as an input to a risk-based Meat Inspection.

A further independent measure is provided in the form of the results of microbiological and/ or meat juice testing carried out as proposed during the slaughter process. A classical risk-based approach is suggested with the frequency of sampling responding to the incidence of adverse findings.

Such rapid capture would facilitate close to real time return of information on the animals slaughtered to the producer. Building these datasets and information generated will ultimately lead to the better producers examining how such information can be linked to on-farm practice and their own on-farm monitoring systems. Downstream data can be made available to food processing and retailing companies to plan their distribution. These data will also provide much needed information on the flows of products across value chains allowing for improved measurement of attribution of pathogens and hence the better search for risk points and investments in risk management. At present the data available is inadequate to refine risk assessments and help direct economically profitable investments in risk management.

8.2.4. Discussion on the IT system

8.2.4.1. The importance of the "relevant unit"

Any discussion of models needs to address the concept of a "relevant unit (RU)". This is the appropriate basic group-size relating to both the species and the husbandry in use by the primary producer.

For cattle this would (presumably) be the individual animal, whereas for commercial poultry production the house suggests itself as the Relevant Unit [RU]. The RU is important as the key in identifying and recording the physical unit in the whole process. The proposed data repository will hold this flow of data, and seek to aggregate it beyond individual RUs up to holding level.

Existing food chain information [FCI] has focussed on these relevant units. There is a potential IT advantage in reducing the size of the RU as much as possible, and this is most apparent when recording *post-mortem* inspection results, which are ideally focussed to the results from a single carcass. Developments using touch-screen technology bring the ability to speed up the recording process on fast-moving lines.

The RU is moreover relevant for the a*nte mortem* inspection, in particular for poultry, pigs and small ruminants, where diagnosis and treatment are most commonly based on a group and treatment is for the group and not individual animals. This information is vital for the *ante mortem* inspection and is essential for the system of risk-based inspection.

The Reference Model needs to encompass a wide range of data, and will enable the aggregation of inspection results to form a statistically relevant and dynamic view of the status of a holding. This would be available (together with the latest FCI) to the official veterinarian *ante mortem* and throughout the slaughter process. The FSA already has a project looking at autonomous hand-held devices to facilitate this (and other) processes, and commercially available solutions are also offered.

The Reference Model is deliberately extended to include downstream FBOs and the direct-accessing retail sector. This is done with acknowledgement of existing public and private schemes. Although it is not necessarily envisaged that the FSA IT model should link to public or private assurance systems, they must be considered to avoid unnecessary duplication of data. Here again a simple web service extension has the capability to provide the two-way flow of information which this model proposes.

8.2.4.2. CCIR data

To maximise the value of CCIR data, it must convey information that is as accurate as possible, and also target the recipient(s) of the information in a structured and timely way.

Producers who sell on a live weight basis suffer no direct financial loss from downgrading or condemnation of the carcass at slaughter. However, CCIR data may nevertheless be of interest in terms of overall herd health.

Electronic means including email and SMS and direct internet-based links are proposed as the most effective way of delivering this information

The Reference Model addresses accuracy and timeliness by a reliance on electronic collection, and a parallel programme to standardise the interpretation of carcass inspection.

A feature of the Reference Model is a communication or notification matrix. This relates the CCIR directly to the actual finding(s). For example, a cow's broken leg noted *ante mortem* needs to be notified to the carrier in addition to the primary producer; whereas a disease notification could go back to the primary producer and their veterinary surgeon - and maybe to a wider recipient audience such as other holdings where the animal(s) have resided after leaving the holding of birth.

The communication matrix will be organised by species and within that by type of inspection outcome - covering both *ante* and *post-mortem* findings. Each individual entry will specify the destination and proposed type of notification and suggest the actual content of the notification. The notification(s) may use an appropriate combination of email, SMS/text and written (postal) notifications. Use will also be made of a notification capability via the data portal. (It is envisaged that notifications to veterinarians and haulage contractors, for instance, will be by the most rapid and economical *electronic* means, and will include a capability to record that the notification has been received).

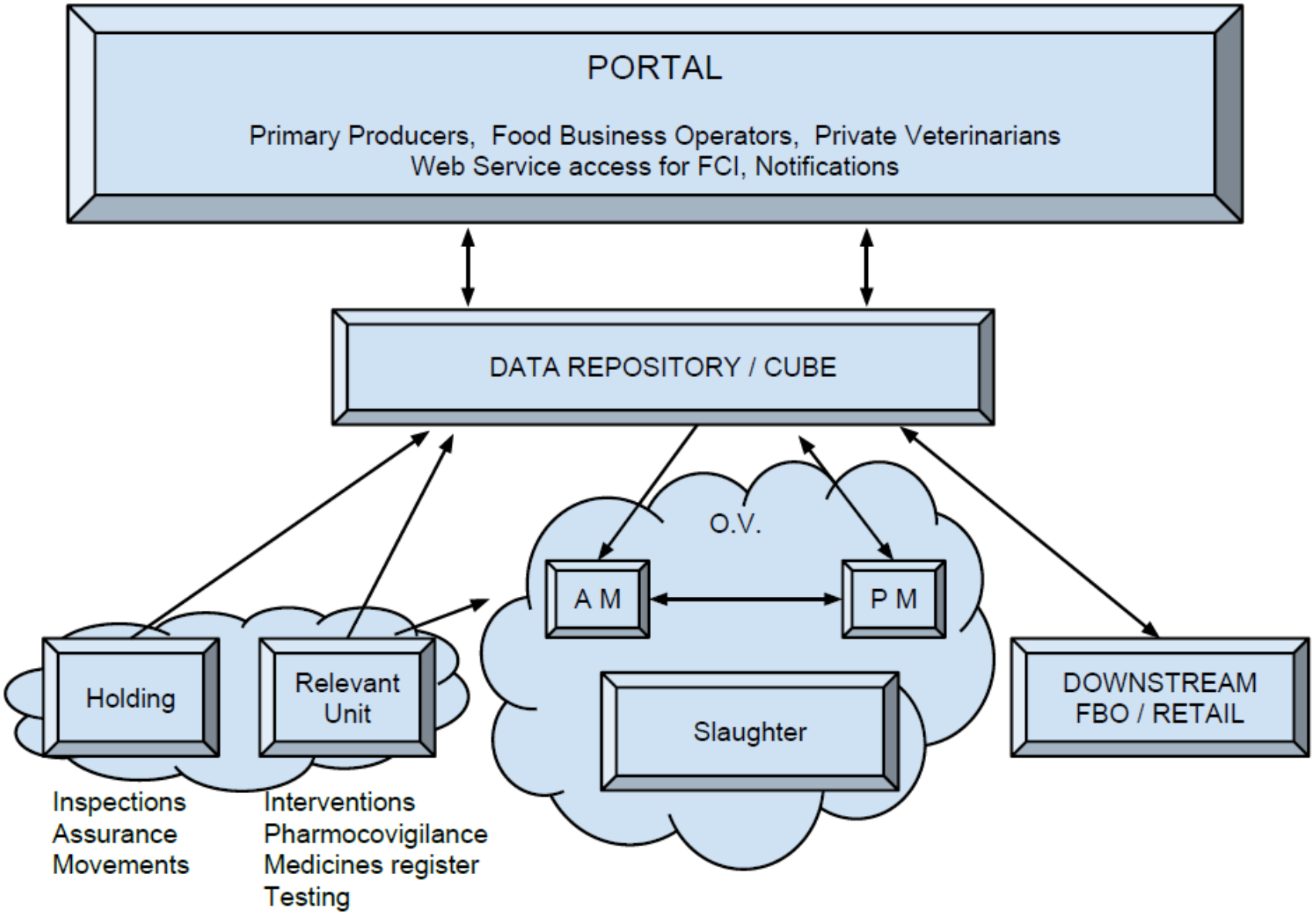
The major components of the proposed system may be summarised as:

- The implementation of a Cloud-Based data collection (repository) based on OLAP architecture. The dimensionality of this to include the Holding as well as the identification of the relevant unit describing the animal.
- The provision of web service integration of existing diverse systems to record information for the Relevant Unit into the data repository - a coordinated effort between the FSA and FBOs to leverage the existing investment in systems
- Specific capture of veterinary and other relevant interventions in support of the defined EU requirements. This will require the support of the veterinary profession and can be implemented with cooperation of the suppliers of veterinary practice management systems.
- Real-time capture of the results of microbiological testing of samples collected in the slaughter facility - the frequency and targeting of such testing being driven by an objective risk-based model.

8.2.4.3. A note on confidentiality

The Reference Model takes traditional FCI and combines it with aggregated data derived from previous inspections relating to that holding and the results of microbiological testing. The aggregated data may well relate to animals presented to more than one slaughter facility, and this could raise concerns about commercial sensitivity and data ownership. The proposal is to use encoded data via web services to provide a sufficient level of aggregation to ensure protection of sensitive commercial information.

8.3. Reference Model



8.4. Discussion on the reference model

The concept of inspecting animals before slaughter and meat and offal after slaughter has been in its existing form for more than 100 years. This system was created on the basis of hazards which today represent only a negligible risk.

The project of modernising meat inspection and live animal inspection has been ongoing for many years. The problems which have been identified are mainly that the hazards which are prevalent in livestock today, and in the population, are not addressed by the existing meat inspection and live animal inspection system and the procedures used during meat inspection might even be considered in some ways hazardous, contaminating the meat (touching the carcasses, cutting in lymph nodes).

One of the solutions which has been suggested and partly implemented is to introduce visual inspection, meaning that the meat inspector is not touching the meat and not cutting the lymph nodes as is been done in the existing system.

A pre-condition for a visual inspection system has always been that the food chain information is used to provide information on animal health and treatment from the farm level. This system of food chain information and visual inspection was introduced in the last version of European legislation in 2004 and has been implemented step by step since.

The system as laid down today in European legislation, does not answer the question where the information regarding the so-called new diseases, the hazards of today, such as Salmonella, Campylobacter, and E. coli (VTEC), should be coming from. The information could possibly be collected at farm level, however this is costly, the samples are difficult to collect, and there might be a conflict of interest. It is not always in the interest of the farmer to provide accurate information on treatments and diagnosis on his farm.

The reference model proposed would be a step towards solving this problem by taking the samples on the slaughter line during meat inspection to be used for basic screening. The samples would be taken by the official veterinarian/meat inspector and delivered to a laboratory for analyses and the results would be fed directly into a central database. Some suggestions how to estimate sampling frequency are presented in section 8.1 above, however, there are policy and economic implications which are beyond the scope of this study and it is recommended to base that decision on proper scientific risk assessment.

Under the regime used in the model, the results from the bacteriology would be fed back to the farmer, or rather he would have access to the results on the central database. This information would accumulate and become a part of the historical information on that holding/farm and become a part of the food chain information for the next batch(es) of animals delivered to slaughter from that holding/ herd.

It is our opinion that this system would create and deliver additional information about the prevalence of some of the most potent foodborne infections of today. It is also our opinion that at this point in time it is not necessary to put any new rules in place regarding the control measures to be taken on the farm. We think at this point in time that it is sufficient to provide the information only, in particular given the state of knowledge regarding the scope of control measures available at farm level.

Providing this information, in addition to any information at farm level, will create the basis for a risk-based meat inspection, which has been discussed for many years but not yet put into practice because the basic information needed to make that decision has been missing. Using this system of sampling, analysing and delivering the information into the food chain information/inspection results data flow will provide at least a part of that missing information.

We have analysed the existing practices used during meat and live animal inspection for the four species of animals covered in this study. We have observed that in many cases people are using pencil and paper or clips to register the results; only in exceptional cases and mainly in the poultry industry are people using modern technologies such as touchscreens.

It is our opinion that any information collected should only be registered once. We therefore considered it essential to provide modern data capture facilities, such as touchscreens, ideally in all slaughterhouses, but at least in medium size and large slaughterhouses.

We have designed a system using modern database technologies which enables data mining from existing information sources for data capture at farm level and slaughterhouse level, as well as the registration of laboratory results. We have made a rough estimate of the software development cost of establishing such a system to be close to £350, 000 considering the size of the industry.

We have been informed about the accuracy of diagnosis on the slaughter floor during meat inspection and concluded that there is a scope for improvement and harmonisation of the practices. A new and better technology of data capture might assist in this endeavour, however it is our opinion that increased training is also necessary in order to achieve acceptable level of expertise and harmonisation. We have not considered this to be a part of the new reference model but rather a deficiency of the existing system which would have to be addressed regardless of the introduction of any new system.

We have also considered the possibility to link to clients further down the food chain. We assume that these clients would be interested in the information collected however there are confidentiality issues which have to be addressed before access is provided to this information. In our opinion this information is owned by the farmer, however the farmer would be obliged to give access to that information in certain cases such as to the food business operators at the slaughterhouse, the official veterinarian and the competent authority. We have considered these confidentiality issues and have taken them into account in our proposals.

Another serious hazard of our times is the contamination of food of animal origin with veterinary medicinal products, pesticides and environmental contaminants. The use of veterinary medicinal products, such as antibiotics, has been mentioned as one of the contributors for increased antimicrobial resistance (the increase resistance of pathogens to antibiotics). This problem is a serious issue for public health demanding continuous introduction of new antibiotics to treat existing diseases, including diseases such as those being considered in particular by our reference model (Salmonella, Campylobacter, VTEC).

New regulation has been introduced at European Union level to register all use of antibiotics and other veterinary medicinal products for animals used for food production. This makes provision for all animals, or batches of animals in case of birds and fattening pigs, to be identified and their treatment registered in farm records.

In our proposed reference model we have considered the possibility of providing farmers and practising veterinarians access to the system to register their diagnosis and treatments at farm level. Such system of centralised registration of treatments has been introduced in other European countries such as Denmark and Holland, and the same system is being seriously considered also in Germany.

It is already a part of the obligatory food chain information, as practised today, to notify any treatments. However this is only valid for treatments if the animal concerned is sent for slaughter within the withdrawal period. In our reference model we suggest to go further and provide the official veterinarian at slaughterhouse level with access to historical data from the farm on diagnosis and treatments. We consider this part of the system an essential additional pillar of modern meat inspection. It will complete the picture of the main hazards faced by the farming community and the public today.

8.5. Summary

The overall assessment of the ongoing systems of food chain information and inspection results indicate that a “vicious circle” has developed where the quality of the data collected is poor and the information generated is non-specific and therefore of minimal value to people and businesses working in food production systems. This chapter has provided a way forward in terms of improvement of data collection and capture at different points in the system – both farm and

slaughter level. These data are then accessible to all associated with the animals and the meat being processed. There is also a role for the veterinary staff to help generate information that would be of use to the farmer and also for the generation of information from the farm that could be used by the slaughterhouses. Once tested the new system should also explore ways in which actions in the slaughterhouse could be triggered by farmers and/ or researcher and research institutions who would like to know the health status of the animals in more detail.

The system proposed creates the virtuous circle – good data collection and data capture as well as an IT system that allows multiple users to access it, generating a specific real time information. If targeted at the most important health problems the systems should be self-sustaining. The question of what are the most important issues faced by the UK livestock food systems will always be relevant.

9. PUBLIC HEALTH BENEFITS AND THE COSTS OF FOOD-BORNE ILLNESS

9.1. Introduction

The public health dimension is relevant to Objective 3 of the study as it generates information on the potential benefit streams from changes in management of public health pathogens, and so relates to a cost-benefit analysis of the improved FCI and CCIR (developed in the next chapter). Public health is concerned with prevention and treatment of human illness. A potential benefit of FCI/CCIR is improved food safety, leading to reduced incidence of human disease and costs associated with illness. Additional potential benefits, which are not the topic of this chapter, are improved animal health and welfare.

The chapter is divided into:

- Approach and Data Sources
- Public Health Risk
- Incidence of Zoonotic Disease
- Total Incidence of Disease
- Food-borne Illness
- Cost of Illness
- Attributing zoonotic pathogens to animal species
- Bringing the Cost of Illness Model Together
- Conclusion

9.2. Approach and Data Sources

We draw on secondary data to derive incidence (number of new human cases of zoonotic food-borne illness per year) and cost measures. We examine the list of pathogens included in each data source.

Step 1. Public Health Risk. The starting point is the list of pathogens and contaminants that are rated by EFSA as posing a risk to public health (compiled in Deliverable 2 of this project).

Step 2. Identify Reported Incidence of Zoonotic Disease. The main source of incidence of zoonotic pathogens in the food chain is "Zoonoses Report 2012" published in September 2013 by the Department for Fisheries and Rural Affairs in conjunction with Public Health England. The 2012 UK Zoonoses Report Working Group was led by Public Health England (formerly the Health Protection Agency).

Step 3. Identify Total Incidence of Disease. The total burden of disease is quantified by the pyramid of illness. It links the number of notified cases to the number of people visiting their GP and incidence in the community. Source: The IID2 study, the second survey of infectious intestinal disease (IID) in the UK.

Step 4. Isolate the Proportion of Disease that is Food-borne. The IID2 study was extended (funded by the Food Standards Agency) in order to find out how much of the infectious intestinal disease identified in IID2 related to food consumption. The report, finalised in March 2014, gives a percentage food-borne attribution to each pathogen.

Step 5. Derive Unit Costs of Illness. The Food Standards Agency publishes annually an estimate of the cost of food-borne illness. We apply this estimate to the measures of food-borne disease to derive costs of illness.

Step 6. Attribute Costs of Illness to Species. We use peer-reviewed literature to give attribution estimates of costs across species, based on attribution of food borne disease.

The rest of the section draws out each of these steps in more detail. The overlap between sources is indicated in the table below, showing which food-borne pathogens/contaminants are contained in which data source. (We note also the main pathogens that are routinely monitored by the Food Standards Agency to survey trends in food-borne illness).

Table 9. Data Source and Pathogen/Contaminant Included

	Risk of FBD (EFSA) Deliverable 2	Zoonoses 2012	IID2	(IID2 Organism Type)	IID2 Extension	FSA Monitors
Bacillus anthracis	Y	Y			Y	
Campylobacter species	Y	Y	Y	Bacteria	Y	Y
Cysticercus (Taenia saginata)	Y	Y				
Dioxins/DL-PCBs	Y					
ESBL/AmpC E. coli	Y					
ESBL/AmpC Salmonella	Y					
Heavy metals	Y					
Salmonella species	Y	Y	Y	Bacteria	Y	Y
Sarcocystis hominis	Y					
Toxoplasma gondii	Y	Y				
Trichinella	Y	Y				
Unlicensed antimicrobials	Y					
VTEC	Y	Y	Y	Bacteria	Y	Y
Yersinia enterocolitica		Y			Y	
Cryptosporidiosis		Y	Y	Protozoa	Y	
Listeria			Y	Bacteria	Y	Y
Giardia			Y	Protozoa	Y	
Adenovirus			Y	Virus	Y	
Atrovirus			Y	Virus	Y	
Enterovirus			Y	Virus	Y	
Rotavirus			Y	Virus	Y	
Norovirus			Y	Virus	Y	Y
Sapovirus			Y	Virus	Y	
Shigella				Bacteria	Y	
Staph . Aureus					Y	
C. Perfringens			Y	Bacteria	Y	

9.3. Public Health Risk

The public health risk analysis explores boundaries and priorities in the study.

9.3.1. Using Risk Types to Set Boundaries of the Cost-Benefit Model

Settling on which pathogens to include is fundamental to the enquiry. We use a deductive approach by considering (a) type of disease, (b) route of transmission and (c) impact on human health, narrowing the focus to zoonotic disease spread through consumption of meat.

We divide pathogens and other risks into seven types:

1. Pure animal health diseases that represent a cost to the producer, e.g. Fascioliasis (liver fluke); Pleurisy/pneumonia/lung lesion; Cysts (Cysticercus ovis/tenuicollis, hydatidosis); Milk spot – liver.
2. Zoonotic diseases that represent a risk to humans through consumption of meat, poultry and dairy products, e.g. Salmonella, Campylobacter, VTEC/STEC.
3. Zoonotic disease that represents a food-borne risk through environmental sources, e.g. Cryptosporidium which is water-borne and enters the food chain through consumption of salad and uncooked vegetables.
4. Zoonotic diseases that represent a risk but are not food borne, e.g. Echinococcus, Brucellosis (which used to be an occupational disease of farmers and vets through contact infection). These diseases may represent a cost to the producer.
5. Diseases which are food borne but not directly linked to animals, such as Staphylococcus aureus thermonuclease, listeria, botulismus, which are likely to be found in the environment, perhaps through contamination during processing.
6. Chemical residues (e.g. dioxins) including veterinary medicines
7. Organisms (pathogens and commensals) carrying antimicrobial resistance factors

Table 10. Categorisation of food related diseases

Human Effect	Route of Transmission	Animal Only	Zoonotic (Animal to Human)	Human Only	Animal-related
Causes food poisoning	*Food-borne – Meat, poultry and dairy products*		Salmonellosis; Campylobacter, VTEC **CATEGORY 2**	**CATEGORY 5** Norovirus	**CATEGORY 6** **CATEGORY 7**
	Waterborne/ environment		Cryptosporidium **CATEGORY 3**	**CATEGORY 5**	
	Person to Person Transmission			**CATEGORY 5** Rotavirus, Norovirus	
Does not cause food poisoning		**CATEGORY 1**	Brucellosis **CATEGORY 4**		

In terms of a cost-benefit analysis:

- benefits to the producer will accrue for categories (1) and (4);
- costs will accrue to the producer for categories (2), (3), (6) and (7) and benefits will accrue to the public;
- we are not addressing category (5) but general hygiene improvements would be expected to yield benefits which would also benefit the public;

- categories (6) and (7) are important but go beyond the scope of this study in terms of human health; further research is required in this area;
- category 2 is the main focus of this enquiry into food-borne costs of illness

9.3.2. Public Health Risk: Rating Risks in the Food Chain

Public health risks are summarised below, graded high-medium-low according to EFSA risk ratings (drawn from Deliverable 2 of this project). The high risk zoonotic pathogens include Salmonella species in cattle, pigs and poultry; Campylobacter species in poultry; VTEC in cattle and sheep; and toxaplasma gondii in sheep. There is a medium-high risk associated with ESBL/AmpC E. coli in poultry. Residues represent a high risk across all species (Dioxins/DL-PCBs) and unlicensed antimicrobials are rated as high risk in poultry.

Table 11. Public Health Risk Ratings (Source: Deliverable 2 of this study)

	Cattle	Pigs	Poultry	Sheep
Bacillus anthracis	L			
Campylobacter species	L		H	
Cysticercus (Taenia saginata)	L			
Dioxins/DL-PCBs	H	H	H	H
ESBL/AmpC E. coli	U		M-H	
ESBL/AmpC Salmonella			L-M	
Heavy metals			M	
Salmonella species	H	H	H	
Sarcocystis hominis	L			
Toxoplasma gondii	U	M		H
Trichinella		M		
Unlicensed antimicrobials			H	
VTEC	H			H
Yersinia enterocolitica		M		

9.4. Incidence of Zoonotic Disease

The zoonoses reported by DEFRA show that in 2012 the number of human cases of zoonosis reported to UK laboratories was 92,532 and include: Campylobacter (78%); Salmonella (10%); VTEC (e-coli) (1%). Toxaplasma gondii comprises only 0.4% (and, while included in the Defra list of zoonoses, does not feature on the IID2 list of pathogens).

Cryptosporidiosis is an important zoonotic pathogen (7% of zoonoses). It is not associated with meat-consumption, as it is a water-borne protozoan that mainly affects salad, so is not included in our CBA model.

Table 12. Reported Incidence of Zoonoses in Humans 2012

Zoonosis	Human Cases Reported to Surveillance Laboratories in UK 2012	% of Zoonotic Pathogens Listed
Bacillus anthracis	6	0%
Campylobacter species	72,592	78%
Cysticercus (Taenia saginata)	70	0%
Salmonella species	8,798	10%
Toxoplasma gondii	327	0%
Trichinella	0	0%
VTEC	1,217	1%
Yersinia enterocolitica	55	0%
Sub- Total	**83,065**	**90%**
Cryptosporidiosis	6,612	7%
Listeriosis	183	0%
Other	2,672	3%
Total Zoonoses 2012	**92,532**	**100%**

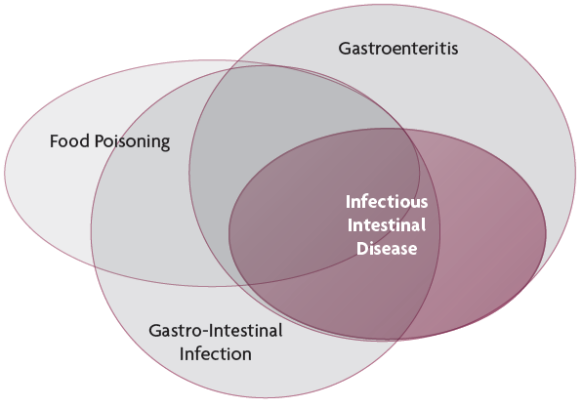
9.5. Total Incidence of Disease

The total incidence of disease describes the relationship between food poisoning (food-borne disease), infectious intestinal disease (IID) and gastroenteritis. It draws on the IID2 survey which quantifies total incidence of IID. (This is a necessary precursor to isolating the food-borne element of IID which has been costed by the Food Standards Agency).

9.5.1. Describing Human Disease: Food Poisoning, Infectious Intestinal Disease and Gastroenteritis

Food-poisoning, infectious intestinal disease and gastroenteritis tend to be used synonymously in everyday language. The venn diagram (below) nevertheless shows that the overlap is partial. Zoonotic food-borne disease would largely be contained within the food-poisoning elipse, overlapping with IID and gastroenteritis, since most zoonotic pathogens are enteric bacteria. Contaminants such as heavy metals and dioxins would be located within food-poisoning but outside IID.

Figure 5. Relationship between Food Poisoning, Gastroenteritis and IID (Source: IID2)



Food poisoning but not IID:

- Chemicals e.g. histamine, dioxin; Heavy metals e.g. mercury; Mycotoxins

Gastroenteritis but not IID

- Irritable bowel syndrome; Inflammatory bowel disease e.g. Crohn's disease; Food intolerance; Alcohol;

Gastrointestinal infection but not IID

- Helicobacter pylori; Botulism

Public health dangers posed by food-borne disease are generally exhibited through 'food poisoning' which is a statutorily notifiable disease (meaning that identified cases are reported to public health surveillance bodies, underpinned by laboratory analysis and reporting). The World Health Organisation (WHO) definition, circulated to all UK doctors by the Chief Medical Officers in 1992 (CMO, 1992), defines food poisoning as: 'any disease of an infectious or toxic nature caused by or thought to be caused by the consumption of food or water'.

Food-borne pathogens may be endemic or sporadic in the population or may cluster through an outbreak. A general outbreak is defined as 'an outbreak affecting members of more than one private residence or residents of an institution'. The definition excludes outbreaks that are confined to a single household, e.g. a family outbreak, but includes geographically widespread outbreaks linked by organism, serotype or phage type.

Salmonella spp. and Campylobacter spp. are enteric pathogens, resulting in infectious intestinal disease in humans, commonly referred to as gastroenteritis. The symptoms of gastroenteritis, for survey purposes, have been defined as "diarrhoea (at least twice a day) with two or more additional symptoms within a period of 7 days. The additional symptoms included: diarrhoea (at least twice a day), vomiting, fever, abdominal cramps, nausea, and blood or mucus in the stool" (De Wit et al, 2000, p714). Gastroenteritis is one of the most common diseases throughout the world (Guerrant et al, 1990; Bern et al, 1992). In developed countries, associated mortality is low but morbidity is high; most episodes are brief and self-limiting, so that they do not require medical attention, but the high incidence places a significant social and economic burden on industrialised countries (De Wit et al, 2001; Hellard et al, 2003).

The IID2 report "estimated that around 25% of people in the United Kingdom suffer from an episode of IID in a year. We estimated that for every case of IID in the UK reported to national surveillance systems there were 147 in the community. The most commonly identified pathogens were, in order of frequency, norovirus, sapovirus, Campylobacter spp. and rotavirus." (p17) While all of these pathogens caused IID, only Campylobacter is zoonotic. (Approximately 80% of total incidence of IID was not related to any specific pathogen). An important source of food-poisoning and IID is viral, e.g. norovirus, rotavirus, and transmitted from person to person.

The Food Standards Agency monitors five main pathogens: Campylobacter, Salmonella, E coli 00157, Listeria monocytogenes and Norovirus[68].

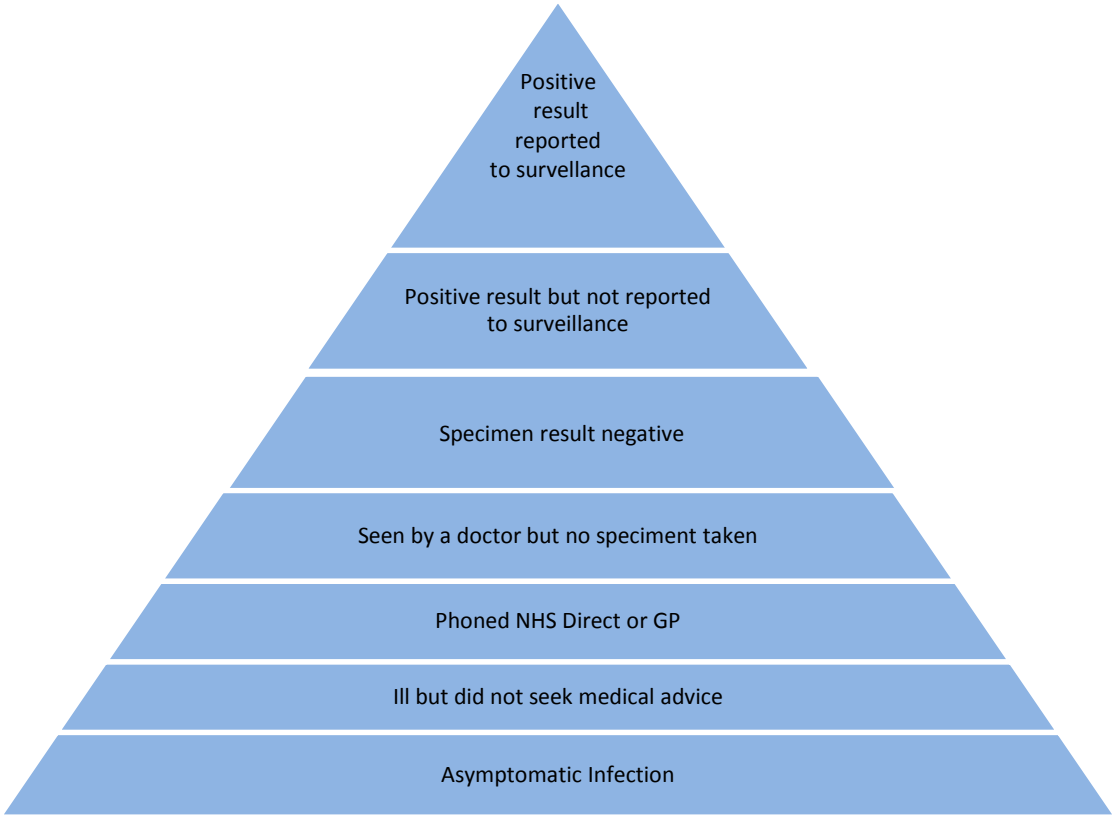
9.5.2. Burden of Illness Pyramid

The number of known cases that are formally reported each year to public health surveillance bodies represents a fraction of the cases presented to general practitioners. Patients who visit their GP with symptoms of gastroenteritis likewise represent a sub-set of the people in the community who experience enteric distress. The total number of cases of IID in the community is unknown. Its mild nature means that there may be an economic consequence, e.g. as individuals take time off work or remain at home to care for sick children, but there is no medical record of the event. Even where the illness is severe or leads to death, the cause of death, e.g. Salmonellosis, may not be investigated. "[U]nknown agents accounted for approximately 81% of food-borne illnesses in the United States and 64% of deaths" (Mead et al, 1999; quoted in Buzby et al, 2009, p1853).

The relationship between reported cases and larger volume in the community is conventionally represented through a burden of illness pyramid shown below. The cause of the illness will only be established if a specimen (stool) is obtained (either by the GP or the hospital physician) and sent to a laboratory for analysis, linked into public health surveillance systems.

[68] Up to 2008 Rotavirus was reported by FSA rather than Norovirus. The FSA website now refers to these pathogens as sources of IID rather than food-borne illness (with a corrigenda noting this), indicating the shifting boundaries between IID and food poisoning in terms of measurement.

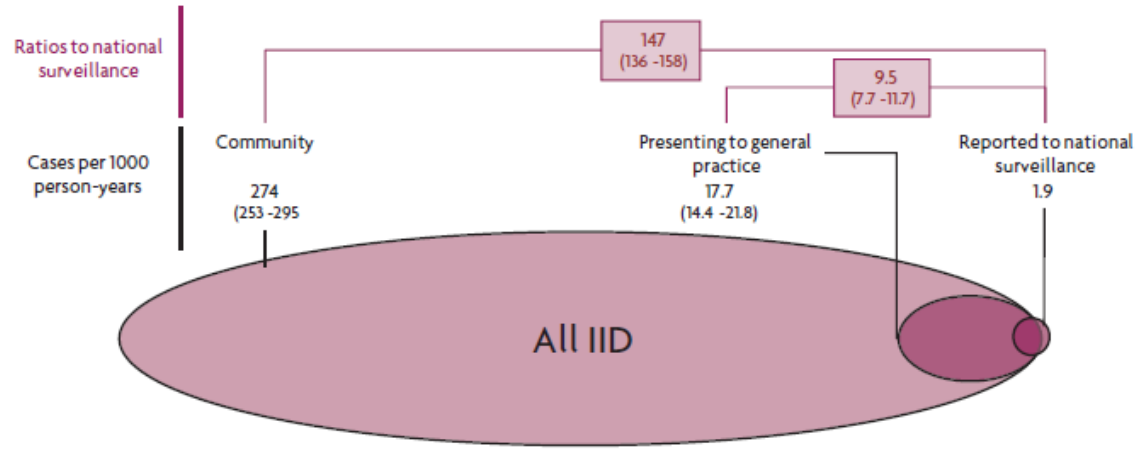
Figure 6 Surveillance pyramid



The laboratory reports represent only a fraction of the true prevalence of IID

A more accurate way of representing numbers is through the surveillance ellipse, which conveys (a) scale, and (b) nesting, showing also that some cases are reported to national surveillance outside the chain of patient-primary care, e.g. hospitals, other institutions, surveys.

Figure 7 The surveillance ellipse



The relationship between IID in the community, presenting to general practice and reporting to national surveillance in the UK (Source: IID2)

The ellipse shows that the estimated rate of IID in the community (in 2008/9 – the time of the survey) was 274 per 1 000 person-years, 147 times higher than that of IID reported to national surveillance. The rate of IID presenting to general practice was 17.7 per 1 000 person-years, a figure 9.5 times higher than that of IID reported to national surveillance. This indicates that for every case of IID reported to national surveillance, 147 cases occur in the community, and 9.5 of these present to general practice for their illness.

9.5.3. Severity

Among the pathogens that cause gastroenteritis, Salmonella and Campylobacter infection causes the most severe illness, with raised temperature and bloody diarrhoea most frequently associated with the pathogen (IID1, 2000, p146). Severity of disease is linked to the pyramid of illness above, and may be described as:

- Mild – those case in the community that are self-limiting. The outcome for this group is full recovery;
- Moderate – patients who feel sufficiently unwell to visit their general practitioner. The outcome for this group is full recovery or chronic sequelae;
- Severe – patients who experience acute symptoms and may be hospitalised. The outcome for this group may be full recovery, chronic sequelae such as reactive arthirits, or death. Nearly 5% of people who suffer acute food-borne disease experience chronic sequelae in the form of joint pain. (Source: Raybourne et al, 2003; in Buzby et al, 2009).

9.5.4. Incidence – Reported Cases and Volume in the Community

The table below shows total incidence, building up from incidence of reported cases. Human cases of disease notified to laboratories for analysis in the UK are multiplied by factors showing (a) GP cases and (b) total cases in the community.

The table below gives figures on the ratio of cases presenting to GP compared to lab cases, and the ratio of cases in the community compared to lab cases. We describe these ratios as 'multipliers', drawn from IID2, which are applied to the volume of lab-reported cases.

Table 13. Incidence of IID Cases 2012

	Human Lab Cases UK 2012	Multiplier to GP	Multiplier Community	Cases GP	Cases Community
Relevant to CBA Model					
Bacillus anthracis	6			0	0
Campylobacter species	72,592	1.3	9.3	94,370	675,106
Cysticercus (Taenia saginata)	70				
Dioxins/DL-PCBs					
ESBL/AmpC E. coli					
ESBL/AmpC Salmonella					
Heavy metals					
Salmonella species	8,798	1.4	4.7	12,317	41,351
Sarcocystis hominis					
Toxoplasma gondii	327				
Trichinella	0				
Unlicensed antimicrobials					
VTEC	1,217		7.4		9,006
Yersinia enterocolitica	55				
Total	**83,065**	**1.28**	**8.7**	**106,687**	**725,462**
Excluded from CBA Model					
Cryptosporidiosis	6,612	2.3	8.2	15,208	54,218
Listeriosis	183				
Other	2,672				
Total Zoonosis 2012	**92,532**	**1.32**	**8.4**	**121,894**	**779,680**
Rotavirus 2008 UK	16,440	4.6	43	75,624	706,920
Other viruses	12,330	10.8	211.61	133,692	2,609,203
Sub-Total Viruses	28,770	7.3	115.3	209,316	3,316,123
Total of Above	**121,302**	**2.7**	**33.77**	**331,211**	**4,095,803**
Total IID (using survey cohorts, and not linked to pathogens)	121,302	9.5	147	1,152,369	17,831,394 – imputed[69]

Many of the diseases in our risk list are not measured in this incidence table, indicating that we have very little information on the extent to which they are present in the food chain and responsible for illness.

Viruses, such as rotavirus and norovirus, are a minor part of the disease burden reported to UK laboratories. However, they form a major source of IID in the community.

[69] The figure is imputed on the basis of a community multiplier of 147. For a population of 64 million it equates to 279 cases per 1000 person years, or 28% of the population. This is consistent with the commentary in the IID2 report, although the IID2 report is based on a survey so does not give global population figures. (IID2 uses 2009 survey and 2008 published figures while this model uses 2012 data which shows an increase of food-related illness). It suggests that 77% of IID is not related to a named pathogen, i.e. 4.1 million cases linked to organisms (bacteria, protozoa, virus) with 17.8 million cases in total. Not all of this is food-borne. An extension of IID2 was commissioned by FSA to elicit the food-borne element.

9.6. Food-borne Illness

The preceding evidence is informative about burden of human disease, but tells us very little about route of transmission, i.e. the proportion that is food-borne disease (FBD). The Food Standards Agency addressed this knowledge gap by commissioning an extension to the IID2 study, the results of which were published recently (final report dated 25th March 2014).

The IID2-extension report (a) recalibrates incidence figures (using 2008/9 as the base throughout, consistent with the IID2 study), (b) presents attribution percentages relating to the food-borne element, (c) models hospital utilisation that differs between pathogens (as an indicator of severity), and (d) assigns attribution to different types of foodstuff.

Our primary interest, for modelling purposes, concerns the food-borne attribution percentages. We apply these rates (using Adak 2002, drawn from IID2-Extension, p49) to the 2012 incidence figures calculated above[70].

9.6.1.1. Comparing IID2-Extension with Figures Modelled Here

The total number of food-related cases estimated in:

- the IID2-extension report (Model 1) = 566,391 (with a wide 95% credibility interval aggregated to 258,107-1,334,242, i.e. -54% to +136%);
- the IID extension report linked to food commodity = 547,953 mean; 480,650 median (with a wide credibility interval aggregated to 1,060,114 - 1,060,114);
- our model = 664,513 cases.

Our model of 664,513 food-related cases is +17% higher than the IID2-extension total of 566,391. We regard this as credible because:

- the estimate lies well within the credibility interval;
- Reported food-borne illness has risen during the period. During the four reporting periods 2008/9 – 2012, reported human disease has increased in the following way: zoonotic +8%, norovirus +40% (10.7% of which is estimated to be food-related); 5 diseases monitored by the FSA (Campylobacter, Salmonella, listeria, E-coli, norovirus) + 11%.

Table 14. Food-borne Disease Attribution

	Proportion that is food-borne	Food-borne Lab Cases	Food-borne GP Cases	Food-borne Community (Total) Cases
Bacillus anthracis	1.000	6	0	0
Campylobacter species	0.797	57 856	75 213	538 059
Salmonella species	0.916	8 059	11 283	37 877
VTEC	0.630	767	0	5 674
Grand Total	0.803	66 688	86 495	581 610
Listeriosis	0.990			
Total Zoonosis 2012	0.721	66 688	86 495	581 610
Giardia	0.100			
Adenovirus	0.000			
Atrovirus	0.107			
Rotavirus 2008 UK	0.025	411	1 891	17 673
Norovirus	0.107			

[70] Our approach to incidence mirrors that of IID2 by building up from reported cases. The Extension Report used a different approach, modelling outbreak data and applying Monte Carlo and Bayesian methods, deriving total incidence that is not linked arithmetically to reported incidence.

	Proportion that is food-borne	Food-borne Lab Cases	Food-borne GP Cases	Food-borne Community (Total) Cases
Other viruses[71]	0.025	308	3 342	65 230
Sub-Total Viruses	0.025	719	5 233	82 903
Shigella	0.082			
Total of Above		67,407	91 728	664 513
Proportion of Cases that is FB		0.556	0.277	0.162

Based on Adak 2002, UK, cited in IID2-Extension, p49

9.7. Cost of Illness

9.7.1. Background and Methodological Problems

We use a cost of illness approach, based on a financial value (rather than other currency such as QALY or DALY), in order to provide an input to the CBA.

There is no perfect means of estimating costs of illness because: (a) costs are notional, derived from often bold assumptions[72]; (b) different inclusions and exclusions pertain to different studies, e.g. statistical cost of life, chronic sequelae, pain and suffering, private out of pocket expenses may be included or excluded[73].

The Food Standards Agency illustrates this point in its 2013/14 Annual Science Report (published 17th September 2014), noting "the estimated economic burden from food-borne pathogens has not been included in this report. This is because further work is needed to update both the underlying methodology and economic cost model for the estimates of the burden of disease" (p25). It marks a parallel with the US position where the US Department of Agriculture cost of illness model has been taken offline in order to review assumptions.

[71] Note: the base of the incidence is IID2 which, in line with then FSA policy, quoted incidence for rotavirus and not for norovirus. Norovirus incidence is imputed based on IID2 ratios. We apply the rotavirus FBD attribution percentage to all viruses here to maintain some comparability with the IID2-extension results.

[72] The US Department of Agriculture Economic Research Service has designed a comprehensive and widely used on-line calculator for costs of illness relating to a range of pathogens. It has been taken out of the public domain in order to review the underlying assumptions. The USDA website points researchers to its report: "Making Sense of Recent Cost-of-Food-borne-Illness", Economic Information Bullentin Number 118, September 2013, by Sandra Hoffman and Tobenna D. Anekwe. This report responds to widely differing estimates of cost of illness (e.g. $152 billion in 2010 and $77.7 billion in 2012), concluding that the main differences are due to (a) incidence measures, (b) number of pathogens being included, and (c) difference in valuation method, e.g. monetized vs. QALY vs. statistical cost of life based on willingness to pay. The account is consistent with our findings in previous research relating to Salmonella in pigs. (See footnote below).

[73] In our EU-27 CBA model relating to Salmonella in pigs, commissioned by the EC SANCO, we included statistical cost of life and excluded chronic sequelae. Mortality (cost of life) accounted for 75% of total costs, even though it was a notional figure. It was also a conservative figure (compared to the US), indexed to labour productivity costs in EU-27 Member States.

One of the problems that may have emerged with publication of the IID2 Extension report is that the incidence of illness that can be substantiated as food-related will have reduced. IID2-Extension refers to over 500k cases; our model is consistent in estimating 680k food-related cases out of 4.1 million total cases of gastric problems caused by pathogens that have the capacity to be transmitted through food consumption. The food attribution factor in the community emerges as 16%, mainly due to the inclusion of virus pathogens. (This percentage varies according to which pathogens are included. Zoonotic pathogens in our list, which are bacterial or protozoan, have a much higher food-borne attribution than viral pathogens). A BBC statement in 2000[74] quotes an FSA press release: "There are an estimated 4.5m bouts of food poisoning in the UK each year". (The report noted that total costs were estimated at £350 million, equating to £80 per case, which is a much lower figure than subsequent estimates). The implication is that the food-consumption attribution factor has served to reduce this illness estimate by over 80%.

The table below shows trend data for England and Wales 2003 – 2011 which has been reasonably consistent around £1.6 billion (apart from spikes in 2004 and 2009). When scaled up for Scotland and Northern Ireland, the FSA estimates that total costs are around £1.8 billion.

Table 15. Estimated Economic Burden from Food-borne Pathogens in England and Wales[75]

Year	Economic Costs (£m) all at 2012 Q1 prices			
	NHS	Lost Earnings and Other Expenses	Pain and Suffering	Total Cost
2003	24	100	1 363	1 487
2004	33	134	1 829	1 996
2005	28	117	1 530	1 675
2006	27	110	1 412	1 549
2007	27	115	1 442	1 584
2008	28	121	1 444	1 593
2009	37	154	1 836	2 027
2010	33	147	1 506	1 686
2011	31	136	1 397	1 564

9.7.2. Method – Top Down Method Using FSA Costs to Derive a Unit Cost

An important requirement, for purposes of this study, is to ensure a degree of consistency. Our approach, therefore, employs a top-down approach by adapting the IID2 findings which uses 2008/9 activity[76]. We use 2012 as the base incidence year (since at the time of modelling, this is the most recently available data) and the table above shows prices at 2012 Q1.

We obtain a unit cost per case of illness by pathogen, using the following method:

- Take 2008 bottom line costs (for England and Wales, at 2012 price base) attributable to all food-borne illness. These separate out (a) NHS utilisation, (b) lost earnings and other expenses, and (c) pain and suffering[77] ;
- Take 2008 incidence of food-borne human disease (for England and Wales);
- Apportion NHS costs across pathogens, based on GP presentations;

[74] http://news.bbc.co.uk/1/hi/health/856221.stm Friday, 28 July, 2000

[75] Food Standards Agency, Annual Report of the Chief Scientist 2012/13

[76] IID2 quoted comprehensive costs of food poisoning at 2008 baseline costs produced by FSA. They are the same format as the table above but use a different price base.

[77] Note: we had originally taken the 2008 costs from the IID2 report and uprated the price base using consumer price index of 2.5% per year. The prices quoted here, however, are set at 2012 Q1 prices so no uprating is required, since we match them against 2012 incidence figures.

- Apportion productivity (e.g. days lost at work due to diarrhoea and vomiting) plus pain and suffering costs based on volumes of community cases;
- Obtain a unit cost per case of human illness.

9.7.3. Results

If we assume that 'all food-borne pathogens' is the denominator in the FSA cost totals, then the unit cost per case is £431, averaging £436 for zoonotic cases. (The unit cost does not vary much between pathogens, which is a reflection of our methodology and masks relative severity).

Table 16. Cost of Food-borne Pathogens in England and Wales in 2008 at 2012 prices

	NHS (based on GP presentation)	Productivity (based on community)	Pain & Suffering	Total Cost (England and Wales)	%	Per Person (Case)
	£ million					
Total Zoonosis 2012	**14.1**	**35.2**	**419.8**	**469.1**	**29%**	**436**
Viruses	13.9	85.8	1 024.2	1 123.9	71%	429
Total of Above	**28**	**121**	**1 444**	**1 593**	**100%**	**£431**

9.7.4. Strengths and Limitations of the Costing Approach

We have used a costing model that has recently been taken out of the public domain[78], so we are very aware of the potential limitations of this approach.

Strengths:

- All pathogens are costed on the same set of inclusions/exclusions;
- The method has an audit trail: we are working from a published reference total and apportioning across named disease types;
- The model avoids spurious accuracy by generating high-level measures ;
- By taking a pre-existing model we do not need to determine inclusion parameters, e.g. costing pain/suffering, chronic sequelae and mortality ;
- We are adopting a conservative approach to costs as some pathogens do not surface in the model. Effectively, the model focuses on high volume zoonotic problems (Campylobacter, salmonellosis, VTEC)[79];
- We are including non-zoonotic (viral) pathogens in the methodology because they are in the cost base, in order to exclude them from the CBA model.

Limitations:

- The top-down approach lacks internal transparency which would be available to a bottom-up methodology;

[78] Until 17th September the FSA costing was regarded as an accepted model in the public domain. Just as this chapter was being finalised, the FSA published its 2013/14 Scientific Report which announced that the model was undergoing review.

[79] It explicitly shows the impact of cryptosporidium and high volume viral illness such as norovirus which is then excluded from the CBA.

- The disease list depends upon food poisoning pathogens included in IID2. Some low volume risks to human health, e.g. Toxoplasma gondii, do not surface as significant costs of illness. The absence of Toxoplasma has been noted as a major limitation in this modelling approach, both through our review of the literature and also in consultative workshops with professional and industry colleagues. Other sources note the high morbidity associated with toxoplasmosis in terms of loss of quality adjusted life years (e.g. Sharff, 2010) and increase in disability adjusted life years (e.g. Havelaar et al, 2007).
- Likewise, unquantified risks to human health that also do not cause food poisoning, e.g. dioxins, do not surface through the costs. The consequence is that any benefits in these areas are not quantified as financial benefits to society;
- The methodology adopts a unit cost approach which is not sensitive to severity of different conditions. In reality, salmonellosis is likely to be more severe in its disease impact (although lower in volume), than norovirus.

Sensitivity – Purpose of Estimates and Future Work

- The purpose of the cost of illness estimates is to give an order of magnitude of public health impact that can be tested against the costs of intervention, set out in the cost benefit analysis which follows. It is dependent upon the FSA costing model which is currently under review. On balance, the costs are likely to underestimate the full public health impact of food poisoning, e.g. by excluding the statistical value of life related to mortality, and omitting known conditions such as Toxoplasma gondii. On the other hand, the revised FSA model may tend to reduce the total costs of food poisoning in the light of IID2 Extension results which isolate food-contamination from other sources of transmission. In conclusion, there is scope for further work to refine the assumptions contained in this report in the light of new evidence as it emerges.

9.8. Attribution to Species

This section looks at how food-borne disease can be attributed to species, linking (a) pathogens to species and (b) total food-borne illness to species and food types. These percentages may be applied to the CBA model to indicate where the costs of human illness can currently be attributed and, similarly, where the benefits will occur.

9.8.1. Attribution between species

We have used peer-reviewed sources and consultation with experts to attribute human disease between species. These are modelling figures and may be varied in the light of evidence.

Table 17. Attribution of Pathogens between Species

	Cattle	Pigs	Poultry	Sheep	Other	All
Campylobacter species[80]	19%	1%	71%	3%	6%	100%
Salmonella species	8%	36%	43%		13%	100%
VTEC	90%			10%		100%

[80] Kittl S, Heckel G, Korczak BM, Kuhnert P (2013) Source Attribution of Human Campylobacter Isolates by MLST and Fla -Typing and Association of Genotypes with Quinolone Resistance. PLoS ONE 8(11): e81796. doi:10.1371/journal.pone.0081796. (Boysen et al (2014) found similar attribtion of 69% poultry and 16% cattle); Campylobacter was noted during our consultation to be the third biggest cause of abortion in sheep and a cause of diarrhoea in lambs.

9.8.2. Attribution of Food-borne Illness (Source: IID2- Extension)

The following table shows attribution of estimated cases of food-borne illness to specific commodities. It is significant to our CBA analysis because it shows that: 51% of cases are attributable to poultry; 9% relates to beef and lamb; only 3% is linked to pork. In total, 63% of food-borne illness is linked to consumption of meat across our four species of interest. The remaining 37% relates to other foodstuffs.

Table 18. Estimated cases of food-borne illness by food commodity, UK 2009

	Mean	Median	95% CrI	% of Total	% of Total
Seafood	32 107	31 761	25 169	41 207	6.6%
Dairy	16 445	14 065	7 304	39 012	2.9%
Eggs	30 963	25 928	11 646	81 948	5.4%
Unspecified Red Meat	12 725	3 352	136	39 356	0.7%
Game	892	546	87	3 520	0.1%
Beef and lamb	74 084	43 357	10 321	217 627	9.0%
Pork	14 350	14 003	9 142	21 728	2.9%
Poultry	248 596	243 988	151 743	372 961	50.8%
Grains and Beans	6 686	6 532	4 542	9 784	1.4%
Oils and sugars	380	127	2	2 167	0.0%
Produce	48 868	47 575	33 035	71 162	9.9%
Complex and other	61 856	49 416	24 270	159 642	10.3%
Total	**547 953**	**480 650**	**277 397**	**1 060 114**	**100.0%**

The table below gives some indication of relative severity of illness associated with different commodities. Poultry is the biggest single cause of food-borne illness in the community, and the largest single cause of food-borne illness presenting to GPs. However, the most acute cases which become admitted to hospital are linked more closely to beef/lamb and eggs. Pork is consistently (and perhaps surprisingly) a low source of food-borne illness according to these figures.

Table 19. Estimated Rates of Food-borne Illness, UK 2009

	Rate per 1000 persons per year			Rate Ratio (relative to grains and beans)		
	Community	GP	Hospital Admission	Community	GP	Hospital Admission
Seafood	0.54	0.04	0.004	5.0	4.9	4.7
Dairy	0.25	0.03	0.004	2.3	4.2	4.2
Eggs	0.40	0.11	0.020	3.7	14.7	25.7
Red meat products	1.61	0.14	0.025	15.0	18.9	30.0
Beef and lamb	1.11	0.09	0.023	10.3	12.7	26.7
Pork	0.24	0.02	0.001	2.2	2.2	1.8
Poultry	4.22	0.48	0.015	38.8	64.7	17.9
Grains and Beans	0.11	0.01	0.001	1.0	1.0	1.0
Oils and sugars	0.00	0.00	0.000			
Produce	0.82	0.10	0.012	7.6	13.1	14.1

9.9. Bringing the Cost of Illness Model Together

The table below brings together relevant fields of the cost of illness model: incidence, food-borne proportion, food-borne incidence, unit cost per person, total cost of food-borne pathogens, total cost of food-borne illness, spread of cost (in £millions) across species.

Caveats:

- The 'unit cost' field is unstable and likely to vary. It drives the rest of the cost of illness attributed to species.
- Attribution of pathogens across species varies between studies. There is scope for further work here.
- Food-borne disease marks 80.3% of enteric zoonotic disease (Campylobacter, Salmonella, VTEC). In principle we could lower this percentage (and costs of illness) further by attributing some zoonotic food-borne disease to non-meat/poultry sources (using the 63:37 split meat: other identified earlier).

Nevertheless, the model provides an input to the benefits side of the cost-benefit analysis. Using these data, it will be possible to make assumptions on the amount of food-borne illness that could be prevented by improved FCI/CCIR.

Table 20. Summary of Cost of Illness Model

	Total Incidence	Proportion that is food-borne	Food-borne Incidence	Unit Cost Per Person	Total Cost Food-borne Pathogens	Total Cost Food-borne Illness
	UK Cases		UK Cases	£	(£million UK)	
Campylobacter species	675 106	0.797	538 059	435	293.70	234.10
Salmonella species	41 351	0.916	37 877	448	18.50	17.00
VTEC	9 006	0.63	5 674	423	3.80	2.40
Grand Total	**725 462**	**0.803**	**581 610**	**436**	**316.40**	**253.50**
Cryptosporidiosis	54 218				23.60	
Total Zoonosis 2012	779 680	0.721	581 610	436	340.30	253.80
Sub-Total Viruses	**3 316 123**	**0.025**	**82 903**	**429**	**1,421.30**	**35.50**
Total of Above	**4 095 803**	**0.162**	**664 513**	**431**	**1,764.80**	**289.40**

Table 21. Annual costs of the major food borne pathogens by species

	Cattle	Pigs	Poultry	Sheep	Other	Total
	(£ million UK)					
Campylobacter species	£44.50	£2.30	£166.20	£7.00	£14.10	£234.10
Salmonella species	£1.40	£6.10	£7.30	£0.00	£2.20	£17.00
VTEC	£2.20	£0.00	£0.00	£0.20	£0.00	£2.40
Grand Total	**£48.10**	**£8.40**	**£173.50**	**£7.20**	**£16.30**	**£253.50**

9.10. Conclusion

Sources. The section on public health has been informed by material that has come into the public domain very recently, namely the IID2-Extension report commissioned by FSA and the 2013/14 Scientific Report published on 17th September 2014. The impact of both reports is to (i) highlight uncertainty surrounding international costing models of food-borne disease and (ii) narrow down the amount of FBD directly attributable to consumption of meat across beef, lamb, poultry and pork.

Focus. The model concentrates on 3 high volume pathogens: Campylobacter, Salmonella, VTEC. It acknowledges the contribution of cryptosporidium, listeria and viruses to food-borne illness.

Development Potential. Four potential areas for development include:

(a) Costing model – introduce more complex assumptions, i.e. build bottom-up model

(b) Investigate incidence, costs and attribution of low volume disease such as toxaplasma

(c) Obtain data relating to contaminants such as dioxins

(d) Gain evidence on the cost of anti-microbial resistance in the food chain and its impact on human health

Sensitivity. We have identified variables in the model that could change in the light of evidence: unit cost of food-borne illness, attribution between species.

Priority. The single biggest zoonotic problem that emerges from this analysis is Campylobacter in poultry. The largest public health benefit will accrue from reduction in this pathogen.

Application. Cost of illness depends on (a) incidence of pathology, (b) cost burden of disease, (c) attribution to species. We have been explicit about the strengths and limitations of the approach used here. While further refinement is possible, there is a reasonable base here for testing the public health benefits of improvements through the FCI/CCIR interventions. Sensitivity analysis and break-even analysis can determine the extent to which further work is required.

10.COST-BENEFIT ANALYSIS

10.1. Introduction

A cost-benefit analysis assesses the economic profitability of a change by examining additional costs and benefits over a period of time. For the assessment of changes in the FCI/CCIR system there are some very specific challenges when carrying out the analysis:

1. The desired intervention needs to be well described indicating the sequence of the actions and the resources required over which time periods.
2. The interventions need to be linked to outcomes, which in this case will relate to changes in management of animals at farm-level, slaughter level, product along the value chain and value and safety of the product for the consumer.
3. The interventions need to be assessed in terms of:
    a. Additional resources, including time, that are required with the costs of these resources;
    b. Resources that are no longer needed as the intervention takes place.
4. The outcomes need to be detailed in terms of:
    a. Additional products generated less any additional resources and costs that may need to produce and process these additional products;
    b. Products that no longer are produced and therefore are no longer sold across the food system because the intervention has removed or reduced them;
    c. Overall health of the human population before and after the intervention with an estimate of the value of this difference.
5. The cost benefit analysis can then compare:
    a. Additional costs of the proposed intervention (3a, 4b);
    b. Additional benefits from the proposed intervention (3b, 4a, 4c).

10.2. Cost benefit analysis structure

The analysis is based on the review of the current FCI/CCIR activities and the proposed change leading to an improved flow of information. The following items are identified as important with regards the intervention:

- Additional costs
    - New costs
        - Computers
        - Data entry devices
        - Software development and maintenance
        - Data analysis
        - Training
        - Reporting procedures
        - Sampling and analysis
    - Lost revenue
        - Value of condemnation material (likely to be zero but has been considered)

- Additional benefits
    - Costs saved
        - Paper work
        - Administration
        - Handling of condemnation material that is no longer generated
    - New benefits
        - Increases in livestock production
        - Improved efficiency at slaughter level and across the food system
        - Public health changes leading to reduced illness and lower health costs

The review of the human health impacts is detailed in the previous chapter, indicating which pathogens and other risks are in the system and providing a basis for estimating possible benefits in the future.

Of the food borne pathogens identified in the previous chapter, Campylobacter stands out as a major source of economic loss. This is a difficult disease to manage in the food system as it does not cause loss in the production birds or currently in the slaughter or processing units. The impact is entirely in the human population. Improving knowledge of this pathogen across the food system should allow logistic measures in the management of slaughter and also post-harvest interventions to be strategically applied in flocks known to be infected.

Other food borne pathogens have also been targeted for new data collection, capture and information generation and these include Salmonella and VTEC.

Salmonella in poultry is becoming well controlled through strategic use of vaccines and also improved management of feed and water. Beyond monitoring to indicate the stability of this shift there seems little extra that could be done to improve the process.

For Salmonella in pigs the situation is more complex, the UK has relatively high levels of infection yet little possibility of modifying these issues with currently available technical solutions in the farm. VTEC is important, yet the knowledge of its epidemiology is such that interventions are not clear. This would change however if vaccines would be approved and in this situation the FCI would provide a very clear indication to farmers of the need to vaccinate.

With regard to the impacts of animal health issues there have been two studies that have systematically looked at animal health problems. The work by VLA[81] with the University of Reading produced estimates of endemic diseases in livestock (Bennett et al, 1997; 1999; Bennett, 2003) This was updated around 10 years ago (Bennett and Ijelaar, 2005) and a summary of their results is shown in Figures 8 to 11.

[81] Now AHPA

Figure 8. Endemic cattle disease impacts (data from Bennett and Ijeplaar, 2005)

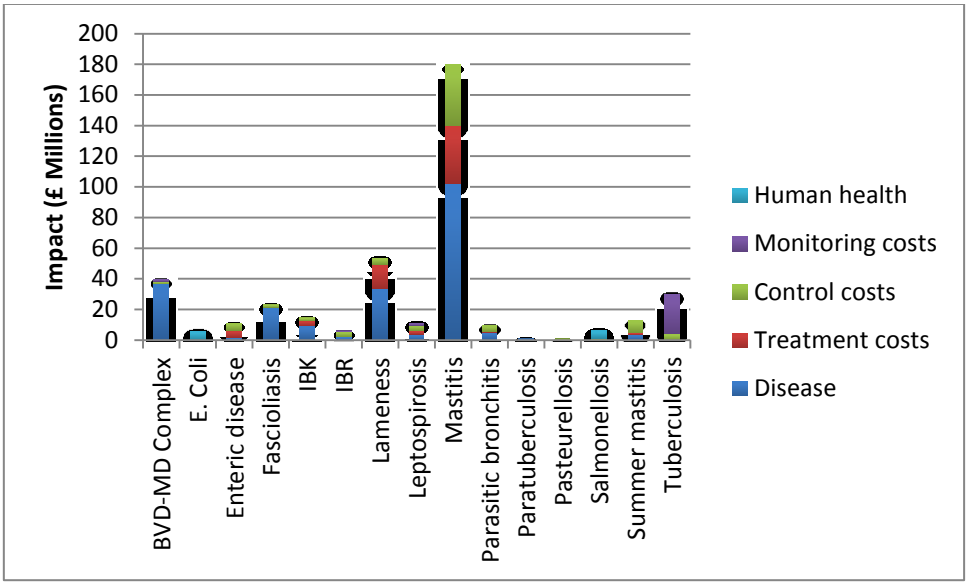


Figure 9 Endemic sheep disease impacts (data from Bennett and Ijeplaar, 2005)

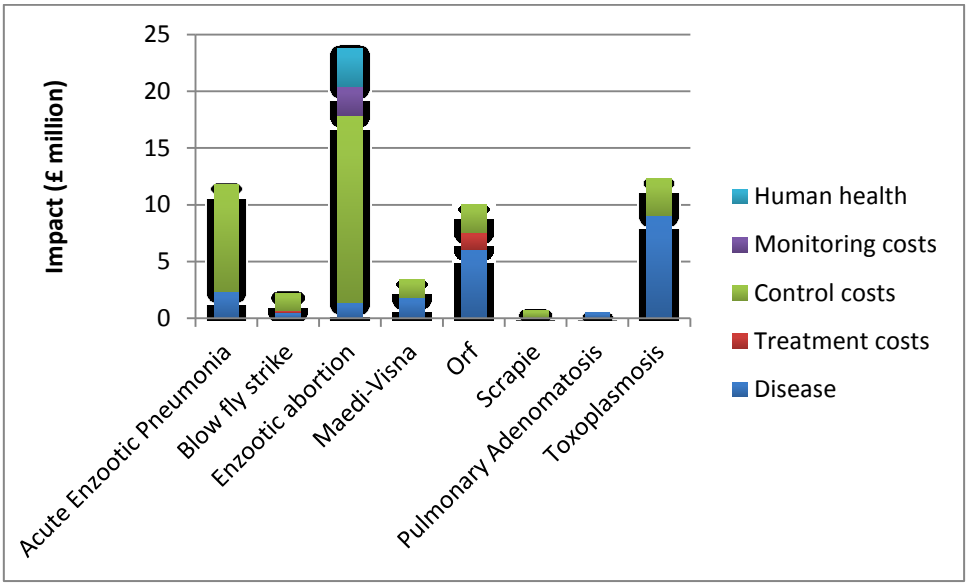


Figure 10 Endemic pig disease impacts (data from Bennett and Ijeplaar, 2005)

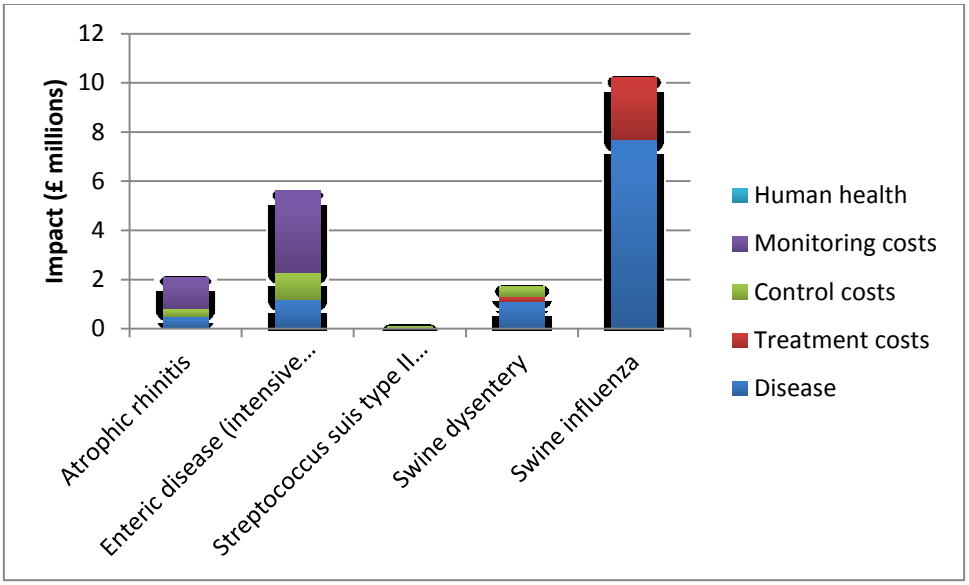
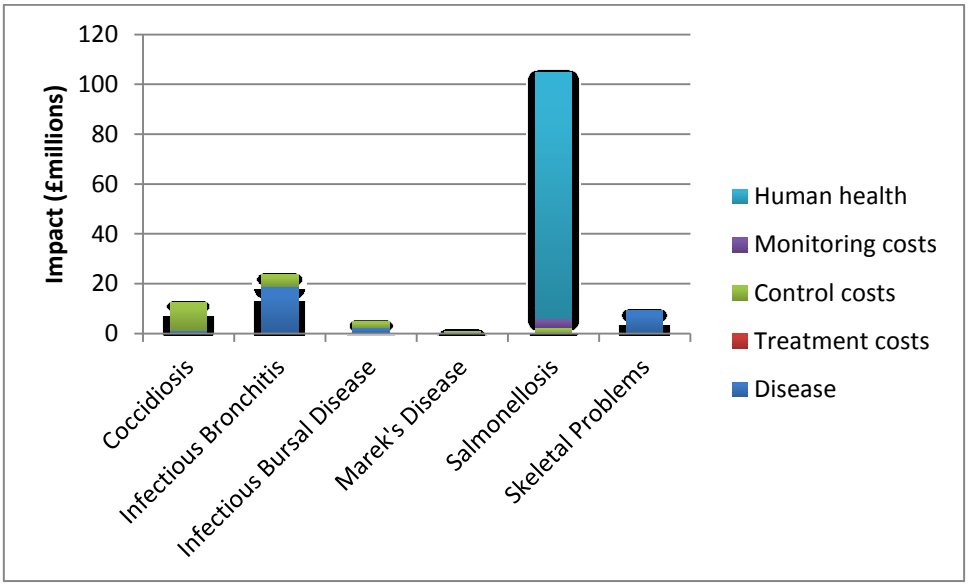


Figure 11 Endemic poultry disease impacts (data from Bennett and Ijeplaar, 2005)



As can be seen the diseases that are identified in the slaughter inspection either were not included in this historical list of priority endemic diseases, therefore no mention of liver fluke as a major issue nor of Campylobacter. The importance of this historical study is that it demonstrates that priorities and awareness of disease changes and the improved FCI system needs to be both focussed on current issues and collecting data to allow the identification of emerging issues.

A more recent study was commissioned by EBLEX and this has both updated the impacts of a select group of health problems and also made estimates of the net benefits of better control of these problems (ADAS, no date). A summary of this work is presented in Table 22.

Table 22. Summary of the major animal health problems in cattle and sheep (ADAS, no date)

Species	Condition	Losses in £ millions	Disease cost per animal	Cost benefit analysis
Sheep	Lameness	24 (GB)	90	4.40*
	Abortion	32 (UK)	122	10.90*
	Ectoparasite	8.3 (GB)	12.3	10.50*
	Intestinal Parasites	84 (GB)	4.4	3.50**
	Liver fluke	14 (Eng)	6	5.60**
Cattle (all UK)	BVD	36.6	58	42.00*
	Johne's	13	45	
	Respiratory disease	50	82	76.00**
	Diarrhoea	11	58	47.00**
	Liver fluke	23	90	87.00**

* per breeding female – ewe or cow

** youngstock – lamb or calf

Of the animal health problems indicated the most obvious in terms of the economically profitability would be liver fluke in calves and abortion and ectoparasites in sheep. Given that the latter two problems are not something this report has focussed on for inspection and information generation, the liver fluke in lambs is considered as being the issue to focus on.

ADAS (no Date) summarise that while liver fluke does not have a vaccine, it can be controlled through systems of pasture and water management and also through antiparasite treatments. There are concerns about the potential build-up of resistance for the antiparasite drugs and this could be better managed through improved information of the disease.

Liver fluke is also of interest for this study as it generates impacts at different points across the food system. This disease impacts on farmers as the animals in the best scenario have lower weight gain and in the worse causes will die. In the slaughterhouse livers with fluke will be totally or partially condemned and ADAS report that up to 50% of livers have a problem. More scientific studies have been carried out for this problem and these will be referred to in more detail below.

In addition to the problems with liver fluke we have also targeted lung lesions which are problematic in sheep, cattle and pigs. There are significant estimates of losses for these syndromes and a lack of clarity on the causative organisms that can lead to readily accessible interventions. Whilst not downplaying the significance of lung lesions the potential viable interventions are less obvious than for liver fluke and would require work that is beyond the scale of this project.

10.2.1. Time period, discount rate and measures of project worth

A major decision with a cost benefit analysis is the time period of the analysis. For the analysis carried out we have taken the decision to look at a five year time horizon. This reflects that many of the interventions will require significant private sector involvement and longer time periods are unlikely to be attractive.

There is also a decision on the discount rate that would be applied and in this calculations presented a rate of 4% has been applied.

With regards the measures of project worth (indicators of economic profitability) the report contains information on the:

- Net present value (discounted benefits less discounted costs);
- Benefit cost ratio (discounted benefits divided by discounted costs);
- Internal rate of return (the discount rate at which the net present value [NPV] is equal to 0).

Due to the uncertainty on some of the existing activities in the FCI/CCIR and the likelihood of changes in production and health with improved information across the food chain it is recommended that the analysis be extended in the future to include:

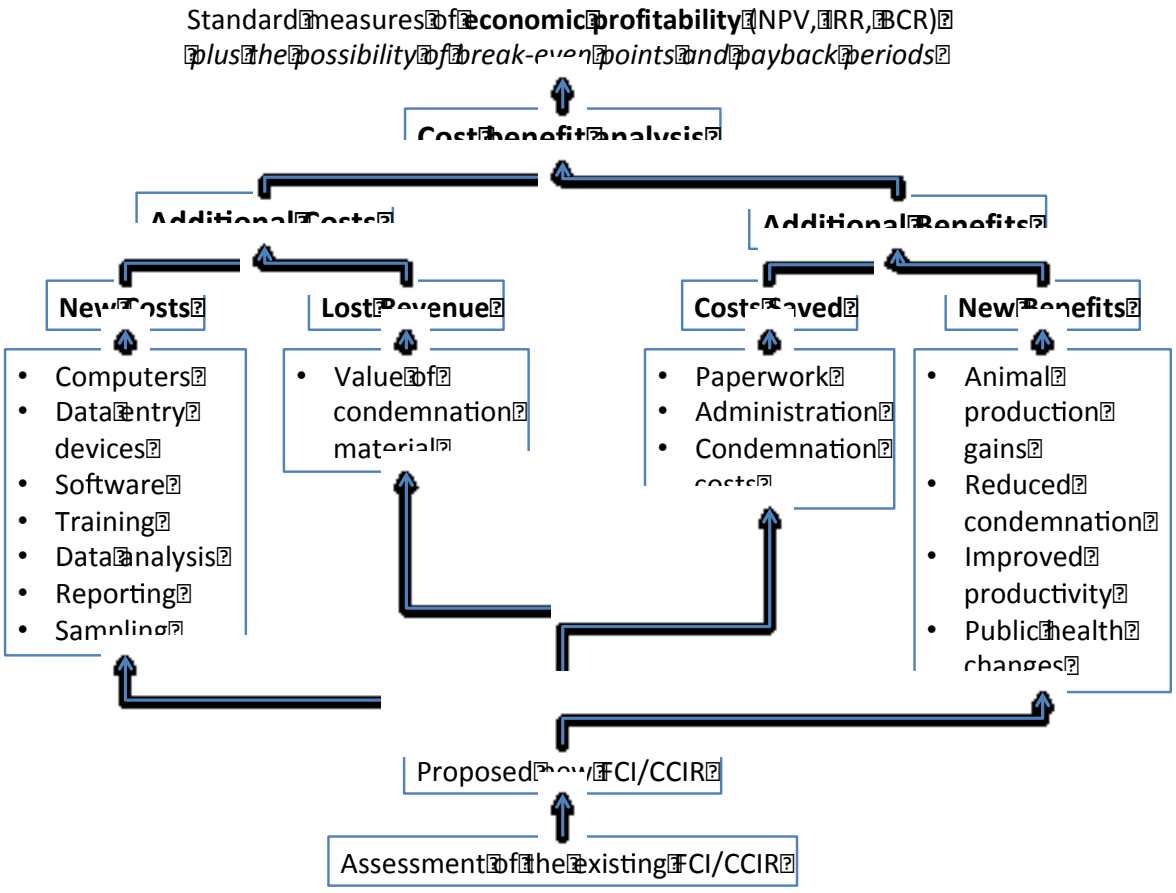
- break-even points with variations on the estimated costs per animal in the different food systems;
- pay-back periods to estimate the length of time required for an investment to improve FCI/CCIR to be returned.

These measures are likely to be of greater interest to the private sector.

10.2.2. Framework for the cost benefit analysis

The overall framework for the cost benefit analysis is presented in the figure below:

Figure 12. Framework for the cost-benefit analysis



The costs and benefits of FCI/CCIR in relation to food safety are likely to be distributed unevenly. The benefits, in terms of health impact, are enjoyed by consumers through reduced costs to individuals and society whereas costs of FCI/CCIR are borne directly by the producers.

For simplicity of the analysis the intervention has been divided into three aspects:

- Data capture which includes the costs of additional sampling and is limited to Campylobacter, Salmonella, VTEC, liver fluke and lung lesions;
- Data systems – this includes the investments in development and the costs of handling the data;
- Information generation and dissemination – this covers the costs of analysis and the distribution of the information.

10.3. Costs

10.3.1. Initial establishment costs

There is estimated to be an initial cost of £365,000 to establish the software that can receive data from the slaughter lines and also provide a platform to generate information. This cost estimation would cover the basic programming cost for the analytical model and cloud storage architecture together with six web services. There is no allowance for contingency nor for commercial profit margin. The estimate used a Function Point Analysis and would be a one-off cost in the analysis. In addition a budget of £1,500,000[82] has been included to cover training costs on data capture with regards sampling and a further £1,500,000 for training of staff on information generation and dissemination.

There are no published data on investment of slaughterhouses and farms in terms of:

- Computers
- Data capture devices
- Communications

It is well known that some slaughterhouses already have this equipment available. Currently we only have data on the specialisation of the slaughterhouses across the United Kingdom.

Table 23. Number of slaughterhouses and species slaughtered

	Cattle	Sheep	Pigs	Poultry	Mixed	Total
England	17	11	18	71	162	279
Wales	0	0	0	4	22	26
Scotland	2	2	4	7	22	37
Northern Ireland	2	0	6	6	9	23

Data from FSA[83], author's analysis

While these data are useful, additional information on throughput and facilities of data capture and storage are necessary to make a detailed cost-benefit analysis. In terms of data on the number of herds of flocks the current figures are shown in the following table.

Table 24. Numbers of herds/flocks of different species in UK

	Dairy	Beef	Sheep	Pigs	Poultry
England	14 360	27 459			
Wales	3 450	9 473			
Scotland	1 975	9 114			
Northern Ireland	3 530	15 389			
Total	23 315	61 435	73 200	11 100	61 756

The data on the cattle and sheep come from 2012 and the pig and poultry are 2013. The numbers of dairy farms is likely to be lower, beef and sheep farms have stabilised but include a large number of very small holdings. Similarly there are a large number of very small holdings in the poultry figures with the core units probably only numbering 2 to 3 thousand.

10.3.2. Sampling and data capture

The slaughterhouse incurs the largest costs, which are comprised of IT implementation costs, cost of training associated with the system and costs of taking and analysing additional tests. For the sample taken there would be a possible focus on:

[82] The budget would allow at least 150 training events in both aspects with a cost of £10,000 per event

[83] https://www.food.gov.uk/enforcement/sectorrules/meatplantsprems/meatpremlicence

- Campylobacter - £6 per test
- Salmonella D - £6 per test
- STEC/VTEC shiga- Verotoxin producing E.coli - £9 per test
- Additional activities associated with liver fluke – no additional costs we added for tests
- Additional activities associated with lung lesions – no additional costs were added for tests

We have not included the time spent taking samples as we have assumed that much of the current infrastructure is in place in the majority of the slaughter plants and we assume that the fee paid will cover the costs courier and transport charges. Detection of problems such as liver fluke and lung lesions is assumed to be captured through existing systems and would not require further testing.

However the data on these problems would be captured, processed and returned to the supplier of the animals in real time. Not all pathogens have been included for all species and the table below details what has been included in the initial analysis.

Table 25. Pathogens and conditions included in the initial cost-benefit analysis

Type of cost	Condition	Cattle	Sheep	Pigs	Poultry
Public health costs	Campylobacter	Yes-£6 per test with one every 100 animals	Yes-£6 per test with one every 1000 animals	Yes-£6 per test with one every 100 animals	Yes-£6 per test with one every 1000 animals
	Salmonella	Yes-£6 per test with one every 100 animals		Yes-£6 per test with one every 100 animals	Yes-£6 per test with one every 1000 animals
	VTEC	Yes-£9 per test with one every 100 animals	Yes-£9 per test with one every 1000 animals		
Animal health	Liver fluke	Improved surveillance no extra cost	Improved surveillance no extra cost	Improved surveillance no extra cost	
	Lung lesions	Improved surveillance no extra cost	Improved surveillance no extra cost	Improved surveillance no extra cost	

10.3.3. Data System

The system that stores the data will require some maintenance over time once it is established. It is envisaged that this will be achieved through a transaction fee basis. The estimated cost per transaction is £0.018 and that these transactions will vary according to the species. The cost estimates is based on a system with limited maintenance requirements, no profit or contingency margins. In the initial costings we have included a transaction per:

- Head of cattle slaughtered
- 20 head of sheep slaughtered
- 20 head of pigs slaughtered
- 10 000 head of poultry slaughtered

The model is designed to adjust these figures. At present the figures relate to the average number of animals supplied by a farm at any one time.

10.3.4. Information generation and dissemination

The samples collected and data captured need to be analysed in order to generate information. This information needs to be disseminated upstream to the farmers who supply the animals and also downstream to the food processing and retail industry. The initial estimate of these costs is as follows:

- Cattle £1 per report for every 20 animals slaughtered
- Sheep £1 per report for every 100 animals slaughtered
- Pigs £1 per report for every 100 animals slaughtered
- Poultry £1 per report for every 10,000 animals slaughtered

These are based on an estimate of administration to generate and send out the report which would be facilitated with the new data capture, database and information system. These costs may change on implementation, they go up if the reporting has to be paper based and may go down if individual farmers are allowed to see the results and generate their own reports through the internet. Again the model can be adapted to reflect better data on the costs of the activity of information generation and dissemination.

10.4. Benefits

The benefit streams are largely based on farm level changes, slaughter plant efficiencies and possible public health changes.

10.4.1. Farm level

At the farm level the most likely impacts would be on the regular information provided to farms on liver fluke (fascioliasis) and lung conditions such as pleurisy, pneumonia and general lesions. At this moment we have not been able to estimate the loss of productivity for these problems, the costs of the interventions and the frequency with which they would change.

10.5. Critique

The elements of the proposed changes in the FCI/CCIR can be described in terms of the requirements on software development and data management. As a consequence it is possible to cost these with some accuracy. What is very difficult is to identify the needs of investment in infrastructure for data capture, data storage and communications at different points in the food system. It is likely that a proportion of slaughterhouses will need some investments and similarly a high proportion of farms.

In addition, the improved information system will only generate benefits at farm, slaughter and consumer level if there are associated actions of disease management, improved pharmaceutical use and overall better husbandry.

On the benefit side there is a poor understanding of the attributions of changes in farm-levels of pathogens and the subsequent outcomes on public health. In addition, the current levels of common animal health problems that are not zoonotic is also uncertain and therefore a baseline to start to estimate potential benefits is cast with uncertainty.

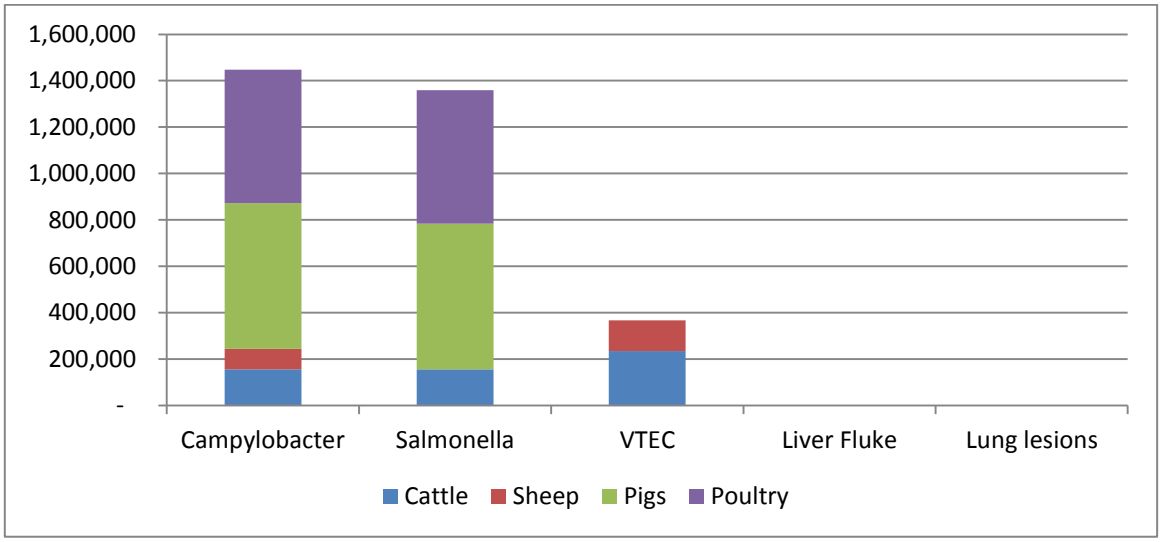
They only way to deal with such levels of uncertainty is for the cost-benefit analysis is to develop a model that can deal with ranges of inputs variables. Such a model is useful, but the process of developing the model can be more helpful in terms of identifying critical data gaps.

10.6. Results

10.6.1. Costs

The model has been populated with information that is indicated above. The following figure presents an estimate of the annual running costs of the information system broken down by species and health issue.

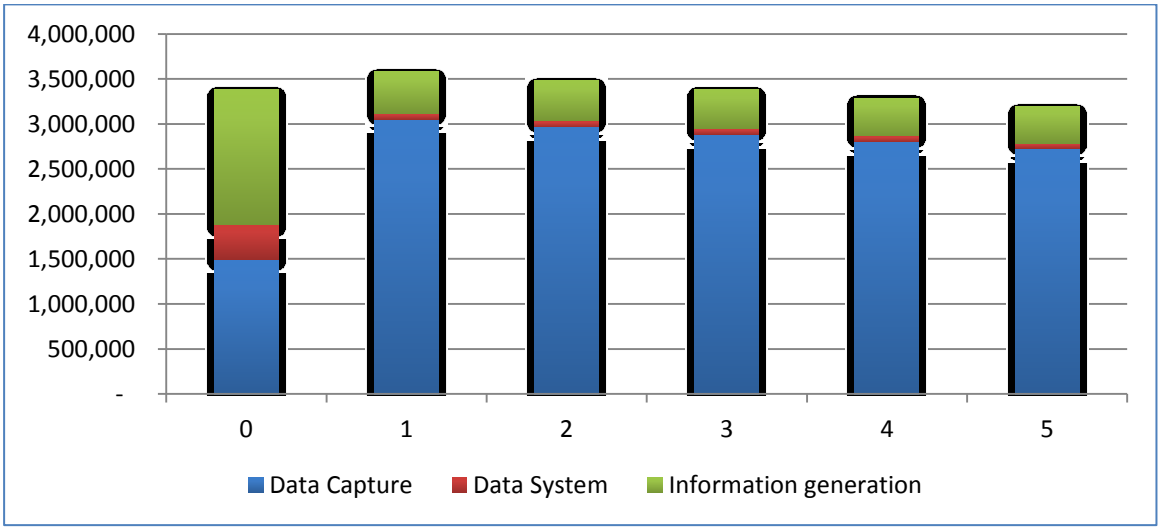
Figure 13. Discounted costs of information system per species and health issue



The chart provides an impression of where the costs will be incurred and in which sectors. However, the parameters generating these estimates still need some refinement and the figures presented should not be circulated or quoted.

The following chart presents the discounted costs of the entire intervention over a six year period. It is based in varying levels of slaughter of all species. This variation is based on historic slaughter trends. Plus the figures around the estimated costs of establishment of the different elements of the new system and the running costs of data capture, data systems and information generation and dissemination.

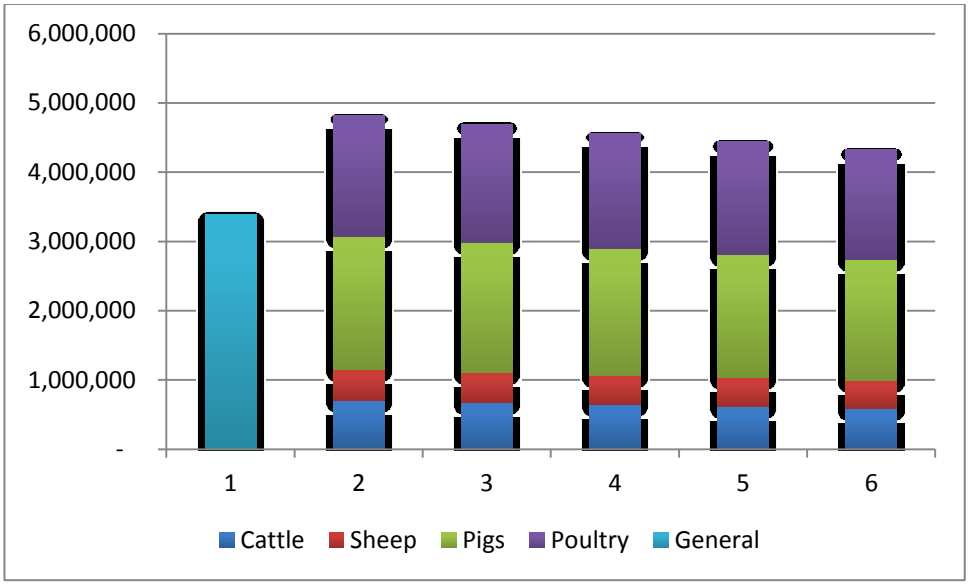
Figure 14. Total discounted costs per year (discount factor 4%).



The structure of the costs would indicate that the data capture which involves extra sampling is the major proportion of the costs. The team will need to revisit this estimate and make decisions on how this is refined.

The final figure for the cost analysis represents the costs by species.

Figure 15. Total discounted costs by species



A large proportion of the costs come from poultry and sheep. Given the growing awareness of Campylobacter this could well be justified for poultry. It could be questioned if there needs to be a reconsideration of how Salmonella is tested in the food system and how this should be tailored to a combination of farmer, slaughterhouse and public health needs.

Overall what has been presented is based on some initial estimates of the unit costs of the proposed changes. These need further modification and none of the results presented should be circulated.

10.7. Benefits

Three areas of interest in the new benefits

- Improved livestock production
- Improved slaughter and processing
- Improved public health

None of these areas are well documented in terms of increases in productivity. The public health impacts are well documented, attribution in terms of information improvements leading to better public health are not well covered in the literature.

10.8. Cost Benefit Analysis

Given the uncertainty of the benefit streams either through a lack of data and information in the food chain or a lack of clear attribution in human health the analysis has not attempted to carry out a classic cost-benefit analysis. In addition we recognize that the system we propose is designed to capture food data and generate through analysis food chain information.

To generate benefits from such a system requires it to be linked to the implementation of action at farm, slaughterhouse and processing levels and probably a change in practices of the animal health system in general. If the proposed system is not linked to the prevention and control activities[84] then it becomes a monitoring system, not a surveillance system.

Therefore the issue for both the scientists and the economists in the future is to establish ways to measure how prevention and control activities are modified across the food system in order to estimate if benefits from better information are generated.

[84] In some circles described as “mitigation activities”

A more crude, but equally valid test is whether the people in the food system value the food chain information system and begin to demand further information from it. This would clearly show that a positive change has taken place and this is leading to improvements in the management of the food system.

Returning to what can be produced from the data generated on the costs and some of the areas of potential benefits there is the presentation of two main aspects of the costs of the proposed changes versus current impacts of the some of the pathogens that are being tested for. This has been done for pathogens with a public health impact and those with a production impact. There is then a final table that summarises the estimates costs of the changes on a per head basis.

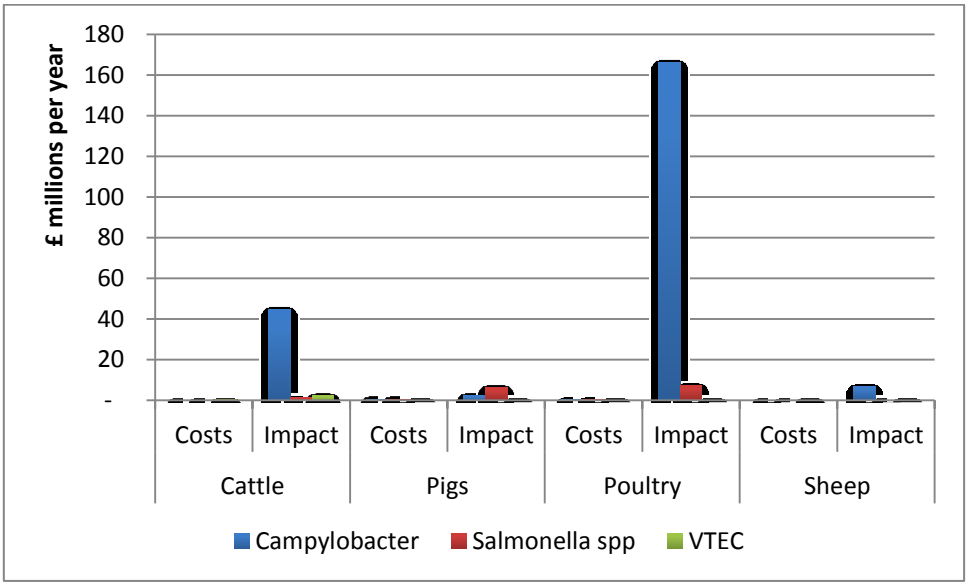
Table 26. The annual costs of the new system compared to the impact of the public health pathogens (£ '000 per year)

Pathogen	Cattle		Pigs		Poultry		Sheep	
	Costs	Impact	Costs	Impact	Costs	Impact	Costs	Impact
Campylobacter	155	44,500	646	2,300	593	166,200	91	7,000
Salmonella spp	155	1,400	646	6,100	593	7,300	-	-
VTEC	232	2,200	-	-	-	-	136	-
Total	541	48,100	1,293	8,400	1,186	173,500	227	7,000

It can be clearly seen that the level of change required to generate a return would only have to be a variation of 1 to 2 percent, hardly an unreasonable expectation and this would generate an immediate return with no need to think about significant capital investment. Therefore in terms of justifying the additional expenditure on the food chain information it would be possible that even minor changes in management of prevention and control would yield sufficient public health benefits to justify the investment.

To emphasise this point the figures presented in the table above are shown graphically below:

Figure 16. Total discounted costs by species



In summary the costs per animal of the changes included in the cost analysis indicate a very limited level of cost increase. Further analysis would also potentially demonstrate a simple shift of resource allocation rather than an overall cost increase. A summary of the costs is shown in the following table:

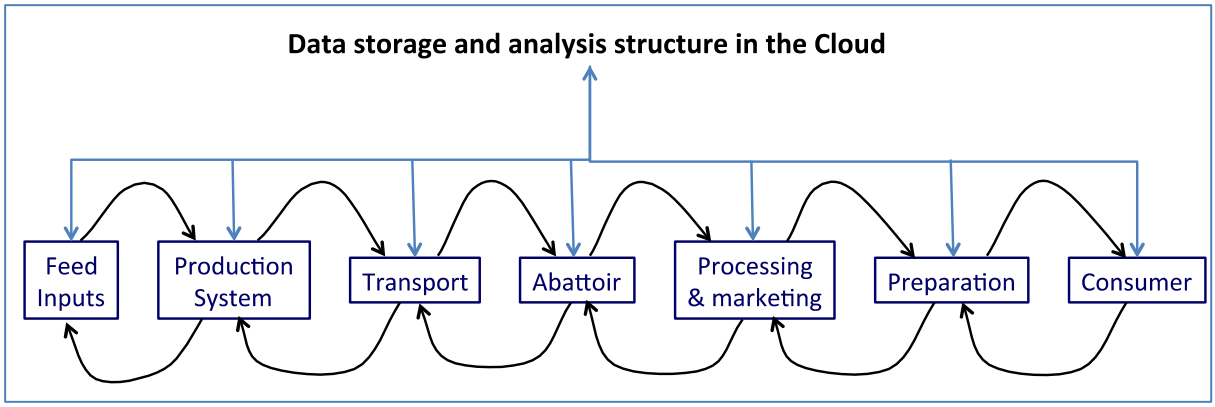
Table 27. The annual costs of the new system (£ '000 per year) and an estimate of the costs per animal slaughtered (£ per animal) and the proportion these costs represent to the public health impacts from these species

Species	Undiscounted costs (£)		Cost per head slaughtered (£/head)	FCI costs as a proportion of public health impact (%)
	5 Years	Annual		
General	3,382,000	676,400		
Cattle	3,583,607	716,721	0.27	1.5
Sheep	2,414,331	482,866	0.03	5.8
Pigs	10,281,823	2,056,365	0.20	28.6
Poultry	9,394,839	1,878,968	0.00	1.1
Total	**29,056,600**	**5,811,320**		**2.5**

10.9. Potential benefits from the improved FCI – the case of production improvements

The system proposed is based on moving towards **consistently collected data** across the production and processing units, and the **flow of these data** into a portal that can facilitate the provision of **useful and specific information** for people making decisions.

Figure 17. Capture of data across the food system.

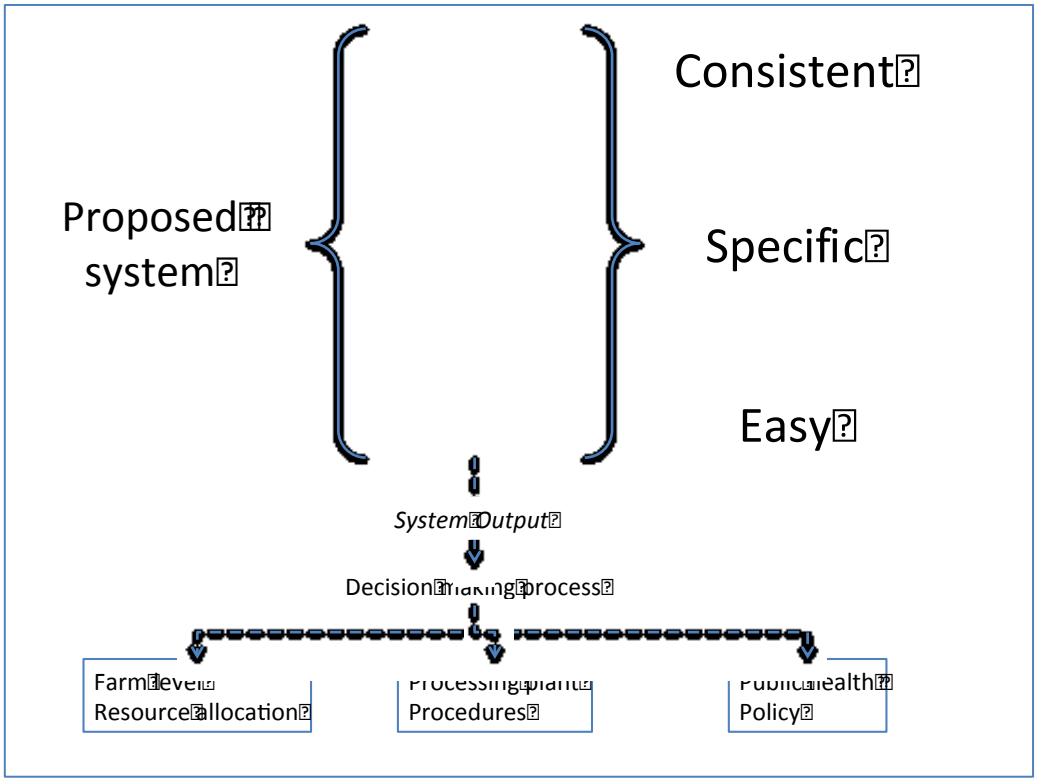


How this information adds value to the decision making process is where the benefits from the system will be generated and these are inherently difficult to predict.

The intention is that the information generated will assist in helping decision makers across the food system. It could simply verify that the management is efficient in their use of resources and generate a non-tangible benefit in terms of peace of mind. It could also indicate that decisions are being made that could be improved through changes in the allocation of resources and management practices – on an individual basis this may bring about change.

The flow of this is show in the diagram below.

Figure 18. Flow of data to information dissemination and decision making processes.



Overall if enough people adopt better practices it could lead to societal benefits of greater efficiency of food production that maintain or even lower prices and greater safety of food leading to benefits due to reduced public health impacts.

The prediction of whether these will occur is not possible until the system is running and generating first a **baseline** to measure against and then the outcomes in terms of the frequency of access to the information generated and how this information is used to modify behaviour.

To illustrate this, an example of a beef system will be provided with some frequently cited data.

10.9.1. Beef system – lung lesions and liver fluke

The data selected for review and improvement from the beef system have focused on lung lesions and liver fluke.

The former is normally a non-specific condition that could be related to the exposure of a range of pathogens some that actually affect the lung tissue, others that affect the immune capacity to respond to general infections. Overall estimates of the impact of lung lesions has been estimated by Potter in 2010 to be £50 million a year, and ADAS in follow up work calculated that on average there was a loss of £82 per calf affected with a strong benefit from control.

For liver fluke there is evidence that there is a reduction in carcass weight and fat coverage of the carcass when slaughter data are examined with thoroughness (Sanchez-Vasquez and Lewis, 2012). Such studies that take into account the breed and sex of the animals demonstrating that 12.5% of cattle slaughtered in the UK between 2005 and 2010 had liver fluke and this affected their performance.

Liver fluke has been estimated to cost the beef industry a significant amount. Of the cull dairy and beef cows a quarter (24.4%) were condemned in 2013 a total of 515,000. This alone has been valued at £1.7 million to the meat trade as this burden is largely borne by the people trading animals, carcass and offal. Others have estimated that this is small in comparison to the farm level impacts which could be between £25-£30 per case of liver fluke due to lower growth rates and higher levels of mortality leading to overall lower levels of feed conversion overall. Very specifically it has been calculated that the disease causes £15.3 million based on a 27 day delay in finishing time, a 10 kg reduction in carcass weight and a carcass conformation score that is half of what is would be in a health animal (ADAS, no date; CHAWG, 2014).

In dairy cattle in Switzerland, the prevalence of infection with Fasciola hepatica has been estimated to be over 16% and that the losses caused are between €22 million to €92 million per annum, which represents a median loss of €299 per infected animal. Most of the losses arise from reduced milk yield and reduced fertility, and smaller losses are due to reduced meat production and the condemnation of livers (Schweizer et al, 2005)

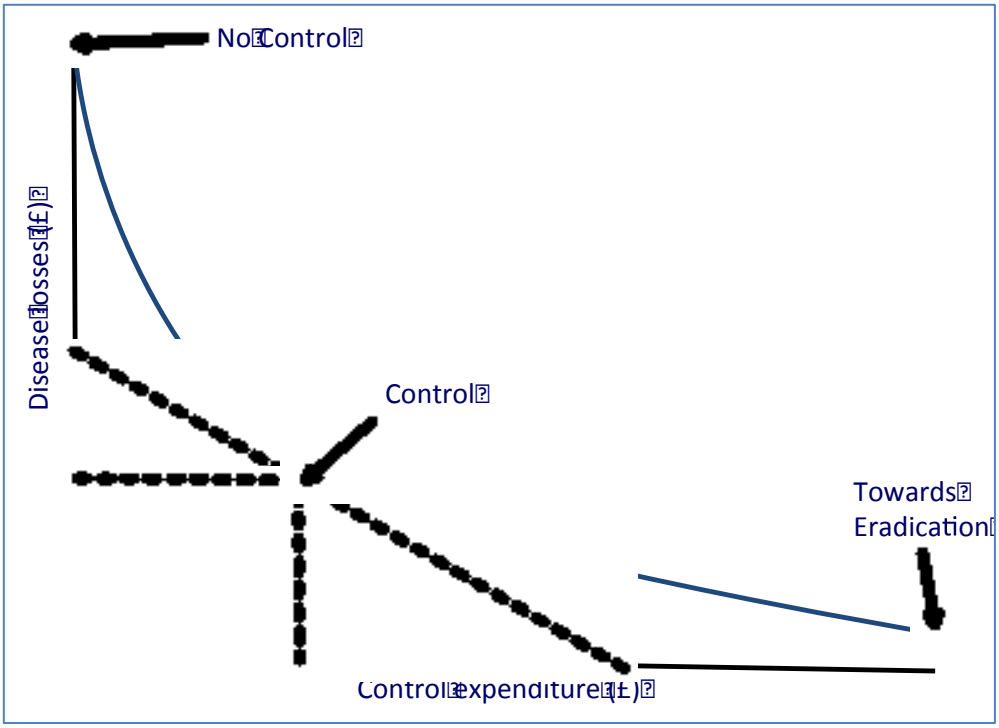
Therefore, fasciola is associated with reductions in weight gain, fertility and milk production (Van Voort et al. 2013). However, prevalence shows regional variation depending on suitable conditions of the intermediate host snail. Infections are mostly subclinical, but clinical presentation can occur in heavily infected animals (mostly sheep). In particular prevalence shows regional variation depending on suitable environmental conditions for the intermediate host snail that thrives in small water bodies on pasture. Herd-level prevalences of 30–80% are commonly encountered across Western Europe. Anthelmintic drug resistance and climatic and environmental changes are thought to lead to increased incidence of disease. (Charlier et al, 2014). Therefore climate change is considered as a threat due to the risk of increasing incidence of fasciolosis. (Van Voort et al., 2013). Yet there is evidence that climate has a significant influence on a number of parasites (van Dijk et al, 2010) therefore any information generated from the food chain requires thoughts of how to link this to the environment and the micro and macro climate in which the animals have been raised. These need to be linked with farm level tools in order to get a benefit (Charlier et al, 2012). The food chain information improvements are a step in the right direction, but they need to be combined with further modeling work to result in farm level benefits and there have been concerns that farmers awareness of the value of these tools can be variable (Charlier et al., 2012).

The assumption from such “impact” studies would be that the proposed new system will provide information on the presence of disease and a health problem, and this will lead to a change which results in an improvement of productivity.

The problem with the information available for both estimating benefit streams and for the specific farmer is that these are averages – it is **non-specific**.

The key piece of data missing in the Sanchez-Vasquez and Lewis (2012) study is the treatment of animals prior to being slaughtered which does not allow the estimate of where a farmer is between the balance of the avoiding loss due to disease and the costs of disease treatment. See the figure below:

Figure 19. Frontier between production loss and control expenditure (adapted from McInerney, 1996)



The relationship between production loss and expenditure is key to decision making. It provides a powerful explanation that while identifying a production loss is a **necessary** part of a decision it is **not sufficient**. Data and information are also needed on the cost and availability of the control options, plus the underlying technical relationship between these cost options and the changes in production loss.

Building such detail would be possible with the proposed system, it will capture consistent and adequate data to begin to populate these relationships and lead to improved conclusions about whether overall current levels of control are optimal for farms and for society in general. This information should **inform policy** on the need for interventions and also identify potential research gaps. In doing so, it will provide **benefits** in the **medium** to **long term**.

Where the new proposed system will generate **benefits** in the **short term** is that it has the potential to bring together:

- Farm-level data on health and husbandry practices
- Slaughterhouse information such as
    - Birth date
    - Slaughter data
    - Breed and sex
    - Carcass weight and conformation
    - Quality of the offal
    - Condemnation
    - General *post-mortem* data

These can be used to assess the performance of the individual farm for its characteristics and compare its performance, not against an average across the UK, but against a **benchmark** of a **similar system** for that **specific** type of production and health management level.

Indications of deviations from the norm could indicate that the farm is doing well – a **peace of mind benefit** (a non-tangible) or that they could do better. The latter should trigger a more thorough investigation with their production and health advisors on where the system could be improved. This again requires an assessment of the technical options for change, the economic profitability of that change and the financial feasibility.

So for example, a farmer who finishes beef animals largely on grass in land areas considered to have little alternative value may reach a conclusion that a liver fluke burden is an acceptable loss given the alternatives of treating and perhaps even draining land to remove snail exposure.

Alternatively a system based on finishing with concentrate feeding and with even a minor level of fluke conditions would probably benefit from better-targeted treatment of animals as they enter the fattening stage.

The benefits will be generated through availability of **specific information** and **targeted** and **tailored interventions**. The processes leading to the interventions will be triggered by the information; they are **NOT** part of the information system.

To capture the benefits from the proposed system would require the frequency with which the current system is being used to tailor management across the food system and how the new system would be anticipated to change and increase this use. At the present there are no data available on this area of information use, simply much anecdotal information and conjecture that the current system is not fit for purpose and therefore not used.

The emphasis of this narrative is to describe where there are benefits – these can be short term in helping farmers and processing plant systems to tailor their individual systems to improve productivity[85], and the medium to long term benefits that should accrue through an improved profile of the sector and that indicate structural issues that require research and programme policy change.

10.9.2. Broiler sector – Campylobacter

There is much ongoing work with the identification of Campylobacter in broiler flocks and how management of the birds can be manipulated to limit infections. Recent reports indicate that biosecurity improvements do make a difference.

Where the improved system of FCI/CCIR begins to make sense for this system is around looking at attribution across the chain and devising actions to both deal with infections and to assign premiums or costs to people who contribute.

It would not be far-fetched to envisage that the system could be used to provide slaughterhouses with information on the Campylobacter status of each batch and that this would then dictate when the birds are slaughtered – logistics and how the carcasses would be treated in the slaughterhouse.

Some companies are known to be experimenting with washing carcasses and also blast freezing – methods that require investments in equipment and variable costs in terms of running on the line. Information on the presence of Campylobacter would both indicate the need for such interventions and also improve mechanisms to pressure the farmers to adopt different biosecurity measures.

Overall these are modest cost issues and the overall impact of this disease in humans (see Table 16 above) would be easily recovered. The FCI/CCIR will assist in ensure that attribution across the food system can be better attained and could be the basis for setting up market structures to recognise positive actions.

10.10. Summary

The proposed changes to the food chain information system are a relatively small in comparison to the numbers of animals slaughtered and the overall impact of the public health and production diseases that the new system would target.

[85] Productivity being the efficiency of the conversion of input to output over a period of time, hence distinct from production which is simply a measure of output

In order to return these costs and add further value to the food systems the new food chain information system will need to be carefully linked to systems that will improve the prevention and control measures at farm, slaughterhouse and processing levels. The proposed training system should allow this to be initiated and it is important that this is properly funded and managed in the future. If this linkage is not maintained then the proposed food chain information system will become as redundant and irrelevant as its predecessor.

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