

**UK publicly funded research relating to risk
assessment and the microbiological safety of food**

Research between 1992 and 2007

**Report from the Microbiological Safety of Food
Funders Group**

October 2008

UK publicly funded research relating to risk assessment and the microbiological safety of food: Research between 1992 and 2007

OVERVIEW

This report is the output of a review by the Microbiological Safety of Food Funders Group (MSFFG) of the publicly funded research relating to risk assessment and the microbiological safety of food supported by its member organisations from 1992 to the end of 2007.

Microbiological risk assessment is increasingly being used as a tool to assess the risks posed to human health from food-associated microbiological hazards. Through a structured approach, a potential microbiological hazard can be identified and characterised, and the level of exposure and risk to humans determined. A quantified approach may enable the objective comparison of, for example, risks associated with different practices or transmission routes, or of new or emerging pathogens.

UK research to support microbiological risk assessment has focused on developing new methodologies, understanding different practices (farm and food handling) and on specific food-borne micro-organisms. Major areas of focus in the period of the report have included *Campylobacter*, *Salmonella* and *Escherichia coli* O157, the practice of spreading farmyard manure onto farm land, specific practices in the handling of poultry and some of the consequences of consumer practice and preferences in relation to food. There is also integration between UK and international research effort in this area, in particular with the EU where significant research to understand and disseminate best practice is supported.

Research to support microbiological risk assessment will continue to be required, in particular to develop a more integrated approach across the entire food supply chain.

LAY OVERVIEW

Microbiological risk assessment of food is the work to understand the risks to human health that may arise as a result of any aspect of food. This includes how animals are managed on farms, food processing practices, how food is stored and how it is cooked. Such risk assessments are useful because they provide the scientific evidence base that is used to support the development of government advice on food safety (for example on safe cooking of meat) which in turn helps to protect public health. They may also be used to provide information which will help food producers to develop good practices.

The research projects recorded in this report help to provide an understanding of what are the best ways of carrying out relevant risk assessments, and also give information on specific topics such as major food-borne pathogens (e.g. *Campylobacter*, *E. coli* O157) of importance to public health.

Table of Contents

| | |
|--|----|
| OVERVIEW | 2 |
| LAY OVERVIEW | 3 |
| 1. INTRODUCTION | 5 |
| 2. METHODS | 6 |
| 3. RESEARCH SUPPORTED BY OTHER FUNDING BODIES | 7 |
| 4. RESEARCH SUPPORTED BY THE MSFFG | 8 |
| 4.1 THE STRUCTURE OF THE REPORT | 8 |
| 4.2 PROJECTS FOCUSED ON RISK ASSESSMENT METHODOLOGY | 8 |
| 4.3 RISK ASSESSMENTS FOR ANIMAL AND FARM PRACTICES | 8 |
| 4.4 ANTIMICROBIAL RESISTANCE..... | 10 |
| 4.5 RISK ASSESSMENTS FOR FOOD AND FOOD HANDLING | 10 |
| 4.6 RISK ASSESSMENT RELATED TO SPECIFIC ORGANISMS..... | 11 |
| 5. GAPS IN CURRENTLY FUNDED RESEARCH..... | 12 |
| 6. CONCLUSIONS..... | 13 |
| GLOSSARY | 14 |
| APPENDIX 1: PROJECTS FROM THE MSFFG DATABASE USED IN THIS REPORT | 16 |

UK publicly funded research relating to risk assessment and the microbiological safety of food

Research between 1992 and 2007

1. INTRODUCTION

1.1 The Microbiological Safety of Food Funders Group (MSFFG) has published a number of reports providing an overview of the research funded by member organisations of the MSFFG relating to various food-borne pathogens including Verocytotoxin-producing *Escherichia coli*¹, *Campylobacter*², *Salmonella*³, *Listeria monocytogenes*⁴, *Yersinia enterocolitica*⁵, food-borne viruses⁶, *Mycobacterium avium* subsp. *paratuberculosis*⁷, *Brucella*⁸ and *Clostridium*⁹ as well as on specific topics: Farm and Abattoir Waste¹⁰ and Antibiotic Resistance in Relation to the Safety of Food¹¹. Copies of all these reports can be found at both the FSA (addresses given below) and MSFFG web sites (www.msffg.org.uk).

1.2 Risk assessment, risk management and risk communication, are three components of microbiological risk analysis. This is the overall structured process of considering the risks posed to human health by microbiological hazards, and is an important tool in addressing issues of public health protection. Risk assessment is usually the first stage of this process, in which a potential microbiological hazard is identified, characterised, the potential human exposure is assessed and then the risk to humans (a combination of the first three) is determined. Risk assessment is usually separated from the process of risk management so as to ensure that the former is unbiased by considerations of policy and practice and the implications of their implementation.

1.3 Microbiological risk assessment provides a recognised tool for identifying and quantifying the risks to humans associated with food-borne microorganisms in a variety of different situations. It enables an objective comparison to be made of the impact of different routes of transmission of the same organism, or of particular practices, or of new or emerging pathogens. For example, in its Risk Assessment Research Programme¹² the FSA identified a number of specific

¹ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/vtec>

² <http://www.food.gov.uk/science/research/researchinfo/foodborneillness/microfunders/msffg/campylobacterupdate/>

³ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/campylobacter>

⁴ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/msffg/55669>

⁵ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/listeria>

⁶ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/yersinia>

⁷ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/msffg/msffgfbv2005>

⁸ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/msffgmapreport>

⁹ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/mffsgbrucellareport>

¹⁰ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/mffsgclostridium>

¹¹ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/mffsgfarmabattoirreport>

¹² <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/mffsgmicrobialantiresist>

12

objectives for risk assessment, achievement of which would lead to increased understanding of risks associated with particular food-borne microbiological hazards. This in turn could contribute to policy development and changes in relevant practices.

- 1.4 In the Codex Alimentarius¹³, it is emphasised that microbiological risk assessment should consider many aspects of a food-borne micro-organism that could contribute to the risk to human health. These include the dynamics of the growth, survival and death of the organism in foods and the complexity of interaction between it and the human host following consumption, as well as the potential for further spread from the infected individual. It is also recognised that research related to microbiological risk assessment may have to be revised in the light of new information and increased understanding, for example of the host: pathogen interaction, or the nature of a transmission route. These underlying principles, accompanied by that of the separation between risk assessment and risk management, significantly influence the research supported by MSFFG member organisations in the area of risk assessment. Recorded in the MSFFG database are a variety of projects specifically focused on risk assessment, some of which are in effect historic and have been superseded by increased and subsequent knowledge. There are also many projects that are aligned to the general area of risk assessment, for example intending to eventually provide data for risk assessment, but which do not address the methodology, specific data gathering or actual development of microbiological risk assessment. The structure of this report reflects these different research inputs.
- 1.5 Finally, the MSFFG has published reports providing an overview of the research supported for most of the micro-organisms that are associated with foodborne disease, as well as major topics of importance to human foodborne disease (see paragraph 1.1). Research into all of these organisms includes some element of risk assessment. This report should therefore be read in conjunction with these other reports.

2. METHODS

- 2.1 This report is based on those research projects that are funded by the member organisations of the MSFFG. These were the Food Standards Agency (FSA), the Department for Environment, Food and Rural Affairs (Defra), the Biotechnology and Biological Sciences Research Council (BBSRC), the Department of Health (DH), the Department of Agriculture and Rural Development, Northern Ireland (DARD), the Environment Agency, the Food Safety Promotion Board (FSPB), FSA Scotland, FSA Wales, FSA Northern Ireland, the Health Protection Agency (HPA), the Medical Research Council (MRC), the Scottish

¹³ http://www.codexalimentarius.net/web/index_en.jsp;
http://www.codexalimentarius.net/web/more_info.jsp?id_sta=357

Government Rural and Environment Research and Analysis Directorate (RERAD) and Scottish Government Health and Wellbeing Executive. In addition, projects from the Med-Vet-Net programme, supported by the HPA and other UK funders as well as the EU have been included in the database for the purposes of this report.

- 2.2 The MSFFG project [database](#)¹⁴ was used to identify projects for inclusion in this report. The database was searched using the term 'risk assessment'. Further projects were identified using a variety of terms, and projects relevant to the focus of the report were selected for inclusion, leading to a total of 58 separate projects for this report.
- 2.3 Studentships have been omitted from consideration unless the research is likely to make a significant contribution to the field.
- 2.4 Research funded by other agencies, including the [Wellcome Trust](#), [Royal Society](#) and [NHS Scotland](#) as well as international research is not included within the body of the report.

3. RESEARCH SUPPORTED BY OTHER FUNDING BODIES

- 3.1 Following a World Health Assembly food safety resolution in 2000 and a request from the Codex Alimentarius Commission, the WHO and FAO began a programme of risk assessments work for the Codex Committee on Food Hygiene and member countries. The Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA) have provided risk assessments for selected pathogen/food combinations including *Salmonella* spp. in broilers/eggs, *Listeria monocytogenes* in ready-to-eat foods, *Vibrio vulnificus* in oysters and *Enterbacter sakazakii* in powdered infant formula. Details are at <http://www.who.int/foodsafety/micro/jemra/assessment/en/index.html>.
- 3.2 In Europe, the European Food Safety Authority (EFSA) commissions work in relation to microbiological risk assessment and further details can be found on their website at http://www.efsa.europa.eu/EFSA/efsa_locale1178620753812_home.htm

¹⁴ The MSFFG maintains a database containing information about research projects in the area of the microbiological safety of food that are funded by the members of the MSFFG. Members of the Group provide the project information from their respective project record systems (www.msffg.org.uk). The earliest projects within the database were initiated in 1990. Some historic project data from member organisations joining the MSFFG in 2005 (eg the EA, HPA, MLC, MRC) may be unavailable to the database. It should be noted that whilst it is the intention of the MSFFG members that the database should include all relevant projects funded by the member organisations, this cannot be guaranteed.

4. RESEARCH SUPPORTED BY THE MSFFG

4.1 The structure of the report

4.1.1 As indicated above, there are a wide variety of projects addressing, or indicating that they will address, risk assessment and the generation of data for risk assessment. In recognition of this, the projects are grouped under a number of headings, reflecting the particular focus of the projects.

4.2 Projects focused on risk assessment methodology

4.2.1 Although much research on microbial risk assessment is focused on specific situations, such as farming practices or types of food, or particular micro-organisms or hosts, there is a body of research that addresses common underpinning issues, such as the development of generic mathematical models, or efforts to harmonise different research approaches. MSFFG member organisations have supported research in a variety of such areas. In particular, there have been several research projects aimed at developing methodologies for handling the limited and uncertain data available in microbiological risk assessment. Research has included probabilistic approaches involving Bayesian Belief networks and Monte Carlo methods (**BBSRC BBSEF00041214**), new methods for quantification of uncertainties and improved understanding of the complexities of risk assessment (**BBSRC BBS/E/F/00042210**) and the development of methodologies to assist in the modelling of all aspects of the complex interactions in the food chain (**BBSRC 0455**). The impact of uncertainty in data as modelled in risk assessment relating to different stakeholders in the food chain (eg producers, users) has also been examined (**ESRC RES-224-25-0090**). Research in this last project also seeks to set microbiological risk assessment into a broader context, and there have been similar efforts to integrate microbiological risk assessment with issues such as epidemiology and economics within the EU (**MVN MVN-WP13**).

4.2.2 At a number of levels, there is research to understand different approaches to microbiological risk assessment, and to bring together best practice from different contexts. For example, practices in different UK organisations have been evaluated with a view to harmonising approaches in different areas including microbiological risk assessment (**Defra OZ0322**), and the possibility of using the US Food and Safety Inspection Service risk assessment model for *Salmonella* in eggs has been considered, with the conclusion that it was not appropriate (**FSA B01017**). Network approaches have also been considered (**FSA B06001**).

4.3 Risk assessments for animal and farm practices

- 4.3.1 Microbiological risk assessment is an important tool in examining animal husbandry and farming practices in order to identify those that will most appropriately reduce the risks of transmission of food-borne disease to humans. MSFFG member organisations have supported research to develop risk assessments in the farm environment (**Defra VF0201**) and in the link to the abattoir (**EU MedVetNet MVN-WP14**), both aimed at understanding and assessing risks that affect the food chain for different animals. A particular concern has been the risks of using imported feeds and research has addressed this, with a particular focus on VTEC and other *E. coli* strains (**Defra OZ0701**).
- 4.3.2 Much data for risk assessment is generated through projects with a different focus. However, risk assessment research has been supported in relation to poultry in order to understand how better to manage *Campylobacter* infections and transmission during broiler production (**Defra OZ0608, OZ0613**) and in particular during the process of thinning (**FSA B15004**). It is important to assess the risks across the entire poultry meat production process, from farm to raw meat and a major literature survey of this topic has been undertaken (**FSA B03005**), which also considered both *Campylobacter* and *Salmonella*. A further concern is transmission of *Campylobacter* from non-chicken poultry, including comparison of the transmission routes from different types of poultry (**FSA B15019**) and consideration of the risks through the entire farm to fork chain (**Defra OZ0608**). The Veterinary Laboratories Agency has an overall risk assessment model for *Campylobacter* and research is in hand to develop data on the prevalence of the bacteria in chicken carcasses at slaughter so as to expand the model (**Defra OZ0613**).
- 4.3.3 Just as *Campylobacter* is a particular concern with poultry, there is risk assessment research for VTEC and other *E. coli* strains with cattle, (**Defra OZ0707, OZ0709, OZ0701**) and for *Salmonella* in pig farming (**Defra OZ0323**) where the focus was on developing an understanding of the risks of transmission of the bacterium to humans through pork all the way through the food-chain.
- 4.3.4 The farm practice that has been subject to the most extensive level of risk assessment research is that of the spreading of farm wastes on farmland. This long-standing practice has been subject of significant research effort, and the MSFFG has published a report addressing the body of research in this area (*UK publicly funded research relating to Farm and Abattoir Waste*¹⁵). Specific projects of relevance to this report include those examining the transmission of VTEC and other *E. coli* (**Defra OZ0709**), pathogen survival (**FSA B05003**), the transmission of antimicrobial resistance genes (**Defra OD2008**) and general assessment of the risks associated with spreading farm wastes on agricultural land (**FSA B17002**). There are concerns that the outcome of such risk assessment research may be to identify optimal

¹⁵ <http://www.food.gov.uk/science/research/researchinfo/food-borneillness/microfunders/mffsgfarmabattoirreport>

contamination from poultry packaging in retail stores (**FSA B03002**) and handling and cooking of chicken meat in the home and catering environments, in particular the risks of undercooking such meat (**FSA B01015**). Separate risk assessment research addresses the subject of the risk of *Salmonella* infections associated with the consumption of eggs (**FSPB 845**, **FSA B01017**, **HPA 2002029**).

- 4.5.3 Information for risk assessment development in relation to *Salmonella* in and on eggs has been gathered (**HPA 2002029** , **FSPB 845**) and consideration given to whether the US risk assessment model for *Salmonella* Enteritidis in eggs was appropriate for the UK (**FSA B01017**). On this last point, the conclusion was that the model did not adequately address some issues of concern in the UK.
- 4.5.4 The impact of the EU proposals on inspection of premises licensed to sell game was evaluated with a view to determining the impact on microbiological risk, with the conclusions that some of the proposals would be effective (**FSA M01025**).
- 4.5.5 Consumer preference is driving a change in the way in which food is processed and preserved, both of which may lead to an increase in the risk of food-borne microbial infection in humans. Considering minimally processed foods, the focus has been on acquiring data and developing risk assessments so as to understand factors that will increase the risks contamination in particular with *Clostridium botulinum* (**BBSRC 4347197**, **BBSEF04341058**, **BBSEF00052311**, **FSA B13006**). Contamination of dairy deserts by spore-forming bacteria is also a concern, and quantitative risk assessment of dairy-based custard deserts has been undertaken (**BBSRC BBSEF00052060**).
- 4.5.6 Given the high mortality associated with listeriosis, research has been undertaken to assess the risk of *Listeria monocytogenes* being transmitted to humans through cheese (**FSA B12006**) and cooked meat and poultry (**FSA B01020**).
- 4.5.7 A product of particular concern is powdered infant formula, and whilst the principle concern is of how this is prepared and stored, data are being gathered on consumer behaviour and practices so as to undertake microbiological risk assessment and enable development of best practices (**FSA B13008**, **B13010**).

4.6 Risk Assessment related to specific organisms

- 4.6.1 The gathering of data for risk assessment is an integral component of the study of micro-organisms involved in food-borne disease, and much of the relevant research is addressed in the MSFFG reports for each specific organism referenced earlier. However, there are a number of research projects that specifically address risk assessment and are not included in current reports.

- 4.6.2 Risk assessments for *Campylobacter* have or are being developed in many countries, and there is an effort to identify the best approaches for risk assessment for *Campylobacter* in different situations (**MedVetNet MVN-WP24**).
- 4.6.3 *Cryptosporidium* is a protozoan parasite that causes a few thousand reports of gastrointestinal illness in the UK every year¹⁸, and transmission can be through a variety of routes including consumption of contaminated food. There has been research to investigate the routes of transmission of the protozoan to humans, including risk assessment of the transmission to humans from animals (**Defra OZ0407**) and in particular farm animals (**Defra OZ0402**).
- 4.6.4 There is some concern in Europe about the occurrence of *Trichinella* infections and the possibility that the source was pigs. Research in this area has included development of risk assessment for *Trichinella* in pigs and pork and transmission to humans (**MedVetNet MVN-WP11, MVN-WP27**).

5. GAPS IN CURRENTLY FUNDED RESEARCH

- 5.1 There are a number of areas where it is recognised there are gaps in risk assessment research as applied to the microbiological safety of food. Perhaps most important is the need to ensure that data used for risk assessments is of high quality. This is not always the case, and it may be that further research is needed to develop high quality data sets for use in developing relevant risk assessments. Similarly, the quality and acceptability of risk assessment methodologies is crucially important and additional research is needed to increase universal confidence and hence method acceptance and use. Interdisciplinary research will bring benefits to this, as will the development of methodologies for the mathematics of risk assessment.
- 5.2 Risk assessments tend to address specific issues, and are not always used to develop an overview of the risks associated with an entire process or food chain. Methodologies for integrating focused risk assessments are needed, so that a wider assessment of microbiological risks associated with food throughout different food chains can be developed.
- 5.3 Aspects of the microbiological safety of food where specific risk assessment may be valuable include issues around salad vegetables and leaves, including involvement and reduction of biofilms, and the impact of changes in consumer preferences such as reduced cooking time and serving temperature. Further research is also needed on consumer behaviour, attitudes and practices, in particular in the

¹⁸ http://www.hpa.org.uk/infections/topics_az/crypto/menu.htm

domestic kitchen.

6. CONCLUSIONS

- 6.1 Research to support the development of risk assessments for the microbiological safety of food has focused on the development of methodologies and on the major components of the food supply chain: farms, farm practices and food handling. Valuable input to the assessment of risks associated with particular practices (for example, spreading of farmyard manure, thinning of poultry) has been gained from this work. Further benefits will be achieved in the future as individual assessments can be brought together to provide a holistic view of microbiological risk across the food supply chain.
- 6.2 Whilst a component of other research programmes, there is also research to develop risk assessments for the impact of the significant food-borne pathogens such as *Campylobacter* and *E. coli* O157. Some of this research has provided important input to policy development and public advice as understanding of food-borne microbiological risks developed during recent years.
- 6.3 Research to support risk assessments for the microbiological safety of food will continue to be required, in particular focusing on developing significant overviews of the wider food supply and addressing changes in consumer preferences and practices as well as farming practices.

GLOSSARY

Campylobacter

A curved Gram-negative, non-sporing bacterium. There are two principal species that cause human disease, *Campylobacter jejuni* and *Campylobacter coli*. *Campylobacter* is the most commonly reported bacterial cause of infectious intestinal disease in England and Wales in humans.

Escherichia coli

A Gram-negative non spore-forming bacterium commonly found in the intestinal tracts of humans and other warm-blooded animals. *E. coli* is widely used in biology, both as a simple model of cell biochemical function and as a host for molecular cloning experiments. In environmental studies, it is a key indicator of water pollution due to human sewage effluent.

***E. coli* O157**

A serotype of *E. coli* associated with serious gastrointestinal disease in humans.

Listeria monocytogenes

Listeria spp. are Gram-positive non-sporing bacteria which have been known to cause human disease for many years. They are ubiquitous in the environment and found world-wide. *Listeria monocytogenes* is the species of *Listeria* most commonly found associated with human disease.

Quantitative Risk Assessment

A Risk Assessment that provides numerical expressions of risk and indication of the attendant uncertainties (stated in the 1995 Expert Consultation definition on Risk Analysis).

Qualitative Risk Assessment

A Risk Assessment based on data which, while forming an inadequate basis for numerical risk estimations, nonetheless, when conditioned by prior expert knowledge and identification of attendant uncertainties permits risk ranking or separation into descriptive categories of risk.

Risk

A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

Risk Analysis

A process consisting of three components: risk assessment, risk management and risk communication.

Risk Assessment

A scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterization, (iii) exposure assessment, and (iv) risk

characterization.

Risk Characterization

The process of determining the qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterization and exposure assessment.

Risk

Communication

The interactive exchange of information and opinions concerning risk and risk management among risk assessors, risk managers, consumers and other interested parties.

Risk Estimate

Output of Risk Characterization.

Risk Management

The process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options, including regulatory measures.

Salmonella

A ubiquitous Gram negative bacterium which causes food poisoning in humans.

APPENDIX 1: PROJECTS FROM THE MSFFG DATABASE USED IN THIS REPORT

| Project Code | Title | Funder | Contractors | Start Date | End Date |
|-------------------------|--|--------|----------------------------------|------------|----------|
| 02200749 | Germination & outgrowth of spores of non-proteolytic & proteolytic <i>Clostridium botulinum</i> | BBSRC | | Apr-95 | Mar-98 |
| 0455 | Systems analysis for risk assessment | BBSRC | Silsoe Research Institute | Apr-01 | Mar-04 |
| 4347197 | Research on factors allowing a risk assessment of spore- forming pathogenic bacteria in cooked chilled foods containing vegetables (RASP) | BBSRC | Institute of Food Research (IFR) | Oct-97 | Sep-00 |
| BBS/E/F/00042210 | Research supporting quantitative risk assessments for complex food borne hazards | BBSRC | | Apr-05 | Apr-07 |
| BBS/E/F/00042264 | Understanding and improving prediction of the behaviour of <i>Clostridium botulinum</i> | BBSRC | Institute of Food Research (IFR) | Apr-05 | Apr-07 |
| BBSEF00041214 | Quantitative risk assessment for microbiological food safety | BBSRC | Institute of Food Research (IFR) | Apr-00 | Mar-05 |
| BBSEF00052060 | Quantitative risk assessment for hazards that arise from non proteolytic <i>C. botulinum</i> in dairy-based desserts: Custard | BBSRC | Institute of Food Research (IFR) | Aug-05 | Feb-06 |
| BBSEF00052088 | Microbial risks associated with salt reduction in foods and alternative options for preservation | BBSRC | IFR | Feb-05 | Jun-05 |
| BBSEF04341058 | Behaviour and prediction of microbial pathogens in food | BBSRC | Institute of Food Research (IFR) | Apr-99 | Mar-00 |
| 0030 41913 | Investigation of the incidence and persistence of <i>Mycobacterium avium</i> subsp. paratuberculosis (MAP) in food and its possible role in Crohn's disease | DARD | Queens University Belfast | Aug-00 | Aug-03 |
| OD2006 | Investigation of persistence of antimicrobial resistant organisms in livestock production | Defra | Veterinary Laboratories Agency | Oct-00 | Sep-05 |
| OD2008 | Transfer of antimicrobial resistance genes between bacteria in stored and spread farm wastes | Defra | Veterinary Laboratories Agency | Sep-00 | Aug-03 |
| OD2023 | Potential risk to human and animal health from the emergence and spread of beta-lactamase resistance in animals in GB | Defra | Veterinary Laboratories Agency | Feb-07 | Jan-10 |
| OD2025 | Antimicrobial use and carriage of antimicrobial-resistant <i>Escherichia coli</i> and staphylococci in dogs and horses in the community: molecular mechanisms of resistance and risk to humans | Defra | University of Liverpool | May-07 | Apr-10 |

| Project Code | Title | Funder | Contractors | Start Date | End Date |
|------------------------|---|----------------|--|------------|----------|
| OD2026 | The clinical treatment of pet dogs and antibiotic resistance in commensal and potentially pathogenic bacteria | Defra | University of Bristol | Jun-07 | May-10 |
| OZ0322 | An evaluation of current animal and human <i>Salmonella</i> research, harmonisation of diagnostic techniques and introduction of novel research tools | Defra | Veterinary Laboratories Agency | May-05 | Apr-06 |
| OZ0323 | An integrated risk based approach to the control of <i>Salmonella</i> in UK pig farms | Defra | Veterinary Laboratories Agency | Apr-05 | Oct-08 |
| OZ0402 | What is the Potential for Human Isolates of Both Genotypes of <i>C.parvum</i> to Infect, Colonise and be Excreted by Farm Animals | Defra | Veterinary Laboratories Agency | Apr-00 | Mar-03 |
| OZ0407 | Evaluation And Risk Assessment Of Zoonotic Transmission Of <i>Cryptosporidium</i> | Defra | Veterinary Laboratories Agency | Apr-03 | Apr-07 |
| OZ0608 | Epidemiological studies and development of practical control measures for <i>Campylobacter</i> in broiler flocks | Defra | Veterinary Laboratories Agency | Jul-02 | Jun-06 |
| OZ0613 | Towards risk-based control of Campylobacter: developing the evidence base using epidemiological and bacteriological approaches | Defra | Veterinary Laboratories Agency | Jan-06 | Mar-10 |
| OZ0701 | An Assessment of the Risks to the U.K Livestock Industry from Animal Feed and Ingredients Contaminated with <i>E.coli</i> and other VTEC strains. | Defra | ADAS | Oct-98 | Mar-99 |
| OZ0707 | Identification of Factors Mediating Colonisation of Cattle by Enterohaemorrhagic <i>Escherichia coli</i> . | Defra | Institute for Animal Health | Oct-99 | Apr-07 |
| OZ0709 | Epidemiology of VTEC O157 and other VTECs likely to be pathogenic to man in farm wastes | Defra | Veterinary Laboratories Agency | Apr-02 | Mar-05 |
| VF0201 | Defra - Veterinary Research Fellowship in Epidemiology | Defra | University of Liverpool | Sep-99 | Aug-04 |
| RES-224-25-0090 | Integration of Social, Natural Sciences to Develop Improved Tools: Assessing and Managing Food Chain Risks | ESRC | University of Surrey | Feb-05 | Jan-08 |
| MVN-WP11 | A European network for risk assessment, detection and control of trichinellosis (TRICHINET) | EU MED-VET-NET | The French Food Safety Agency (Afssa), France | Sep-04 | Feb-06 |
| MVN-WP13 | Integrating risk assessment, epidemiology and economics to support decision making in food safety | EU MED-VET-NET | National Institute for Public Health and the Environment (RIVM), | Mar-06 | |

| Project Code | Title | Funder | Contractors | Start Date | End Date |
|-----------------|---|----------------|--|------------|----------|
| | | | The Netherlands | | |
| MVN-WP14 | Pre-harvest Microbiological Risk Assessment | EU MED-VET-NET | Danish Institute for Food and Veterinary Research, Denmark (DTU) | | |
| MVN-WP24 | Comparison of <i>Campylobacter</i> risk assessment models: Towards a European consensus model? | EU MED-VET-NET | National Institute for Public Health and the Environment (RIVM), The Netherlands | Mar-06 | |
| MVN-WP27 | Harmonisation of <i>Trichinella</i> infection control methods, quantitative risk assessment in pigs and an early diagnosis in humans to increase treatment efficacy | EU MED-VET-NET | The French Food Safety Agency (Afssa), France | Mar-06 | |
| B01015 | Determine exposure assessment & modelling risks associated with the preparation of poultry, catering & home | FSA | University of Wales - Cardiff | Jun-99 | Jun-01 |
| B01017 | Evaluation of the US FSIS <i>Salmonella enteritidis</i> Risk Assessment Model | FSA | HVR Consulting Services Ltd | Nov-99 | Aug-00 |
| B01019 | Development of a risk assessment model for the different pathways of infection of VTEC 0157 | FSA | Water Research Centre | Apr-01 | Mar-04 |
| B01020 | A microbiological risk assessment of <i>Listeria monocytogenes</i> in cooked meat and poultry | FSA | Campden and Chorleywood Food Research Association | May-01 | Dec-04 |
| B02001 | Thermal death of pathogenic microorganisms in real foods | FSA | Institute of Food Research (IFR) | May-97 | Apr-00 |
| B03002 | Risk factors of cross infection by <i>Salmonella</i> spp from fresh poultry packaging in retail stores | FSA | Campden and Chorleywood Food Research Association | Sep-98 | Nov-99 |
| B03005 | A Review of Measures to Reduce Levels of <i>Salmonella</i> and <i>Campylobacter</i> in Poultry and Development of an Appropriate Risk Assessment Model | FSA | ADAS, Silsoe Research Institute, University of Nottingham | Sep-98 | Aug-99 |
| B03006 | Review of measures to reduce levels of <i>Salmonella</i> and <i>Campylobacter</i> in poultry & development of an appropriate risk assessment model | FSA | University of Nottingham | Sep-98 | Aug-99 |

| Project Code | Title | Funder | Contractors | Start Date | End Date |
|---------------|---|-------------|----------------------------------|------------|-----------|
| B03007 | Review of measures to reduce levels of <i>Salmonella</i> and <i>Campylobacter</i> in poultry & development of an appropriate risk assessment model | FSA | Silsoe Research Institute | Sep-98 | Aug-99 |
| B05003 | Pathogens in organic wastes: their levels and survival both during storage and following application to agricultural land | FSA | ADAS | Jul-99 | Dec-02 |
| B05008 | The levels of pathogens in abattoir wastes | FSA | University of Bristol | Nov-99 | Feb-02 |
| B06001 | Risk Assessment for Microbial contamination Hazards: A Network Approach | FSA | Institute of Food Research (IFR) | Apr-96 | Jun-00 |
| B10004 | Assessment of, relative to other pathways, the contribution made by the food chain to the problem of quinolone resistance in microorganisms causing human infections | FSA | Veterinary Laboratories Agency | Apr-02 | Mar-05 |
| B12001 | Microbiological Risk Assessment for <i>Norovirus</i> infection - Contribution to the overall burden afforded by food-borne infections | FSA | CAMR | Aug-02 | Jan-04 |
| B12006 | Risk assessment of <i>Listeria monocytogenes</i> in UK retail cheese | FSA | Food Safety Assurance | May-05 | Apr-06 |
| B13008 | An investigation into the attitudes and behaviours of consumers and caregivers in the preparation, handling, storage and feeding of powdered infant formula inside and outside the home | FSA | University of Wales - Cardiff | May-07 | Apr-09 |
| B13010 | Bacteriocidal preparation of powdered infant milk formulae | FSA | Nottingham Trent University | Apr-07 | Sep-08 |
| B15004 | Measures and Best Practice to Minimise Infection of Remaining Birds with <i>Campylobacter</i> when Broiler Flocks are Thinned. | FSA | University of Birmingham | Jan-04 | Jan-06 |
| B15019 | Review of current information on campylobacter in poultry other than chicken and how this may contribute to human cases | FSA | ADAS | Aug-06 | 28-Feb-07 |
| B17002 | Assessment of the risks to food safety associated with spreading of animal manure and abattoir waste on agricultural land | FSA | Water Research Centre | May-01 | Apr-02 |
| M01004 | Microbiological Contamination of poultry carcasses, control measures and scope for risk assessment modelling | FSA | Silsoe Research Institute | Jul-98 | Mar-99 |
| M01025 | An evaluation of the effect of EU proposals to inspect licensed premises on the marketing of wild game: a qualitative risk assessment. | FSA | Veterinary Laboratories Agency | Dec-02 | Apr-03 |
| S14005 | Prevalence and concentration of <i>Escherichia coli</i> serotype O157 and other VTEC in sheep presented for slaughter in Scotland | FSA | Scottish Agricultural College | Jul-05 | Sep-06 |
| 845 | Development of a risk assessment for <i>Salmonella</i> in shell eggs and | FSPB - Food | | Oct-04 | 30-Sep- |

| Project Code | Title | Funder | Contractors | Start Date | End Date |
|-------------------|---|-----------------------------|--------------------------------|------------|----------|
| | processed eggs in Ireland | Safety Promotion Board (NI) | | | 07 |
| 2002029 | Genetic characterisation of the mechanism of multiplication of the <i>Salmonella enteritidis</i> in eggs | Health Protection Agency | Health Protection Agency (HPA) | Oct-01 | Feb-07 |
| RELU-04 | Sustainable and Safe Recycling of Livestock Waste | Research Councils UK RELU | IGER | Feb-05 | Jan-08 |
| uab/007/99 | Survival and dispersal of <i>E. coli</i> O157 in Scottish agricultural soils, and potential for the contamination of private water supplies | SEERAD | University of Aberdeen | Apr-99 | Mar-02 |
| P2-161 | Sewage Sludge : Pathogens SL/06 | The Environment Agency | Water Research Centre | Jan-00 | Dec-02 |
| | | | | | |